NEPAL ELECTRICITY AUTHORITY

(An Undertaking of Government of Nepal)
Project Management Directorate

KOHALPUR-NEPALGUNJ 132 KV TRANSMISSION LINE PROJECT

(A Component of Electricity Grid Modernization Project-Additional Financing)

BIDDING DOCUMENT
FOR

Procurement of Plant for

Design, Supply, Installation, Testing and Commissioning of 132 kV Double Circuit Transmission Line and Associated Air Insulated Substation at Bakaspur, Janaki Rural Municipality, Banke District (Package A-3)

Single-Stage, Two-Envelope
Bidding Procedure

Issued on:	**10 August, 2022**
Invitation for Bids No.:	**PMD/EGMPAF/KNTLP–079/80 – 01**
OCB No.:	**PMD/EGMPAF/KNTLP–079/80 – 01**
Employer:	**Nepal Electricity Authority**
Country:	**Nepal**

VOLUME – II(A) OF III
Employer's Requirement: Transmission Line

August 2022

Kohalpur-Nepalgunj 132 kV Transmission Line Project
Project Management Directorate
NEA Project Management Directorate
Matatirtha, Kathmandu, Nepal
Telephone: +977-9851155752

Preface

This Bidding Document for Procurement of Plant – Design, Supply, and Installation has been prepared by Nepal Electricity Authority and is based on the Standard Bidding Document for Procurement of Plant – Design, Supply, and Installation (SBD Plant) issued by the Asian Development Bank dated December 2021.

ADB's SBD Plant has the structure and the provisions of the Master Procurement Document entitled "Procurement of Plant – Design, Supply, and Installation", prepared by multilateral development banks and other public international financial institutions except where ADB-specific considerations have required a change.

Table of Contents - Summary Description

VOLUME – II-A OF III

CHAPTER - 1

Project Specific Requirement (PSR)

CHAPTER 1

PROJECT SPECIFIC REQUIREMENT

1. General Information and Scope

Kohalpur-Nepalgunj 132 kV Transmission Line Project consist of construction of 132 kV double circuit transmission line Loop-In Loop-Out (LILO) through four circuit tower from Kohalpur to Nepalgunj. Volume II-A of bidding documents covers the technical requirement for construction of approximately 10km long, 132 kV transmission line starting from tapping tower located at Bankatuwa, Baijanath Rural Municipality-5 of Banke District and ending at Nepalgunj substation located at Bakaspur Village, Janaki Rural Municipality -5 of Banke District. The proposed 132 kV Transmission line traverses through plain landscape of Banke district of Nepal. The variations of altitudes of the proposed 132 kV transmission line ranges from approximately 146.13 m to 158.1 m above MSL.

*Design, engineering, drawing and construction of works shall satisfy the general technical requirements specified in the Specification or **implied as per relevant IEC/IEEE/ IS/ASTM/British standard codes (B S Codes)/ equivalent International Standards**.*

1.1 Scope

1.1.1 The following 132 kV transmission line associated with Project Management Directorate **for Execution of 132 kV D/C Kohalpur-Nepalgunj Transmission Line** are included in the scope of the contractor for this package: -

	Line Length (approx.)
Kohalpur-Nepalgunj 132 kV D/C Transmission Line	- 10 km

1.1.2 This Specification covers the following scope of works:

(i) Check survey; tower spotting, optimization of tower locations, soil resistivity measurement, geo-technical investigation.

(ii) Fabrication and supply of all type 132 kV transmission line towers, including River crossing towers (wherever applicable) as per Employer design/drawings including fasteners, step bolts, hangers, D-shackles etc.

(iii) All types of tower accessories like phase plate, circuit plate (where ever applicable), number plate, danger plate, anti-climbing device, Bird guard (where ever applicable).

(iv) Supply of Conductor, Insulator, OPGW, Hardware Fittings and Conductor & OPGW Accessories.

(v) Classification of foundation for different type of tower, design drawings of foundation casting of foundation (including special foundation locations, viz. pile/well foundation locations) for tower footings as per approved foundations drawing

(vi) Erection of towers, tack welding of bolts and nuts including supply and application of zinc rich primer & two coats of enamel paint, tower earthing, fixing of insulator strings, stringing of conductors and earth wires along with all necessary line accessories.

(vii) Painting of towers & supply and erection of span markers, obstruction lights (wherever applicable) for aviation requirements (as required).

(viii) Testing and commissioning of the erected transmission lines and

(ix) Other items not specifically mentioned in this Specification and / or BPS but are required for the successful commissioning of the transmission line, unless specifically excluded in the Specification.

1.1.2.1 Employer shall provide structural drawings, shop drawings (if required) & Bill of Materials of all type of transmission line towers and its extensions, river crossing towers/special towers as required to the Successful Contractor after placement of award, in sequence, suiting the project requirement. However, design drawings for all type of foundations for the towers shall be designed by the Contractor and submit to Employer for approval.

1.1.2.2 (a) The provisional quantities of fabricated & galvanized steel parts as per specifications required for towers and other items are given in appropriate Schedule of Bid Price Schedule (BPS). However, the work shall be executed as per approved construction drawings.

(b) The various items of work are described very briefly in the appropriate Bid Price Schedule (BPS). The various items of the BPS shall be read in conjunction with the corresponding sections in the Technical Specifications including amendments and, additions, if any. The Bidder's quoted rates shall be based on the description of activities in the BPS as well as other necessary operations required to complete the works detailed in these Technical Specifications.

(c) The Unit rates quoted shall include minor details which are obviously and fairly intended, and which may not have been included in these documents but are essential for the satisfactory completion of the various works.

(d) The unit rate quoted shall be inclusive of all plant equipment, men, material skilled and unskilled labor etc. essential for satisfactory completion of various works.

(e) All measurements for payment shall be in S.I. units, lengths shall be measured in meters corrected to two decimal places. Areas shall be computed in square meters & volume in cubic meters rounded off to two decimals.

1.1.2.3 The Bidder shall submit his offer taking into consideration that the tower designs/drawings shall be developed/ provided by Employer, but and foundation design and drawing shall be developed by the bidder themselves and design rights will be strictly reserved with Employer. Bidder shall quote the unit rates for various items of towers and foundations as per units mentioned in appropriate schedule of BPS. However, payment of these items identified in the schedule of prices shall be made as follows:

A)	**TOWER**	
i)	Supply items	On supply of respective complete tower
ii)	Erection items	On erection of respective complete tower
B)	**Foundation items:**	On completion of respective foundation in all respect

The payment to be made for towers/foundations shall be worked out based on the unit rates and approved Bill of Materials (BOM) for towers and quantities/volumes as per approved tower foundation drawings.

1.1.3 This specification also includes the supply of Conductor, Insulators, OPGW, hardware fittings and all type of accessories for conductor and OPGW as detailed in the specification. Bidders shall clearly indicate in their offer, the sources from where they propose to procure these materials in appropriate Schedule of BPS. The technical description of these items is given in relevant section of this Volume of the bidding documents.

1.1.4 All the raw materials such as steel, zinc for galvanizing, reinforcement steel, cement, coarse and fine aggregates for tower foundation, coke and salt for tower earthing etc. are included in the Contractor's scope of supply.

1.1.5 Bidder shall also indicate in the offer, the sources from where they propose to procure the fasteners, anti-theft fasteners, step bolts, hangers, D-shackles etc., tower accessories, aviation signal (if required) etc.

1.1.6 **Stringing**

a) The entire stringing work of conductor and earth wire shall be carried out by tension stringing technique. **The bidder shall indicate in their offer, the sets of tension stringing equipment he is having in his possession and the sets of stringing equipment he would deploy exclusively for each package which under no circumstance shall be less than the number and capacity requirement indicated in Qualifying Requirements for Bidder.** However, the Bidder having requisite experience has freedom to use helicopter for stringing. The Bidder intending to use helicopter shall furnish detailed description of the procedure, type & number of helicopter & accessories etc., to be deployed for stringing operation.

b) In hilly terrain and thick forest or area with site constraints, where deployment of tension stringing machine is not possible, manual stringing may be adopted after getting approval of Employer's site Engineer. The contractor shall deploy appropriate tools / equipment's / machinery to ensure that the stringing operation is carried out without causing damage to conductor / earth wire and conductor / earth wire is installed at the prescribed sag-tension as per the approved stringing charts.

1.1.7 The casting of special pile/well foundations (if applicable) wherever required shall be in the scope of the Contractor. The design shall be developed by the contractor and submit to employer for approval. If the bidder does not have necessary experience, some other agencies meeting the qualifying requirements may be engaged by the bidder for the casting of pile/well foundations. The Unit rate shall be derived as per pro rata basis with existing items/ Foundations.

1.2 **Details of Transmission Line Routes and Terrain**

The check survey shall be carried out using Total stations, DGPS, etc. along the approved route alignment. As an alternative, the Contractor may also use ALTM (Airborne Laser Terrain Modeling) techniques of equal or better accuracy for the survey.

Bidders may however visit the line route to acquaint themselves with terrain conditions and associated details of the proposed transmission lines. For this purpose, they are requested to contact to the project office.

1.3 **Location Details and Terminal Points**

i. 132 kV D/C Kohalpur-Nepalgunj Transmission Line shall emanate from Tower no. 19 of Kohalpur-Mahendranagar 132 kV D/C transmission line located at Bankatuwa, Baijanath Rural Municipality-5 of Banke District and terminate at Nepalgunj substation located at Bakaspur Village, Janaki Rural Municipality -5 of Banke District.

ii. The Contractor shall have to construct the 132 kV D/C transmission line in four circuit towers with dead end towers at one end (near Suspension Tower no. 19) to the dead end tower of to be constructed Nepalgunj Substation. **Stringing shall also be carried out from dead end tower to terminal arrangements/terminal points (Gantry Points of respective Station).**

1.4 **Access to the Line and Right of Way**

Right of way (RoW) and way leave clearance shall be arranged by the Owner in accordance with work schedules. The responsibility of the owner shall be limited to securing the RoW, compensation of land acquisition and permanent structure. All other responsibilities shall be of the Contractor as mentioned in the respective Chapters. Owner will secure way leave and Right of way in the Forest area. However, the details of RoW i.e., plot number and area of the land required for construction of tower foundation and plot number and area of the land within 9 m on the either side of the center of the transmission line, shall be prepared and submitted by the Contractor.

2.0 Transmission towers and Line data

2.1 General Description of the Tower

2.1.1 The transmission towers are of self-supporting hot dip galvanized lattice steel type, designed to carry the line conductors with necessary insulators, earth wires and all fittings under all loading conditions. Outline diagram of single circuit and double circuit towers are enclosed with the Specification.

2.1.2 The tower shall be fully galvanized using mild steel or/and high tensile steel sections as specified in relevant clause in section-IV. Bolts and nuts with spring washer are to be used for connections.

2.1.3 The towers are of the following types:

A) 132 kV Four Circuit (QA, QB, QC, QD &DD)

2.2 Classification of Towers

2.2.1 The towers for 132 kV Lines are classified as given below:-

Type of Tower	Deviation Limit	Typical Use
QA	0 deg.-2 deg.	i) To be used as tangent tower.
QB	2 deg - 15 deg	i) Angle towers with tension insulator string. ii) Also to be used for anti-cascading condition.
QC	15 deg-30 deg	i) Angle tower with tension insulator string. ii) Also to be used for anti-cascading condition.
QD	30 deg-60 deg	i) Angle tower with tension insulator string. ii) For river crossing anchoring with longer wind span & 0 deg. Deviation on crossing span side and 0 deg. To 30 deg. Deviation on other side.
D/QD		i) Dead end with 0 deg. To 15 deg. Deviation both on line side and sub-station side (slack span)

Note: The above towers can also be used for longer span with smaller angle of deviations without infringement of ground clearance.

2.2.2 Extensions

2.2.2.1 Towers were designed so as to be suitable for adding 3M, 6M and 9M body extensions and 1.5M, 3M, 4.5M, 6M, 7.5M and 9M leg extensions for maintaining adequate ground clearances without reducing the specified factor of safety in any manner.

2.2.2.2 The towers have been designed for providing unequal leg extensions as given in the BPS. The details of unequal leg extensions provided in the design shall be indicated to the contractor during execution stage, so that proper optimization of benching / revetment requirement can be done accordingly by the contractor. The towers are designed for unequal leg extensions of 1.5M, 3M, 4.5M, 6M, 7.5M and 9M generally with 3M maximum leg differential and in specific cases with 6m maximum leg differential. In exceptional situations where difference in leg differential does not suit the standard unequal leg extension provisions on the tower mentioned above, then suitable chimney extension shall be provided.

2.2.2.3 All above extension provisions to towers and foundations shall be treated as part of normal towers and foundations only.

2.2.2.4 The leg extensions, unequal leg extensions, chimney extensions and / or a combination of these suitable for a tower location shall be selected on the basis of techno-economics.

2.3 Span and clearances

2.3.1 Normal Span

The normal ruling span of the line is 350m.

2.3.2 Wind Span

The wind span is the sum of the two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span.

2.3.3 Weight span

The weight span is the horizontal distance between the lowest points of the conductors on the two spans adjacent to the tower. For spotting of structures, the span limits given in Table below for 132 KV lines shall prevail.

TOWER TYPE	NORMAL CONDITION		BROKENWIRE CONDITION	
	MAX (m)	MIN (m)	MAX (m)	MIN (m)
QA	500	0	300	0
QB	600	-600	360	(-) 360
QC	600	-600	360	(-) 360
D/DD	600	-1000	360	(-) 600

2.3.4 In case at certain locations where actual spotting spans exceed the design spans and cross-arms and certain members of towers are required to be modified/ reinforced, in that case drawings for the modified/reinforced towers will be supplied to the Contractor as per requirement.

2.4 Electrical Clearances

2.4.1 Ground Clearance

The minimum ground clearance from the bottom conductor shall not be less than 7000 mm for 132KV lines at the maximum sag conditions i.e at 80° C and still air.

a) An allowance of 150mm shall be provided to account for errors in stringing.

b) Conductor creep shall be compensated by over tensioning the conductor at a temperature of 26°C lower than the stringing temperature for ACSR “BEAR” conductor.

2.4.2 Line Data for 132 kV transmission line:

A. Electrical System Data:

a	Nominal Voltage	kV	132
b	Maximum system voltage	kV	145
c	BIL(Impulse)	kV (Peak)	650

d	Power frequency withstand voltage (Wet)	kV (rms)	275

B. Details of Line Materials

A. Conductor and shield wire

Sl. No.	Description	Unit	Shield wire	Conductor
1.	Name/Type		OPGW	ACSR Bear
2.	Size	mm	48 single mode OPGW	30/3.35 +7/3.0 steel
3.	Configuration		single to run on top of the towers	Vertical

C. Insulator Strings

Sl. No.	Particulars	Tension String	Suspension String
1.	Type of Insulator	Composite long rod	
2.	E&M Strength of the insulator string in KN Single	120	70
	Double	240	140
3.	Rated lightning impulse withstand voltage, kV	650	650
4.	Rated power frequency withstand voltage, kV a. Dry	357	
	b. Wet	325	

Note:

- For double suspension and tension string the hardware shall have at least 3 time higher strength than the insulator.
- The above parameters are applicable for installations up to an altitude of 1000m above mean sea level. For altitude exceeding 1000m above MSL, necessary altitude correction factor shall be applicable as per IEC or part thereof. **Bidders shall furnish the suitable value after taking altitude correction factor in Chapter 7: Technical Data Sheet (Guaranteed Technical Particulars) separately for each items as applicable.**
- The insulation and RIV levels of the equipment's shall be as per values given in the respective chapter of the equipment's.

D. Insulator String Hardware (As may be applicable)

a) Anchor Shackle
b) Chain Link
c) Ball Clevis / Socket clevis / Clevis Eye
d) Arcing horns / Arcing horn holding plate
e) Yoke plate
f) Free center type/Armor grip suspension clamp for suspension strings.
g) Compression type dead end clamp.
h) Grading ring.
i) Sag adjuster.
j) Balancing weight

E. Accessories for Conductor & OPGW (As may be applicable)

a) Preformed Armor rods
b) Mid Span compression joint
c) Repair Sleeves
d) Flexible copper bonds
e) Vibration dampers
f) Suspension assembly for OPGW.
g) Tension assembly for OPGW.

2.5 CONDITIONS OF SERVICE

All plant and equipment supplied under the contract shall be entirely suitable for the climatic conditions prevailing at site. Climate varies from moderately hot and humid tropical climate to cold climate.
Between June and August low-lying areas are subject to flooding.
All structures shall be designed with the seismic factor of 0.36g.

Maximum ambient shade temperature	46 degree C
Minimum ambient shade temperature	5.4 degree C
Annual average temperature	31 degree C
Maximum wind velocity	47 m/sec
Rainfall	1,385 mm/annum
Monsoon season	June-August
Relative humidity,	maximum 100 %
	Minimum 10 %
Altitude	158.1 MSL (Max.)
Atmospheric pollution	Light to medium
Isokeraunic level (thunderstorm days)	60

The information in this Clause is given solely for the general assistance to Bidders. No responsibility for it will be accepted, nor will any claim based on this Clause be considered. The Bidder is advised to survey the sites covered under this Bid to acquaint him with site conditions.

2.6 Variation in Quantities of Work

a) The provisional quantities required are mentioned in the respective schedule of prices. Final quantities shall be determined after completion and approval of the detailed route survey and check survey.

b) The final quantities of towers, line materials and foundations shall be confirmed by the NEA based on the requirement of quantities of various items furnished by the Contractor after completion of check survey. Hence it will the responsibility of the Contractor to intimate the exact requirements of all towers, line materials and foundations required for the line at the earliest after the survey. NEA will order the final quantities at the unit rates quoted in the bid.

c) NEA reserves the right to increase or decrease up to **15% (fifteen percent only)** of Contract value. The quantities of individual items may very up to any extent after the final route plans and route profiles of the lines covered in the package are finalized.

d) The Contractor shall agree to make no claim for anticipated profits or for alleged losses because of any difference between the quantities actually furnished and installed and the estimated quantities as indicated in these Bidding Documents.

e) In the course of check survey, tower staking; installation of special tower (other than the tower type specified in the schedule) or modification on the cross-arm may be found necessary. In such case the Contractor shall conduct design related works without any additional cost to the Employer. Payment for the special tower and the modified cross-arm will be made at the unit rate of the tower material (weight) used. Unit rate will be derived as described above on the basis of DDM type tower.

2.7 Expected life cycle

Life expectancy of the following items shall be as given below:

Long rod insulator:	min. 20 years
Optical terminal equipment:	min. 10 years

The Contractor shall submit certificate from independent laboratory for the life expectancy above material equipment or the manufacturer shall provide any other reliable document to prove the life expectancy.

2.8 Additional responsibilities of the Contractor

The Contractor shall take care of the following during execution of the works under the Contract.

2.8.1 The Contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities for the transportation of the equipment. The dimension of the equipment shall be such that when packed for transportation, it will comply with the requirements of loading and clearance restrictions for the selected route. It shall be the responsibility of the Contractor to coordinate the arrangement for transportation of the Transformers for all the stages from the manufacturer's work to site.

The conditions of roads, capacity of bridges, culverts etc. in the route shall also be assessed by the bidders. The scope of any necessary modification/ extension/ improvement to existing road, bridges, culverts etc. shall be included in the scope of the bidder. The Contractor shall carry out the route survey along with the transporter and submit the detail proposal and methodology for transportation of Tower parts for approval of Employer within three months from the date of award

2.8.2 The Contractor shall also be responsible for the overall co-ordination with internal/external agencies; project management, training of Owner's manpower, loading, unloading, handling, moving to final destination for successful erection, testing and commissioning of the Transmission Line.

2.8.3 Design of Transmission line and its associated electrical & mechanical auxiliaries systems includes preparation of tower spotting, foundation layout, tower protection works, earthing layout, erection key diagrams, electrical and physical clearance diagrams, design calculations for earthing and lightening protection system (including Direct Stroke Lighting Protection), control and protection schematics, civil designs **(as applicable)** and drawings and other relevant drawings & documents required for engineering of all facilities for the transmission line to be provided under this Contract, are covered under the scope of the Contractor.

2.8.4 Any other items not specifically mentioned in the specification but which are required for erection, testing and commissioning and satisfactory operation of the transmission line are deemed to be included in the scope of the specification unless specifically excluded.

Employer has standardized its technical specification for various equipment's and works for different voltage levels. Items, which are not applicable for the scope of this package as per schedule of quantities described in Schedules of Rates and Prices, the technical specification for such items should not be referred to.

2.9 Specific Requirement

a. The bidders are advised to visit the site and acquaint themselves with the topography, infrastructure, route alignment, road heads, and access/approach roads etc.

b. The bidder shall be responsible for safety of human and equipment during the working. It will be the responsibility of the Contractor to co-ordinate and obtain Electrical Inspector's clearance before commissioning. Any additional items, modification due to observation of such statutory authorities shall be provided by the Contractor at no extra cost to the owner.

c. The Contractor shall arrange all T&P for erection, testing & commissioning of the system at his own cost. Further, all consumables, wastage and damages shall be to the account of Contractor.

VOLUME – II-A OF III
CHAPTER - 2
GENERAL INFORMATION AND SCOPE
FOR
132 kV DOUBLE CIRCUIT TRANSMISSION LINE

1. GENERAL INFORMATION AND SCOPE

Salient Features of the Project

Kohalpur Nepalgunj 132 kV Transmission Line Project consist of construction of 132 kV double circuit transmission line Loop-In Loop-Out (LILO) through four circuit tower from Kohalpur to Nepalgunj. Volume II-A of bidding documents covers the technical requirement for construction of approximately 10km long, 132 kV transmission line starting from tapping tower located at Bankatuwa, Baijanath Rural Municipality-5 of Banke District and ending at Nepalgunj substation located at Bakaspur Village, Janaki Rural Municipality -5 of Banke District. The proposed 132 kV Transmission line traverses through plain landscape of Banke district of Nepal. The variations of altitudes of the proposed 132 kV transmission line ranges from approximately 146.13 m to 158.1 m above MSL.

Intent of the Specification:

This part of the specification is intended to cover the design, manufacture, engineering, inspection and testing at Bidder's work(s), packaging, forwarding to site, unloading, erection, testing, commissioning, performance testing and handing over of 132 kV Double Circuit Transmission Line from Kohalpur to Nepalgunj and from Nepalgunj to Kohalpur through Four Circuit Towers with all associated ancillaries and auxiliaries.

This specification shall be read and construed in conjunction with the drawings and annexure to determine the scope of work and terminal points. The quantities shown on drawings and annexure are indicative. Any variation arising during detailed engineering stage will be taken into account by the Bidder without any extra cost and time to the Employer.

Bidder shall be responsible for providing all material, equipment and services, specified or otherwise which are required to complete the scope and fulfill the intent of ensuring efficiency, 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 design and construction of equipment. Nevertheless, the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing continuous commercial operation, in a manner acceptable to Employer, who will interpret the meaning of the specification, drawings, requirements of operation, maintenance redundancy 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 and/or applicable International standards mentioned elsewhere in the specification.

Bidder is requested to carefully examine and understand the specifications and seek clarifications, if required, to ensure that they have understood the specifications. In the event of conflict between the requirements of any two clauses of this specification or requirements of different codes/ standards, the more stringent requirement shall govern, unless confirmed otherwise by the Employer in writing before the award of this contract, based on a written request from the bidder for such a clarification. However, if the bidder feels that, in his opinion, certain features brought out in his offer are superior to what has been specified, these may be highlighted separately.

Scope of Work

The scope of works covering design, engineering, procurement, inspection & testing at manufacturer's works, supply, insurance, receipt at site, storage and preservation at site, site transportation, construction, erection, commissioning, trial operation, handing over to Employer, guarantee all equipment, spares and material, catalogues, drawings, documents and services including lubricants, transformer oil, consumables for the proposed 132 kV Double Circuit Transmission Line from Kohalpur to Nepalgunj inclusive of all mechanical, electrical and civil, structural & architectural works on basis of single point responsibility.

The scope of work shall include but not limited to the following:

- Detailed survey and check survey including route alignment and profiling, right of way identification and clearance, tower spotting, optimization of tower locations, soil resistivity measurement, geotechnical investigation and check survey.
- Complete engineering services for the project including basic & detailed engineering, design philosophy, operation philosophy, submission of technical parameters, characteristic curves, capability curves, etc of equipment and material for Employer's approval.
- Prototype testing of towers at manufacturing plant of the Contractor.
- Any study through which the capacity and rating of equipment offered shall be proved for the main & auxiliary system on analysis of site location and attitude.
- Submission of manuals, engineering & construction drawings, design basis reports, optimization study reports, design calculations, quality assurance plans, testing procedures, operation and maintenance manuals, commissioning procedures, etc.
- Obtaining of any consents, licenses and approvals from relevant statutory authorities required as per applicable law in Nepal, other than those obtained by the Employer. The scope of Bidder also covers extending necessary assistance wherever logically required to enable Employer to obtain the requisite approval.
- Quality assurance of all work related to scope of work of the Bidder.
- Submission of schedule of work from zero date to handing over for complete plant to Employer and equipment in the form of chart, 'S'-curve; write up, visual chart etc for Employer's approval. Submission of monthly progress reports, photographs, graphs etc for engineering, supply, construction and commissioning for all major works with suggestions and plans for making up back log if any for review of Employer. To attend meetings, review, discussion etc for resolving all issues.
- Submission of shipping schedule of equipment and material from country of origin up to receipt at site for off shore supply and ex-works to site for on-shore supply matching with schedule of work for approval of Employer.
- Manufacture, fabrication, quality control, shop testing of equipments and material after approval of required technical data and drawings by Employer. To furnish notice to Employer for inspection.
- Packing, forwarding, shipment and transportation (including port handling and custom clearance) from the manufacturer's works to site. Comprehensive marine/ transit-cum-storage-cum-erection insurance coverage of all equipment from Nepal Border/ ex-works to project site till the equipment supplied is taken over by Employer. Preservation of all equipment starting from transportation till completion of testing and commissioning.
- Hiring of a suitable storing area which shall be approved by the Employer,
- Receipt at site, unloading, movement to proper storage, carriage to storage area/ interim/ final foundation location, security, preservation and conservation of equipment at the site.
- Erection and construction including supply of construction material and labour complete for structural and including all temporary enabling works, cabling, testing, start-up, successful trial operation and performance guarantee testing of the plant as indicated under the specifications and bidding documents.
- Performance Guarantee of the plant.
- Supply of spares parts.
- Supply any other equipment including special tools & tackles, for operation, capital maintenance.

- Supply of all manuals covering erection and commissioning, performance testing, operation, preservation, and capital maintenance including supply of as-built drawings and services required for satisfactory completion of the project.
- Supply of all construction consumables, e.g., welding electrodes, cleaning agents, diesel oil as well as materials required for temporary supports, scaffolding, storage tanks, illumination as necessary.
- Deployment of all skilled and unskilled manpower required for erection, commissioning, testing, etc, supervision of erection, commissioning, testing etc for services to be rendered.
- Deployment of all erection tools & tackles adequate number and capacity of cranes, construction machinery, transportation vehicles, and all other implements in adequate number, capacity and size. Any other tools, tackles and resources required to complete the contract with required quality and within the schedule.
- Training of Employer's personnel as specified.
- Arrangement of construction power and construction water at site.
- Any other activity not listed above but required for safe and trouble free operation of the works shall be deemed to have been included in the Bidder's scope.

1.1.1 Major Equipment and Works

The following list of the major plant items and systems shall be included in the Bidder's scope of work. This list is not exhaustive and is without prejudice to the more fundamental responsibility of the Bidder for completeness of 132 kV Double Circuit Transmission Line from Kohalpur to Nepalgunj.

a) Conductors and Accessories
   - Line Conductor (ACSR – BEAR) and accessories
   - Optical fibre ground wire (OPGW) and accessories
   - Optical fibre terminal equipment (OLTE) at Nepalgunj Substation
   - Insulator, hardware Fittings and other accessories

b) Tower and Tower Accessories
   - All types of transmission line towers (total 4 types – QA, QB, QC and QD including bolts, nuts and washers, hangers, D-shackles etc.
   - All types of tower accessories like phase plate, circuit plate, number plate, danger plate, anti climbing device, bird guard, aviation signals, painting of towers etc.

   Foundations
   - Classification of foundations for different soil conditions for different type of towers and casting of foundation for tower footings including stub setting.

c) Grounding of each towers.

d) Other items not specified above but required to complete the transmission line as per technical specifications, Bid Forms & Price Schedules.

Exclusions

None

Terminal points

The Bidder's scope of work shall terminate at the points as shown on the table below. These interconnection points represent the physical boundary points of the Bidder's scope of works. They do not necessarily define the operational responsibilities between the Bidder and the third parties.

System	Terminal Points
Termination of Line conductor Nepalgunj Substation	132 kV Gantry of the line bay within Nepalgunj Substation. Connection with the Gantry including supply of string insulators hard ware and other accessories are included in the scope of work of this specification.
Termination of OPGW	Optical line terminal equipment (OLTE) shall be supplied and installed within communication room inside control building of Nepalgunj substation. Connection of OLTE with Multiplexer (MUX) of Nepalgunj substation is included in the scope of this specification.

Additional responsibilities of the contractor

The Contractor shall take care of the following during execution of the works under the contract.

1.1.2 Existing Fences

Where it is necessary to operate equipment through existing fences, the Contractor shall install suitable temporary gates. The temporary gates shall be constructed of materials and to standards equal to those of the existing fence. Before cutting the fences for the installation of temporary gates, the Contractor shall install adequate braces and additional posts, if necessary, on each side of the opening and shall fully anchor the fence so that all wires will maintain their original tension after opening is cut. Except when equipment is passing, such gates shall be kept closed. After completion of the work, the fence shall be restored as nearly as practicable to its original condition. Deviation from the above requirement will be permitted only where the Contractor furnishes advanced written approval from the landowner or landowners for a different method of operation.

Where it is necessary for the Contractor to remove or to alter portions of existing fences to permit construction, temporary fence protection shall be provided at all times during construction and upon completion of the construction, the fence shall be rebuilt in its original or relocated position.

The cost of all work herein described shall be borne by the Contractor. Should the contractor refuse or neglect to perform any work required by the above provisions within twenty-four hours after notification by the Employer to do so, the Employer reserves the right to perform the work and the cost thereof will be deducted from payment due to the Contractor.

1.1.3 Transmission, Telegraph and Telephone Lines:

The Contractor shall make all necessary or required provisions concerning any interference with the operation or maintenance of traffic or service of any transmission, telegraph or telephone lines existing on the date of receiving bids, caused by the work of the Contractor under this Contract, all in a manner satisfactory to the Employers or operators and to the Employer.

The Contractor shall notify the Employers of such facilities of any damage, which is his responsibility and shall promptly settle proper claims. Pending settlement of such claims by the Contractor, an appropriate sum as determined by the Employer may be withheld from payments due to the Contractor until the matter is settled.

The cost of providing and maintaining all necessary or required watchmen, signals, guards and temporary structures, of making any necessary repairs, replacements, or similar operations and all or any other costs required by this Sub-Clause shall be borne by the Contractor.

1.1.4 Operation and maintenance

The Contractor shall provide at least one operating and maintenance expert at the site for a continuous period of Six (6) months or any extension required thereof because of serious breakdown or any extensions of warranty period, from the commencement of the Defect Liability Period to train the local staff on the operation of various equipment.

1.1.5 Commissioning and pre-commissioning

The Contractor shall provide sufficient, properly qualified personnel; shall supply and make available all raw materials, utilities, lubricants, chemicals, catalysts, other materials and facilities; and shall perform all work and services of whatsoever nature required to properly carry out Pre-commissioning, Commissioning and Guarantee Test all in accordance with the provisions of the Contract Agreement.

1.1.6 Other Responsibilities

a) The Contractor shall be responsible for selecting and constructing appropriate communication means necessary for the executing of the project at his own expense. If required, the Employer will assist the Contractor in obtaining licences/ permits from the concerned government agencies.

b) Gasoline, oil and lubricants for construction equipment and vehicles are available in Nepal and the Contractor will not be permitted to import such products for use on the work.

c) The Contractor shall be responsible for the arrangement of water supply for drinking and construction purposes at his own cost.

d) The Contractor shall be responsible for the arrangement of electricity supply for construction and any other purposes at his own cost.

e) The Employer requires to get approval of cutting trees falling in RoW of the transmission line. For this the Contractor shall be responsible for enumeration of trees i.e. marking of trees at breast height, calculation of number and types of trees and its total volume to be removed in close coordination with the concerned forest department. Cost of all such activities is deemed to be included in the bid proposal. The Employer shall however assist in all such activities and getting approval from the concerned agencies.

Required Completion Schedule

The scope under Volume – II-A of the bidding document includes following component of Kohalpur Nepalgunj 132 kV transmission line project:

a. Design, manufacturing, supply, construction, installation, testing and commissioning of 132 kV double circuits Transmission Line from Kohalpur to Nepalgunj.

b. All works under the scope shall be completed within Thirty (30) months from the effective date of the contract.

Supply of all material and equipments shall be done by the contractor according to the approved supply schedule and this should be the responsibility of the contractor to submit and get approval of the supply schedule from the employer.

Pariyar

VOLUME – II-A OF III
CHAPTER - 3
PRELIMINARY WORKS

TABLE OF CONTENTS

Manjan

3 PRELIMINARY WORKS

3.1 Check Survey and Staking

qualified surveyor. Not less than 15 days prior to commencement of work, the Contractor shall submit qualification of surveyors, work program and list of surveying equipment for the entire section of the proposed transmission Line and obtain approval of the Employer. Latest portable hand GPS shall also be used for determination/ verification of coordinates. The GPS used during detail/ check survey shall be the property of NEA after completion of said works. The Employer has studied several alternatives for the route alignment of the said transmission line and selected a route alignment. The Contractor shall be responsible for undertaking check survey of that selected route alignment.

The proposed 132 kV Transmission double circuit line with ACSR BEAR Conductor is passing through plain landscape of Banke district of Nepal. The variations of altitudes of the proposed 132 kV transmission line ranges from approximately 146.13 m to 158.1 m above MSL. It is envisaged to adopt towers suitable for systems with 750 kV peak BIL (for balance length) for the proposed 132 kV Transmission line.

The Contractor along with the Employer shall examine the angle points and fix them within 60 days from Contract signing date. Immediately after that the Contractor shall carryout check survey and prepare Strip plans and longitudinal profile sections of that section at scales horizontal 1:2,000 and a vertical scale of 1:200 or 1:400 as appropriate.

The Contractor shall study the plan and profile and locate the intermediate tower location. The contractor shall fix the type of towers for the complete alignment. For the proposed 132 kV Transmission line, the contractor shall submit the following drawings:

(i) Three (3) copies of profile drawings.

(ii) Two (2) sets of sag templates showing the sag in still air at maximum temperature of the conductor along with sag calculations, the ground clearance line and the line showing the sag for the entire length of the transmission line.

(iii) Two (2) sets of sag templates showing the sag in still air, 0^0C temperature of the conductor along with sag calculations, ground clearance line and the line showing the sag for transmission line.

(iv) Tower schedule indicating tower coordinates (X,Y,Z) tower number, tower type, insulator type, tower type, line angle, span length, elevation of tower spot, leg extensions, dampers, etc.

Construction of transmission line should be completed within the set mile stone date.

The quantities given in the Price Schedule are provisional only and the Contractor shall finalise the quantities after the tower and foundation selection. Any delay in tower selection works will not be held as a valid reason for lack of progress in manufacture and construction and the Contractor will be expected to commence manufacture and construct the line even though the final quantities are not known until a later stage.

The Contractor shall perform all necessary survey work which consists of determination, checking and lay out the accurate centre of line and elevation of all the reference points, based on the key map and plan and profile drawings. Furthermore, the Contractor shall check the minimum clearance of conductor crossing the existing highways, major waterways, power and telecommunication lines, etc.

The tower to be erected shall comprise of Basic body and leg extensions as provided in the Price Schedule, if for some reason the leg extensions are not sufficient or require some modification in the body extension part, the Contractor shall make necessary changes with the prior approval of the Employer. The Contractor shall not be entitled to claim for any materials furnished or work performed in this respect.

During check survey, the Contractor shall assess and design works required to be undertaken for the protection of the foundations.

The check survey work shall be performed by qualified and experienced personnel and supervised by Project team.

Following points shall also be considered during tower staking and preparation of tower schedule;

a) Road Crossing

At all important road crossings, the tower shall be fitted with double suspension or tension insulator strings depending on the type of tower but the ground clearance at the roads under maximum conductor design temperature and in still air shall be such that even with conductor broken in adjacent span, ground clearance of the conductor from the road surfaces will not be less than the values specified at Schedule A-3, Section-11 for 132 KV lines. At all national highways crossing span will not be more than as basic span specified in schedule A.4 (Support Types and Design Spans) item no. 2 in section –11.

b) River Crossings

In case of Major River crossings which are more than 500 meter, towers shall be of suspension type and the anchor towers on either side of the main river crossing shall be DD type tower. Clearance required by navigation authority shall be provided. For non-navigable river, clearance shall be reckoned with respect to highest flood level (HFL). In case of river crossing with a span up to 500 meter normal tower spotting procedure shall be followed to achieve minimum clearance as given in schedule A-3, Section-11 (Minimum Clearance).

c) Power Line Crossings

Where this line is to cross over another line of the same voltage or lower voltage, tower with suitable extensions (if necessary) shall be used. Provisions to prevent the possibility of its coming into contact with other overhead lines shall be made in accordance with the directions of the Employer. All the works related to the above proposal shall be deemed to be included in the scope of the Contractor except if modifications are required to line below, in which case, the conditions to be agreed upon. The minimum clearance while crossing the lines up to 132 kV shall be 3500 mm as given in schedule A-3, Section-11 (Minimum Clearance).

For power line crossings of voltage level of 132 kV and above, an angle towers shall be provided on either side of DA type tower which can be temporary dead end condition with proper guying.

d) Telecommunication Line Crossings

The angle of crossing shall be as near to 90 degreess as possible. However, deviation to the extent of 30 degrees may be permitted under exceptionally difficult situations.

When the angle of crossing has to be below 60 degrees, the matter will be referred to the authority in charge of the telecommunication System. On a request from the Contractor, the permission of the telecommunication authority may be obtained by the Employer.

Also, in the crossing span, power line support will be as near the telecommunication line as possible, to obtain increased vertical clearance between the wires.

Payment:

Payment for the contract item, **Check Survey and Staking**, will be made at the unit price bid (per km) based on horizontal distance measurement. Therefore, in the schedule the unit bid price shall include full compensation for all costs incurred in furnishing all materials, equipment and labor and other operations related to the scope of work of survey as specified before.

3.2 Detail Survey works

The Employer has studied several alternatives for the route alignment of the said transmission line and selected a route alignment. For some practical reason such as change in topography due to construction of some new object in the line route, to avoid heavy afforestation or to avoid abolishment of houses under the line in some section of the line route minor modifications may require. Therefore, the Contractor along with the Employer shall examine the angle points and fix them within 60 days from Contract signing date. As route selection has been confirmed few years ago, there is probability of new constructions performed on the route. Moreover, some portion of previously selected route may subject to rerouting demanded by both technical and site based reasons. The heading **Detail Survey works** deems to meet this requirement for few portions of the route. The Contractor shall be responsible for undertaking detailed survey of few portion of rerouting work.

The contractor shall carryout detailed survey of some part of the transmission line route, where relocation of angle towers may be required. The provision of detail survey has been made and payment shall be done in accordance to BoQ.

The Contractor shall perform all necessary survey work which consists of determination, checking and lay out the accurate centre of line and elevation of all the reference points, based on the key map and plan and profile drawings. Furthermore, the Contractor shall check the minimum clearance of conductor crossing the existing highways, major waterways, power and telecommunication lines, etc.

Payment:

Payment for the contract item, **Detail Survey works**, will be made at the unit price bid (per km) based on horizontal distance measurement. Therefore, in the schedule the unit bid price shall include full compensation for all costs incurred in furnishing all materials, equipment and labor and other operations related to the scope of work of survey as specified before.

3.3 Preparation of Land parcel data for Tower and RoW lands

The work “Preparation of Land parcel data for Tower and RoW lands” consists of;

a) Land Schedule preparation work

The land schedule of the given line route will be prepared by the Contractor. ***The land parcel preparation work shall be done in close coordination with district “Survey office” and district “Land Revenue office” as Land Parcel data will be approved by employer only after verification from these district level offices and work will be considered mature for payment.*** The Employer shall assist the Contractor to the extent possible. The Contractor will identify the ***exact land parcel number and area of the land required for the tower foundations and protection works*** to be acquired for land acquisition purpose.

b) Routes, Right-of-Way and Access data preparation work

The land schedule of the given ***line route*** will be prepared by the Contractor. The Employer shall assist the Contractor to the extent possible. The Contractor will identify the exact land parcel number and area of the land required for the RoW for compensation purpose. The Contractor shall identify exact land parcel number and area of such land falling within RoW (9 m X 9 m) for compensation purpose and rectify all the errors if arises to the satisfaction of the concerned land owners and the Employer.

Later, the necessary right of way for the lines to enable the Contractor to carry out stringing and erection will be obtained by the Employer. But the Contractor will not be reimbursed for waiting time caused by delay in obtaining right of way unless he has established on site as per instruction of the Employer in advance of obtaining right of way. Where partial right of way only is granted, the Contractor shall program his work accordingly.

The Contractor shall make all necessary arrangements for the access roads with the land owners before going onto private land, but if any difficulty should arise, the Contractor shall promptly inform the Employer. Such arrangements shall be at least one month in advance of the desired access date to allow time to clear any difficulties. The Employer shall be kept informed of all negotiations and successful arrangements.

At any early stage of the Contract the Contractor shall arrange all proposed points of access and after the approval of the Employer shall prepare maps for submission to the Employer for the settlement of way leave arrangements. No other access shall be used without the prior consent of the Employer.

It shall be clearly understood by the Contractor that the cost of construction of access roads and delivery of construction material to erection points shall be deemed to be included in the bid price and the Contractor shall have no claim whatsoever to extra payment for construction and maintenance of access as may be required.

Further the contractor should understand clearly that the following are his responsibility;

I. Clearing

The Contractor shall be responsible for clearance of the foundation site. Clearing shall include removal and disposal of all tress, bushes, down timber, tree roots, debris, indicated structures and other obstructions from the areas to be occupied by permanent works of the contract, and as indicated on the drawings, specified herein and as directed by the Employer at tower foundation site and the access. The Contractor shall be responsible for removal of creeping vines and all vegetation on all existing towers from the base to the top. The cost of this work shall be included in the Bid price. The Contractor shall also be responsible for trees enumeration and removal of trees during foundation excavation, erection and stringing works at its own cost. However, compensation of such trees shall be borne by the Employer. The Employer shall be responsible for the clearance of the right of way for the transmission line as regards houses.

II. Protection

The Contractor shall be responsible for prevention of damage to structures and other objects which are not included in the clearing work. No objects of any kind outside the indicated limits of the work shall be removed or damaged. Existing utilities which are not specifically included in the work shall be protected by the Contractor. The Contractor shall be responsible for employment of safe methods of demolition and clearing.

III. Notices

Before construction commences, the Contractor shall give to the Employer not less than seven days' notice that support positions have been pegged and are available for inspection.

Before the Contractor commences work he shall obtain from the Employer a way leave schedule giving details of any special requirements of the occupiers or Employer concerned.

When the Contractor is about to carry out erection of the conductors along or across power, telegraph or telephone lines, or public roads he shall give the requisite notice to the appropriate authorities of the date and time which he proposes to perform the work and shall send a duplicate copy of each notice to the Employer. The Contractor shall construct trestles for such line or road crossings. No separate payment shall be made for such works.

The Contractor shall at all times during the execution of the Works ensure compliance with all such reasonable requirements of the occupier or Employer as are brought to the Contractor's notice by the Employer.

IV. Damage

The Contractor shall take all reasonable precautions to avoid damage to land, property, roads, crops, fences, walls, gates, etc., and shall ensure that the work is adequately supervised so that unavoidable damage is reduced to the minimum. The Contractor will be liable for all damage arising by or in consequence of the works except unavoidable damage to crops and shall pay compensation or make good at the option of the Employer. The Contractor shall remove all soil and surplus material after erection.

The Contractor will be responsible for payment necessary for agreed passage over private roads, where arrangements have been made by the Contractor.

The Contractor will be responsible for notifying the Employer of all instances of damage to crops which in the opinion of the Contractor are unavoidable. In the event of such notification not being received by the Employer, Employer may at his discretion refuse to consider any claim by the Contractor for compensation resulting there from.

V. Crossing of obstacles

The Contractor shall make all necessary arrangement and take all necessary precautions where the route crosses buildings, power lines, orchards, gardens or other obstacles or ground over which erection cannot be carried out in the normal manner.

Where the local authorities or other public undertaking affected deem it necessary to make provision for the protection of their employees or property or of the public, or for the assistance of traffic, the cost of such provision shall be borne by the Contractor.

The provision of special scaffolding for purposes of effecting crossings of the route over roads, railways, rivers, telegraph and telephone lines or other similar obstructions as the Employer and/ or the Contractor may consider necessary shall be the Contractor's responsibility and all cost of such special crossings shall be borne by the Contractor.

Adequate provision shall be made by the Contractor to prevent the straying or damage to livestock during the execution of the Contract Works and until permanent reinstatement of fences, walls, hedges, gates and the like is completed, the Contractor shall be held responsible for any loss or damage due to failure to comply with the above requirements.

Payment:

Payment of identification of land parcel number and their areas shall be done as per quoted bid price but no separate payment shall be made for clearing, cutting and special scaffolding arrangements and access road. Therefore, the Contractor shall include all the cost in the unit bid for construction of foundation, stringing or tower erection.

50 % of the quoted sum shall be paid after submission and rectification of land parcel number and area of land required for tower foundations and protection (acquisition purpose) and remaining 50 % of the sum shall be paid after submission and rectification of land parcel number and areas falling under RoW for (compensation purpose).

3.4 Soil Test

3.4.1 Scope

This specification covers all the work required for geotechnical investigation and preparation of a detailed report. The work shall include mobilization of necessary equipment, providing necessary engineering supervisors and technical personnel skilled and unskilled labor and other as required, to carry out field investigations and test, laboratory tests and analysis and interpretation of data and results, preparation of a detailed soil report including recommendations and providing technical services as and when called for by the Employer. The investigation method shall be as described herein or any other methods approved by Employer giving the same information as needed to ensure that soil parameters are sufficient for reliable foundation design. The location for the geo-technical investigation shall be approved by the employer.

3.4.2 Codes and standards

All work shall be carried out strictly in accordance with the Technical Specifications unless otherwise approved by the Employer in writing. Where not specified, the latest-edition of one or more of the following codes of practice or any other applicable code shall be followed.

SP 32(Part-2)	: Compendium of Indian Standards on soil engineering Laboratory (Field Testing of soils for Civil Engineering Purpose.
BS 1377	: Methods of Test for Soils for Civil Engineering Purposes
BS 1924	: Methods of Test for Stabilized Soils
BS 5930	: Code of Practice for Site Investigations
BS 6031	: Code of Practice for Earthworks
CP 2004	: Code of Practice for Foundations
CBIP Manual on Transmission Line	

Codes equivalent to these in American/ DIN Standards can also be used.

3.4.3 Purpose

The purpose, in brief, of the proposed geotechnical investigation, is to ascertain the type of sub-strata such as soil, rock etc., their characteristics and their suitability for the structures proposed to be built and to decide on the choice of the type of foundation to be adopted for the type and magnitude of envisaged loading. All the tests that are considered necessary in the opinion of the Employer for this purpose shall be conducted. Any additional tests/ works, change in the number and type of specified tests revision in the diameter, depth of bore holes, samples to be collected etc. shall be carried out as directed by the Employer.

3.4.4 Calibration of equipment

The Contractor shall ensure that all the equipment/ instruments are properly calibrated, at the start of the work, to reflect actual values. If so demanded by the Employer, the Contractor shall have the instruments tested at an approved laboratory at his cost and the test reports shall be submitted to the Employer. If the Employer desires to witness such tests, the Contractor shall arrange for the same at his own cost.

3.4.5 Field work

a) General

It is essential that personnel on this work of geotechnical investigation and laboratory testing should have the appropriate experience. The entire investigation shall be supervised by a suitably qualified and experienced engineer or engineering geologist. All field and laboratory work shall be executed by experienced technicians.

The Contractor shall have on site all required survey instruments as determined by the Employer to carry out the work accurately according to Specification and Drawings. All the specified locations for boreholes and field tests shall be set out at site by the Contractor. At each location of bore-hole, and other field tests the Contractor shall establish the ground level prior to commencing of the boring operation. The ground level shall be related to an established bench mark.

b) Method of boring

- Boring in soil

In soil strata, boring may be carried out by auger or percussion tools or by method approved by the Employer or Employer's representative. Bentonite slurry or mud circulation process can also be used if permitted. However, for those boreholes, where water samples are to be collected for chemical analysis, bentonite slurry or mud circulation method shall not be used or shall be restricted as directed by the Employer or Employer's representative. The diameter of the boreholes, unless stated otherwise shall be such as to permit collection of undisturbed samples of 90mm diameter.

Where necessary boreholes shall be cased and whenever a borehole is cased, the bottom of the casing shall always be maintained within 150mm of the bottom of the borehole. The casing shall never be in advance of the bottom of borehole during undisturbed sampling or standard penetration tests.

- Borehole depth

All the boreholes shall be sunk to a depth of 6m at field.

c) Sampling

- Sequence of sampling

The general sequence of sampling adopted shall be such as to obtain alternatively undisturbed samples at every 1.5 meter intervals and at every significant change of stratum. Undisturbed sample wherever possible, shall be collected at every 3.0 meters interval and at every identifiable change of soil formation. Likewise disturbed samples, as obtained in the standard split spoon, shall be collected by conducting the standard penetration test at every 3.0 meters interval and at the significant change of soil stratum.

- Undisturbed sampling in boreholes

Samplers used for collecting undisturbed samples in soils shall meet IS/ BS and American Standards requirements and shall be appropriate to the type of soil to be sampled. Undisturbed soil samples collected shall be 90mm in diameter and 450mm in length so as to enable laboratory testing.

The area ratio of samplers shall be within the permissible limit and shall not exceed 25 percent for samples of 90mm diameter. The cutting edge of the cutting shoe of the sample shall be tapered at an angle not exceeding 20 degrees and inside clearance ratio shall generally be limited to 0.5 to 1.5 percent. Samples with lower clearance ratio shall be used in soft strata and these with higher clearance ratio shall be used in stiff strata. The cutting edge or shoe of sampler shall be free from rust, pitting, burring or any other defect. The sampler shall be fitted with ball check valve at the upper end.

For clays other than very soft clays open drive samplers are permissible whereas in very soft clays and in sandy soils piston samplers with core catcher device or other approved samplers shall only be used. The use of oil inside the samplers in operation shall be limited to minimum practicable.

Before sampling operation, the Contractor shall clean the bottom of borehole very carefully and every care shall be taken to avoid disturbance of material to be sampled. For sampling the sampler shall be lowered to the bottom of borehole without impact and pressed into the soil in a single continuous movement at a sufficiently slow rate to permit the check valve to pass the water in the tube with creating excess back pressure. In firm material, and whenever approved by the Employer the sampler may be driven into the soil; but the sampler shall never be pushed or driven to its full length. After penetration to the required depth, the sampler shall be free from the soil by being rotated by one full turn and then shall be withdrawn.

The sample shall not be removed from the tube but shall be trimmed back from the ends of the tube and the space filled with molten microcrystalline wax, the tube capped with metal or plastic cap and sealed with adhesive tape.

- Undisturbed soil samples from trial pits and other sources

The Contractor may be required to collect undisturbed soil samples from trial pits excavations or other sources. these samples may be core samples or block samples and may be obtained with a special orientation as indicated by the Employer core samples shall generally be obtained by jacking a thin walled open drive sampler of around 100mm diameter into the stratum. The sample tubes shall be driven if approved by the Employer or Employer's representative. The sample tubes shall be held steady during jacking/ driving and a suitable frame shall be used for guiding inclined samplers.

- Disturbed soil samples

The material from the cutting shoe of the thin walled sampler and from the split spoon sampler of the standard penetration test can be treated as disturbed sample, but will not be paid for separately. All disturbed samples collected shall be placed without delay in an air-tight jar of not less than 0.4kg nominal size and each sample shall fill the jar as far as possible.

Larger disturbed samples may be required to be collected from trial pits or excavations. Each of such samples should be at least 10 kg. Such samples shall be sealed into heavy duty polythene bags immediately on collection.

- Water samples

Contractor shall take water samples from boreholes, whenever directed by the Employer, before addition of water to the hole. If this is not possible prior to collection the water level in the borehole shall be lowered by about 0.5m, water allowed to rise by seepage through walls of bore hole and then water sample collected.

No water sample shall be taken when bentonite slurry or mud has been circulated in the borehole. The method of sampling shall be such as to ensure that the sample is not contaminated by rain water, surface water etc. The quantity of sample to be collected is about 1 liter and shall be stored only in approved airtight, clean container. Water samples should be tested as soon as possible after collection.

- Numbering of samples

The Contractor shall assign a reference number to each soil and water sample taken from the borehole. this number shall be unique for that borehole and shall be in order of depth below ground level.

- Labeling of samples

All samples shall be clearly labeled indicating job number, borehole number sample number, date of sampling, brief description of samples, type of sample, elevation of sample etc. and in case of undisturbed samples, the top and bottom of samples shall also be clearly labeled. Each such label shall be pasted on the container and shall also be included in the container.

- Transporting and storing of samples

The Contractor shall store properly all the samples at the site till they are transported to his laboratory for testing. All rock cores and samplers with undisturbed soil samples shall be placed in order of their occurrence in strong wooden boxes suitably partitioned and provided with hinged wooden covers, so that the samples are not damaged during transit by impact or improper handling. To minimize disturbance during shipment samplers containing undisturbed soil samples shall be packed with wood dust or similar other resilient material and as directed by the Employer or Employer's representative

The Contractor shall transport all samples to his testing laboratory as quickly as possible and test the samples. Samples shall be transported by air, if the stipulated completion period so warrants. All unused and excess samples after testing should be retained and safely stored by Contractor till three months after the end of submission of the report.

d) Specific observations during boring

The observation to be made by the Contractor during boring shall include but not be limited to the following:

- Sequence and thickness of different strata

Visual description of each stratum shall be provided.

- Ground water table

The depth at which ground water is struck during boring shall be carefully noted and the depth of water table shall be ascertained subsequently in the complete borehole by daily observing the depth for the next six to seven days. Depth of ground water shall also be observed in wells, if wells exist in the vicinity.

- "Loss" or "Make" of drilling fluid

The "Loss" or "Make" of drilling fluid if observed during the boring shall be noted and brought to the attention of the Employer or Employer's representative. Attempts shall be made to detect joints, fissures, artisan conditions etc.

- Presence of lime, mica. etc.

The soil and rock samples shall be examined for presence of lime, mica etc. and shall be recorded, if any. The Contractors rate for boring shall be deemed to include these and all other relevant observations.

e) Submission of field logs

The Contractor shall submit or mail to the Employer as directed, two copies of the preliminary log of each borehole as soon as the borehole is completed.

f) Field tests

- Standard penetration test (SPT)

Unless directed otherwise by the Employer or Employer's representative, the Contractor shall carry out standard penetration test at 1.0 meter intervals and at every noticeable change of soil formation and as per the procedure in IS/ BS or ANSI. The finest test shall generally begin at 1.0 m depth unless an undisturbed sample is collected at that depth, and further test at 2.0 m, 3.0 m, 4.0 m, 5.0 m and 6.0 m depths shall be done.

For conducting the test, the bottom of borehole shall be cleaned properly and the spoon shall be properly and centrally seated in position in the borehole. The derive weight assembly shall consist of a driving head of 65 kg weight with 75 cm free fall. It shall be ensured that the energy of falling weight is not reduced by friction between the drive weight and guides or between rope and winch drum. Standard connecting rods shall be used.

The test shall be stopped (When the test is not conducted in weathered/ Soft rock) when the total blow count including seating drive reaches 120. The corresponding penetration shall be noted. If the total penetration is more than the seating penetration of 15 cm, a breakup of blow count for 15 cm seating penetration and for the remaining portion of penetration shall also be given

g) Excavation of trial pits

The Contractor shall excavate trial pits to the depth of 3.0 meters. Relevant tests specified in these pits shall also be carried out. Whether specified or not, in every trial pit, including those excavated for loading tests, tests by "Pocket Penetrometer" and by "Picket " shall be generously carried out at different depths in different strata. Picket test shall be conducted in non-cohesive strata. In this test a wooden picket of dimensions 5cm x 5cm in cross section, with a sharp point and about 70 cm long shall be pushed perpendicular to the surface of soil by a force of about 70 kg and the penetration of the picket shall be recorded. The test by pocket penetrometer shall be done in soils with cohesive touch and in weathered rock.

h) Backfilling of boreholes and pits

The Contractor shall backfill the boreholes and pits. The borehole shall be back filled by bentonite/ mud-cement grout. The cement and bentonite/ mud for the grout shall be in the ratio 1 to cement and bentonite for the grout shall be in the ratio 1 to 1 by weight, and shall be made into a slurry with no more water than is necessary for placing the slurry in the borehole. If there is standing water in the borehole, grout shall be placed by Tremie. The pit shall be backfilled with proper ramming using the excavated material.

3.4.6 Laboratory tests

a) General

All the laboratory testing shall be performed by qualified and experienced personnel, familiar with and having access to equipment and facilities for the accurate determination of data necessary for requirements under this specification.

b) Independent laboratory

The Employer reserves the right to have the samples tested in an independent laboratory. If the Contractor is directed to get the samples tested in an independent laboratory, he shall be paid only the actual cost of such tests.

c) Program for testing

The Employer or Employer's representative will direct Contractor on samples to be tested and on type of test to be conducted. The Employer or Employer's representative is not bound to furnish this information at the beginning of the investigation itself but shall instruct the Contractor at appropriate time during the course of the investigation. In case of clayed soil tri-axial compression test on undisturbed soil samples shall be carried out.

d) Standards for testing

The Contractor shall test the samples as per the relevant BS, ANSI or directed by the Employer.

e) Access to the laboratory

The Employer shall have the right of access to Contractor's Laboratory or other Laboratory where tests have been arranged to be carried out during the progress of this investigation.

f) Submission test data and results

The Contractor shall submit when demanded by the Employer preliminary copy of the data and the computed results tests he has conducted. However, the final report shall contain all the experimental data and the results as stated below in Article 3.2.7.

3.4.7 Formal report

a) General

The Contractor shall submit his report in two separate volumes. Volume I shall be the main body of the report containing geological history of the Site summarized test data, observations, conclusions and recommendations. Volume II shall be in the form of appendix and shall contain actual field and laboratory observations, calculations of test results, supporting calculations for the recommendations made etc. Initially, the Contractor shall submit these volumes to the Employer in a draft form.

b) Route plan

A route plan showing location of all boreholes, trail pits, etc. shall be presented in the report.

c) Bore logs

A true cross-section of all boreholes, trial pits showing thickness, position and classification of each soil stratum found between top surface and bottom of the hole shall be submitted. The various tests conducted and recovered from every soil and rock stratum shall be clearly against that stratum.

A record in full of every trial pit or incomplete boring with appropriate explanations shall be reported in the same manner as the completed pits or boreholes.

d) Ground water

All available data on ground water conditions shall be presented separately and shall be identified by borehole number and sampling dates and timing of observations, showing clearly the number of observation made in a particular safe.

e) Test results

The recommendations shall be based on observations and test results and shall encompass theoretical as well practical considerations for foundations for the types of structures envisaged. The Contractor shall acquaint himself with the type of structures proposed.

Recommendations shall include but not be limited to the following:

- A brief geological description including that of faults, folds, etc. if any on the basis of published literature.
- Seismic history including a brief description of previous earthquakes, giving time, period, magnitude, ground acceleration, epicenter, damage done etc.
- Recommended type of foundations and safe/ allowable Cardinalin capacities.
- Possibility and extent of scour in river beds.
- Recommendation for class of concrete to be used for foundations vis-a-vis deleterious effect of ground water/soil chemicals concrete and steel.
- Earth pressure coefficients that may be adopted.
- Any other relevant information and data.
- Technical services as and when called by the employer.

Payment

Payment for the contract item, Soil Test, will be made at the unit price bid. Therefore, in the schedule the unit bid price shall include full compensation for all costs incurred in furnishing all materials, equipment, technical services, labor and other operations related to the scope of work of soil test as specified before.

3.5 Measurement of Ground Resistance

The Contractor is required to perform ground resistance test at every support/ tower locations. Method of measurement, tools and instruments shall be submitted to the Employer for approval.

The measurement of ground resistance shall be performed at every meter depth from ground surface to the specified depth or to maximum depth of sub-soil tests except where ground resistance value of 10 ohms or less is obtained at any adjacent levels, no further measurement is required.

The Contractor may use drilling rod(s) of sub-soil test equipment during performing the sub-soil test as earth electrodes for measuring the ground resistance.

The Contractor shall recommend the type of earth electrodes in accordance with the results of ground resistance obtained. Selection of earth electrode type shall be suitable for each structure and its particular site conditions. The data obtained shall be prepared in an approved form and submitted to the Employer.

Payment

Payment for the contract item measurement of ground resistance will be made at the unit price bid. Therefore in the schedule the unit bid price shall include full compensation for all cost incurred in furnishing all equipment and labor related to "Measurement of Ground Resistance".

3.6 Ground Handling for crossing of 132 kV lines

This is provisional item. The designated 132 kV transmission line have no high voltage line crossing of 132 kV till to date. Incase during stringing, any crossings of 132 kV transmission lines or dedicated feeder is demanded in field, this work should be performed.

The need of use of ERS or any other suitable alternatives shall be proposed by the contractor to the satisfaction of the employer for approval to avoid prolonged shut down of 132 kV transmission lines or dedicated feeder lines during stringing works under the scope of the contract. The work should be carried out only after approval of plan proposed by contractor.

Payment: Ground handling cost during shutdown shall be decided upon submission of the detail methodology and procedures to be adopted by the contractor and payment shall be made to the contractor upon completion of approved work as per approved procedure. ***The price quoted for ground handling in the price bid is only provisional***. The contractor shall provide full details of the cost to be incurred to the satisfaction of the employer. Employer shall decide the amount to be paid in this regard and shall be final and binding to the contractor but in no case the quoted price shall be exceeded.

VOLUME – II-A OF III
CHAPTER - 4
TRANSMISSION LINE TOWER

TABLE OF CONTENTS

4 TRANSMISSION LINE TOWER

4.1 General

The scope of work comprises of Design, prototype testing, Supply and erection of steel lattice Four-circuit towers (QB and QC type) and design of 132 kV four-circuit towers of (QA and QD type) and double circuit Dead End Towers (DDE-type) will be provided for 10 km long 132 kV transmission line from Kohalpur to Nepalgunj. The towers shall be self-supporting, hot dip galvanized, latticed steel type & designed to carry the line conductors with necessary insulators, shield wires and all fittings under all loading conditions. Outline diagram of Four-circuit towers are enclosed with the Specification. Please refer to drawing No DWG011.

4.2 Design Spans

The design shall provide for basic, wind and weight spans given in Schedule A.4. of Chapter 11.

The term basic span shall mean the horizontal distance between centers of the adjacent towers on ground level.

The term wind span shall mean half the sum of adjacent horizontal spans lengths supported on any one support.

The term weight span shall mean the equivalent length of the weight of conductor supported at any one support at maximum temperature in still air.

4.3 Conductor and OPGW Clearances

For all supports the clearances from conductors, arc horns, jumper loops and all live metal to the structure or grounded steel work shall not be less than those specified in the table below.

Sr. No	Type of insulator string	Swing in deg.	Min. Live metal Clearance in mm
1	Single suspension insulator string	Nil	2130
		15	1980
		30	1830
		45	1675
		60	-
2	Jumper (without Pilot String)	Nil	2130
		10	2130
		20	1675
		30	-

The length of angle structure cross-arm shall be such as to ensure that the distances between conductors from straight-line structures are maintained in plain normal conductors.

The minimum clearances between the live conductors and other objects at maximum sag condition of the conductor shall not be less than those specified in schedule A.3 of section -11.

Where uplift condition occurs at tension tower positions, details should be provided to show that the above requirements are not infringed.

For 132 kV towers carrying deviation angles up to 30° cross arms shall generally be so proportioned that proper live metal clearances are maintained under all conditions without the use of pilot suspension insulators. Pilot suspension insulator strings must be used on tension structures with deviation angle of 30° or more. However, for tension structures with deviation angle below 30°, suspension insulator strings should be used on locations where sufficient clearance of the jumpers is not available with the structure without any additional cost to the Employer.

The minimum ground clearances from the bottom conductor at maximum sag condition shall not be less than the clearances specified in Schedule A.3 of Section 11.

However, to achieve the above clearance during operation the height of tower shall be increased in the following manner:

a) An allowance of 500 mm shall be provided to account for errors in stringing.
b) Long term conductor creep shall be compensated by over tensioning the conductor at temperature of 21°C lower than the stringing temperature for ACSR BEAR.

The phase distance:

The minimum distance between testing point at insulators shall set as per standard practice at IEC or any other standards. Allowance shall be made for increasing or decreasing the length and varying the arrangement of all terminal tower cross arms to enable span connections to be made in any desire phase sequence.

Where obstructions of other types are met requiring special clearance, the clearance shall be approved by the Employer. If any factors likely to cause infringement of clearance become apparent the Contractor shall inform the Employer immediately.

Clearance between phases:

The distance between conductors belonging to different circuits shall be 1.20 times the distance belonging to the same circuit. However, the distance shall not be less than 3.0 m.

Clearances with OPGW:

The sag of the OPGW for the basic span at the severest condition, shall not be more than 80% of the phase conductors.

4.4 Extensions

The Double Circuit towers for ACSR BEAR Conductor shall be designed so as to be suitable for adding -3M, -1.5M, -/+0M, +1.5M, +3M, +4.5M, +6M, +7.5M and +9M extensions for maintaining adequate ground clearances without reducing the factor of safety (actual stress/ allowable stress) available for the members of tested extensions in any manner. Reference drawings for leg extension arrangement are enclosed in the Bid Document.

The special tower with deviation angle more than 60^0 or Leg extension greater than +9 meter and up to +18 meter shall be treated as DF Tower. Though tower spotting by survey report shows no need of +18 meter DF tower, though, due to some changes in the route in the long course of time after initial survey, check survey report may demand +18 meter DF tower. So the cost of such tower in case of need shall be as per cost offered by successful bidder. **(or spotting should be such that to avoid +18 m leg extension at any case)**

The towers shall be designed for providing unequal extensions with maximum difference between the shortest and the longest leg of 3M for DA tower and 6M for DB, DC and DD/ DDES towers. These unequal extensions to be provided in the design shall be used during tower spotting/ execution stage to optimize the benching/ revetment requirement.

All above basic body/ extension provisions to towers shall be treated as part of basic tower only.

4.5 Tower Design

4.5.1 Design Requirement

Towers shall be self-supporting type of vertical configuration and are designated as suspension towers, tension towers, transposition towers and special (DF) towers. The requirement of transposition and special towers shall be assessed after finalization of the detailed survey, profiles etc. The proposed Double circuit suspension towers shall be provided with single suspension string single conductor and jumper pilot string and double suspension string of EMS rating as specified in relevant section of this document.

The details of Insulators, ACSR BEAR Conductor and OPGW Earth wire are as specified in the Section 11 Schedules A.9, Schedule A.10 & Schedule A.11. The minimum ground clearance and height of bottom conductor, wind spans & weight span are as indicated in the Section 11 Schedule A.3 & Schedule A.4.

In case of certain locations where actual spotting spans exceed the design spans, cross arms and certain members of towers are required to be modified/ reinforced, the bidder shall submit the proposal to Employer for approval for reinforcement.

4.5.2 Base Width of the Towers (Not Applicable)

In view of the difficult hilly/ ridges terrain conditions, forest reaches, restricted ROW of 18 m, narrow based towers are conceived for this Transmission Line so as to minimize the benching, rock cutting/ revetment works. The base width of narrow based basic towers shall be fixed on techno-economic considerations as well to expedite the execution of project. The recommended base widths for different Towers (i.e. Centre to Centre distance between tower legs at the point of connection between legs & chimney for normal ±0 m body extension shall be as follows:

Types of Tower	Minimum Values (meter)	Maximum Values (meter)
QA	3.0	4.5
QB	4.5	5.5
QC	5.5	6.5
DD/ DDES	6.5	7

DF/ Special Tower	7	9.0

As substantial portion of Transmission Line traverses through hilly area, the maximum and minimum weight span under Normal Condition and Broken Wire Condition for Angle Towers shall be based as per CBIP Publication No 323 Tower Manual.

4.5.3 Sag Tension

The sag tension calculation for conductor and earth wire shall be made in accordance with the relevant provision of IS 5613 (Part-2/Sec-I) -1985 of the following load conditions. Appropriate drag co-efficient and gust response factors (Corresponding to Terrain Cat-II) shall be considered for accounting the wind pressure.

Ref. Cl. No. 10.3 of IS802)				
Condition I (Every day Temperature + 100% Wind load)	Condition	Temperature	Wind Load	Ice Load
	0	32°	100% (full)	Nil
Condition II (Minimum Temperature + 36% Wind load)	Condition	Temperature	Wind Load	Ice Load
	0	0°	36% (full)	Nil

In addition, all the standard conditions for Sag Tension calculation as per IS 802 and CBIP Manual shall be considered as per good Industries practice.

4.5.4 Preliminary design

The preliminary design of the towers including suspension and tension tower design shall be prepared at the start of the project which shall be sound in engineering and economical in design. The preliminary design shall consist of all the necessary item/ components required to complete the tower to be erected. This preliminary design shall be presented to the Employer with the line diagram and design calculation for approval. Necessary changes, as per Employer shall be incorporated to the design by the Contractor if necessary, without additional financial implication, and should not affect the period of completion of the project.

The line diagram which is approved by the Employer shall be released for detailed design and for preparation of shop drawing.

4.5.5 Wind Load

The Transmission line is traversing in wind Zone: 4 as per IS 802 and the corresponding wind velocity is 47 m/s. This wind speed is applicable up to height of 10 m at every day temperature of 32^0C corresponding to 3 second peak gust wind. As this transmission line is traversing & encountering hilly/ ridges terrain, higher value of terrain roughness factor, K2 =1.08, corresponding to terrain Cat-I shall be adopted. However the Gust Response factors corresponding to Terrain –II for conductors, Earth wire, Tower and Insulator shall be adopted for accounting the wind pressure.

The above base wind speeds shall be applicable for Four circuit towers. The corresponding Design Wind Pressure on towers, conductors and insulators shall be obtained from the relation $P_d = 0.6V^2$ as follows:

- Reliability Level — 1 (50 yrs return period)
- Risk Co-efficient (k_1) — 1.00
- Terrain Roughness Co-efficient (K_2) — 1.08
- (But Gust factors corresponding to terrain category –II shall be considered for conductors/ earth wire, Tower and Insulator for arriving the wind load)
- Design Wind Speed (V_d) — 47 m /sec

4.5.6 Seismic Consideration

The design of towers and foundations shall be checked for seismic forces under no wind conditions and coefficient of seismic load as per IS: 1893 and check their criticality considering minimum seismic Load magnitude of 0.36g vis-à-vis wind load designs.

4.5.7 Shade Protection (Lightning Consideration)

To protect the line and towers against lightning, the angle of shield for 132 kV double circuit towers shall be less than 30^0.

4.6 Loads on Towers

Loads shall be computed for the following considerations as per IS: 802 (Part I/ Sec1): latest & CBIP publication No: 323, Manual on Transmission Lines and technical specification

i) Classification of Loads

- Climatic Loads under Normal Condition (Reliability)
- Failure Containment Loads (Security Requirements)
- Construction and Maintenance Loads (Safety Requirements)

ii) Computation of Loads

- Transverse Loads comprising Reliability requirements, security requirements and safety requirement
- Vertical Loads comprising Reliability requirements, security requirements and safety requirement
- Longitudinal Loads comprising Reliability requirements, security requirements and safety requirement

iii) Wind Load on Tower

The wind load on towers shall be worked out by dividing the tower into different panels duly considering appropriate drag coefficient and gust response factors.

iv) Wind Load on Conductor/ Ground Wire

The wind load on conductors and ground wire corresponding to wind loads at 100% design wind pressure at every day temperature or 36% wind pressure at minimum temperature shall be worked out on each Line conductor and ground wire considering the average height of conductor/ ground wire up to clamping point on tower less 2/3 of conductor/ ground wire sag at minimum temp and Nil wind pressure.

v) Wind Load on Insulator Strings

Wind load on insulator Strings corresponding to wind loads at 100% design wind pressure at every day temperature or 36% wind pressure at minimum temperature shall be determined from the attachment point to the center line of the conductor in case of suspension towers and up to the end of clamp in case of tension towers in the direction of the wind for design wind pressure. 100% of the area in case of polymer insulator shall be adopted for working out the projected area of insulator string.

4.6.1 Loading Conditions

- Reliability Conditions
  - Transverse Loads
  - Vertical Loads
  - Longitudinal Loads
- Security Conditions
  - Transverse Loads
  - Vertical Loads
  - Longitudinal Loads
  - Narrow front wind load (for Suspension Towers only DA)
- Safety Conditions
  - Transverse Loads
  - Vertical Loads
  - Longitudinal Loads

4.6.2 Specific Details of Loading under Safety Conditions

- **Transverse Loads**

  i) Wind loads to be considered as Nil.

  ii) Mechanical tension at 32°C and Nil wind on account of line deviation shall be considered under Normal and Broken Wire Conditions

- **Vertical Loads**

i) Load of 150 kg to be considered acting at each cross-arm as a provision for weight of lineman with tools

ii) Load of 350 kg to be considered acting at the tip of Cross-arms

iii) Erection load of 1000 kg at each lifting point located a distance of 600 mm from tip of cross-arm

iv) All bracing and redundant members of the towers which are horizontal or inclined up to 15˚ from horizontal shall be designed to with stand an ultimate vertical loads of 150 kg considered acting at center independent of all other loads

v) Loads due to weight of conductors/ ground wire based on design weight span, weight of insulator strings and accessories. For broken wire condition where the load due to due to weight of conductor/ ground wire shall be considered as 60% of weight span.

vi) Self-weight of tower structure up to point/ level under consideration

- **Longitudinal Loads**

  These loads shall be taken as under

i) **For normal conditions** – These loads for dead end towers shall be considered as corresponding to mechanical tension of conductor/ ground wire at everyday temperature and no wind.

ii) For broken wire **conditions**

a) **Suspension Towers** – Longitudinal load per conductor and ground wire shall be considered as 1000 kg and 500 kg respectively.

b) **Tension Towers** - Longitudinal load equal to twice the sagging tension (sagging tension shall be taken as 50 percent of tension at everyday temperature and no wind) for wires under stringing and 1.5 times the sagging tension for all intact wires (stringing completed).

4.6.3 Broken wire criteria

Broken wire conditions as applicable to Four circuit towers during the design of towers:

- **Suspension Tower (0^0 - 2^0) (QA)**

  Any two phases broken on the same side and same span or anyone phase and one ground wire broken on the same side and same span whichever combination is more stringent for a particular member.

- **Small (0^0 -15^0) and Medium angle tension towers (15^0 -- 30^0) (QB, QC)**

  Any two phases broken on the same side and same span or anyone phase and one ground wire broken on the same side and same span whichever combination is more stringent for a particular member.

- **Large angle tension towers (30^0-60^0) and dead end towers (QD, DD)**

  Any three phase broken on the same side and same span or any two phases and one ground wire broken on the same side and same span whichever combination is more stringent for a particular member.

- **Extra Large angle tension towers (60^0-90^0) (QF) or Special Tower**

Manjan

Any three phase broken on the same side and same span or any two phases and one ground wire broken on the same side and same span whichever combination is more stringent for a particular member.

4.6.4 Anti-cascading checks

All Tension towers shall be checked for anti-cascading/ sectional considerations with all conductors and ground wire intact only on one side of the tower.

- **Transverse Loads**

These loads shall be taken under NIL wind condition.

- **Vertical Loads**

These loads shall be the sum of weight of conductor/ ground wire as per weight span of intact conductor/ ground wire, weight of insulator strings and accessories.

- **Longitudinal Load**

These loads shall be pull of conductor/ ground wire at everyday temperature and NIL wind applied simultaneously at all points on one side with zero-degree line deviation.

4.6.5 Tension Limits

Line Conductor/ ground wire tension at everyday temperature and without external load, should not exceed the following percentage of the ultimate tensile strength of the conductor:

- Initial unloaded tension 35%
- The final unloaded tension of conductors at every day temperature for Transmission line shall not exceed 22% of UTS of conductor and 20% of UTS of ground wire.

Provided that the ultimate tension under everyday temperature and 100% design wind pressure, or minimum temperature and 36% design wind pressure does not exceed 50% of the ultimate tensile strength of the conductor/ ground wire.

4.6.6 Strength Factors Related to Quality

The reduction in strength due to dimensional tolerance of the structural sections and yield strength of steel used, the following strength factors shall be considered:

i. If steel with minimum guaranteed yield strength is used for fabrication of tower, the estimated loads shall be increased by a factor of 1.02.

ii. If steel with minimum guaranteed yield strength is not used for fabrication of tower, the estimated loads shall be increased by a factor of 1.05. In addition to the provision (i) above.

4.7 Details of Structural Steel

Details of structural steel		
a)	Steel quality	IS:2062, BS:4360

Details of structural steel			
	1. Minimum guaranteed yield stress (kg/cm^2)		
		MS	2600
		HT	3600
	2. Maximum allowable stress (kg/cm2) for tension members (on net area)		
		MS	2600
		HT	3600
	3. For compression member (on gross area)		
		MS	As per IS:802
		HT	As per IS:802
b)	Details of nuts & bolts		
	1. Shear stress on shank of class 5.6 bolts (kg/cm^2)		3160
	2. Bearing stress on shank of class 5.6bolts (kg/cm2)		
		MS	4440
		HT	6322
	3. Tension on net area of the thread (kg/mm2) Class 5.6		2590

4.8 Slenderness Ratio L/R

The Slenderness ratio (L/R) {Ratio of maximum un-braced or unsupported length (L) to the least radius of gyration (R)} of a member shall not exceed:

a. For Compression Members

Leg members, ground wire peak and cross arm chord members: 120

Bracing and other member having calculated stress : 200

Redundant or Secondary members without calculated stress: 250

b. For Tension Members

All tension Members : 400

In determining the slenderness ratios for various members suitable provisions shall be taken into consideration for various types of end connections, eccentricity of load transfer in the members effective length of members as per the CBIP Manual Guideline Annexure-12 and 13.

4.9 Miscellaneous Design Criteria

a) Redundant Members

Redundant members, if placed at an angle less than 15^0, are required to be checked to withstand bending also due to mid-point concentrated load of 150 kg independent of other loads

b) Bolted Joint

In case where the bolt and structural member are of different materials, the lowest of the ultimate strength of bolt and structural member governs the breaking strength of the joint.

c) Framing

The angle between any two members common to a joint of a trussed frame shall preferably be greater than 20^0 and never less than 15^0 due to un-certainty of stress distribution between two closely spaced members.

d) Gusset Plates

Minimum thickness of gusset shall be 2mm more than the lattice it connects, only in case when the lattice is directly connected on the gusset outside the leg member. In no case gusset shall be less than 5mm in thickness

e) Minimum Thickness of Members

Leg Members : 6 mm

Other Members : 4 mm

f) Minimum size of Members : ISA 45x45x4mm

g) Minimum Width of Flange

Minimum flange widths for bolts of different diameter are given as under:

Bolt Día (mm)	16	20	24
Flange Width (mm)	45	50	60
Thickness of spring washers (mm)	3.5	4.0	4.5

The Loading trees for Reliability, Security, Safety conditions of all towers shall be prepared and ensure that the proposed tower geometry is satisfying all essential electrical clearances before design of the tower.

The unsupported length of stub between chimney and the last bracing connection to the leg should also be checked for combined direct and bending stresses and an additional cleat of required size be provided. The supporting calculations shall also be provided. The design of stub & foundation cleats shall be designed as per the CBIP manual & ASCE 10-97, ASCE-52.

The structural assembly drawing should be prepared according to IS 696 and IS 962. The drawing shall show the complete design dimensions, member length, slope factors or triangles, section sizes, bend lines, gauge lines, diameter, length and number of bolts, spacers, washers, sizes of gusset plates, position of holes etc., and relative location of various members.

Sufficient number of elevation, cross section and plan view should be presented to clearly indicate the details of joints and arrangement of members.

All members should be clearly shown and respective identification mark allotted to each member.

The drawing should be drawn to scale large enough to convey the information adequately.

All connection should be detailed to minimize eccentricity of connections. Due consideration should be given to the additional stresses introduced in the member on account of eccentricity of connection.

Dimension of all members and on a member, the distances such as hole – to – hole, length, gauge distance etc., should be given in full integers and not in decimals.

4.10 Construction of Tower Steel work

All designs shall be such that no trouble shall arise in service from vibration or excessive deflection due to the use of too light a section.

Bolt holes shall not be more than 1.5 mm larger in diameter than the corresponding bolt diameter. The distance from the center of bolt holes to the edge of any steel section shall not be less than 1.5 times the diameter of the bolt.

All tower member joints or joints between prefabricated panels to be made at Site shall be secured with bolts, nuts and washers. As far as conveniently possible, bolt heads, rather than nuts, shall be on the outer or upper faces of support joints.

Structure cross-arms shall be so arranged that they can be disconnected from the body without disturbing main structure body members.

The conductor landing points on cross-arms shall be so arranged that an additional hole for the attachment of conductor erection and maintenance tackle is provided adjacent to each hole for tension shackles. It shall be possible to apply full conductor tension and weight safely to these additional attachment points.

Mild steel when stored in the fabricators stockyard prior to fabrication and galvanizing shall be marked continuously throughout its length with a light blue water paint line. In addition, the grade number of the steel shall be painted on and ringed around with paint.

Members that are capable of being fitted in more than one position on the structure shall all be of the grade of steel suitable for the most onerous loading conditions.

4.10.1 Step bolts

Two diagonally opposite legs of all structures shall be equipped with galvanized step bolts (M16 x 160mm) confirming IS:10238 on the leg at intervals not exceeding 380 mm commencing immediately above the anti-climbing device and extending to within one meter of OPGW. Step bolt design shall be to the approval of the Employer or the Employer's Representative. Holes for removable step bolts below the anti-climbing device shall be provided at no more than 380 mm intervals on the legs to which the permanent step bolts are fitted.

Fifty (50) nos. spare step bolts shall be supplied for fixing in the above holes whenever required.

4.10.2 Workmanship

All work shall be in accordance with the best modern practice in the manufacture and fabrication of materials covered by this specification. The Contractor shall be responsible for the correct fitting of all parts, shall replace free of cost any defective material discovered during erection and pay all costs of field corrections for such replacement. All parts of the structure shall be neatly finished and free from kinks, twists or bends. All holes shall be made with sharp tools and shall be clean cut without torn or ragged edge. The fabrication shall be in strict compliance with the shop drawings prepared by the Contractor and approved by the Employer or the Employer's Representative.

Structural materials shall be straight and cleaned of all rust and dirt before laid out or worked in any manner. Shearing and cutting shall be performed carefully. Manually guided cutting torches shall not be used.

All bolt holes in steel members shall be punched, sub-punched, reamed or drilled before galvanizing. Holes shall be drilled instead of being punched if the thickness of the metal exceeds the diameter of the hole. All holes shall be clean-cut and without torn or ragged edges. All holes shall be cylindrical and perpendicular to the member.

The diameter of the finished bolt hole shall not be greater than the normal diameter of the bolt plus 1.5 mm. Plugging, welding or slotting of mis punched, mis reamed or mis drilled holes will not be permitted. The holes shall be located accurately so that when the members are in position the holes will be lined up before being bolted.

4.10.3 Member fabrication-galvanising

All galvanizing shall be carried out by the hot dip process and shall conform in all respects with BS 729.

All surface defects in the steel including cracks surface laminations, laps and folds shall be removed in accordance with BS 4360/IS 2629/IS 209/IS2633. All drilling, cutting, welding, forming and final, fabrications of unit members and assemblies shall be completed before the structures are galvanized. The surface of the steelwork to be galvanized shall be free from welding slag, paint, oil, grease and similar contaminants.

The preparation for galvanizing and the galvanizing itself shall not distort or adversely affect the mechanical properties of the material.

For all parts other than steel wires the coating shall consist of at least 610 grams of zinc per square meter of surface and be not less than 0.086 mm in thickness for steel members thickness equals to or more than 5mm.

At least 460 grams of zinc per square meter and 0.065 mm for thickness of members less than 5mm.

On removal from the galvanizing bath the resultant coating shall be smooth continuous free from gross surface imperfections such as bare, spits, lumps, blisters and inclusions of flux, ash or dross.

During off loading and erection of supports the use of nylon or braided slings shall be used. Galvanized steel work which is to be stored in the works or on site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining.

Small areas of the galvanized coating damaged in any way shall be restored in accordance with the procedures to be approved by the Employer.

Tests on samples shall be carried out to BS 729/IS 4759/IS6745/IS14394. The Contractor is required to furnish Elcometer or any other appropriate equipment for verification of galvanizing thickness of tower members at site to the satisfaction and the equipment shall be the property of the Employer at the completion of all works. Price of the said equipment is deemed to be included in the contract.

4.10.4 Bolts and nuts

No bolt of diameter less than 16mm shall be used. No screwed threads shall form part of shearing plane between members.

When in position all bolts or screwed rods shall project through the corresponding nuts by at least one full thread but such projection shall not exceed 10mm.

Bolts shall be galvanized after thread cutting to the same specified coating weight as specified in BS 729/IS1367/IS1368/IS12427 /IS14394

Spring washers shall confirm to IS3063 and pack & plain washers confirm IS6821.

Nuts and heads of all bolts shall be hexagonal.

All bolts, nuts and washers shall be hot dip galvanized and subsequently centrifuged (according to BS 729). Nuts shall be tapped after galvanizing and the threads oiled to permit the nuts to be finger turned on the bolt for the full depth of the nut.

After fixing, bolt heads, washers and nuts shall receive two coats of zinc rich paint. Only one type of bolt for the whole project, either mild steel or high tension steel will be permitted in order to prevent inadvertent misuse. The Contractor shall state clearly which type of bolt his designs are based upon.

All bolts supplied for this contract will be provided with one nut and one spring washer of approved design. Taper washers and packers are to be fitted where necessary.

The Contractor shall select two samples of each type of bolt and nut to be used on the Contract and send these samples to the Employer or the Employer's Representative for approval within one month of the effective date of the Contract. The Employer or the Employer's Representative will then reject bolt consignments, which in his opinion fall in any respect below the standard of samples submitted and approved.

4.10.5 Payment for Line Tower

Payment for the contract item, "Line tower" including any required painting, will be made at the unit bid price per tower type. For supply, the tower is divided into Basic body and leg extension. For Erection the unit price shall include all cost incurred in transportation and erection of a complete tower. Therefore, in the Price Schedule, the unit bid price shall include full compensation for all the costs incurred in furnishing all materials, equipment, labors and all other operational related to tower design, fabrication delivery etc. as specified.

4.11 Tower Earthing

4.11.1 General

In addition to the mechanical OPGW termination requirement, all steel towers shall be fitted with separate earth bonds for OPGW continuity and the Contractor shall provide all necessary connecting facilities.

All the four legs of the tower shall be connected to the earth through electrode as shown in Drawing Nos. DWG008 and DWG009.

The footing resistance shall be measured by the Contractor and approved by the Employer or the Employer's Representative for every tower prior to the stringing of the OPGW. The maximum footing resistance to the general mass of earth shall be 10 Ohms.

Steel towers need not be fitted with a separate earth bond and earthing continuity throughout the support will therefore depend upon surface contact between members.

All towers shall be provided with means for connecting an additional earthing device as required by the Employer or the Employer's Representative. Holes are to be provided in all supports near ground level to take bolts for earth lead connections.

All legs of every tower shall be equipped with galvanized steel wire and cast into the foundation concrete to be readily available for the connection of additional earth electrodes in the event of the initial footing resistance exceeding 10 ohms. Bidder's rates for the structures shall include for such additional works.

Galvanized steel rods shall be driven where necessary in sufficient number to ensure the combined structure footing and earth electrode resistance does not exceed 10 Ohms. Where it is necessary to drive more than one earth electrode at any support, the locations shall be to the approval of the Employer or the Employer's Representative. All earth electrodes shall be electrically bonded together using galvanized steel wire.

The tops of all electrodes shall be at least 500 mm below the surface of the normal reinstated ground level.

Connection of earth wires to the structure stub-angles shall be by bolting. Bidders shall submit details of their proposals in this regard.

4.11.2 Payment for Grounding Materials

Payment for grounding materials shall be made at the unit price bid. Therefore, in the Price Schedule, the unit bid price shall include full compensation for all the costs incurred in furnishing all materials, equipment, labors and other operational related to the scope of work of earthing as specified. Each set shall mean one complete set for each tower footing.

4.12 Tower Accessories

4.12.1 Anti-climbing device

At a height of at least 3 m from floor or normal ground level (whichever is the higher) an adjustable anti climbing frame shall be fitted to all faces of each tower.

The device for tower shall also prevent climbing access inside the structure body.

At each climbing leg a suitable gate shall be provided to allow access by the Employers maintenance staff.

4.12.2 Danger, Phase and Number Plate

All structures shall be equipped with a suitable framework mounted immediately above the anti-climbing device level, to accommodate the followings in a conspicuous position:

a) One (1) Danger Sign
b) One (1) Tower Number Sign
c) Two (2) Circuit Plate
d) Twelve (12) Phase Signs (Phase Color Plates)

All terminal structures shall be equipped with additional frameworks, mounted immediately above the anti-climbing device level, to accommodate a set of three phase color plates.

All plates shall be affixed to the framework by means of galvanized bolts, nuts and lockouts. Washers should be of such material and so positioned that damage to the enamel will be prevented. The height for fixing these accessories shall not be more than 4.5 m above the ground level. The corners of the number, danger & circuit plate shall be rounded off to remove sharp edges. All plates shall be manufactured from mild steel sheet with vitreous enameled finish. The letters figure and the conventional skull and bones of danger plates shall conform to IS:2551-1963 and shall be in a signal red on the front of the plate. A detail drawing for such plates shall be prepared by Contractor subject to the Employer's approval.

Line color-coded vitreous enamel identification plates should be fitted to the climbing legs of every structure in accordance with line color code scheme to be supplied to the successful Bidder. Each plate shall be approximately 70 mm wide and shall be applied one immediately below the anti-climb device, one halfway up the towers and one immediately below the lowest cross arm.

4.12.3 Arial Patrol Sign (Aviation Sign)

The Contractor shall install Aerial Marker Balls along the length of OPGW to act as a visual warning so low flying aircraft don't run into them in the vicinity of airports or aviation route as required. The size of such aerial balls shall not be less than 91 cm to be observed from and distinctively shaped (spherical or cylindrical). Orange, Red & White are some of the most commonly used colors in such aerial markers. After final check survey, the Contractor shall propose the sections where such aviation signs are essential. The Employer reserves the right to approve the sections proposed by the Contractor.

Payment of such aviation signs shall be made in accordance to the BoQ and one set is meant to number of such balls in one section of line (i.e. in between two adjacent towers)

4.12.4 BIRD GUARDS

To prevent birds perching immediately above the suspension insulator string of suspension and/ or tension towers and fouling the same with dropping, suitable bird guards shall be provided at cross arm tips of all suspension towers. The bird guard arrangement shall be such that it shall either prevent bird from perching in position where they are liable to cause the damages or ensure that if birds do perch, dropping will fall clear of the insulator string.

4.12.5 Payment for Tower Accessories

Payment for tower accessories such as anti-climbing device, danger sign, tower number sign, circuit plate, phase sign, areal patrol sign, and bird guards shall be made at the unit price. Therefore, in the Price Schedule, the unit bid price shall include full compensation for all the costs incurred in furnishing all materials, equipment, labors and other operational related to the scope of work as specified.

4.13 Final Design and Design Drawing

The detailed design shall be prepared in line with the approved line diagram, which shall be submitted to the Employer in required number of copies.

The tower accessories drawings like anti climbing device, danger sign, tower number sign, circuit plate, phase sign, areal patrol sign, and bird guards, step bolt, D-shackle etc. shall also be prepared by the Contractor and shall be submitted to the Employer required number of copies along with the soft copies in USB Flash Drive. These drawings shall be prepared in A4 size sheet only.

Once the design is approved, the approved design drawing shall be submitted to Employer in four copies, along with one soft copy. The overall responsibility of fabricating tower for its correctness lies with the Bidder only, and should ensure that all the tower members can be fitted without any undue strain on them.

4.13.1 Shop drawing

The shop drawings shall be prepared based on the approved design drawing. Shop drawing should contain complete information necessary for fabrication of the component parts of the structure. These drawings should clearly show the member size, length and marks, hole positions, gauge lines, bend lines, edge distances, amount of chipping and notching etc.

For gusset fabrication, separate individual item wise template can be made to facilitate gusset fabrication as well as inspection. In case of member to be bent, shop drawing should indicate the provision for variation in length. At the design/ drawing stage itself, drawing should indicate that the degree of bend given in any member such that neither flange width nor thickness shall vary beyond permissible limits.

Items requiring steep bending may be cut and welded as per approved welding procedure.

At the time of proto stage/ tower testing itself specific bend gauge and template to locate the holes after bending must be established for the items to be bent.

4.13.2 Bill of Material

Bill of material for each type of tower and extensions required should be prepared separately. This should indicate grade of steel (like high tensile steel, mild steel etc.), mark numbers, section sizes, member's lengths, their calculated weights, type & number of bolts, nuts and washer and their sizes, total quantities and structural drawing numbers.

4.13.3 Marking

Each individual member shall have an erection mark conforming to the component number given to it in the fabrication drawings. This mark shall be made with marking dies of 16 mm size before galvanizing and shall be legible after galvanizing.

A-BB-CC-DDD

A	=	NEA's code assigned to the Bidder –Alphabet
BB	=	Bidder's Mark-Numerical
CCC	=	Tower type-Alphabet + Numerical
DD	=	Number mark to be assigned by Bidder -Numerical.
HT	=	High Tensile steel

4.13.4 Shop Erection/ Proto type Tower Assembly

Steel work should be temporarily erected in horizontal or vertical so that accuracy of the member can be checked before testing the towers or commencing mass fabrication as applicable. The proto assembly is done on the basis of approved structural shop drawings of towers, all leg extensions, stubs & templates for all types of towers.

4.14 Testing of Towers

4.14.1 General

Testing of tower generally serves as guide to good tower design and therefore shall not be considered as requisite proof test for all towers. The test shall be conducted on full scale prototype tower as per the approved loading schedules and rigging diagram. The members constituting the prototype shall be of same grade of steel as specified in the design and fabrication shall conform to the provision stipulated in IS 802 (Part – II). The tower shall be tested on rigid foundation.

The test tower shall successfully withstand the ultimate loads specified for various conditions.

4.14.2 Leg Anchorage

The tower shall be erected vertically on rigid foundation with as much unbraced portion of the stub protruding above ground level as provided in the drawing.

4.14.3 Calibration of Measuring Instruments

All measuring instruments shall be calibrated in a systemic manner with the help of standard weights. The calibration shall, before commencing the test on each tower, be done up to the maximum anticipated load to be applied during testing. Calibration curves for the instrument to be used during testing shall be drawn by the testing authorities and the test loads shall be suitably corrected with the help of these curves.

Calibration of load cells shall be done with Universal Testing Machine (UTM) or by using standard weights. The UTM in turn shall be calibrated once in every six months or periodically as per advice of the supplier of UTM.

4.14.4 Types of Tests

- Bolt-Slip Test
- Load Tests
    - Reliability Condition (Normal Condition)
    - Security and Safety Conditions as well as Anti-Cascade Conditions
    - Broken Wire Condition
- Destruction Test including Material test after Destruction Test

4.14.5 Method of Load Application

Load shall be applied according to approved rigging diagram through normal wire attachments, angles, or bent [plates. U bolt/ D shackle or swinging brackets (hangers) may be used in the test tower if desired by the Employer, provided that satisfactory and safe rigging is attained.

The various type of loads, transverse, vertical and longitudinal shall be applied in such a way that there is no impact loading on the tower due to jerk from the winches.

Loading cases (values, direction and points of application of loads) shall be determined by the Bidder and get approved form the Employer before applying to the test towers.

4.14.6 Loads and Deflection Measurement

Harijan

All loads shall be measured through a suitable arrangement of strain devices or by using weights. Positioning of strain devices shall be such that the effect of pulley friction is eliminated. In case the pulley friction cannot be avoided the same shall be measured by means of standard weight and accounted for in the test loads.

Tower deflection under loads shall be measured by suitable procedure at the top cross arm level on the front side of the transverse and longitudinal faces or front and rear side of the transverse faces. Deflection reading shall be recorded for the 'before load', ' load on' and 'load off' conditions.

4.14.7 Testing Procedure

Bolt slip test – In bolt slip test, the test loads up to 50% of Ultimate Normal Condition (Reliability Condition) Loads are gradually applied and kept constant for 1 minute at these loads and then the loads are released gradually.

The initial and final reading on the scale before application and after the release of loads respectively shall be taken with the help of theodolite. The difference between these readings gives the value of the bolt slip.

Normal load/ broken wire load tests – All loads shall be applied gradually up to the ultimate design loads in the following steps and shall be released in the similar manner:

- 25%
- 50%
- 75%
- 90%
- 95%
- 100%

4.14.8 Observation Periods

Under normal and broken wire load tests, the tower shall be kept under observation for sign of failure for one minute (excluding the time for adjustment of loads) for all intermediate steps of loading up to and including 95 % of ultimate design loads.

For normal as well as broken wire tests, the tower shall be kept under observation for five minutes after it is loaded up to 100 percent ultimate loads.

While the loading operations are in progress, the tower shall be constantly watched, and is it shows any tendency of failure anywhere, the loading shall be immediately stopped, released and then the entire tower shall be inspected. The reloading shall be started only after the corrective measures are taken.

4.14.9 Recording

The deflection of the tower shall be recorded at each intermediate and final stage of normal loads/ broken wire load test by means of a theodolite and graduated scale.

4.14.10 Destruction Test

If the Employer desired so, destruction test for the tower shall be carried out.

Destruction test shall be carried out under normal condition or broken wire condition as agreed between the Employer and the Bidder.

All the provision of the specification and IS 802 for normal and broken wire conditions shall be applicable to destruction tests of Double circuit towers during the design of towers.

4.15 Material Quality Control

Various grade of steel used in tower, details of sections, bolts and nuts and other accessories need a detailed scrutiny and quality control procedure before being processed for fabrication, assembly etc. All structural material including nuts and bolts shall be in compliance with their respective Indian and international Standards.

Chemical composition and mechanical properties of various grade of steel used shall be clearly mentioned and those shall be in accordance with relevant IS or international standards.

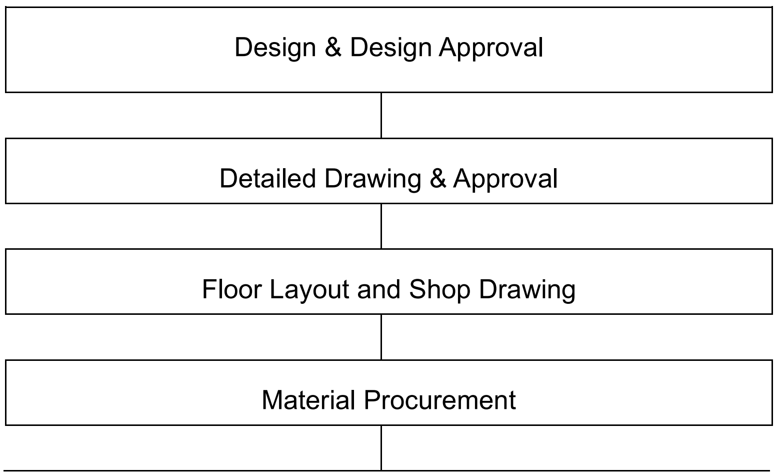
Steel Sections of tested quality in conformity with IS: 2062 (Designated Yield Strength. 250 MPa) and/ or IS: 8500 grade 490 (Designated Yield Strength 350 MPa) are to be used in towers, extensions, stubs and stub setting templates. The Contractor can use other equivalent grade of structural steel angle sections and plates conforming to latest International Standards. However, use of steel grade having designated yield strength more than that of EN 10025 grade S355 JR/JO (designated yield strength 355 MPa) is not permitted, unless otherwise indicated in this specification.

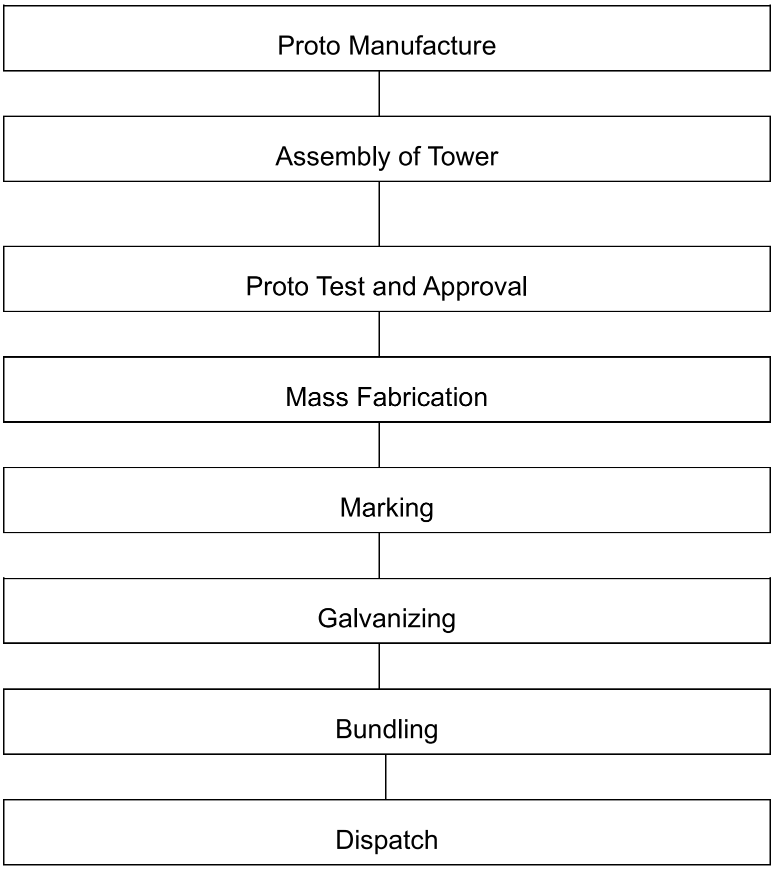
For designing of towers, preferably rationalized steel sections shall be used. During execution of the project, if any particular section is not available, the same shall be substituted by higher section. Any cost on account of the same shall be borne by the Bidder. However, design approval for such substitution shall be obtained from the Employer before any substitution and records of such substitutions shall be maintained by the Bidder.

At the time of procurement of steel other than that conforming to IS 2062, green color on the edge of HT material on both sides is applied so that there is no mix up of MS and HT steel in stockyard as well as in shop. A distinct green color patch is maintained throughout and on shop sketch also, HT marking is added for identifying high tensile steel item.

4.16 Process Flow Chart for Fabrication of Towers

In general, following flow chart shall be followed for design, assembly, testing and supply of towers:





4.17 Packing (Tower wise)

Angle section shall be wire bundled.

Cleat angles, gusset plates, brackets, fillet plate, hanger and similar loose pieces shall be tied and bolted together in multiples or securely wired through holes. Bolts, nuts washers and other attachments shall be packed in double gunny bags accurately tagged in accordance with the contents. The packing shall be properly done to avoid losses & damages during transit. Each bundle or package shall be appropriately marked. It is however recommended that the Contractor make bundle for each tower as per tower number before dispatch of tower parts to avoid member sorting problem at site.

4.18 Standards

The design, manufacturing, fabrication, galvanizing, testing, erection procedure and materials used for manufacture and erection of towers, design and construction of foundations shall conform to the following Indian Standards (IS)/ International Standards which shall mean latest revisions, with amendments/ changes adopted and published, unless specifically stated otherwise in the Specification. In the event of supply of material conforming to Standards other than specified, the Bidder shall confirm in his bid that these Standards are equivalent to those specified. In case of award, salient features of comparison between the Standards proposed by the Bidder and those specified in this document will be provided by the Contractor to establish their equivalence.

The material and services covered under these specifications shall be performed as per requirements of the relevant standard code referred hereinafter against each set of equipment and services. Other internationally acceptable standards which ensure equal or higher performance than those specified shall also be accepted.

Sl. No.	Indian Standards (IS) Standards / Guides	Title	Internationally recognized
1.	IS: 209-1992	Specification for Zinc	ISO/R/752 ASTM B6
2.	IS: 278-1991	Galvanized Steel Barbed wire	ASTM A131
3.	IS: 800-2007	Code of Practice for General Building Construction in Steel	CSA 6.1
4. (a)	IS: 802(Part1) Sec 1-1995	Code of Practice for General	ASCE 52
		Building Construction in Steel Sec 2-1992 in Overhead Transmission Line Towers: Materials, loads and Permissible Stresses	IEC 826 BS 8100
		Section 1 Materials and loads	
		Section 2 Permissible stresses.	
4. (b)	IS: 802-1990 (Part 2)	Code of practice for use of structural steel in over-head Transmission Line : Fabrication, Galvanizing, Inspection and Packing	
4. (c)	IS: 802-1990 (Part 3)	Code of practice for use of Structural Steel in over-load Transmission Line Towers Testing	ASCE 52 IEC 652
5.	IS: 808-1991	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections.	
6.	IS: 875-1992	Code of Practice for Design Loads (other than Earthquakes) for Buildings and Structures.	
7.	IS: 1363-1990	IS: 1363-1990 Hexagon Nuts(size range M5 to M36)	
8.	IS: 1367-1992	Technical Supply Conditions for Threaded Steel/ Fasteners	
9.	IS: 1477-1990	Code of practice for Painting of Ferrous Metals in Buildings:	
		Part-I Pre-treatment	

Sl. No.	Indian Standards (IS) Standards / Guides	Title	Internationally recognized
		Part-II Painting	
10.	IS: 1573-1991	Electro-Plated Coatings of zinc on iron and Steel	
11.	IS: 1852-1993	Rolling and Cutting Tolerances of Hot Rolled Steel Products	
12.	IS-1893-1991	Criteria for Earthquake Resistant Design of Structures	IEEE 693
13.	IS: 2016-1992	Plain Washers ISO/R887	ANSIB18-22.1
14.	IS: 2062-1992	Steel for general structural purposes	
15.	IS: 2074-1992	Ready Mixed Paint. Air Drying, Red Oxide, Zinc Chrome, Priming Specification.	
16.	IS: 2551-1990	Danger Notice Plates	
17.	IS: 2629-1990	Recommended Practice for Hot Dip Galvanizing of iron and steel.	
18.	IS: 2633-1992	Method of Testing Uniformity of Coating of Zinc Coated Articles	ASTM A123 CSA G164
19.	IS: 3043-1991	Code of Practice for Earthing	
20.	IS: 3063-1994	Single coil Rectangular section Spring Washers for Bolts, Nuts Screws	DIN-127
21.	IS: 3757-1992	High Strength Structural Bolts	
22.	IS: 4759-1990	Specification for Hot zinc coatings on structural steel and other Allied products	
23.	IS: 5369-1991	General Requirements for Plain Washers	
24.	IS: 5613-1993	Code of Practice for Design installation and Maintenance of Overhead Power Lines	
		Section 1 Design Part 2,	
		Section 2 Installation and Maintenance	
25.	IS: 6610-1991	Specification for Heavy Washers for Steel structures.	

Sl. No.	Indian Standards (IS) Standards / Guides	Title	Internationally recognized
26.	IS: 6623-1992	High Strength Structural Nuts	
27.	IS: 6639-1990	Hexagon Bolts for Steel Structure.	ASTM A394 CSA B334
28.	IS: 6745-1990	Method for Determination of weight of Zinc coated iron and Steel Articles.	ASTM A90
29.	IS: 8500-1992	Specification for Weldable Structural Steel (Medium & High Strength Qualities)	
30.	IS: 10238-1989	Step Bolts for Steel Structures	
31.	IS: 12427-1988	Bolts for Transmission Line Towers	
32.	IS:4091-1979	Code of practice for design and construction of foundation for transmission line between tower & poles.	
33.	IS:5358	Specification for hot dip galvanized coating and fasteners	
34.	IS: 7215-1992	Specification for tolerance for fabrication of steel structures	

VOLUME – II-A OF III

CHAPTER - 5

TOWER FOUNDATION AND CIVIL WORKS

TABLE OF CONTENT

5 TOWER FOUNDATION AND CIVIL WORKS

5.1 General

The Contractor shall furnish all materials, equipment and labor and perform all operations required for the design and construction of all of the concrete foundations and other relevant civil works, as specified herein and as evidently necessary to complete the work.

Before start of design of foundation, successful bidder shall carry out geotechnical investigation during detailed/ check survey of Transmission Line route primarily consists of laying trial bore-holes (normally up to 6.0 meter below natural ground level) at all tower locations or as directed by the Employer to have a fair idea of soil type/ nature and subsoil water position. If the soil characteristics are changing rapidly or soil up to 6.0 meter is very weak, the depth of bore-hole be increased beyond 6.0 meters so as to know the soil properties/ type below the foundation. The bore log data containing information such as position of sub-soil water table, soil strata, the crop pattern in the agricultural fields where the foundation is to be laid and the suitability for founding the required foundation, shall be submitted to the Employer for according approval for “Classification of foundation” at each location.

5.2 Foundation Design

General

The foundation for tower structure plays an important role in the safety and satisfactory performance of the structure as it transmits the load from the structure to the soil. Therefore, the foundation shall be so designed to carry the entire load as required, with sufficient factor of safety as recommended by the Code of practices.

The foundation in various types of soils shall be designed to suit the soil conditions of particular type, from the recommendation of the geotechnical investigation report, which has to be approved by the Employer.

Several types of foundations are used for different type of transmission towers and different types of soil. The foundation should be strong and stable, and able to take care of all the loads like dead load, live load, wind loads, seismic load, erection loads etc., causing vertical thrust, uplift as well as horizontal reaction.

The quantity of foundations in every type given in the Price Schedule is provisional only and may vary as per the result of the detail soil test.

Foundations should be designed for a working life of 50 years and Bidders should comply in full with the requirements of these specifications in establishing his design. In all locations, all steelwork, whether part of the tower or part of the stub angle foundations shall be completely encased in concrete to ensure a cover of 100mm from any part of the stub leg or tower from a point 300mm above ground down to the base of the main foundation block. All Stubs shall have cleats designed to carry the entire stub load.

The Contractor shall design at least one foundation for each of the foundation types specified on the bid drawings for all types of towers used in the line to produce an economical family drawings and calculation for the approval of the Employer or Employer's representative before commencement of construction. Upon completion of detail soil test, the Contractor shall select the most economical foundation subject to the approval of the Employer or Employer's representative. The general foundation design parameters are given in Schedule A. 13 and Conceptual Drawing is given in Dwg. No. DWG012.

Submittal

The Contractor shall submit for each type of foundation required number of sets of design calculations, detail drawings and reinforcing steel and concrete schedules to the Employer or Employer's representative for review and approval/ comment before construction commences. Review of the foundation designs by the Employer or Employer's representative in no way relieves the Contractor from his responsibility for an adequate foundation design, even though this specification sets forth the basic foundation design criteria. Upon receiving the Employer's or Employer's representative's comments, the Contractor shall submit to the Employer required number of sets, electronic copy and prints of drawings of all foundation details, including reinforcing steel schedules on drawing sheet sizes, form, heading, etc., as required by the Employer for record.

Structural Design of Foundation

It comprises the design of chimney and the design of base slab/ pyramid/ block. Structure design of chimney shall be suitable for maximum bending moments due to side thrust in transverse and longitudinal directions combined with uplift (tension), down thrust (compression). The combined uplift and bending shall determine the requirement of longitudinal reinforcement in the chimney. The stub angle shall be embedded in the chimney to its full depth and anchored to the bottom slab/ pyramid. The chimney shall be designed considering the passive resistance of soil leaving 500 mm from ground level.

Design of foundation based on stub embedded in the chimney for required development length alone and the same is not taken to bottom of the foundation, is not permitted.

Structural Design of Base Slab

The base slab in RCC foundation may be single stepped or uniform. The design of concrete foundation shall be done as per Limit state method of design given in IS: 456.

Criteria for Structural Design of Foundation

a) Isolated identical footings shall be provided for each leg of the tower.

b) All foundations shall be designed so as to satisfy and meet the following requirements:

   i) The chimney of the foundation shall at least be 400 mm square providing a minimum clear concrete cover of not less than 100 mm over any part of the stub angle in case of dry foundations and at least 450 mm square with minimum clear concrete cover of not less than 150 mm over any part of the stub angle in case wet, fully submerged foundations.

   ii) The chimney top shall extend 500 mm (Minimum) above ground level and coping shall be up to 50 mm below the joint between the bottom bracing and the leg members.

   iii) In all foundations, a lean concrete sub-base having a thickness of 100 mm and of size equal the concrete pyramid base/ RCC shall be provided under structural concrete. The lean concrete shall be of grade M-10 (1:3:6) conforming to IS: 456-2000. The lean concrete sub-base provided under the footings shall not be considered in the structural calculations.

   iv) The embedded end of the stub angle shall have a 150 mm thick clear concrete cover up to the top of the lean concrete sub-base in the case of dry foundations and a 200 mm thick clear concrete cover in the case of wet, partially submerged and fully submerged foundations.

   v) The depth of foundation below ground level shall not be more than 3.0 m.

   vi) The centroidal axis of the stub shall coincide with axis of the chimney and pass through the centre of the footing base. The design of the foundation shall take into account the additional forces resulting from eccentricity introduced due to non-compliance of above requirements.

   vii) Wherever reinforcement is provided in foundation, the clear concrete cover to reinforcement shall not be less than 50 mm.

   viii) The slab type isolated RCC foundations shall also satisfy and meet the following requirements:

      - The structural design of foundations shall be strictly in accordance with IS: 456-2000 and other relevant IS codes.
      - The design of RCC foundations shall be carried out by Limit state method in accordance with IS: 456-2000.
      - The minimum thickness of footing slab at chimney perimeter shall not be less than 300

mm.

- The minimum thickness of footing slab at the edges shall not be less than 150 mm as specified in IS: 456-2000.
- In the design of the footing slabs, actual soil pressure under the footing shall be considered to calculate the maximum moments and shears at various sections. The critical sections for moments and shears shall be as specified in IS: 456-2000. The reinforcement in the footings shall be accordingly calculated and provided.

5.3 Design loads

The loads used to design the foundations shall be actual loads applied to the foundations by the towers.

The foundations shall be designed in such a manner that the factors of safety shall not be less than the following requirements:

Types of loads on foundations

The foundation may be subjected to three types of forces (ultimate loads):

- Compression or downward thrust
- Tension or uplift, and
- Lateral force or side thrust in both transverse and longitudinal directions.

The magnitudes of each of type of load depend on the type of tower and configuration of the transmission lines.

Partial Factors of safety for foundation design

a) Towers up to an angle of 15 deg deviation 1.1

b) Towers above an angle of 15 deg deviation 1.2

Weight of concrete (kg/m^3)		Dry	Wet, PS and FS
1.	Plain (M10)	2240	1240
2.	RCC (M15)	2400	1400
3.	RCC (M20)	2400	1400

S.N	Type of Soil	Angle of Earth Frustum. (deg)	Unit weight of soil (kg/m^3)	Limit Bearing Capacity (kg/cm^2)
1	Normal Dry Soil			
	Without Under-cut	30	1440	25,000
2.	wet soil due to presence of sub	15	940	12,500

	soil water / surface water			
3.	Black Cotton soil (a) in dry portion (b) in wet portion	 0 0	 1440 940	 12,500 12,500
4.	Sandy soil (a) with clay content 0-5% (b) with clay content 5-10%	 10 20	 1440 1440	 25,000 25,000
5.	Fissured Rock / Soft Rock (b) In wet portion	 10	 940	 62,500
6.	Hard Rock	-	-	1,25,000

Unless specified otherwise, design and details shall comply with the latest published editions of BS /IS 6403, IS456, IS 1786, CBIP Tower manual or with other standard specifications provided they are of equal or higher standard. Support foundation designs which in the opinion of the Employer or Employer's representative do not demonstrate an acceptable type of foundation for the type of soil condition will be rejected.

5.4 Foundation type

In some section of the proposed transmission line, water level of terrain is high. In such cases the foundation is to be designed for fully submerged condition. If required by the Employer, the Contractor shall construct embankments for tower sites where footings are located in standing water of sloughs, pot holes and marshes. No separate payments shall be made for such embankments.

Reinforced cement concrete footing shall be used for all types of normal towers/ extension towers in conformity with the present day practices followed in the country and the specifications laid herein. All the four footings of the tower and their extensions, if any shall be similar irrespective of down thrust and uplift.

Foundation includes supply of materials such as cement, fine and coarse aggregates, water, reinforcement steel and binding wire etc. Rates quoted for foundations shall include all items of work relating to supply and installation of foundations such as form work, excavation and back filing with good soil, compaction, stub setting, shoring & timbering etc. where ever required, placing of reinforcement in position, concreting and all other works related for completion of foundation.

Classification of Foundations

General Classification of Foundations

The foundation classification shall depend upon the type of soil, subsoil water level and the presence of surface water which have been classified as follows:

a. Dry Foundation

To be used for locations where normal dry cohesive or non- cohesive soils are met and sub- soil water is met at 3.5 meters or more below the ground level

b. Wet Foundation

To be used for locations:

i. Where sub- soil water is met at 1.5 meters or more below the ground level.

ii. Which are in surface water for long periods with water penetration not exceeding one meter below the ground level e.g. the paddy fields.

c. Fully Submerged Foundation

To be used at locations where sub-soil water is met at less than 1.5 meters below the ground level.

d. Dry Fissured Rock Foundation

To be used at locations where decomposed or fissured rock, hard gravel, kankar, limestone, laterite or any other soil of similar nature is met and sub- soil water is met at 3.5 meters or more below the ground level. Under cut type foundations is to be used for this Foundation.

e. Wet Fissured Rock Foundation

To be used at locations where decomposed or fissured rock, hard gravel, kankar, limestone, laterite or any other soil of similar nature is met and sub- soil water is met at 1.5 meters or more below the ground level. Under cut type foundations is to be used for this Foundation.

f. Hard Rock Foundation

The locations where chiselling, drilling and blasting is required for excavation, hard rock type foundations are to be used. For these locations rock anchoring is to be provided to resist the uplift forces.

For quoting prices of Hard Rock foundations Rock level shall be assumed at 1.5 meters below the ground level. Due to change in Rock level, no extra payment shall be payable on account of increase in concrete volume, excavation volume and weight of reinforcement, also no recovery shall be made if the actual volume of concrete, excavation and weight of reinforcement are less than that quoted in Schedule of prices. However, for design purpose, Rock level shall be considered at ground level and no over burden soil weight shall be considered for resisting the uplift.

g. In addition to above, if required, depending on the site conditions special type foundations shall also be provided by the Contractor suitable for intermediate conditions under the above classifications to affect more economy for following reasons:

a) Shallow Depth or ***Raised Chimney foundations*** are necessarily required to suit the site condition or

b) Soil properties as per the soil report at particular location are found inferior than that considered in design. However, in case, soil properties as per soil report are found superior than that considered in design, no change in foundation design/ price shall be applicable.

The proposal for special foundations shall be submitted by the Contractor based on the detailed soil investigation report to suit site conditions and approval for the same shall be obtained from the Employer. Decision of the Employer shall be final and binding with respect to requirement of special foundation.

Payment for concreting and reinforcement bar for ***raised chimney foundation*** shall be made in accordance to unit rate as stated in BoQ. But no extra Payment of foundation excavation and back filling, shoring, formwork etc shall be made on such item.

5.5 Footings

Concrete spread footing

The foundation shall be designed to carry maximum shear loads below ground level, that is, the stub legs are not to be considered as reinforcement. Allowance shall be made for the loss of uplift resistance due to overlap of frusta where applicable. Uplift foundations shall be cast against undisturbed soil for a minimum height of 250 mm and 50 mm lean concrete.

For the purpose of bidding the Bidder shall design each type of foundation with the value of soil bearing capacity as stated in Foundation Application Schedule.

These are only reference values and are taken from similar type of soil location from nearby site. After award of contract the Contractor shall carry out detail soil test of support site and shall design each type of support foundation accordingly. No extra payment will be made for change in the quantity of concrete/ rebar and other associated works due to change in design parameters.

Pile Foundation

This type of foundation is usually adopted when soil is very weak and has very poor bearing capacity or foundation has to be located in filled up soil or tower are to be erected in the land which is prone to flash flood. Piles are long and slender members which transfer load to the deeper soil or rock of high bearing capacity avoiding the shallow soil of low bearing capacity.

The piles should be cast in place fast setting concrete which should have 28 day cubical compressive strength of 210 kg/sq.cm.

The pile should be designed for the pile diameter of 900mm.

Piles in a footing should be firmly connected by horizontal tie beam of minimum 900x900mm sizes with adequate reinforcement which should be 1.5m above the existing ground level.

Though NEA has not envisaged the need of Pile foundation in this route, incases need is seen after soil test, separate cost estimate along with design should be provided by contractor for approval without any extra cost for such design and estimation.

All arrangement for anchor plate (or any other arrangement) with anchor bolts etc whichever is appropriate for the connection of the tower legs to the foundation shall be in the scope of the pile foundation.

Spread foundation in hard rock

The rock which cannot be excavated using normal tools and require chiseling, drilling and blasting are classified as hard rock. These include hard sand stone, quartzite, granite, basalt, marble etc.

The foundation in hard rock shall be designed to carry maximum shear loads below ground level, that is, the stub legs are not to be considered as reinforcement. Allowance shall be made for the loss of uplift resistance due to overlap of frusta where applicable. The footing should be safe against overturning. In case if it is unsafe against overturning, appropriate measures (e.g. counter weight) should be provided.

5.6 Stub Angle Anchor

Stub Angle

Tower Stub angles shall be of galvanized steel and shall have cross-sectional area of not less than the structure leg member to which it will be attached. The stub angle shall not be included in the calculation of the steel reinforcement requirements against bending and tension forces in concrete foundation design.

Only those holes in the stub which have been previously punched and galvanized at the manufactures works will be used for the attachment of cleats. Site drilling will not be permitted.

Stub setting template

Stub setting templates, to approval of Employer or Employer's representative, shall be provided by the Contractor. They shall be of such design and construction as to resist distortion and damage and withstand repetitive use. They shall be manufactured from mild steel angle or channel or a combination of both, of approved and adequate cross- section, and shall be equipped with central alignment notches or holes corner braces, riser braces, and stub-angles in respect of the following requirements:

- Route longitudinal center line
- Structure lateral central line
- Stub elevations (with reference to datum)
- Stub leveling
- Stub rake
- Stub hip bevels
- Stub angle spacing

No concreting shall be commenced before the stub setting is approved by the Employer or Employer's representative. After the completion of Works all the template sets shall be handed over to Employer. No extra payment for the design, manufacturing and delivery for the templates shall be claimed by the Contractor.

5.7 Excavation and Backfilling

Scope

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

General

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

b. The Contractor shall carry out the check survey of the site before excavation and set properly all lines and establish levels for foundations.

c. The excavation shall be done to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades on ground excavated areas and warning lamps at night for ensuring safety.

d. The item also includes for dumping of excavated materials in regular heaps, bunds, riprap with regular slopes as directed by the Employer or Employer's representative, within the lead specified and leveling the same so as to provide natural drainage. Rock/nSoil excavated shall be stacked properly as directed by the Employer or Employer's representative. As a rule, all softer material shall be laid along the center of the heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.

e. Clearing

   The area to be excavated/ filled shall be cleared of trees, plants, logs, stumps, bush, vegetation, rubbish, slush etc. and other objectionable matter. If any roots or stumps of trees are met during excavation, they shall also be removed. The materials so removed shall be burnt or disposed-off as directed by the Employer. Where earth fill is intended, the area shall be stripped of all loose/ soft patches, topsoil containing objectionable matter/ materials before filling commences.

f. Precious object, relics, objects of archeological importance

   All gold, silver, oil, mineral, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the Employer and Contractor shall duly preserve the same to the satisfaction of the Employer and from time to time deliver the same to such person or persons as the Employer may from time to time authorize or appoint to receive the found goods.

g. The Contractor shall excavate earth, rock, stumps and all other materials encountered as required for construction of each foundation. The Contractor shall place all suitable excavated material in backfill or in graded embankment in the immediate area at structures. Materials found to be unsuitable for foundation backfill or grading shall be wasted and disposed at Contractor's own cost.

h. The Contractor shall excavate each foundation hole to the nominal excavation depth for the applicable foundation type except in case where the material being excavated is not capable of supporting 0.5 kg/sq.cm.

i. At the nominal excavation depth, the foundation shall be carefully graded to a level plane and all loose or disturbed material shall be removed. The foundation excavation shall then be examined by the Contractor and a final determination will be made on the foundation type to be used.

j. Excavations shall be maintained in a clean, safe and sound condition until completion of the foundation construction and shall be diked to prevent flooding by surface runoff. Suitable pumping equipment shall be provided and used to dewater excavations so that all installation work and backfilling is performed in the dry state. Any previously prepared foundation bearing surface that is softened by water runoff or otherwise contaminated before placement of the structure foundation shall be excavated and replaced at the Contractor's expense.

k. Those excavations where the base is unstable, lies below groundwater level, or has been over excavated, the Contractor shall furnish and place a layer of crushed stone, or selected backfill, or borrow to stabilize the base for placement of foundation materials. No extra payment shall be done for over-excavation and backfilled crushed stone layer.

l. Topsoil and excavated material that is suitable for backfill around the foundations shall be stockpiled separately for use in backfill. Material that is unsuitable for backfill shall be disposed of. The stockpiles shall be sloped to drain and shall be protected from rainfall or other elements, which render the material unsuitable for backfill.

m. Backfill shall be placed in not greater than 20cm lifts before compaction. Each lift shall b thoroughly compacted before the following lift is placed. Pneumatic or equivalent tampers shall be used on cohesive materials; vibratory compactors shall be used on non-cohesive materials. Compaction shall achieve a density at least equal to that of the surrounding undisturbed earth. Large stones or rock fragments may be used in the backfill provided they do not interfere with proper compaction. Particles larger than 25 cm shall be placed not nearer than 0.5 m of the structure and at least 1.0m below ground surface.

n. Rock particles larger than 10 cm shall not be in contact with the concrete.

o. Following completion of 75 percent of the compacted backfill portion, the remaining backfill and topsoil shall be placed and the topsoil mounded 30 cm above the ground surface and sloped to drain. Compaction of this material will not be required. Before final acceptance of the Works, the Contractor shall refill any locations that settle below the surface of the surrounding ground.

p. Earth is defined as material which shall include all kinds of soil containing gravel, sand, silt, moorum or shingle, gravel, clay, loam, peat, ash, etc. which can generally be excavated with the aid of shovels and pick axes. This shall also include embedded rock boulders not longer than one meter in any direction and not more than 200 mm in any of the other two directions.

q. Rock is defined as material which shall include rock, boulders, shale, chalk, slate, hard mica, schist, laterite and all other materials which in the opinion of the Employer is rock and can be removed with picks, hammer, wedges, crowbars, pneumatic breaking equipment and blasting. This category shall also include excavation in macadam and tarred roads and pavements.

r. Rock excavation may be made by drilling, barring, wedging, or compressed-air tools. No blasting will be permitted. The Contractor shall furnish all material and equipment to perform all work required for excavation of rock.

   For selection of rock type foundation for any tower location, the characteristics of rock shall be thoroughly investigated by the Contractor. Disintegrated rock or other types of rock such as soluble limestone, soft shale, slate, hard pan and organic rocks may not be suitable for construction of rock foundation.

s. All loose boulders, semidetached rocks (along with earthy mounds) not directly in the excavation area but so close to the area to be excavated as to be liable, in the opinion of the Employer, to fall or endanger the workman, equipment or the Works, shall be stripped off and removed away from the area of the works. Any material not requiring removal as contemplated in the work, but which in the opinion of the Employer is likely to become loose or unstable later, shall also be promptly and satisfactorily removed as directed by the Employer.

Payment:

No separate or direct payment will be made to the Contractor for preparation of site, excavation, and backfill and rock excavation of tower foundation. All costs of soil and rock excavation incurred in connection therewith shall be included in the unit bid prices for the construction of the various foundation types.

5.8 Dewatering

Scope

This specification covers the general requirements of dewatering during excavations in general.

a. All excavations shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas.

   The Contractor shall remove by pumping or other means approved by the Employer or Employer's representative any water inclusive of rainwater and subsoil water accumulated in excavation and keep all excavations/trenches free of water required for further work.

   Method of pumping shall be approved by the Employer or Employer's representative; but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing-in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction.

b. When there is a continuous inflow of water and quantum of water to be handled is considered in the opinion of the Employer as large, well- point system- single stage or multistage shall be adopted. The Contractor shall submit to the Employer his scheme of well-point system including the stages, the spacing number and diameter of well points, headers, etc., and the number, capacity and location of pumps for approval.

Payment

No separate or direct payment will be made to the Contractor for dewatering of tower foundation and any other foundation works. All costs incurred in connection therewith shall be included in the unit bid prices for the construction of the various foundations and other civil works.

5.9 Timber Shoring

Scope

This specification covers the general requirements of timber shoring for open excavations for structure foundation.

a. Close timbering shall be done by completely covering the sides of the pits generally with short, upright members called polling boards. These shall be of minimum 25 cm x 4-cm sections or as directed by the Employer or Employer's representative.

   The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal walling of strong wood at maximum 1.2 meters spacing, strutted with bellies or as directed by the Employer or Employer's representative. The length of the bellies struts shall depend on the excavation and supported by vertical walling, which in turn shall be suitably strutted. The lowest boards supporting the sides of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

b. Timber shoring shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit. The type of timbering shall be as approved by the Employer. It shall be the responsibility of Contractor to take all necessary steps to prevent the sides of excavations, pits, etc., from collapsing.

c. Timber shoring may be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instruction from the Employer.

Payment

No separate payment will be made to the Contractor for timber shoring. All costs incurred in connection therewith shall be included in the unit bid prices for the construction of the various foundation types and other civil works.

5.10 Select Borrow

a. Where the material excavated for the foundation is unsuitable for backfill or is required for construction of embankment, the Contractor shall provide and compact select borrow. Excavated material shall be disposed at the Contractor's own expense.

b. Material for select borrow shall be well-graded bank-run gravel, relatively free from clay, loam or vegetation matter and with no stones over 10 cm in maximum dimensions, or materials of equivalent strength and characteristics. Representative sample from proposed borrow sources shall be submitted to the Employer for approval of the borrow source. Approval of borrow source shall not mean automatic approval of all materials obtained from that source.

c. The Contractor shall, at his option, use areas approved by the Employer or Employer's representative for production of select borrow or at his own expense, make arrangements for obtaining select borrow at other sources.

d. The select borrow shall be placed and compacted as specified for the backfill in Article 5.7 Excavation and Backfilling.

Payment:

No separate payment will be made to the Contractor for select borrow required for back filling tower foundation. Hence, all costs incurred in connection therewith shall be included in the unit bid prices for the construction of the various foundation types and other civil works.

5.11 Foundation Construction

General requirement

All materials and labor required for the construction of foundations shall be furnished by the Contractor.

a. The Contractor will be required to remove and replace at his expense any materials incorporated in the work that do not conform to these specifications.

b. The Contractor shall furnish without any extra cost all materials the Employer require for testing. The cost of the tests shall be borne by the Contractor.

c. The final selection of the type of foundation footing to be actually constructed for each particular structure will be done by the Contractor after the results of the sub soil tests and shall be subject to the approval of the Employer.

Measurement for Foundation Payment

Measurement for payment for the Contract item, Foundations, shall be on the basis of the actual number of each type of structure foundations constructed by the Contractor.

Payment

Payment for the contract item, “Foundation”, will be made at the unit price per tower, such unit price shall include full compensation for all costs incurred in furnishing all materials, equipment and labor and all other operations related to Foundation design and construction, including but not limited to:

i) Performing detail foundation design and preparation of construction drawings.

ii) Supply and transporting all foundation materials such as concrete, reinforcement, etc to the job site.

iii) Tower pegging and foundation orientation.

iv) Excavation, dewatering, timber shoring and backfilling for the foundation.

v) Gravel packing in the base of footings, where necessary.

vi) Template and stub setting

vii) Lean concrete

viii) Construction of foundations and associated works.

Reference to standard specifications

Standards referred to in these specifications are as follows:

a. ASTM referred to the latest edition of publications of American Society for the Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

b. ACI refers to the latest edition of publications of American Concrete Institute, P.O. Box 19150, Redford Station, and Detroit, Michigan 48219.

c. BIS referrers to the latest ,Bureau of Indian Standard Manak Bhawan, 9. Bahadur Shah Zafar Marg, New Delhi India.

Measurement Standards

Measurement standards referred to in these specifications are as follows:

a. Gallons - Wherever used in these specifications, gallons shall be understood to be U.S. gallons.

b. Bag - Wherever used in these specifications, bag will be understood to mean 50-kg bag of Portland cement. Concrete shall be composed of cement, sand, coarse aggregate, water and admixtures, if required, all well mixed and brought to the proper consistency.

Concrete

The Contractor shall design and test concrete mixes, which have 28-day cubicle compressive strength of 210 kg/ sq.cm.

a. At least one month prior to the placement of any concrete, the Contractor shall make a set of test concrete compressive strength test cubes for each design mix under field conditions. The test cubes shall be made and tested in accordance with the applicable standards.

b. The concrete mix shall be of such proportions as to produce a plastic and workable mix which will not separate during the placing and will finish well without using excessive quantities of mixing water. Addition of water to compensate for stiffening of concrete before placing will not be permitted. Uniformity in concrete consistency from batch to batch will be required.

c. After the test results are known for the field condition test cubes, the Contractor shall submit these result to the Employer or Employer's representative and the Employer or Employer's representative will notify the Contractor of the approval of test results and the acceptable design mixes.

d. When placing concrete in hot weather, the recommendations of the American Concrete Institute's publication "Recommended Practice for Hot Weather Concreting"(ACI 605) or equivalent shall be followed insofar as the Employer or Employer's representative may direct.

   The use of set accelerators will be at the Employer's or Employer's representative's discretion. For concrete placed during extremely hot weather, the aggregate shall be cooled by frequent water spraying in such a manner as to utilize the cooling effect of evaporation. Concrete with a temperature of 35 degree centigrade or higher before placement will be rejected and shall be wasted at the Contractor's expense.

e. Submerge concrete

   Concrete to be placed under water shall be deposited by tremie, and only after it has been determined by the Employer or Employer's representative that placing of concrete in an unwatered excavation cannot be practically accomplished by any other means. The tremie will not be allowed to drop below the level of water outside. Under no circumstances will concrete be allowed to drop through water within the tremie.

   The tremie shall be watertight and sufficiently large to permit a free flow of concrete. The bottom of the tremie shall be as near to the surface against which the concrete is to be placed as practicable and the tremie shall not be raised until seal has been established by the concrete sufficiently to prevent the entry of water of the tremie. The discharge of the tremie shall be kept submerged in concrete at sufficient depth so as to maintain an adequate seal during underwater placement. Placing of concrete shall proceed without interruption until underwater placing in the foundation has been accomplished. As placing of concrete under water progresses, the Contractor shall remove water displaced by the concrete when the top of the concrete being placed by tremie reaches the elevation of the water table level; no further placement by tremie shall be performed.

f. The concrete used as lean concrete or base concrete shall be as mentioned on respective drawings. The aggregate size shall be 40 mm nominal. Base concrete shall be well compacted. The top surface of base concrete shall be leveled before placing the reinforcement.

g. During excavation, if excavation exceeds the required depth or if any loose pocket of earth is met below the base of footing, then the loose earth shall be removed or excavation depth be increased till normal hard soil is met as per satisfaction of the Employer. This extra depth shall be filled with lean concrete. No extra shall be paid on account of this extra excavation and lean concrete.

h. The cement concrete used for foundation shall be of grade M-20 (1:1.5:3) nominal Mix (1:1.5:3) conforming to IS 456 using 20mm size coarse aggregate shall be adopted.

i. The Water Cement ratio shall be minimum 0.50 and maximum 0.55.

j. For volumetric use of ingredients for concrete mix, the contractor along with the Mix Design shall intimate the size of measuring boxes along with the Mix design.

k. The nominal of Mix Design shall not absolve the contractor from the responsibility of achieving the required strength, workability etc. during actual execution. In case of failure of concrete samples, the work done is liable to be rejected. In such case the contractor shall recast the foundation at the same location by dismantling the rejected foundation or at a nearby location as directed by the Employer. In case of honey combing, the contractor shall do the pressure grouting as directed and to the full satisfaction of the Employer. The construction of new foundation in place of rejected one and pressure grouting if done shall be without any extra payment.

l. The water used for mixing concrete and for curing purpose shall be fresh, clean and free from oils, acids and alkalis, organic materials or other deleterious substance. Potable water is generally preferred. Saltish or brackish water shall not be used. Water used shall conform to clause 5.4 of IS 456.

Cement and Aggregates

In locations where conditions do not require high sulphate resistance, cement shall conform to the requirements of ASTM C150 Type T or equivalent(IS263, IS8112,IS12269)

a. In locations where, in the opinion of the Employer or Employer's representative, the conditions require the use of high sulphate resistance cement, cement conforming to the requirements of ASTM C150 Type V or equivalent shall be used. No extra payment will be made to the Contractor for the use of high sulphate resistance cement.

b. The aggregates shall consist of clean, natural material or, subject to the approval of the Employer or Employer's representative, manufactured aggregates may be used.

c. Aggregates shall be separated into sand and coarse aggregate before being used. The Employer or Employer's representative will permit no pit or crusher run materials without prior approval.

d. Natural fine aggregate or sand shall be graded within the following limits and the fineness module be between 2.5 and 2.8 as per IS 383:

Sieve size		Amounts Finer than Each weight Percent
Laboratory (U.S Std. Sieve)		
3/8	(9.5mm)	100
4	(4.75mm)	95 to 100
8	(2.36mm)	80 to 100
16	(1.18mm)	50 to 85
30	(600 micron)	25 to 60
50	(300 micron)	10 to 30
100	(150 micron)	2 to 10

Natural coarse aggregate shall be graded within the following limits, depending upon the clear spacing between reinforcing bars.

U.S. Standard Sieve		Nominal 1-1/2"	Nominal 3/4" (19mm)
2"	(50.8mm)	100	

U.S. Standard Sieve		Nominal 1-1/2"	Nominal 3/4" (19mm)
1-1/2"	(25-38mm)	95-100	
1"	(25mm)	70-95	100
3/4"	(19mm)	35-70	90-100
3/8"	(9.5mm)	10-30	20-55
No.4	(4.75mm)	0-5	0-10
No.8	(2.36mm)		

Slump

All concrete used shall have a slump of maximum 120 mm and minimum 75 mm at the time of placing. The water cement ratio shall be determined by consideration of the specified strength, the water reducing admixtures, the slump required for proper placement, air entraining requirements the available and maximum allowable aggregate size and its specific gravity, and the amount of water carried on the aggregates.

The slumps and maximum sizes of aggregate as well as, the computation of trail mixes shall be as described in the America concrete Institute Recommended Practice for Selected Proportions for concrete (ACI 613).

Storage of material

Cement and aggregates shall be stored at the Site of the work in such manner as to prevent deterioration or intrusion of foreign matter in Contractor’s own cost. Special care shall be taken in storing cement to keep it thoroughly dry at all times.

a. Cement that has been caked in storage is still usable only if, when pressed between the thumb and fingers, it powders readily. Otherwise, its use will not be permitted.

b. When reinforcing steel is delivered to the job site in advance of the Contractor's requirements, the Contractor shall provide suitable protection in order to prevent rust developing on the reinforcing steel as it will be Contractor's responsibility to remove the rust.

Concrete mixing and placing

Before any concrete mixing is begun, all equipment for mixing, transporting and debris shall be cleaned of all dirt and debris. All dirt and debris shall also be removed from the places to be occupied by the concrete.

a. All mechanical equipment shall be checked before starting a concrete pour to ascertain whether or not it is in good operating condition and if not shall be tuned-up, or repaired, or replaced to the satisfaction of the Employer or Employer's representative. Also the stock of construction material (cement, aggregate and sand) shall be checked before starting the concreting work to ascertain whether or not it is in sufficient quantity for one foundation work.

b. When a foundation location is ready for concrete placement, the Employer shall be notified at least 24 hours prior to concreting so that he may inspect to assure that the excavation is free of water, mud and debris; that the bottom surface of the excavation is well leveled and compacted; and where required, a crushed stone sub-base has been placed; that the reinforcing steel is properly secured in place; and that the formwork is properly braced.

c. Rock surfaces shall be as flat as possible and projecting ridges shall be leveled off before the concrete is placed or spaces between the ridges shall have been previously filled with concrete to form a horizontal surface.

d. The Contractor shall see that all material that is to be embedded in the concrete has been placed before the concrete is placed. The Contractor shall be responsible for the accurate location of all embedded materials. Any work inaccurately or improperly set shall be relocated and reset at the Contractor's expense.

e. All batching components of the concrete shall be accurately measured. Measuring on a weight basis is preferred, however, measuring on a volume basis will be allowed as long as careful controls are maintained. Weight measurements shall be made using standard batching equipment for large quantities and wheelbarrow scales for small quantities. Volume measurements shall be made in batching boxes. The batching boxes shall be as large as is practical.

f. The batch mixer shall be rotated at a speed recommended by the manufacturer and mixing shall be continued for at least one and one-half (1-1/2) minutes after all materials are in the mixer, unless the size of the batch is over 1.2 cu.m., when additional mixing time shall be required as advised by the Employer. A mechanically-operated batch mixer shall be used for mixing unless otherwise approved by the Employer.

g. The tempering of concrete which has partially hardened, that is, remixing with or without additional cement, aggregate or water, will not be permitted.

h. Concrete shall be conveyed from the mixer to the place of final deposit within 30 minutes by methods which will prevent the segregation or loss of the materials. After 30 minutes of mixing the concrete shall be rejected and replaced by fresh concrete without any extra cost to the Employer.

i. Equipment for chuting, pumping and pneumatically conveying concrete shall be of such size and design as to ensure a practically continuous flow of concrete at the delivery end without separation of the materials. The chutes shall never be on a slope that is steeper than two vertical to three horizontal. Conveying equipment shall not have any aluminum parts that come in contact with the concrete.

j. When the concrete is to be placed on hard rock or other concrete, after the existing surface has been properly cleaned and otherwise prepared, the existing surface is to be wetted until it is saturated. The first batch of concrete placed shall be a grout obtained by omitting the coarse aggregate from the mix and reducing the water as required. The grout shall be evenly spread on the water-saturated surface and then the concrete shall be deposited continuously and as rapidly as practicable.

k. The concreting shall be carried on at such a rate that the concrete is at all time plastic and flows readily into the spaces between the bars and so that each successive layer properly bonds with its predecessor. Successive layers shall be placed within 15 minutes of the preceding layer.

l. When placing foundations with drops over 2 meters, hoppers and trunks must be provided of a size to allow for proper placing.

   Not less than four hoppers of any size shall be available and used, if requested, and a sufficient number of sections of trunk shall be furnished to reach within 500 mm of the bottom of the foundation.

m. The concrete shall be compacted during and after depositing by vibration. The concrete shall be thoroughly worked around embedded materials.

n. All concrete must be consolidated by means of internal vibration except where the Employer has given written permission to use some other method of consolidation. The type and make of vibrator must have a speed of at least 6,000 vibrations per minute (VPM) when the machine is being supplied at its rated voltage, air pressure, etc. The Contractor shall at his own expense, furnish sufficient transformers, compressors, etc. of approved type to operate all vibrators at the voltage, pressure, etc., specified by the manufacturer.

o. The Contractor shall always have at least two vibrators in operating condition at the location of the concrete placement.

The Contractor shall make one set of concrete compressive strength test cubes for each structure or as directed by the Employer or Employer's representative. There shall be three cubes to a set and the cubes shall be made in accordance with ASTM C31. Only one cube shall be made from any one batch containing less the 1/2 cubic meters of concrete. The Contractor shall also make one set of concrete compressing strength test cube for each new batch of cement purchased two week before using that cement.

After the cubes have aged at least 24 hours in the field, the Contractor shall deliver them to a location designated by the Employer where they will be tested in accordance with ASTM C39/IS 516. If two of the cubes tested at 28-day tests indicate a compressive strength of 210kg/sq.cm (3,000 psi) or more, the remaining cubes shall be discarded. If the 28-day compressive strength indicates a compressive strength of less than 210kg/sq.cm., the Employer or Employer's representative will determine what remedial measures are necessary and the Contractor shall perform the remedial measures at his own expense. The remedial measures may include, but are not limited to, the replacement of the entire foundation. Payment of foundation works shall only be initiated after submission of satisfactory cube test report to the satisfaction of the Employer.

Concrete formwork

Forms shall be used, wherever necessary, to confine the concrete for structures and shape it to the required lines, or to insure against contamination of the concrete by materials caving or sloughing from adjacent surfaces left by excavation.

a. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, and shall be maintained rigidly in position. Forms shall be sufficiently tight to prevent loss of mortar from the concrete. Molding strips shall be placed in the corners of forms so as to produce chamfered edges on permanently exposed concrete surfaces. All exposed surfaces may be formed with any material of adequate strength and tightness to hold the wet concrete in proper position and prevent the loss of mortar.

b. If plywood or steel forms are not readily available, the Contractor with Employer's special recommendation may substitute wood planking provided exposed surfaces are rubbed to remove ridges on exposed surfaces.

c. The Contractor shall provide templates, which firmly hold the stub angles within 10 mm of the horizontal side setting dimensions and within 5 mm of the required elevation during the placing of the concrete. Details of the templates shall be submitted to the Employer or Employer's representative at least one month before the commencement of any foundation construction. The bottom portion of the structure may be used for this purpose providing that adequate cribbing and bracing are supplied for support.

d. Before concrete is placed, the surfaces of all forms shall be oiled with a form oil that effectively prevents sticking and will not stain the concrete surfaces. For wood forms, form oil shall consist of straight, refined, pale paraffin mineral oil. For steel forms, form oil shall consist of refined mineral oil compound.

e. Forms shall be removed only when the strength of the concrete is such that form removal will not result in cracking, spelling, or breaking of edges of surfaces, or other damage to the concrete. Usually formwork shall be removed after 48 hours from concreting times. Any concrete damaged by form removal or otherwise shall be repaired immediately without any extra cost to the Employer.

Concrete finishing and curing

a. The exposed top surfaces of all concrete foundation piers shall be slightly sloped to prevent the accumulation of water.

b. Immediately after the removal of forms, the holes left by form tie rod fasteners shall be filled with mortar and all damaged or defective concrete shall be repaired or removed and replaced to the satisfaction of the Employer or Employer's representative. Improperly consolidated concrete shall be removed by chipping, and the chipped openings or recesses shall be of such depth and shape as required by the Employer or Employer's representative to insure that the patching material placed in the openings or recesses will be thoroughly keyed and bonded to the concrete. "Dry pack" mortar shall be used for filling relatively deep required for the replacement of defective concrete where surface dimensions of the chipped openings or recesses are relatively large. The depth of chipped recesses for concrete patches shall extend at least 25 mm beyond the nearest reinforcing steel.

c. To ensure proper curing, all concrete shall be kept moist for a period of at least 10 days. Burlap or an equivalent material or a curing compound shall be applied over exposed concrete surfaces. The burlap shall be kept moist at all times. If the foundation is backfilled before the one-week curing time has elapsed, the burlap protection shall remain on the exposed projection.

Membrane curing compound

Membrane curing compound shall be applied uniformly by spray, leaving no pinholes or gaps, at a rate not to exceed 4.91 square meter per liter. The curing compound shall be applied after finishing operations are completed and surface moisture has disappeared. If forms are removed prior to 7 days after placing the concrete, the uncovered surfaces shall be coated with the curing compound as specified herein.

a. Foundation shall not be backfilled before they have been inspected to see that they are free from surface defects and voids, or that the defects and voids have been properly repaired.

b. The foundations shall not be subjected to any loads in addition to those existing at the time of the placing of the foundation concrete until the curing period has elapsed.

Torsteel Reinforcing Bar

All torsteel-reinforcing bars shall conform to the requirements of Grade fe-415 (IS :1786) and shall be fabricated in accordance with the "Manual of Standard Practice" of the Concrete Reinforcing Steel Institute.

a. Mill scale, rust, oil and mud shall be removed from reinforcing steel by firm rubbing with burlap or equivalent treatment before the reinforcing steel is placed.

b. The minimum center-to-center distance between parallel bars shall be two and one-half (2-1/2) times the diameter of the bars. In no case shall the clear spacing between bars be less than 25 mm nor less than one and one-third (1-1/3) times the maximum size of coarse aggregate.

c. All torsteel-reinforcing bars shall have a protective concrete cover of not less than:

- 50 mm - on the bottoms of footings and on any surface of concrete that will be exposed to salt water.
- 50 mm - concrete exposed to weather or ground.

d. Torsteel reinforcing bar shall be accurately located and shall be secured in position by the use of annealed iron wire of no less than No.16 gauge, and shall be supported in a manner that will keep the reinforcement away from the exposed concrete surfaces. Concrete blocks shall be used to support the reinforcing steel in the foundation mat; broken stones or wooden blocks shall not be used for supporting the reinforcing steel.

Payment

No separate or direct payment will be made to the Contractor for concrete, lean concrete, tests, form works, etc. reinforcement bars of tower foundation. All costs incurred in connection therewith shall be included in the unit bid price for the construction of the various types of towers.

5.12 Foundation Protection Works

The Contractor shall suggest for foundation protection works where needed. The Employer will evaluate and give instruction for the protection design. The Contractor shall design the protection work and submit design of such protection works for Employer's or Engineer's approval.

5.12.1 Random rubble stone masonry including excavation (1:5 cement concrete)

The stone shall be hand placed with uncoursed close joints to the lines and grades as designed. The rubble stone shall be placed with 1:5 cement mortar after having joints thoroughly moistened. The surface joints shall be finished with 1:3 cement mortar.

After completion of masonry wall, it shall be cured with water for more than 10 hrs.

Weep-holes with Perforated Poly Vinyl Chloride (PVC) pipes of 10 cm in diameter shall be made in each 2 sq. m. of slope surface of the masonry wall or as required by site conditions. The upper surface of the masonry wall shall be finish smooth with concrete. The perforated pipe shall be extended at least 30 cm both ends from the stone masonry wall & in the backfilling end the perforated PVC shall be covered with gravel at least 30 cm in all-around.

The sides of the stone masonry wall should be backfilled, compacted and leveled as directed by Engineer.

Payment:

Measurement for payment of Random rubble stone masonry works shall be made on the basis of actual placed volume of stone masonry in cubic meters. Payment shall be made for the number of cubic meters measured as provided at the unit price specified in the schedule. The unit price shall include all labor, tools and equipment, materials including furnishing, transporting and placing the materials, installation of PVC pipes, excavation, gravel packing and all other cost necessary for the performance and completion of the work.

5.12.2 Stone bound in galvanizing wire netting (Gabion) including excavation

The standard type gabion shall be a flexible hot dip galvanized gabion of the type and size specified below. It is made of wire mesh of the type and size and selvedge as specified in the following:

- The mesh shall be hexagonal woven mesh with the joints formed by twisting each pair of wires through three and half turns.
- The size of mesh shall conform to the standard specification issued by the factory and shall be not greater than 1/3 of the smallest stone filled in the gabion.
- All wire used in the fabrication of the gabions and in the wiring operations during construction shall be "Mild steel wire", i.e. wire having average tensile strength of 44 kg/sq.mm.
- The diameter of the wire used in the fabrication of the netting shall be at least 3.0 mm depending on the design requirement.
- All wires used in the fabrication of the gabions and in the wiring operations during construction shall be hot dip galvanized.

All edges of the standard gabions including end panels and the diaphragms, if any, shall be mechanically selvedge in such a way as to prevent unraveling of the mesh and to develop the full strength of the mesh. The wire used for the selvedge shall have a diameter greater than that of the wire used to form the mesh. Wire having a diameter of 3.0 mm and the selvedge wire shall have diameter equal to or greater than 3.9 mm.

The stone for the gabion shall be taken from the quarry or river deposit material or as approved by the Employer or Employer's representative. The rock shall be of compact, firmly-bound and uniformly grain texture and absolutely weather-resistance, shall not have cracks, holes, laminations or detrimental materials. The stone blocks shall be of natural irregular cubical shape. The thin sliced blocks shall not be accepted. The size of stone shall be at least 10 cm.

The sides of the gabion wall should be backfilled, compacted and leveled as directed by Employer / Employer's representative.

The standard gabion shall have following dimension:

Length : 2.0 meter

Width : 1.0 meter

Height : 1.0 meter

Sufficient lacing and connecting wire shall be supplied with the gabions for all the wiring operations to be carried out in the construction of the gabion work. The quantity of such wire is estimated to be 8% of the gabion supplied. The 2.4 mm lacing wire shall be used for the gabion made of wire gauge 3.0 mm.

Payment:

Measurement for payment of gabion works shall be made on the basis of actual placed volume of gabions in cubic meters. Payment shall be made for the number of cubic meters measured as provided at the unit price specified in the schedule. The unit price shall include all labor, equipment, materials, excavation, backfilling with compaction and all other cost necessary for the performance and completion of the works.

5.12.3 M20 Concrete Nominal Mix 1:1.5:3 for Protection works

Complete Concrete Works shall be performed as per Article 5.11 “Foundation construction-concrete”. The concrete mix shall be as mentioned in BOQ.

Complete steel reinforcement work shall be performed as per IS 456.

Complete Form Work shall be performed as per Article 5.11 “Foundation construction-form works”.

Payment:

Measurement for payment of “Concrete protection works” shall be made on the basis of actual placed volume of concrete in cubic meters. Payment shall be made for the number of cubic meters measured as provided at the unit price specified in the schedule. The unit price shall include all labor, equipment, materials, excavation, backfilling with compaction and all other cost necessary for the performance and completion of the works.

4.12.4 Benching, Slope Cutting and revetment works:

This section covers the cutting of slopes where sufficient electrical ground clearance of the line is not available. After slope cutting, revetment wall shall be constructed as directed by Engineer. Back filling of the revetment wall shall be done with leveling.

Payment:

Measurement for payment of “Slope cutting and revetment Works” works shall be made on the basis of actual cut volume of slopes in cubic meters. Payment shall be made for the number of cubic meters measured as provided at the unit price specified in the schedule. The unit price shall include all labor, equipment, materials, revetment walls and all other cost necessary for the performance and completion of the works.

VOLUME – II-A OF III
CHAPTER - 6
LINE CONDUCTOR

Turnkey Bidding Document

Kohalpur Nepalgunj 132 kV TLP

TABLE OF CONTENTS

6 LINE CONDUCTOR

6.1 General

ACSR "BEAR" conductor for 132 kV transmission line from Kohalpur to Nepalgunj shall be fully type tested and in production for at least five (5) years.

6.2 Conductor Specification

All conductors shall be of aluminum conductor steel reinforced (ACSR) construction and shall be manufactured in strict conformity with BS 215 (Part 2). Bidders must offer conductor from reputable and experienced manufacturers with not less than five years manufacturing experience and the manufacturers shall possess manufacturing and testing facilities for producing the offered conductor at the time of bidding.

The steel core and the first layer of aluminum of ACSR conductors shall be greased. The grease shall be of neutral type and at a temperature of 100-degree centigrade. The grease shall neither flow within nor extrude from the conductor. The grease shall retain its properties as resistance to oxidization and chemical stability at all service temperatures.

The outermost layer of all conductors shall be stranded with right hand lay.

The correct tension must be maintained on the stranding machine when spinning the cable to avoid the possibility of bird caging during stringing. Any conductor not complying may be rejected at the discretion of the Employer.

The purity of the aluminum shall be the highest commercially available and not less than 99.5%, the copper content not exceeding 0.04%. The Contractor shall submit certificates of analysis giving the percentage and nature of any impurities in the metal from which the wires are made. Aluminum wires shall be made to BS 2627 and steel wires to BS 4565.

Precautions shall be taken during the manufacture, storage and erection of steel-cored aluminum conductors to prevent the possibility of contamination by copper or other materials, which may adversely affect the aluminum. The manufacture of steel-cored aluminum conductors shall be carried out in a portion of the factory specially set aside for such purposes. Machinery previously used in the manufacture of copper or copper bearing conductors shall not be used for the manufacture of these aluminum or steel wires.

6.2.1 Conductor drum lengths

Conductors shall be supplied on drums of approved construction and the drums shall be securely battened to protect the conductor. Drum battens shall not be removed until the drum is properly mounted at the drum station on the line and battens shall be immediately refitted to the drum if any surplus conductor is left thereon.

Each drum shall be marked with length and size of the conductor and in addition, the conductor manufacturing batch number shall be inscribed on the drum. Empty drums shall become the property of the Employer and be returned by the Contractor to the Employer's stores nominated by the Employer. The maximum length of conductor shall not exceed 2 km per drum.

6.2.2 Creep of ACSR-conductors

When stringing ACSR-conductors, the creep shall be adopted into account using suitable method for stringing the conductor to a higher tension. This is expressed as a temperature difference corresponding to the estimated creep.

6.2.3 Details of ACSR Conductors

The ACSR Conductor shall generally conform to BS: 215(Part-2) /IS: 398 (Part-II) except where otherwise specified herein.

The details of the ACSR BEAR Conductor are tabulated in schedule A.10 of section-11.

6.2.4 Joints in Wires:

a. Aluminium Wires

No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However, joints in the 12 wire inner layer of the conductor unavoidably broken during stranding provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium wires. Such joints shall not be more than four (4) per conductor lengths. These joint shall be made by cold pressure butt-welding and shall be such that no two such joints are within 15 metres of each other in the complete stranded conductor.

b. Steel Wires

There shall be no joint of any kind in the finished wire entering into the manufacture of the strand nor strand joint or strand splices in any length of the complete stranded steel core of the conductor.

6.2.5 Materials

The Aluminium strands shall be hard drawn from electrolytic aluminum rods having a purity of not less than 99.5% and a copper content not exceeding 0.04%. They shall have the same properties and characteristics as prescribed in IEC: 889-1987.

The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or basic open hearth process, the electric furnace process, or the basic oxygen process and shall conform to the following requirements as to the chemical composition:

Element	% composition
Carbon	0.50 to 0.85
Manganese	0.50 to 1.10
Phosphorus	Not more than 0.035
Sulphur	Not more than 0.045
Silicon	0.10 to 0.35

The steel wire stands shall have the same properties and characteristics as proscribed for regular strength steel wire in IEC:888-1987.

The zinc used for galvanizing shall be electrolytic high grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS: 209.

6.2.6 Packing

The conductor shall be supplied in non-returnable, strong, wooden drums provided with lagging of adequate strength, constructed to protect the conductor against all damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The drums shall generally conform to IS: 1778, except as otherwise specified hereinafter.

The drums shall be suitable for wheel mounting and for letting off the conductor under a minimum controlled tension of the order of 5 KN.

The Bidder should submit their proposed drum drawings along with the bid.

For conductor, one standard length not exceeding 2,000 m shall be wound on each drum.

All wooden components shall be manufactured out of seasoned soft wood free from defects that may materially weaken the component parts of the drums. Preservative treatment shall be applied to the entire drum with preservatives of a quality which is not harmful to the conductor.

The flanges shall be of two ply construction with each ply at right angles to the adjacent ply and nailed together. The nails shall be driven from the inside face flange, punched and then clenched on the outer face. The thickness of each ply shall not vary by more than 3 mm from that indicated in the figure. There shall be at least 3 nails per plank of ply with maximum nail spacing of 75 mm. Where a slot is cut in the flange to receive the inner end of the conductor the entrance shall be in line with the periphery of the barrel.

The wooden battens used for making the barrel of the conductor shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.

Barrel studs shall be used for the construction of drums. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing.

Normally, the nuts on the studs shall stand protruded of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be counter sunk. The ends of barrel shall generally be flushed with the top of the nuts.

The inner cheek of the flanges and drum barrel surface shall be painted with bitumen based paint.

Before reeling, card board or double corrugated or thick bituminized water-proof bamboo paper shall be secured to the drum barrel and inside of flanges of the drum by means of a suitable commercial adhesive material. After reeling the conductor, the exposed surface of the outer layer of conductor shall be wrapped with water proof thick bituminized bamboo paper to preserve the conductor from dirt, grit and damage during transport and handling.

A minimum space of 75 mm for conductor shall be provided between the inner surface of the external protective tagging and outer layer of the conductor.

Each batten shall be securely nailed across grains as far as possible to the flange, edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nails shall not protrude above the general surface and shall not have exposed sharp, edges or allow the battens to be released due to corrosion.

The nuts on the barrel shall be tack welded on the one side in order to fully secure them. On the second end, a spring washer shall be used.

A steel collar shall be used to secure all barrel studs. This collar shall be located between the washers and the steel drum and secured to the central steel plate by welding.

Outside the protective lagging, there shall be minimum of two binders consisting of hoop iron/galvanized steel wire. Each protective lagging shall have two recesses to accommodate the binders.

The conductor ends shall be properly sealed and secured on the side of one of the flanges to avoid loosening of the conductor layers during transit and handling.

As an alternative to wooden drum Bidder may also supply the conductors in non-returnable painted steel drums. After preparation of steel surface according to IS: 9954, synthetic enamel paint shall be applied after application of one coat of primer. Wooden/Steel drum will be treated at par for evaluation purpose and accordingly the Bidder should quote in the package.

6.2.7 Marking

Each drum shall have the following information stencilled on it in indelible ink along with other essential data:

- Contract/ Award letter number.
- Name and address of consignee.
- Manufacturer’s name and address.
- Drum number
- Size of conductor
- Length of conductor in meters
- Arrow marking for unwinding
- Position of the conductor ends
- Distance between outer-most Layer of conductor and the inner surface of lagging.
- Barrel diameter at three locations & an arrow marking at the location of the measurement.
- Number of turns in the outer most layer.
- Gross weight of drum after putting lagging.
- Tear weight of the drum without lagging.
- Net weight of the conductor in the drum.
- Material Inspection & Clearance certificate Number.
- The above should be indicated in the packing list also.

6.2.8 Verification of Conductor Length

The Employer reserves the right to verify the length of conductor in any conductor drum to be supplied by contractor.

6.3 Accessories of Line Conductor

The following are the accessories for ACSR Bear Conductor. 2.5% extra fasteners and retaining rods shall be provided.

6.3.1 Mid Span Compression Joint

Mid Span Compression Joint shall be used for joining two lengths of conductor. The joint shall have a resistively less than 75% of the resistivity of equivalent length of conductor. The joint shall not permit slipping off, damage to, or failure of the complete conductor or any part thereof at a load less than 95% of the ultimate tensile strength of the conductor.

The joint shall be made of Steel and aluminium sleeves for jointing the conductor. The aluminum sleeve shall have aluminum of purity not less than 99.5%. If whole of the sleeve is not to be compressed, then tapered aluminium filler plugs shall also be provided on the line of demarcation between compression and non-compression zone. The steel sleeve should not crack nor fail during compression. The Brinnel Hardness of steel sleeve shall not exceed 160. The steel sleeve shall be hot dip Galvanised.

6.3.2 Repair Sleeve

Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from 99.5% pure aluminum and shall have a smooth surface. The repair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece.

Hariyan

The edges of the seat as well as the keeper piece shall be so rounded that the conductor strands are not damaged during installation.

6.3.3 Vibration Damper

Vibration dampers of 4R-stockbridge type with four (4) different resonances spread with the specified Aeolian frequency band width corresponding to wind speed of 1 m/s to 7 m/s shall be used at suspension and tension points on each conductor in each span to damp out Aeolian vibrations as mentioned herein after.

Alternate damping systems or offering equivalent or better performance also shall be accepted provided the manufacturer meets the qualifying requirements stipulated in the Specifications. Relevant technical documents to establish the technical suitability of alternate systems shall be furnished by the Bidder along with the bid.

One damper minimum on each side of conductor shall be used for ruling design span.

The clamp of the vibration damper shall be made of high strength aluminum alloy of type LM-6 or equivalent. It shall be capable of supporting the damper and prevent damage or chafing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the conductor without damaging the strands or causing premature fatigue failure of the conductor under the clamp. The clamp groove shall be in uniform contact with the conductor over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free form projections, grit or other materials which could cause damage to the conductor when the clamp is installed. Clamping bolts shall be provided with self locking nuts and designed to prevent corrosion of threads or loosening in service.

The messenger cable shall be made of high strength galvanized steel/ stainless steel with a minimum strength of 135 kg/sq mm. It shall be of preformed and post formed quality in order to prevent subsequent droop of weight and to maintain consistent flexural stiffness of the cable in service. The number of strands in the messenger cable shall be 19. The messenger cables other than stainless steel shall be hot dip galvanized in accordance with the recommendations of IS: 4826-1979 for heavily coated wires.

The damper mass shall be made of hot dip galvanized mild steel/ cast iron or a permanent mould cast zinc alloy. All castings shall be free from defects such as cracks, shrinkage, inclusions and blowholes etc. The surface of the damper masses shall be smooth.

The damper clamp shall be casted over the messenger cable and offer sufficient and permanent grip on it. The messenger cable shall not slip out of the grip at a load less than the mass pull-off value of the damper. The damper masses made of material other than zinc alloy shall be fixed to the messenger cable in a suitable manner in order to avoid excessive stress concentration on the messenger cables which shall cause premature fatigue failure of the same. The messenger cable ends shall be suitably and effectively sealed to prevent corrosion. The damper mass made of zinc alloy shall be casted over the messenger cable and have sufficient and permanent grip on the messenger cable under all service conditions.

The damper assembly shall be so designed that it shall not introduce radio interference beyond acceptable limits.

The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed under Annexure-A, shall have to be submitted by the Bidder along with his bid. The technical particulars for vibration analysis and damping design of the system are as follows.

The damper placement chart for spans ranging from 100 m to 1100 m shall be submitted by the Bidder. Placement charts should be duly supported with relevant technical documents and sample calculations.

The damper placement charts shall include the following: -

a. Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per conductor per span.

b. Placement distances clearly identifying the extremities between which the distances are to be measured.

c. Placement recommendation depending upon type of suspension clamps (viz Free centre type/ Armour grip type etc.)

d. The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers.

6.4 Tests

The following acceptance and routine tests and tests during manufacture shall be carried out on the conductor. For the purpose of this clause, the following shall apply.

Acceptance tests shall mean those tests which are to be carried out on samples taken from each lot offered for pre-despatch inspection, for the purpose of acceptance of that lot.

Routine tests shall mean those tests, which are to be carried out on each strand/ spool/ length of the conductor to check requirements which are likely to vary during production.

Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the manufacture to ensure the desired quality of the end product to be supplied by him.

For all acceptance tests, the acceptance values shall be the values guaranteed by the bidder in the guaranteed technical particulars of his proposal or the acceptance value specified in this specification, whichever is more stringent for that particular test.

6.4.1 Design (Type) Tests

Only type tested conductor and the equipment should be offered. Type test reports as specified in section-2 of this specification shall be submitted by the Bidder along with the bid. The type test report includes:

a) Surface condition test

b) Test for ultimate breaking load on stranded conductor

c) Stress-strain test

d) Measurement of diameter of individual aluminum and steel wires.

e) Measurement of lay ratio.

f) Breaking load of individual wires.

g) Ductility test

h) Wrapping test

i) Resistance test and

j) Galvanizing test

6.4.2 Acceptance Tests

a) Visual and dimensional check on drum

b) Visual check for joints scratches etc. and lengths of conductor by rewinding

c) Dimensional check on steel and Aluminium strands

d) Galvanizing test on steel strands

e) Torsion and elongation test on steel strands

f) Check for lay-ratios of various layers

g) Breaking load test on steel and aluminum strands

h) Wrap test on steel and aluminum strands

i) DC resistance test on aluminum strands

j) UTS Test on welded joint of strands

Note: All the tests except (j) shall be carried out on Aluminium and steel strands after stranding only.

6.4.3 Routine tests

a) Check to ensure that the joints are as per specification.

b) Check that there are no cuts, fins etc. on the strands.

c) Check that drums are as per specification.

d) All acceptance tests as mentioned above to be carried out on each coil.

6.4.4 Tests during manufacture

a) Chemical analysis of zinc used for galvanizing

b) Chemical analysis of aluminum used for making aluminum strands

6.4.5 Testing Expenses

The entire cost of testing for the acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted unit price except for the expenses of the inspector/ Employer's representative.

6.4.6 Test Reports

Record of routine test reports and acceptance tests shall be submitted to the Employer for approval.

Test certificates of tests during manufacture shall be maintained by the manufacturer. These shall be produced for verification as and when desired by the Employer.

6.4.7 Inspection

The representative of the Employer shall at all times be entitled to have access to the works and all places of manufacture, where conductor shall be manufactured and representative shall have full facilities for unrestricted inspection of the manufacturer works, raw materials and process of manufacture for conducting necessary tests as detailed herein.

No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested, unless the inspection is waived off by the Employer in writing. In the later case also the conductor shall be dispatched only after satisfactory testing for all tests specified herein have been completed and the test results have been approved by the Employer.

The acceptance of any quantity of material shall in no way relieve the manufacturer and the contractor of any of his responsibilities for meeting all requirements of the specification, and shall not prevent subsequent rejection if such material is later found to be defective.

6.5 Standards

The conductor shall conform to the following Indian/ International Standards, which shall mean latest revisions, with amendments/ changes adopted and published, unless specifically stated otherwise in the Specification.

In the event of the supply of conductor conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the standards proposed by the Supplier and those specified in this document will be provided by the Supplier to establish their equivalence.

Sl. No.	Indian Standard	Title	International Standard
1.	IS: 209-1992	Specification for zinc	BS: 3436-1986
2.	IS: 398-1982	Specification for Aluminium Conductors for Overhead Transmission Purposes	IEC: 1089-1991 BS: 215-1970
3.	IS: 398-1990 Part-II and IS:398-1994 Part-4	Aluminum Conductor Galvanized Steel Reinforced and All Aluminium Alloy Conductors	BS: 215-1970 IEC: 1089-1991
4.	IS: 1778-1980	Reels and Drums for Bare Conductors	BS: 1559-1949
5.	IS: 1521-1991	Method of Tensile Testing of Steel Wire	ISO 6892-1984
6.	IS: 2629-1990	Recommended Practice for Hot Dip Galvanizing of Iron and Steel	
7.	IS: 2633-1992	Method of Testing Uniformity of Coating on Zinc Coated Articles	
8.	IS: 4826-1992	Galvanized Coating on Round Steel Wires	IEC: 888-1987 BS: 443-1969
9.	IS: 6745-1990	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS: 433-1969 ISO 1460 - 1973
10.	IS: 8263-1990	Method of Radio Interference Tests on High Voltage Insulators	IEC: 437-1973 NEMA: 107-1964 CISPR
11.		Zinc Coated steel wires for stranded Conductors	IEC: 888-1987
12.		Hard drawn Aluminium wire for overhead line conductors	IEC: 889-1987

VOLUME – II-A OF III
CHAPTER - 7
INSULATOR AND ACCESSORIES

TABLE OF CONTENTS

7. INSULATOR AND ACCESSORIES

7.1 Composite Long Rod Insulator

The composite long rod type insulators shall be fully type tested and has been in production for at least five years.

The insulators shall be of puncture-proof type. These insulators shall be made of a core with fiberglass reinforced resin and sheds of HT Silicon Rubber. They shall be of light weight and high tensile strength. They must withstand safely all operating stresses even in the presence of Ozone and UV radiation. The composite material shall be of inherent stability.

To cope with lightning over-voltages, the insulator sets have to be designed with respect to insulation coordination according to IEC 60071-1, which determine the gap between the grounded fittings and the live parts.

The insulators shall be matched with the accessories to be used. The insulator shall confirm to IEC 61109 “Composite insulators for A.C. overhead lines with a nominal voltage greater than 1000V”.

Bidder shall quote such composite insulators which have proven use under foggy/ humid operational conditions. The Bidder shall furnish evidence in the form of certification from the power utilities that the similar type of product supplied to them had been performing satisfactory. The Bidder shall also submit certified test report for an accelerated ageing test of 5000 hours such as that described in Annexure-C of IEC-61109 and other type test reports.

The parameters characterizing the insulators profile shall be as follows:

Table 7.1

<table>
<tr><th rowspan="2">Sl. No.</th><th rowspan="2">Type of string</th><th colspan="2">Basic Insulation Level</th><th rowspan="2">Creepage Factor
(C.F.)
*</th><th rowspan="2">No. of individual units per string (Nos)</th><th rowspan="2">Mechanical strength
(kN)
**</th></tr>
<tr><th>Impulse Withstand Voltage (kV / peak)</th><th>Power frequency withstand voltage (kVrms)</th></tr>
<tr><td>1</td><td>Single “I” suspension</td><td rowspan="4">950</td><td rowspan="4">395</td><td rowspan="4">3.5</td><td>1</td><td>90</td></tr>
<tr><td>2</td><td>Single ‘I’ Tension</td><td>1</td><td>160</td></tr>
<tr><td>3</td><td>Double “I” suspension</td><td>2</td><td>2 x 90</td></tr>
<tr><td>4</td><td>Double “I” Tension</td><td>2</td><td>2 x 160</td></tr>
</table>

“*”C. F. = Creepage Factor for pollution level II, as described in Appendix – D of IEC 60815. Creepage distance (mm) = C.F X Arcing Distance of insulator.

“**”Mechanical strength of insulator string along with hardware fittings (kN).

For other technical parameters of insulators, please refer to schedule A.9 in section - 11. Bidder shall submit GA drawing showing core diameter, the overall string length and other details of the insulator with the Bid.

Note: If type tested insulators for 750 kV peak and 950 kV peak, are not available. The bidders may propose insulators, type tested at higher BIL (1050 kV peak) normally used for 220kV system.

7.2 Materials

7.2.1 Core

It shall be a glass-fiber reinforced (FRP rod) epoxy resin rod of high strength. Glass fibers and resin shall be optimized. The rod shall be electrical grade corrosion resistant (ECR), boron free glass and shall exhibit both high electrical integrity and high resistance to acid corrosion.

7.2.2 Housing & Weather sheds

The FRP rod shall be covered by a seamless sheath of a HT-silicone rubber compound of a thickness of minimum 3mm. The housing & weather sheds should have silicon content of minimum 30% by weight. It should protect the FRP rod against environmental influences, external pollution and humidity. It shall be extruded or directly molded on the core. The interface between the housing and the core must be uniform and without voids. The strength of the bond shall be greater than the tearing strength of the polymer. The manufacturer shall follow non-destructive technique (N.D.T.) to check the quality of jointing of the housing interface with the core. The technique being followed with detailed procedure and sampling shall be furnished along with the bid. The details for this shall be finalized during detailed engineering and finalization of MQP.

The weather sheds of the insulators shall be of alternate shed profile. The weather sheds shall be vulcanized to the sheath (extrusion process) or molded as part of the sheath (injection moulding process) and free from imperfections. The vulcanization for extrusion process shall be at high temperature and for injection moulding shall be at high temperature & high pressure. Any seams / burrs protruding axially along the insulator, resulting from the injection moulding process shall be removed completely without causing any damage to the housing. The track resistance of housing and shed material shall be class 1A4.5 according to IEC60587. The strength of the weather shed to sheath interface shall be greater than the tearing strength of the polymer. The composite insulator shall be capable of high pressure washing.

7.2.3 End Fittings

End fittings transmit the mechanical load to the core. They shall be made of malleable cast iron spheroid graphite or forged steel. They shall be connected to the rod by means of a controlled compression technique. The manufacturer shall have in-process Acoustic emission arrangement or some other arrangement to ensure that there is no damage to the core during crimping. This verification shall be in-process and done on each insulator. The gap between fitting and sheath shall be sealed by a flexible silicone rubber compound. The system of attachment of end fitting to the rod shall provide superior sealing performance between housing and metal connection. The sealing must be humidity proof and durable with time.

7.2.4 Grading Rings

Grading rings shall be used at both ends of each composite insulator unit for reducing the voltage gradient on and within the insulator and to reduce radio and TV noise to acceptable levels. The size and placement of the metallic grading rings shall be designed to eliminate dry band arcing/corona cutting/ exceeding of permissible electrical stress of material. The bidder shall furnish calculations along with the proposed placement and design of corona ring in support of the above. Grading rings shall be capable of installation and removal with hot line tools without disassembling any other part of the insulator assembly.

The supply of grading rings shall preferably be in the scope of the composite insulator supplier.

7.3 Dimensional Tolerance of Composite Insulators

The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows:

$\pm$ (0.04d+1.5) mm when $d \leq 300$ mm.

± (0.025d+6) mm when d>300 mm.

Where, d being the dimensions in millimeters for diameter, length or creepage distance as the case may be. No negative tolerance shall be applicable to creepage distance.

7.4 Details of Hardware Fittings

Single suspension, Double Suspension, Single tension and Double tension hardware fittings shall be supplied suitable for attaching to hanger/ strain plate fixed to tower. Each hardware fittings shall be supplied complete in all respects and shall include the following hardware parts:

a. Suitable arcing horn specified in hereinafter.
b. Suitable Yoke plate complying with the specification given hereinafter.
c. Sag-Adjustment plate for double tension hardware fittings.
d. Suspension and dead end assembly to suit conductor size.
e. Provision for attaching balancing weights on the line side yoke plate of single suspension pilot hardware fittings.
f. Other necessary fittings viz D-shackles, eye links, extension links, ball clevis, socket clevis, clevis eye, U clevis and chain link etc. to make hardware fittings completer.

7.5 Ball and Socket Designation

The dimensions of the balls and sockets shall be of 16 mm designation for 90 kN & 20 mm designation for 160 kN disc insulator in accordance with the standard dimensions stated in IS: 2486 - (Part - II)/IEC:120.

7.6 Pin and Cap

Pin and Cap shall be designed to transmit the mechanical stresses and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric, of such design that it will not yield or distort under load conditions.

The design shall be such as to permit easy removal of replacement of either insulator units or fittings under the live line conditions.

7.7 Interchangeability

The composite long rod insulators inclusive of the ball and socket fittings shall be of standard design suitable for use with the hardware fittings of any make conforming to relevant Indian/ IEC Standards.

7.8 Security Clip

Security clip for use with ball and socket coupling shall be of R-shaped hump type which shall provide positive locking of the coupling as per IS: 2486-(Part-III)/IEC: 372. The legs of the security clips shall be spread after installation to prevent complete withdrawal from the socket. The locking device should be resilient, corrosion resistant and of suitable mechanical strength. There shall be no risk of the locking device being displaced accidentally or being rotated when in position. Under no circumstances shall locking device allow separation of insulator units or fittings.

The hole for the security clip shall be countersunk and the clip shall be of such design that the eye of clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required to pull the security clip into its unlocked position shall not be less than 50N (5 kg) or more than 500N (50 kg).

7.9 Corona and RI Performance

All surfaces must be clean, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The insulator metal parts shall be so designed and manufactured that it shall not generate any Radio Interference beyond specified limit and not produce any noise generating corona formation under the operating conditions.

7.10 Arcing Horn/ Intermediate Arcing Horn

The arcing horn / Intermediate Arcing Horn shall be ball ended rod type.

The air gap shall be so adjusted to ensure effective operation under actual field conditions.

7.11 Yoke Plate

The strength of yoke plates shall be adequate to withstand the minimum ultimate tensile strength as specified in the bid drawings.

The plates shall be either triangular or rectangular in shape as may be necessary. The design of yoke plate shall take into account the most unfavorable loading conditions likely to be experienced as a result of dimensional tolerances for disc insulators as well as components of hardware fittings within the specified range. The plates shall have suitable holes for fixing corona control rings/ grading ring/ arcing horn. All the corners and edges should be rounded off with a radius of at least 3 mm. Design calculations i.e. for bearing & tensile strength, for deciding the dimensions of yoke plate shall be furnished by the bidder. The holes provided for bolts in the yoke plate should satisfy shear edge condition as per Clause No. 8.10 of IS: 800-1984.

7.12 Sag-Adjustment Plate

The sag-adjustment plate to be provided with the double tension hardware fitting shall be of three plate type. The sag adjustment plate shall be provided with a safety locking arrangement. The device shall be of such design that the adjustment is done with ease, speed and safety.

The maximum length of the sag adjustment plate from the connecting part of the rest of the hardware fittings shall be 520 mm. The details of the minimum and maximum adjustment possible and the steps of adjustment shall be clearly indicated in the drawing. An adjustment of 150 mm minimum at the interval of 6 mm shall be possible with the sag adjustment plate.

Design calculations for deciding the dimensions of sag adjustment plate shall be furnished by bidder. The hole provided for bolts should satisfy shear edge condition as per Clause No.8.10 of IS: 800-1984.

7.13 Suspension Assembly

The suspension assembly shall be suitable for ACSR ‘BEAR’ Conductor.

The suspension assembly shall include free center type suspension clamp along with standard preformed armor rods or armor grip suspension clamp; except for Pilot insulator string for which only suitable Envelope type suspension clamp shall be used.

The suspension clamp along with standard preformed armor rods set shall be designed to have maximum mobility in any direction and minimum moment of inertia so as to have minimum stress on the conductor in the case of oscillation of the same.

The suspension clamp along with standard preformed armor rods/ armor grip suspension clamp set shall have slip strength for ACSR 'BEAR' Conductor.

The suspension assembly shall be designed, manufactured and finished to give it a suitable shape, so as to avoid any possibility of hammering between suspension assembly and conductor due to vibration. The suspension assembly shall be smooth without any cuts, grooves, abrasions, projections, ridges or excrescence, which might damage the conductor.

The suspension assembly/ clamp shall be designed so that it shall minimize the static & dynamic stress developed in the conductor under various loading conditions as well as during wind induced conductor vibrations. It shall also withstand power arcs & have required level of Corona/RIV performance.

Bids offering suspension assemblies with magnetic power loss more than 4 watts except for envelope type clamps for which magnetic power loss more than 8 watts at sub-conductor current of 600 amps shall be liable to be rejected. The Bidders are requested to enclose test certificates for magnetic power loss test along with the bid.

In case, the magnetic power loss of the suspension assembly obtained during type testing of the same exceeds the value guaranteed by the Bidder in his bid, the material shall be rejected outright or the same shall be accepted after suitable liquidated damages for non-performance calculated at the rate of US$ 4.68 per suspension assembly for each watt of additional power loss, which shall be recovered from the contract price.

7.13.1 Free Centre Type Suspension Clamp

For the Free Center Suspension Clamp seat shall be smoothly rounded and curved into a bell mouth at the ends. The lip edges shall have rounded bead. There shall be at least two U-bolts for tightening of clamp body and keeper pieces together.

7.13.2 Standard Preformed Armor Rod Set

The Preformed Armor Rods Set suitable for ACSR ‘BEAR’ Conductor shall be used to minimize the stress developed in the sub-conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from the suspension clamp as a result of unbalanced conductor tension in adjacent spans and broken wire condition. It shall also withstand power arcs. Chafing and abrasion from suspension clamp and localized heating effect due to magnetic power losses from suspension clamps as well as resistance losses of the conductor.

The preformed armor rods set shall have right hand lay and the inside diameter of the helices shall be less than the outside diameter of the conductor to have gentle but permanent grip on the conductor. The surface of the armor rod when fitted on the conductor shall be smooth and free from projections, cuts and abrasions etc.

The pitch length of the rods shall be determined by the Bidder but shall be less than that of the outer layer of conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristic wholly independent of the skill of linemen.

The amour rod shall not lose their resilience even after five applications.

The conductivity of each rod of the set shall not be less than 40% of the conductivity of the International Annealed Copper Standard (IACS).

7.13.3 Armor Grip Suspension Clamp

The Armor grip suspension clamp shall comprise of retaining strap, support housing, elastomer inserts with aluminum re-enforcement and AGS preformed rod set.

Elastomer insert shall be resistant to the effects of temperature up to 75^0 C, Ozone ultraviolet radiations and other atmospheric contaminants likely to be encountered in service. The physical properties of the elastomer shall be of approved standard. It shall be electrically shielded by a cage of AGS preformed rod set. The elastomer insert shall be so designed that the curvature of the AGS rod shall follow the contour of the neoprene insert.

The AGS preformed rod set shall be as detailed in above in general except for the following.

7.13.4 Envelope Type Suspension Clamp

The seat of the envelope type suspension clamp shall be smooth rounded and suitably curved at the ends. The lip edges shall have a rounded bend. There shall be at least two U-Bolts for tightening of clamp body and keeper pieces together. Hexagonal bolts and nuts with split pins shall be used for attachment of the clamp.

7.13.5 Dead End Assembly

The dead end assembly shall be suitable for ACSR Bear Conductor.

The dead end assembly shall be compression type with provision for compressing jumper terminal at one end. The angle of jumper terminal to be mounted should be 300 with respect to the vertical line. The area of bearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contract and avoid local heating due to I^2R losses. The resistance of the clamp when compressed on Conductor shall not be more than 75% of the resistance of equivalent length of Conductor.

Die compression areas shall be clearly marked on each dead-end assembly designed for continuous die compressions and shall bear the words ‘COMPRESS FIRST’ suitably, inscribed near the point on each assembly where the compression begins. If the dead end assembly is designed for intermittent die compressions, it shall bear identification marks ‘COMPRESSION ZONE’ AND ‘NON-COMPRESSION ZONE’ distinctly with arrow marks showing the direction of compressions and knurling marks showing the end of the zones. Tapered aluminum filler plugs shall also be provided at the line of demarcation between compression & non-compression zone. The letters, number and other marking on the finished clamp shall be distinct and legible

7.14 Fasteners: Bolts, Nuts and Washers

All bolts and nuts shall conform to IS: 6639-1972/ISO-R-272-1968. All bolts and nuts shall be galvanized. All bolts and nuts shall have hexagonal heads, the heads being forged out of solid truly concentric, and square with the shank, which must be perfectly straight.

Bolts up to M 16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 MPa minimum as per IS: 12427. Bolts should be provided with washer face in accordance with IS: 1363 part-i/ ISO-4016-1979 to ensure proper bearing.

Nuts should be double chamfered as per the requirement of IS: 1363 Part-III, 1984. It should be ensured by the manufacturer that nuts should not be over- tapped beyond 0.4 mm oversize on effective diameter for size up to M 16.

Fully threaded bolts shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts.

All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit the firm gripping of the component parts but no further. It shall be ensured that the threaded portion of the bolt protrudes not less than 3 mm and not more than 8 mm when fully tightened. All nuts shall fit and tight to the point where shank of the bolt connects to the head.

Flat washers and spring washers shall be provided wherever necessary and shall be of positive lock type. Spring washers shall be electro-galvanized. The thickness of washers shall conform to IS: 2016-1967.

The Bidder shall furnish bolt schedules giving thickness of components connected, the nut and the washer and the length of shank and the threaded portion of bolts and size of holes and any other special details of this nature.

To obviate bending stress in bolt, it shall not connect aggregate thickness more than three time its diameter.

Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.

Fasteners of grade higher than 8.8 are not to be used.

7.15 Maintenance

The long rod insulators offered shall be suitable for employment of hot line maintenance technique so that usual hot line operation can be carried out with ease, speed and safety.

All insulators shall be designed to facilitate cleaning and insulators shall have the minimum practical number of sheds and grooves. All grooves shall be so proportioned that any dust deposit can be removed without difficulty either by wiping with a cloth or by remote washing under live line condition.

7.16 Workmanship

All the material shall be of the latest design and conform to the best modern practices adopted in the extra high voltage field. Suppliers shall offer only such insulators as are guaranteed by him to be satisfactory and suitable for Transmission lines specified and will give continued good service.

The design, manufacturing process and material control at various stages shall be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish and elimination of sharp edges and corners to limit corona and radio interference.

The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

The core shall be sound and free of cracks and voids that may adversely affect the insulators.

Weather sheds shall be uniform in quality. They shall be clean, sound, smooth and free from gross defects and excessive flashing at parting lines.

End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively, sealed to prevent moisture ingress, effectiveness of sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth with the projecting points or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly.

All ferrous parts shall be hot dip galvanized to give a minimum average coating of Zinc equivalent to 600 gm/ sq. m and shall be in accordance with the requirement of IS:2629 and shall satisfy the tests mentioned in IS:2633. The zinc used for galvanizing shall be of Grade Zn 99.95 as per IS: 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters. The galvanized metal parts shall be guaranteed to withstand at least six successive dips each lasting for one (1) minute duration under the standard preece test. The galvanizing shall be carried out only after any machining.

7.17 Equipment Marking

Each Composite Long Rod Insulator shall be legibly and indelibly marked with the trade mark of the manufacturer, name of Employer and month & year of manufacture. The guaranteed combined mechanical and electrical strength shall be indicated in kilo Newton followed by the word ‘kN’ to facilitate easy identification and to ensure proper use.

One 10 mm thick ring or 20 mm thick spot of suitable quality of paint shall be marked on the cap end fitting of each composite long rod insulator of particular strength for easy identification of the type of insulator. The paint shall not have any deteriorating effect on the insulator performance. Following codes shall be used as identification mark:

For	90 kN Long rod	:Orange
For	160 kN Long rod	:Green

7.18 Bid Drawings

The Bidder shall furnish full description and illustration of the material offered.

The Bidder shall furnish along with the bid the outline drawing of each insulator unit including a cross sectional view of the insulator shell. The drawing shall include but not limited to the following information:

a) Long rod diameter and ball to ball spacing with manufacturing tolerances
b) Minimum Creepage distance with positive tolerance
c) Protected creepage distance
d) Eccentricity of the long rod unit
e) Axial run out
f) Radial run out
g) Unit mechanical and electrical characteristics
h) Size and weight of ball and socket parts
i) Weight of composite long rod units
j) Materials
k) Identification mark
l) Manufacturer's catalogue number

After award of the Contract, the Contractor shall submit full dimensioned insulator drawings containing all the details to Employer for approval. After getting approval from Employer and successful completion of all the type tests, the Supplier shall submit 10 more copies of the same drawing to the Employer for further distribution and field use at Employer's end.

After award of the Contract, the Contractor shall also submit fully dimensioned insulator crate drawing for different type of insulators.

7.19 Tests

The acceptance of any quantity of material shall in no way relieve the bidder of any of his responsibilities for meeting all requirements of the specification, and shall not prevent subsequent rejection if such material is later found to be defective.

The sample taken from any numbers of crates for carrying out any type of tests will be to the supplier account.

The equipment should be offered type tested. The Bidder shall submit type test reports as specified in section-2 of this specified along with the bid.

7.19.1 Design Tests on Composite Long Rod Insulator Units

The design tests are intended to verify the suitability of the design, materials and method of manufacture (technology).

(a)	Tests on interfaces and connections of metal fittings (Tests to be performed on the same samples in the sequence given below) i. Test specimens and preliminary tests ii. Dry power frequency voltage test iii. Prestressing a. Sudden load release test b. Thermal mechanical test c. Water immersion test iv. Verification tests a. Steep front impulse voltage test b. Dry power frequency voltage test	IEC: 61109
(b)	Assembled core load time test i. Determination of the average failing load of the core of the assembled unit ii. Control of the slope of the strength time curve of the insulator	IEC: 61109
(c)	Brittle fracture resistance test	Annexure-A
(d)	Test of housing, Tracking and erosion test	IEC: 61109
(e)	Tests for the core material i. Dye penetration test ii. Water diffusion test	IEC:61109
(f)	Flammability test	IEC:61109
(g)	Recovery of Hydrophobicity test	Annexure-A
(h)	Mechanical Load Time test and test of tightness between end firings and insulator housing	IEC:61109
(i)	Silicone content test	Annexure-A
(j)	High Pressure washing test	Annexure-A

7.19.2 Type Tests on Composite Long Rod Insulator Units

The electrical type tests shall be performed only once on insulators satisfying the electrically defined criteria for one type and shall be performed with arcing devices, if they are in integral part of the insulator type.

The electrical type tests shall be repeated only when one or more of the above characteristics are changed.

a)	Dry lightning impulse withstand voltage test	IEC : 61109 & IEC : 60383
b)	Wet Power – frequency test	IEC : 60383
c)	Mechanical load-time test	IEC : 60383
d)	Corona and RIV test under dry condition	IEC : 60437 & IEC : 60383
e)	Vibration Test	Annexure-A
f)	Silicone content test	Annexure-A
i.	Flammability test	IEC : 61109 & IEC : 60383
ii.	Recovery of Hydrophobicity test	

7.19.3 Acceptance Tests:

For Composite Long Rod Insulators

(a)	Verification of dimensions	IEC : 61109
(b)	Galvanizing test	IEC : 60383
(c)	Verification of locking system	IEC : 60383
(d)	Verification of tightness of interface between end fittings and insulator housing and of specified mechanical load	IEC : 61109
(e)	Recovery of Hydrophobicity	Annexure-A
(f)	Silicone content test	Annexure-A

In the event of failure of the sample to satisfy the acceptance test(s) specified in above, the retest procedure shall be as per clause 7.6 of IEC 61109.

7.19.4 Routine Tests

For Composite Long Rod Insulator Units

a)	Identification of the composite insulators	As per IEC : 61109
b)	Visual Inspection	As per IEC : 61109
c)	Mechanical routine test	As per IEC : 61109

7.19.5 Tests during Manufacture

On all components as applicable

a) Chemical analysis of zinc used for galvanizing As per Annexure-A

b)	Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.	As per Annexure-A
c)	Chemical analysis hardness tests and magnetic particle inspection for forgings	As per Annexure-A
d)	Tracking and erosion test on insulating material	IEC 60587

7.19.6 Testing Expenses

The entire cost of testing for type, acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted Ex-works/ CIF Price.

In case of failure in any type test, if repeated type tests are required to be conducted, then all the expenses for deputation of Inspector/ Employer's representative shall be deducted from the contract price. Also if on receipt of the Supplier's notice of testing, the Employer's representative does not find 'plant' to be ready for testing the expenses incurred by the Employer for re-deputation shall be deducted from contract price.

7.19.7 Sample Batch for Type Testing

The Supplier shall offer material for sample selection for type testing only after getting Quality Assurance Programme approved by the Employer. The Supplier shall offer at least three times the quantity of materials required for conducting all the type tests for sample selection. The sample for type testing will be manufactured strictly in accordance with the Quality Assurance Programme approved by the Employer.

Before sample selection for type testing, the Supplier shall be required to conduct all the acceptance tests successfully in presence of Employer's representative.

7.19.8 Schedule of Testing

The Bidder has to indicate the schedule of following activities in their bids:

a) Submission of drawing for approval.
b) Submission of Quality Assurance Programme for approval.
c) Offering of material for sample selection for type tests.
d) Type testing.

7.19.9 Additional Test

The Employer reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at Supplier's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material comply with the Specifications.

The Employer also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Supplier's premises or at any other test Centre. In case of evidence of non-compliance, it shall be binding on the part of the Supplier to prove the compliance of the items to the technical specifications by repeat tests or correction of deficiencies or replacement of defective items, all without any extra cost to the Employer.

7.19.10 Co-ordinate for testing

The Contractor/ Supplier shall have to co-ordinate testing of insulators with hardware fittings to be supplied by other Supplier and shall have to guarantee overall satisfactory performance of the insulators with the hardware fittings.

7.19.11 Guarantee

The Contractor/ Supplier of insulators shall guarantee overall satisfactory performance of the insulators with the hardware fittings.

7.19.12 Test Reports

Copies of type test reports shall be furnished along with one original. One copy shall be returned duly certified by the Employer only after which the commercial production of the concerned material shall start.

Copies of acceptance test reports shall be furnished. One copy shall be returned duly certified by the Employer, only after which the material shall be dispatched.

Record of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Employer's representative, if so desired by the Employer.

Test certificates of test during manufacture shall be maintained by the Supplier. These shall be produced for verification as and when desired by the Employer.

7.19.13 Inspection

The Employer's representative shall at all times be entitled to have access to the works and all places of manufacture, where insulator, and its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Supplier's and sub-Supplier's works, raw materials, manufacture of the material and for conducting necessary test as detailed herein.

The material for final inspection shall be offered by the Supplier only under packed condition.

The Employer shall select samples at random from the packed lot for carrying out acceptance tests. The lot should be homogeneous and should contain insulators manufactured in 3-4 consecutive weeks.

The Supplier shall keep the Employer informed in advance of the time of starting and the progress of manufacture of material in their various stages so that arrangements could be made for inspection.

No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the inspection is waived off by the Employer in writing. In the latter case also the material shall be dispatched only after satisfactory testing for all tests specified herein have been completed.

The acceptance of any quantity of material shall be no way relieve the Supplier of his responsibility for meeting all the requirements of the specification and shall not prevent subsequent rejection, if such material are later found to be defective.

7.20 Packing and Marking

All insulators shall be packed in suitable PVC/ plastic tubes/ any other suitable packing along with temporary wrap-on shields/ shrouds for each insulator unit. The packing shall provide protection against rodent. The shields/ shrouds shall be for protection during transport and for preventing bird pecking during erection. Further, the shields/ shrouds shall be made of opaque, weather proof material of adequate strength and shall be color coded. The shields/ shrouds shall have smaller diameter than the insulator to stay in place against winds & weather and shall be designed so as to leave only the end fittings exposed for attachment of insulator to tower and line hardware until line construction is complete. The shield/ shroud shall have suitable pull off loop for easy detachment just prior to charging of the line without causing any damage to the insulator. The bidder Supplier shall furnish detailed design of the packing and shield/ shroud along with attachment and detachment procedure in this regard. For marine transportation, crates shall be pelleted.

The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.

Suitable cushioning, protective padding, or tonnage or spacers shall be provided to prevent damage or deformation during transit and handling.

The Supplier shall guarantee the adequacy of the packing and shall be responsible for any loss or damage during transportation, handling, storage and installation due to improper packing.

All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each case/ crate shall have all the markings stenciled on it in indelible ink.

7.21 Standards

The insulator strings and its components shall conform to the following Indian/ International Standards which shall mean latest revision, with amendments/ changes adopted and published, unless specifically stated otherwise in the Specification.

In the event of supply of insulators conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the standards proposed by the Bidder and those specified in this document will be provided by the Supplier to establish equivalence.

Sl. No.	Indian Standard	Title	International Standard
1.	IS: 209-1992	Specification for zinc	BS: 3436
2.	IS: 406-1991	Method of Chemical Analysis of Slab Zinc	BS: 3436
3.	IS: 731-1991	Porcelain insulators for overhead Power lines with a nominal voltage greater than 1000 V	BS: 137- (I&II) IEC: 60383
4.	IS:2071 Part (I) – 1993 (Part(II)- 1991 Part(III)- 1991	Methods of High Voltage Testing	IEC:60060-1
5.	IS: 2486 Part- I-1993 Part- II-1989 Part-III-1991	Specification for Insulator fittings for Overhead Power Lines with a nominal voltage greater than 1000V General Requirements and Tests Dimensional Requirements Locking Devices	BS: 3288 IEC: 60120 IEC: 60372
6.	IS:2629-1990	Recommended Practice for Hot, Dip Galvanization for iron and steel	ISO-1461 (E)
7.	IS:2633-1992	Testing of Uniformity of Coating of zinc coated articles	
8.	IS:3188-1988	Dimensions for Disc Insulators	IEC: 60305
9.	IS:6745-1990	Determination of Weight of Zinc Coating on Zinc coated iron and steel articles	BS: 433-1969 ISO:1460-1973

Sl. No.	Indian Standard	Title	International Standard
10.	IS:8263-1990	Methods of RI Test of HV insulators	IEC: 60437 NEMA Publication No.07/ 1964/ CISPR
11.	IS:8269-1990	Methods for Switching Impulse test on HV insulators	IEC: 60506
12.		Thermal Mechanical Performance test and mechanical performance test on string insulator units	IEC: 60575
13.		Salt Fog Pollution Voltage Withstand Test	IEC: 60507
14.		Residual Strength of String Insulator Units of Glass or Ceramic Material for Overhead Lines after Mechanical Damage of the Dielectric	IEC: 60797
15.		Guide for the selection of insulators in respect of polluted conditions	IEC:60815

ANNEXURE 7-A TESTS ON COMPLETE STRINGS WITH HARDWARE FITTINGS

1.1 Corona Extinction Voltage Test (Dry)

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 154 kV (rms) line to ground under dry condition. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC: 383.

1.2 Test (Dry)

Under the conditions as specified under (1.2) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 154 kV line to ground under dry condition. The test procedure shall be in accordance with IS: 8263/IEC: 437.

1.3 Mechanical Strength Test

The complete insulator string along with its hardware fitting excluding arcing horn, corona control ring, grading ring and suspension assembly/ dead end assembly shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to disassemble them by hand. Hand tools may be used to, remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.4 Vibration Test

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 meters. In the case of suspension string a load equal to 600 kg shall be applied along the axis of the suspension string by means of turn buckle. The insulator string along with hardware fittings and two sub-conductors (each tensioned at 43 kN shall be secured with clamps. The system shall be suitable to maintain constant tension on each sub-conductor throughout the duration of the test. Vibration dampers shall not be used on the test span. Both the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulators string (more than 10 Hz) by means of vibration inducing equipment. The peak to peak displacement in mm of vibration at the antinode point, nearest to the string, shall be measured and the same shall not be less than 1000/ f1.8 where f is the frequency of vibration in cycles/ sec. The insulator string shall be vibrated for not less than 10 million cycles without any failure. After the test the insulators shall be examined for looseness of pins and cap or any crack in the cement. The hardware shall be examined for looseness, fatigue failure and mechanical strength test. There shall be no deterioration of properties of hardware components and insulators after the vibration test. The insulators shall be subjected to Mechanical performance test followed by mechanical strength test as per relevant standards.

2.0 Composite Long rod Insulator Units

2.1 Brittle Fracture Resistance Test

Assembled core load time test with container that contains 1n-HNO3 concentric acid that is applied at the naked rod. The rod should be held at 80% of SML for the duration of the test.

The rod should not fail within the 96 hour test duration

2.2 Recovery of Hydrophobicity Test

1) The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the HC classification. Dry the sample surface.

2) Treat the surface with corona discharges to destroy the hydrophobicity. This can be done utilizing a high frequency corona tester, Holding the electrode approximately 3mm from the sample surface, slowly move the electrode over an area approximately 1” x 1”. Continue treating this area for 2 – 3 minutes, operating the tester at maximum output.
3) Immediately after the corona treatment, spray the surface with water and record the HC classification. The surface should be hydrophilic, with an HC value of 6 or 7. If not, dry the surface and repeat the corona treatment for a longer time until an HC of 6 or 7 is obtained. Dry the sample surface.
4) Allow the sample to recover and repeat the hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2 within 24 to 48 hours, depending on the material and the intensity of the corona treatment.

2.3 Silicone content test

Minimum content of silicon as guaranteed by supplier shall be verified through FT-IR spectroscopy & TGA analysis or any other suitable method mutually agreed between Employer & Supplier in Quality Assurance Programme.

2.4 High Pressure washing test

The test is to be carried out at 3800 kPa with nozzles of 6 mm diameter at a distance of 3m from nozzles to the insulator, followed by a dry power frequency voltage test as per IEC 61109.

3.0 Tests on All components (As applicable)

3.1 Chemical Analysis of Zinc used for Galvanizing

Samples taken from the zinc ingot shall be chemically analyzed as per IS: 209-1979. The purity of zinc shall not be less than 99.95%.

3.2 Tests for Forgings

The chemical analysis hardness tests and magnetic particle inspection for forgings, will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Supplier and Employer in Quality Assurance Programme.

3.3 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic, particle inspection for castings will be as per the internationally recognized procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Supplier and Employer in Quality Assurance Programme.

3.4 Autoclave Test

For cement used in the assembly of the insulators six samples from different batches shall be tested in accordance with ASTM C-151. The cement shall have an expansion less than 0.12%.

ANNEXURE 7-B BASIC INSULATION LEVELS OF INSULATORS

SYSTEM PARTICULARS

Transmission Line		
A	System Voltage	132 kV
B	Maximum Voltage	145 kV
C	Rated Lightning Impulse withstand (dry)	950 kVp (max)
D	Rated Power frequency withstand voltage (wet)	360kV rms

VOLUME – II-A OF III
CHAPTER - 8
OPTICAL GROUND WIRE (OPGW)
AND
OPTICAL TERMINAL EQUIPMENT

Turnkey Bidding Document

Kohalpur Nepalgunj 132 kV TLP

TABLE OF CONTENTS

8 OPTICAL GROUND WIRE & OPTICAL TERMINAL EQUIPMENT

8.1 General

The scope of work comprise of supply, installation, testing and commissioning of Optical Fiber Ground Wire (OPGW), including necessary accessories for fiber termination and splicing, for 10 km long Kohalpur - Nepalgunj 132 kV Transmission Line.

Bidders shall offer the OPGW and their accessories from reputed manufacturer. The contractor shall ensure complete supervision by competent technical personnel(s) of the OPGW manufacturer during installation, testing and commissioning of the whole OPGW system in totality under the project. The supervision shall also include the on-site training to the Employer's Representative(s).

8.2 Technical Requirements

The optical fiber ground wire (OPGW) shall have supporting cross section of 68 mm^2. The ground wire of the 132 kV line shall be a steel wire (or Aluminium clad steel wire) with an OPGW Composite Fiber Optic communication cable in the center. The Optical Fiber Cable, containing 48 single-mode optical fibers shall be embedded loosely inside the protective tube. The protective tube shall be of aluminum alloy or stainless steel. Both fiber optic and stranding part of OPGW shall comply with this Specification, and with the following standards:

Single mode fibers	**ITU-T (former CCITT) G. 652**
Optical fiber cables	IEC 60793-1 & 2
	IEC 1089/91, IEC 60889/87
Stranding part	IEC 60104/87; BS 3242

The earth wire shall be suitable for the climatic conditions with no attenuation changes or negative effects on the cable, and compatible with the stringing condition of the phase conductor. Under no condition shall the OPGW sag exceed the conductor sag.

The optical fiber shall be made of germanium doped silica glass or pure silica glass. It shall have a primary coating made of silicone or similar material with physical and mechanical properties at least those of silicone (acrylic or similar).

The tube shall be made of suitable material sufficiently strong to hold its shape and provide protection for the optical fibers against deformation and friction. The strength member of the fiber optic cable shall provide protection against buckling, kinking and strain. The material to be used shall be fiber reinforced plastic.

The direction of lay of the outer layer of strands shall be right hand. Lay ratio of any layer shall be not greater than the lay ratio of the layer immediately beneath it. The make up of ground wire shall be such that the strand shall remain and shall not twist when the conductor is cut. The earth wire shall be manufactured so that no twisting occurs when subjected to axial loads, i.e. when unrolling and stringing.

All wires used in the manufacture of the earth wire shall be free from protrusion, sharp edges, abrasion and any other imperfections.

No jointing of the aluminum clad steel wires shall be permitted.

There shall be no joints or splices in any optical fiber in any reel length of the complete optical cable.

The creep characteristic of the finished earth wire shall be of virtually unvarying uniformity.

Optical fibers

All fiber installed as a part of this Contract shall have a minimum life of 30 years from the date of final acceptance.

The OPGW shall include minimum 24 fibers. The main optical characteristics of the OPGW are mentioned in the schedule A.11 of Section - 11.

The other characteristics of the OPGW shall be as follows:

Outer diameter	:	11.4 mm
Cable weight	:	approximately 487 Kg/ km
Calculated breaking load	:	86.6 kN
Modulus of elasticity	:	162 kN/mm^2
Coefficient of thermal expansion	:	3.0x10^{-6} per degree K
Nominal short time current capacity at		
Initial/final temperature 20/200 ^{0}C	:	5.5 kA (min)
DC resistance at 20 ^{0}C	:	Not more than 1.247 ohm/ km

Attenuation

The attenuation coefficient for wavelengths between 1285 nm and 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than + 0.05 dB/km.

The attenuation coefficient for wavelengths between 1535 and 1565 shall not exceed the attenuation coefficient at 1550 mm by more than + 0.05 dB/km. The attenuation of the fiber shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.1 dB.

The cable shall consist of single mode dual-window color coded optical fibers. There shall be no factory splices within the cable structure.

8.3 Optical Fiber Identification

Color-coding is essential for identifying individual optical fibers and groups of optical fibers. Individual optical fibers within a fiber unit and fiber units will be identifiable using a color-coding scheme. The color-coding system shall be discernible throughout the design life of the cable.

Each cable shall be traceable of each fiber back to the original fiber manufacture's fiber number and parameters of the fiber.

If more than the specified numbers of fibers are included in any cable, the cable manufacturer shall test the spare fibers and any defective fibers shall be suitably bundled, tagged and identified at the factory by the fiber manufacturer.

Fiber units	Fiber No. & Color					
Blue tube	1	2	3	4	5	6
	Blue	Orange	Green	Brown	Gray	White
Orange tube	7	8	9	10	11	12
	Blue	Orange	Green	Brown	Gray	White

Green tube	13	14	15	16	17	18
	Blue	Orange	Green	Brown	Gray	White
Brown tube	19	20	21	22	23	24
	Blue	Orange	Green	Brown	Gray	White

8.4 Buffer Tube

Loose tube buffer construction shall be applied. A buffer for protection from physical damage shall surround the individually coated optical fiber(s) during fabrication, installation and performance of the cable. The fiber coating and buffer shall be strippable for splicing and termination. The inside diameter of the buffer tube shall be of appropriate size to allow free movement of the fibers during cable Contraction or elongation resulting from thermal, tensile or vibration loads.

Buffer tubes shall be sleeved over multiple fibers forming a fiber unit. A fiber unit may consist of up to 6 fibers, individually identifiable utilizing the color code in conformance with EIA 359 A.

8.5 Optical Fiber Termination and Splicing

Suitable splice boxes (enclosures) shall be provided to encase the optical cable ends and fusion splices in protective, moisture and dust free environment. The splice boxes shall be designed for the storage and protections of a minimum of 12 fibers cables and provide access through locked doors.

Fiber-optic cable of adequate length shall be provided so that all splicing can be performed at ground level at the towers. All splicing and necessary material shall be included in the price schedule presented by the Contractor.

8.6 Outdoor Splice Boxes

Splice boxes provided by the Contractor for outdoor use shall be suitable for use with the cable type provided as part of this Contract. The splice boxes shall be appropriate for mounting on steel structures and accommodate pass-through splicing and fiber terminations.

The splice box, including organizer/ splice trays, shall be designed to seal and protect the fiber cable splices from the environment defined in this specification and it shall provide easy access for any maintenance function.

All splice boxes shall be of metal construction that are clean and smooth finished, treated to resist rust, accommodate the storage of a minimum of 3 meters of coiled fiber and allow easy access to the splice trays. In addition there shall be a steel frame to coil up about 10 meters of OPGW outside the protection box.

8.7 Test

The testing must be done by recognized equipment and it shall be possible to produce a computerized print out from the computer and the software, all of which (lap top computer, printer and software) must be included in the testing, commissioning or installation unit prices.

There are different test series to assure the quality of OPGW:

- Routine test (in–process testing according to internal quality plan)
- Factory acceptance test (FAT, witnessed by customer)
- Type test (only in case of a basic new design, repetition in exceptional cases)

OPGW tests shall be in accordance with applicable standards or agreements between Employer and Contractor / manufacturer.

As a general rule the tests will be performed according IEC 60794-4-10.However, if necessary tests can be done according to IEEE Std1138.

8.8 Maintenance

To maintain the cable the Contractor shall propose and provide suitable equipment and necessary training for the Employer personnel to execute the work.

8.9 Joints

Number of Joints shall be kept to a minimum. Approved equipment and methods must be used to test the cable from both ends.

8.10 Particular Requirement for OPGW Earth Wire fittings and accessories

The associated fittings and other accessories have to satisfy the specific function of OPGW and fiber optics requirements for a total integrity of their components. The best way to achieve these goals shall be in application of suitable performed products. A brief description of the accessories is as follows:

a. **Suspension Assembly: Suspension assembly shall consist of:**

   - armor grip suspension clamp (aluminum alloy hyper formed armor rods and suspension clamp);
   - associated hardware for earth wire suspension:
   - Flexible grounding loop connection.

b. **Tension Assembly: The tension assembly shall consists of:**

   - Hyper formed alum weld dead end grip;
   - associated hardware for earth wire attachment (shackle, link, clevis, clamps);
   - Flexible grounding loop connection.

c. **Vibration Dampers**

   Dampers where necessary, shall be of Stockbridge type installed complete with the armor rods of the size suitable to the earth wire size.

d. **Fiber Optic Splice Closure-Joint Box**

   The fibre optic splice closure allows clamping of the cables to be spliced. It shall have following characteristics:

   - The splice capacity for minimum 12 single-mode fibers from metal free optical cable with loose tube construction;
   - waterproof housing of the closure aluminum or stainless steel construction with protection class IP 65 of IEC 60529;
   - box and cable glands tightened by sealing compound.

   Installation height shall be 1.5 m above the anti-climbing devices of the towers.

e. **Fiber Optic Hood Closure-Terminal Box**

The fibre optic splice closure allows termination of OPGW on the substation gantry and interface with the underground fiber optic cable leading into the control building. It shall have the following characteristics:

- the cable glands for accepting of one metal free optical cables with minimum 12 single-mode fibers and loose tube construction;
- waterproof housing of the closure aluminum or stainless steel construction with protection class IP 65 of IEC 60529;
- box and cable glands tightened by sealing compound.

It shall be installed on the terminal gantry 1.5 m above ground level.

8.11 Payment for OPGW and accessories

Payment for the supply and installation for the contract item "Optical fiber ground Wire (OPGW) and accessories" will be made at the unit bid price. Therefore, in the Price Schedule, the unit bid price shall include full compensation for all the costs incurred in furnishing all materials, equipment, labors and all other operations related to OPGW conductor and accessories fabrication, delivery etc.

8.12 OPGW Tests

The following tests shall be conducted once on sample/ samples of OPGW for every 50 km of production from the manufacturing facility:

- Structure and dimension test
- Transmission characteristics test
- Characteristics test of ACS
- UTS test

8.13 Indoor Splice box/ Optical Distribution Frame Construction and Design

The indoor splicing box/ optical distribution frame shall be of the wall mounted type and accommodates pass-through the splicing and interconnection for the equipment.

VOLUME – II-A OF III

CHAPTER - 9

ERECTION, STRINGING AND MISCELLANEOUS WORKS

Turnkey Bidding Document

Kohalpur-Nepalgunj 132 kV TLP

TABLE OF CONTENTS

9 ERECTION, STRINGING AND MISCELLANEOUS WORKS

9.1 ERECTION OF STEEL TOWERS

All towers shall be vertical under the stresses set up by the completed overhead line.

Precautions shall be taken to ensure that no parts of the structures are strained or damaged in any way during erection and drifting shall not be allowed.

Support members, which arrive on Site with slight distortions due to handling in transit, shall be straightened by the Contractor using an approved means and offered to the Employer or Employer's representative for inspection and subsequent acceptance or rejection before erection commences.

Suitable ladders shall be used whenever necessary during erection but such ladders and removable step bolts shall be removed when erection is not in progress.

Spanners used during erection shall be well shaped and fit closely on the hexagon to avoid damaging nuts and bolt head.

Reaming or drilling for correction of mismatched holes will only not be allowed without the written approval of the Employer or Employer's representative.

The Contractor shall ensure that a rigid bolt-checking program is carried out on all supports. On completion of initial assembly of towers, an organized bolt checking team shall check all bolts for tightness from the structure top downwards.

Bolt checking shall be carried out within one week from the time the support is erected. The bolt tightening shall be as follows:

Size of Bolt	Tightening Torque (kg.cm.)
16	1000-1200
20	1400-1800

Throughout the course of support erection the Contractor shall ensure that unbraced members are adequately supported by stays or guys or temporary struts prior to being braced.

The bracing of all four sides of the support shall be completed before guys are removed and before any erection of a higher section of the tower is commenced.

In no case the tower structure shall be erected until seven days after completing the foundation concrete work, and until proper backfilling and compaction.

The Contractor shall notify the Employer two weeks before the supports are ready for inspection. The inspection and correction of defects if any shall be complete before the start of the stringing operation.

Damaged galvanizing shall be repaired on site by galvanizing paint and as specified in accordance with Article 1.7 of General Technical Specification.

All bolts and nuts below the anti-climbing device shall be properly punched such as to provide safety against opening of the nut-bolts even with the wrench set. The punched area shall immediately be coated with zinc paint.

9.1.1 Payment

Payment for the contract item Steel tower erection will be made at the unit price bid "Erection of tower and leg extensions". Therefore in the schedule the unit bid price shall include full compensation for all cost incurred in furnishing all materials, tools, labours etc. for erection work related to this item.

9.2 CONDUCTORS STRINGING

At least 3 months before conductor stringing commences, the Contractor shall submit to the Employer a detailed account of his proposed stringing procedure which should include details of temporary support stays and compensation for initial stretch and long term creep of the conductors.

Full use shall be made of maximum conductor lengths in order to reduce the number of mid span joints to a minimum.

There shall not be more than one joint per conductor in any one span, and tension joints shall not be less than 15 meters from any conductor clamp. No tension joints shall be used:

- In section of less than 3 spans between tensions supports.
- In spans over navigable rivers, buildings, power lines, telecommunication lines, public roads and in any span subject to special way leave conditions or in any adjacent span.

Conductor repair sleeves shall not be used without the permission of the Employer or Employer's representative.

The conductors, joints and clamps shall be erected using the approved tools and in such a manner that no bird-caging, over tensioning of individual wires or layers or other deformation or damage to the conductors occurs. Clamps or other devices used in erection shall be of approved design and shall allow no relative movement of strands or layers of the conductors.

The Contractor shall keep a record of all conductor joints giving the location, the date of assembly and the name of the lineman responsible for the jointing. Where records of joints made by a particular lineman show a repeated performance below that required, the Contractor shall cease to employ the lineman on jointing operations and shall immediately replace him with other qualified personnel.

Phase conductors and OPGW shall be erected with such sags that everyday temperature in still air and 20 degree C temperature with maximum wind pressure, the final tensions shall provide factors of safety on the ultimate tensile strength of the conductor. The Contractor shall submit erection and final sag and tension charts for each type of conductor. These charts shall plot inter-related curves of tensions against equivalent span lengths, and actual span lengths against sags, at temperatures of 0^0 C, 20^0C, 32^0C, 40^0C, 60^0C and 80^0C in still air conditions, and shall show details of conductor size, conductor breaking load, and conditions of loading.

In calculating the sags and tensions, allowance shall be made for the elasticity and coefficients of expansion of the conductor materials.

The term "final tension" shall mean the tension existing in a line conductor, for any given condition of loading after sufficient period in service to allow for "bedding down" stretch and creep to take place. For purposes of calculating creep allowance this shall be taken as ten years from erection.

The "equivalent span" method shall be used, in which the tension in any section length is that which would apply to a single span equal to the square root of the length arrived at by dividing the sum of the cubes of the individual span lengths, in the section considered, by their sum. The calculated tensions at the time of initial erection shall be increased by an approved amount to allow for settling of the conductors, other means may be adopted subject to the approval of the Employer or Employer's representative.

At the end of the guarantee period the specified ground clearance plus the conductor creep age allowance shall not be infringed, in addition, the sag of any phase conductors in the same span.

Where required by the Employer, prior to the issue of the Operational Acceptance Certificate, the Contractor shall be responsible for checking that the relative sags of the conductors are within the specified tolerance. Such checks shall be carried out at selected point along the route as required by the Employer. Clearances between conductors and ground and between jumpers and structures shall be checked by the Contractor during erection and before handing over the line.

The Contractor shall provide dynamometers, sighting boards and levels suitably mounted for clamping to support steelworks and other approved apparatus necessary for the proper checking of the work. When required by the Employer, dynamometers shall be tested and if necessary recalibrate at the Contractor's expense.

During the progress of the work, the Contractor shall record on approved schedules the particulars of the sagging of conductors on each section of the route. These schedules shall show the support numbers of the section, individual span lengths, the equivalent span, the design and erection sags, together with the mean actual sag of the phase conductor as well as the temperature, and the dates of the stringing and checking. At the end of the Contract six sets of these schedules shall be handed to the Employer.

Blocks for running out conductors shall be of approved type and shall be robust and full running.

The wheel of the running out block shall have a diameter of not less than 20 times the outside diameter of the conductor and shall be fabricated from aluminum.

The Contractor shall provide as a minimum sufficient running blocks commensurate with stringing the longest section of the project.

Jumper-loops shall be cut to length such that the loop arcs at the points of departure from tension-clamp are naturally tangential to the tension-clamp departure angle.

All conductor, connections and clamps shall be treated with approved jointing grease to prevent galvanic corrosion between dissimilar metals and to inhibit aluminum surface oxidization.

After the line conductors have been finally tensioned to their correct sags, the Contractor shall erect vibration dampers at the recommended distance from the conductor clamps.

The Contractor shall identify the spans where aeronautical signs on the earth wire may need. However instruction from the Employer to put such signs at any span shall be fulfilled.

<u>Payment</u>

Payment for the contract item conductor stringing will be made at the unit price bid "Stringing of Conductor". Therefore in the schedule the unit bid price shall include full compensation for all cost incurred in furnishing all materials, equipment and labor for installation of insulators strings, jumpers, hardware, stringing and any other related works to this item. No additional payment will be made for any restringing and rearrangement of the existing circuit necessitated by the interconnection of the existing line with the Tee-off tower for the new line. Measurement for the payment shall be based on the both double circuit conductor km calculated by addition of the horizontal distance between towers.

<u>Shutdown</u>

For the stringing work of the lines, the Contractor shall request the Employer for the shutdown of existing transmission and/ or distribution lines, where necessary, at least 15 days in advance. The request letter or form shall include the place of work and duration of shutdown needed. The period of shutdown shall be as minimum as possible. The Employer has right to decrease the justified period of shutdown, if requested period of shutdown by Contractor is excessive and to shift the date of shutdown.

The Contractor shall complete the work, during the shutdown within the stipulated time period. If the Contractor fails to complete the work within the stipulated time limit, the Employer will claim the amount of money arising from the loss of energy not transmitted or distributed.

VOLUME – II-A OF III
CHAPTER- 10
INSPECTION, TESTING AND COMMISSIONING

Turnkey Bidding Document

Kohalpur Nepalgunj 132 kV TLP

TABLE OF CONTENTS

10 INSPECTION, TESTING AND COMMISSIONING

10.1 Scope

The whole of the Works supplied under the Contract shall be subject to inspection and test by the Employer or their Representative during manufacture, erection and after completion. The inspection and tests shall include, but not be limited to, the requirements of this Chapter of the Specification.

All appliances, apparatus, supervision, labour and services necessary to carry out all tests shall be provided by the Contractor unless specifically stated otherwise.

All expenses related to the factory tests of steel structures, conductor and insulator string shall be borne by the Contractor.

10.2 Quality, Assurance, Inspection and Testing

To assure that the supply and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his subcontractor's premises or at the Site or at any other place of work are in accordance with the Specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points necessary. Such program shall be outlined by the Contractor and shall be finally accepted by the Employer after discussions before the award of the Contract. A quality assurance program of the Contractor shall generally cover, but not be limited to the following:

a. His organization structure for the management and implementation of the proposed quality assurance program.
b. Documentation control system.
c. Qualification data for bidder's key personnel.
d. The procedure for purchases of materials, parts, components, and selection of sub-contractors' services including vendor analysis, source inspection, incoming raw materials inspection, verification of materials purchases.
e. System for shop manufacturing including process controls and fabrication and assembly controls.
f. Control of non-conforming items and system for corrective actions,
g. Control of calibration and testing of measuring and testing equipment.
h. Inspection and test procedure for manufacture.
i. System for indication and appraisal of inspection status.
j. System for quality audits.
k. System for authorizing release of manufactured products to the Employer.
l. System for maintenance of records.
m. System for handling storage and delivery.
n. A quality plan detailing out the specific quality control procedure adopting for controlling the quality characteristics relevant to each item of supply.

The quality plan shall be mutually discussed and approved by the Employer after incorporating necessary corrections by the Contractor as may be required.

10.2.1 Quality Assurance Documents

The Contractor shall be required to submit all the Quality Assurance documents as stipulated in the Quality Plan at the time of Employer's inspection of material/ equipment.

The Employer, through his duly authorized representatives, reserves the right to carry out Quality Audit and Quality Surveillance of the systems and the procedures of the Contractor's and the subcontractor's Quality Management and Control Activities.

10.2.2 Inspection, Testing and Inspection Certificates

The provisions of the clauses on Test and Inspection of the GCC and SCC shall be applicable to the supply and erection portions of the Works. The Employer shall have the right to re-inspect at his expenses any material though previously inspected and approved by him at the Contractor's works, before and after the same are inspected at Site following the latter, material is found defective, then the Contractor shall bear the cost of this inspection and reinstatement according to specification.

10.3 Guarantees

Bidders shall state and guarantee the technical particulars listed in the Schedules of Technical Particulars and Guarantees forming a part of the other sections. These guarantees shall be binding and shall not be departed from without the written permission of the Employer. The tolerances permitted in the BS, ISO or ANSI will apply unless stated otherwise.

10.4 Test at Manufacturers Works

10.4.1 General

Where no specific test is specified then the various items of materials and equipment shall be tested in accordance with the relevant, Indian, British, IEC, or American Standards. Where no appropriate standard is available, tests shall be carried out in accordance with the maker's standard practice which must meet with the approval of the Employer.

At least thirty days (30) notice in writing shall be given to the Employer of the readiness of plant for test or inspection and every facility shall be provided by the Contractor and sub-Contractor(s) to enable the Employer or their Representative to carry out the inspections and witness the tests. This includes progress, test rig and packing inspection.

Inspection of equipment will not be carried out unless copies of the relevant sub-orders, drawings and test procedures have been approved by the Employer.

No equipment shall be packed, prepared for shipment, or dismantled for the purpose of packing for shipment, unless it has been satisfactorily inspected, or inspection has been waived by the Employer.

Functional electrical and mechanical tests shall be carried out on the completed plant after assembly in the Works. The extent and method of recording the results shall be agreed by the Employer in sufficient time to enable the tests to be satisfactorily witnessed or to make any change to the proposed program of tests.

All instruments and apparatus used in the performance of the tests shall be to the approval of the Employer and, if required by the Employer, shall be calibrated to an agreed standard at a laboratory of National standing to be nominated by the Contractor and approved by the Employer.

The cost of carrying out such calibration shall be borne by the Contractor in all cases.

10.4.2 Material Tests

Requirements for the testing of castings and forging are detailed elsewhere in the Specification. Representative samples of all plates, bars and pipes etc. which form components of the equipment/ accessories shall be tested as required by the relevant standard or code at the request of the Employer.

10.4.3 Test Certificates

Sets of all principal test records, test certificates and performance curves shall be supplied to the Employer in number of copies within the time frame mentioned in section-2 of this specification.

These test records, certificates and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Employer or his Representative. The information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificate refers and should also bear the contract reference title. Specified requirements shall be shown on each certificate for comparison with actual test results.

When all equipment has been tested, test certificates from all Works and Site tests shall be compiled by the Contractor into volumes and bound in an approved form complete with index. Two copies of each volume shall be supplied to the consultant and four copies to the Employer.

10.5 Type Test

Type tests are required to prove the general design of the equipment. Type test reports of test performed on similar equipment shall be acceptable. But in case some type tests are required by the Employer, these tests prescribed shall be carried out at the Contractor's cost.

10.5.1 Tests on Tower

Test on each type of towers to be supplied, shall be made at the manufacturer's plant. The number of tower test, if required, is given in price schedule.

The Contractor shall give Employer not, less than 30 days advance notice, in writing or by fax, of the date when towers will be ready for tests. Employer reserves the right to waive the requirement for performing any or all tests. Should Employer exercise this right, the applicable unit prices for performing the test will be deducted from the total contract sum. The Contractor will not be entitled to any additional compensation by reason of such waiving.

Each test shall be performed in accordance with the following requirements:

a. Tower: The tower shall be fabricated from approved detail drawings in a manner as close to final production procedures as is practicable. The tower shall be complete in every detail.

b. Erection: The tower shall be erected on rigid foundation using the specified tower and bolts and nuts shall be tightened to the specified torque. The vertical axis through the center of gravity of the erected tower shall not be out of gravity of the erected foundation and shall not be out of plumb by more than 1 cm for every 500 cm height.

c. Rigging: The Contractor shall submit for approval as to compliance with the specifications, diagrams showing the proposed methods of applying loads and measuring deflection.

d. Loading: All test loads corresponding to conductor and overhead ground wire loading shall be applied directly to the regular attachment. Details shall be provided for these loads. Test wind loads equivalent to wind loads on the tower shall be applied where convenient and in such a manner that the summations of applied load and overturning moment are as close as possible to the actual behaviour as designed. Extra compressible member is not allowed for use of applying wind loads on tower. To ensure application of full-test loads to the tower, friction losses in rigging shall be added to the rigging loads.

e. Load Programs: The contractor shall program the tests to most favourably demonstrate that the towers will carry all design loads and conditions specified in the loading diagrams. Test wind loads on tower shall be the same as applied in design calculation.

f. Deflection Measurements: Deflections shall be recorded for the "before-load", "load-on" and "load-off" condition to provide longitudinal and transverse deflections at the tower top canter, at the elevation of the middle cross arm (s) and at least one intermediate point of tower body.

g. Design Load Tests: The initially applied loads and the increment of loading shall be 25 percent of the loads given in the loading diagrams. Each load increment shall be maintained for not less than two minutes for each assumption except under maximum (full) design loads the period of five minutes shall be maintained and during which time there shall be no slacking off or adjustment of the loads. Should it become necessary to adjust the loading, the two or five minutes period shall start after the loading is stabilized and constant. All test loads shall be removed completely before the loads for testing under different assumptions are applied.

h. Destruction Tests: After the successful completion of the load tests, the tower shall be further tested to destruction by increasing the transverse loads under any condition specified by Employer in increments not to exceed five per cent of full design transverse loads. The vertical and/or longitudinal load (s) is kept constant at their full design values while deflections are being recorded.

i. Modification of Tower Components: Any conspicuous yielding or any failure of any part of the tower under any of the tests specified in sub-article shall be considered a defect. If a defect develops, the Contractor shall modify his design of the tower and send to Employer for approval. The modified tower shall then be retested at the Contractor's expense (including the cost of witness, if any) until satisfactory results are obtained.

j. Material Tests: Steel materials used for tested towers shall be subject to tension or bend test in accordance with ASTM A370. Tests shall be performed by the Contractor at no additional cost to Employer. The test specimens shall be selected as follows:

   - Two sets selected from the destructed members of each tested tower.
   - Two sets selected from the undisturbed members of each tested tower.

k. Reports: The Contractor shall furnish four certified copies of full reports of all tower and material tests, the calibration of the dynamometers or gauges, including clear photographs of the test set-ups and nature of all failures, diagrams showing deflection of towers at each interval of loading, details diagrams deflection records.

10.5.2 Insulators

- **Impulse voltage withstand and flashover tests**

  The insulators for Impulse Voltage withstand tests shall be tested applying five standard 1.2/ 50 waves as specified in BS 137 and BS 923. If there is no flashover or puncture the insulator shall be deemed satisfactory. If there is more than one flashover the insulator shall be deemed not to comply with BS 137. In the event of one flashover occurring, a new series of ten impulses shall be applied. The insulator shall be considered to comply with BS 137 if during the second series of tests there is no flashover or puncture.

10.5.3 50% Flashover tests shall be carried out per BS 137

Additional tests will be required to show that the specified impulse level is obtained when the insulator strings are mounted on the structure. Bidders should note that the impulse test rig will therefore require earthen metalwork to simulate the proposed power configuration.

Flashover tests to determine the optimum lift shall be carried out in order to avoid cascade over as many line end insulators as possible.

10.5.4 Dry power frequency withstand

The Dry power frequency withstand test shall be carried out as specified in BS 137. The test voltage shall be maintained for one minute and the insulator shall be considered satisfactory if no flashover or puncture occurs.

10.5.5 Wet power frequency voltage withstand tests

The wet power frequency withstand test shall be carried out as specified in BS 137. The test voltage shall be maintained for one minute and the insulator shall be considered satisfactory if no flashover or puncture occurs.

10.5.6 Radio interference tests

Radio interference tests shall be carried out in accordance with IEC 437.

10.6 Insulator Fittings

Tensile tests, resistance tests and galvanizing tests shall be carried out in accordance with the requirements of BS 3288 Part 1 and BS 729.

10.7 Conductors

The conductors shall be tested in accordance with the requirements of BS: 215 or IS:398.

10.8 Routine Test

All equipment shall be subjected to routine tests at the manufacturer's work and shall include but not be limited to the following:

10.8.1 Operational tests

All equipment shall be tested after complete assembly to ensure the correct operation.

10.8.2 Clamps, joints and insulator fittings

Sample parts selected at random by the Employer shall be subjected to such tests as the Employer may direct in order to demonstrate compliance with Specifications and BS 3288 as applicable.

10.8.3 Insulators, fittings and conductor overall tests

A complete mechanical test of insulator string, fittings and section of conductor for suspension and tension sets at each voltage level will be required. The complete units shall withstand load tests including the safety factors specified. Tests other than mechanical tests on the complete unit may be required at the discretion of the Employer.

10.9 Cost of tests at manufacturer's works

The costs of making any test to be conducted at the manufacturer's works shall be borne by the Contractor. This shall apply to tests performed at the site or elsewhere.

After receiving the prior information about the completion of manufacturing at the factory, the Employer will depute his personnel to the Contractor’s factory to witness the fabrication, assembly and testing of any or all parts of major equipment. The number of the Employer's personnel and equipment to be witnessed will be as listed below. The duration of such visits shall be as per inspection/ testing requirements but not less than seven days.

- Prototype testing of Tower type QB & QC	2 persons, 1 visit
- Conductor	2 persons, 1 visit
- OPGW	2 persons, 1 visit
- Insulators	2 persons, 2 visit
- Hardware/ fittings	2 persons , 1 visit

The travelling expenses of the inspectors nominated by the Employer will be borne by Employer. However, the Contractor shall bear all the expenses (including travelling expenses as per NEA norms) occurred due to the repetition of the tests required due to:

- Failure of the test;
- Test facilities not ready at the time of inspection or mismatch of test schedule/program provided by the Contractor.

10.10 Site Tests

10.10.1 Measurement of footing resistance

Before stringing the conductor, the footing resistance of each support shall be measured with an earth resistance measuring instrument to the approval of the Employer.

10.10.2 Measurement of earth electrode resistance

Where the footing resistance is found to exceed 10 ohms additional earth electrodes are to be installed and the combined earth electrode and footing resistance measured together and recorded using the same test instrument. Additional electrodes are to be installed to obtain a maximum resistance value of 10 ohms.

10.10.3 Measurement of line impedance

Positive and zero sequence impedance measurement tests shall be carried out after final line inspection has been completed. The measurement tests shall be carried out on all new lines covered by this Contract, by the Contractor and at his cost.

10.10.4 Conductor joint tests

In the case of tension clamps, joints and bi-metal terminals the resistance of each part shall be measured by instruments supplied by the Contractor and approved by the Employer. The resistance of such fittings shall not exceed 75% of the electrical resistance of the equivalent length of conductor. The tests shall be carried out in the presence of the Employer. Stringing shall not commence until suitable instruments are on Site, approved by the Employer and ready for use.

10.10.5 Measurement of galvanizing thickness

The Contractor shall have available on Site for the Employer's use an instrument suitable for the accurate checking of galvanizing thickness. The gauge shall be available from the time of arrival of the first consignment of steel work until the issue of the Operational Acceptance Certificate. The cost of the gauge and other operating expenses are deemed to be included in the Contract Price and the gauge will remain the property of the Employer.

10.10.6 Tests on completion

Acceptance tests shall be carried out on Site by the Contractor on each section of the Works. These tests shall immediately follow the commissioning of each section of the Works.

The lines shall be energized at full working voltage before handing over and the arrangement for this, and such other tests as the Employer shall desire to make on the complete line, shall be assisted by the Contractor who shall provide such labour, transport and other assistance as is required without any extra charge. Apparatus for special tests shall be provided by the Contractor.

The Contractor shall submit to the Employer at least two months before the anticipated commencement of acceptance tests his detailed proposal for carrying out acceptance tests.

10.10.7 Test instrumentation

The method of measuring all quantities and qualities and the measurement tolerances shall be in accordance with the appropriate BS, ISO or ANSI.

The terminal conditions required for establishing whether the guarantees are met shall be measured by precision test equipment to be installed by the Contractor in addition to the permanent measuring equipment where supplied under the contract.

The overall design of the Works shall provide for the installation and use of test equipment so as not to interfere with the plant loading or delay the guarantee completion dates.

All the precision test equipment to be used for carrying out tests shall be calibrated against standard instruments before the tests, and if required by the Employer, also after the tests. Calibration records shall be available for inspection by the Employer or his Representative.

During the design stage of the plant, the contractor shall give details of measurements to be made to substantiate that the performance of the plant meets the requirements of the specification and in particular shall submit for approval a schedule of performance test instrumentation necessary to demonstrate the guarantees.

10.10.8 Test reports

For each of the specified tests the contractor shall agree the test figures with the Employer and shall submit for approval triplicate copies of the test report containing a complete analysis of the test results within one month of the completion of the relevant test. Eight copies of the final approved report shall be submitted to the Employer.

10.11 Commissioning Test

The contractor shall be responsible for checking that total and relative sags of conductors are within the specified tolerances. Such checks shall be carried out at positions along the route selected by the Employer and the contractor shall provide the necessary surveying instruments to enable the checks to be carried out with the line in service without any extra charge.

The commissioning tests are as follows:

10.11.1 Measurement of line parameters

The line insulation resistance shall be measured on each individual section of the lines before the jumper loops are closed and again on the whole lines when they are completed.

The electrical parameters of the lines such as resistance, reactance, suspectance etc. shall be measured in a manner to be approved by the Employer, sufficiently accurately to enable the positive, negative and zero sequence impedance to be determined for the lines.

The lines shall then be energized at the proposed operating voltage from the Employer's system or generating station and the charging current measured and other such tests performed as the Employer may require making on the completed line.

The contractor shall carry out all these tests in the presence of the Employer, and shall provide all the necessary labour, transportation, apparatus, instruments and other assistance as required, without any extra charge.

10.11.2 High voltage tests

The overhead lines shall be tested with DC voltage applied between each phase and earth by means of a DC high voltage testing unit and without cleaning of the insulators. Bidders shall state leakage current expected for such tests, for the different section of lines and taking into consideration and atmospheric conditions. The contractor shall supply the necessary apparatus, instruments and the D.C. high voltage supply and the testing unit including those required for carrying out test and should be shown in the schedules in Volume I.

The test voltage shall be applied for five minutes for 132 kV overhead lines and shall be as follows:

Line Voltage	D.C Test Voltage to Earth
132 kV	187 kV

The electric power necessary for the tests at Site shall be supplied by the Employer on condition of availability. The contractor shall satisfy himself that all connections are good before switching power and shall be responsible for, and make good any damage that may arise because of faulty connections.

All D.C. measuring apparatus, instruments including D.C. high voltage testing unit will be subject to checking and calibration by the Employer before starting the high voltage D.C. current test, catalogues and details to be submitted with offer. Full details and catalogue of the proposed high voltage D.C. testing equipment shall be submitted for approval before shipping the test equipment.

10.12 Field test quality plan

A field test quality plan is given in the appendix-10.1. The Contractor shall provide necessary information to the Employer/ site engineer so that the tests are conducted and results recorded well.

APPENDIX - 10.1: FIELD QUALITY PLAN FOR TRANSMISSION LINES

S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testing Extent	Counter Check/ Test by Employer	Accepting authority in Employer
1.	Detailed Survey	a. Route alignment	Optimization of route length	a. Preliminary survey. b. Topographical map c. Tower Spotting Data	Contractor	100% at Field	100% based on record documents	To be notified by the Employer
		b. Route profiling & tower spotting.	1. Ground clearance. 2. Cold wt. Span 3. Hot wt. Span 4. Sum of Adj. Span (wind span) 5. Angle of Deviation.	a. Sag template b. Tower Spotting data c. Route alignment	Contractor -do- -do- -do- -do-	100% at Field -do- -do- -do- -do-	100% based on record documents -do- -do- -do-	To be notified by the Employer
2.	Check Survey	Tower Location & Final Length	i) Alignment	a. Route alignment	Contractor	100% at Field	i) All angle towers in plains and 50% in	To be notified by the Employer

S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testing Extent	Counter Check/ Test by Employer	Accepting authority in Employer
			ii) Final Length	b. Tower Schedule c. Profile	-do-	-do-	hilly terrains. ii) Final length to be checked on 100% basis based on records/documents	
3.	Detailed Soil Investigation	a. Bore log	1. Depth of bore log 2. SPT Test 3. Collection of samples	As per Employer Specification	Contractor	100% at Field	To witness 20% at Field	To be notified by the Employer
3	Tower Foundation	b. Tests on samples	As per tech. Specs.	As per Employer Specification	Lab appd. By Employer	100% by testing lab	Review of lab test results	To be notified by the Employer
		1. Cement	1. Source approval	Source meeting Employer Specification/Approved vendor	Contractor	As proposed by Contractor	To verify the proposal based on the supply made and factory test results.	-do-
			2. Physical tests	As per specification	Samples to be taken jointly with Employer and tested at Employer approved	Review of all MTC's and one sample for every 500 MT	100% review of lab test results	-do-

S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testing Extent	Counter Check/ Test by Employer	Accepting authority in Employer
					lab			
			3. Chemical Tests Chemical composition of Cement	-do-	Contractor to submit MTC	100%% review of MTC by Contractor	100% review of MTC	-do-
		2. Reinforcement Steel	1. Source approval	To be procured from main producers only.	Contractor	As proposed by Contractor	To review the proposal based on the test reports.	-do-
			2. Physical and Chemical analysis test	As per specification	Contractor to submit MTC	All MTC's	100% review of MTC	-do-
		3. Coarse Aggregates	1. Source approval	Source meeting Employer Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the test results of Joint samples tested in Employer approved lab	To review the proposal based on the documents	To be notified by the Employer

S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testing Extent	Counter Check/ Test by Employer	Accepting authority in Employer
			2. Physical tests	As per document at Annexure-3 of this FQP at page 16	Samples to be taken jointly and tested in Employer approved lab	One sample per lot of 200 cum or part thereof	100% review of lab test results	- do-
		4. Fine aggregate	1. Source approval	Source meeting Employer Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the results of Joint samples tested in Employer approved lab.	To review the proposal based on the documents.	- do-
			2. Physical test	As per Annexure-4 of this FQP at page 17	Samples to be taken jointly and tested in Employer approved lab	One sample per lot of 200 cum or part thereof	100% review of lab test results	- do-
		5. Water	1. Cleanliness	Employer	Contractor	100% visual	Verification at random	- do-

S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testing Extent	Counter Check/ Test by Employer	Accepting authority in Employer
			(Water shall be fresh and clean)	Specification		check at Field		
			2. Suitability of water for concreting	Employer Specification	Contractor	100% Visual Check at Field	Verification at random	- do-
		Foundation Classification	1. Visual observation of soil strata 2. Ground water level 3. History of water table in adj. Area/surface water 4. Soil Investigation wherever required	Employer Specification	Contractor	100% at Field	100% at Field	- do-
		1. Bottom of excavated earth	Depth of foundation	Appd. Drawings.	Contractor	100% at Field	100% check by Employer	- do-
		2. Stub setting	1) Centre Line	-do-	-do-	-do-	-do-	-do-
			2) Diagonals					

S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testing Extent	Counter Check/ Test by Employer	Accepting authority in Employer
4.	Tower Erection	1. Materials a. Tower member/bolts & nuts/washers/accessories	Visual checking for 1. Stacking 2. Cleanliness 3. Galvanizing 4. Damages	Appd. Dwg./BOM	Contractor	100% at stores	100% verification of records	- do-
		2. Erection of Super-structure	1. Sequence of erection	As per Appd. Drawings/ Employer specification	Contractor	100% at field	100% check	- do-
			2. Check for completeness	-do-	-do-	-do-	-do-	-do-
			3. Tightening of nuts and bolts	-do-	-do-	-do-	-do-	-do-
			4. Check for verticality	-do-	-do-	-do-	-do-	-do-
			5. Tack welding for bolts & nuts	Employer Specification	Contractor	100% at Field	100% Check	- do-
		3. Tower footing resistance (TFR)	TFR at locations before and after earthing.	Employer Specification	Contractor	100% at Field	20% locations to be verified	- do-

Nanjan

Turnkey Bidding Document

Kohalpur Nepalgunj 132 kV TLP

S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testing Extent	Counter Check/ Test by Employer	Accepting authority in Employer
5.	Stringing	1. Materials						- do-
		a. Insulators	1. Visual check for cleanliness/glazing/ cracks/and white spots.	Employer Specification	Contractor	100% at Field	100% verification of records and to carry random checks 10%	- do-
			2. IR Value	(min. 50M Ohms)	-do-	One test per sample size of 20 for every lot of 10,000	To verify Contractor's records 100% and joint check 20% of total tests	-do-
			3. E&M test	-	Insulator supplier	a. 20 per 10,000 for discs b. 3 per 1500 for long rod	Collection of samples, sealing them and handing over by Employer to Insulator supplier	Tests to be witnessed/ Appd. at Manufacturer's works
			4. Traceability (Make/batch No./Locations where installed)	Packing list/CIP	Contractor	100% at field	100% Review of records	To be notified by the Employer(NEA)
		b. Conductor	On receipt, 1. Visual check of drum.	Packing list	Contractor	100% at stores	20% check	To be notified by the Employer(NEA)

S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testing Extent	Counter Check/ Test by Employer	Accepting authority in Employer
			2. Check for seals at both ends, and Employer sticker on outer end	-do-	-do-	-do-	-do-	-do-
			3. Check depth from top of flange to the top of the outer most layer	-do-	-do-	-do-	-do-	-do-
		c. OPGW	Check for seals at both ends	Packing list	Contractor	100% at stores	20% check	-do-
		2. Field activity						
		a. Before Stringing	Readiness for stringing	Stringing procedures as per Employer specification	Contractor	Readiness certificate to be submitted by the Contractor	Review of Certificate	-do-
		b. During stringing	(Conductor /OPGW)					-do-
			1. Scratch/cut check (Visual)	Appd. Drawings/ Employer Specification.	Contractor	100% at Field	100% record & Field check 20%	-do-

S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testing Extent	Counter Check/ Test by Employer	Accepting authority in Employer
			2. Repair sleeve	-do-	-do-	-do-	-do-	-do-
			3. Mid span Joints	-do-	-do-	-do-	-do-	-do-
			4. Guying (in case of towers not designed for one side stringing)	Appd. Guying arrangement/ Employer specification.	-do-	-do-	100%	-do-
		c. After stringing	Check for,					
			1. Sag/Tension	Sag tension chart/tower Spotting data	-do-	-do-	100% record & Field check 20%	-do-
			2. Electrical clearances	As per appd. Drawings/ Employer specifications	-do-	-do-	-do-	-do-
			i) Ground clearance	-do-	-do-	-do-	-do-	-do-
			ii) Live metal clearance etc.	-do-	-do-	-do-	-do-	-do-
			3. Jumpering	-do-	-do-	-do-	-do-	-do-

S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testing Extent	Counter Check/ Test by Employer	Accepting authority in Employer
			4. Copper bond	As per Appd. Drawings/ Employer Specification	Contractor	100% at Field	100% record & Field Check 20%	-do-
			5. Placement of damper	As per Specification/ drawings/ placement chart	-do-	-do-	-do-	-do-

APPENDIX - 10.2: PRE – COMMISSIONING PROCEDURES FOR TRANSMISSION LINES

1.1 Introduction

Over all procedure, safety rules, Statutory Requirements, dispatch procedures, switching sequences, observations, passing criteria and documentation of test results have been documented in this APPENDIX-II.

The detailed inspection and handing over documents are required to be checked for the entire length of transmission line before energization.

The detailed inspection/ test procedures for each activity have been elaborated in Chapter 10 and Appendix-I separate section of this documentation. The contents are as following:

1. Definition
2. Overall Procedures
3. Safety procedures
4. Inspection
5. Statutory Requirements
6. Handing over
7. Protective system
8. Dispatch procedures
9. Switching procedures
10. Testing
11. Energization
12. De-energization
13. Observations and duration
14. Passing criteria
15. Documentation

1.2 Definition

"Main Transmission Lines" means all high pressure cables and overhead lines (not being an essential part of the distribution system of a licensee) transmitting electricity from a generating station to another generating station or a sub-station, together with any step-up and step-down transformers, switch-gear and other works necessary to and used for the control of such cables or overhead lines, and such buildings or part thereof as may be required to accommodate such transformers, switch-gear and other works and the operating staff thereof;

"Power System" means a system under the control of the Government or any other statutory body of Generating Company or other agency and having one or more:-

- Generating station; Or
- Main transmission lines and sub-stations; Or
- Generating stations and main transmission lines and substations;

"Load Dispatch Centre" means the Centre so designated where the operation of Integrated Nepal Power System constituting the country's power system is coordinated;

"Sub-Station" means a station for transforming or converting electricity for the transmission or distribution thereof and includes transformers, convertors, switch-gear, capacitors, synchronous condensers, structures cables and other appurtenant equipments and any buildings used for that purpose and the site thereof, a site intended to be used for any such purpose and any buildings used for housing the staff of the sub section;

"Tie-Line" means a line for the transfer of electricity between two power systems together with switchgear and other works necessary to, and used for the control of such line.

1.3 Overall Procedure

First it is to be ascertained that the transmission line to be energized is ready for operation and has been properly handed over (released) in writing. This will include all safety aspects, statutory clearance, and final inspection by the Employer and regulatory body, if any.

Instructions for the work and supervision are given by the test leader (Line in charge). However all switching and all operational activities will be executed by the regular operators.

Line charging instructions received from LDC are clearly understood by the Line in charge and doubts, if any, are to be got clarified prior to the energisation of the line.

Once the line is handed over for charging no work shall be permitted without a valid WORKPERMIT.

When the whole system has been energized, including the AC line, it will be kept in this state for 8 hours or more for "soaking" with continuous inspection and monitoring.

1.4 Safety Procedures

Energization implies an abrupt and serious change of the working conditions in the plant. In order to avoid serious accidents, thorough information must be imparted to all personnel involved in the construction of transmission line. It should be ensured that due publicity has been made to the public in all the villages/ areas along the line route cautioning them against climbing the towers etc. and that the line is proposed to be charged on so and so date. It is also to be confirmed that the AGENCIES involved in the construction activities shall not carry out any job on the said line without a valid WORK PERMIT.

It shall be ensured before charging that all men, material, Tools and plants and any temporary earthing on any part of the entire length of line are removed.

It must be ensured that any power supply/ low voltage charging used as anti-theft measure must be disconnected and isolated to avoid accidental connection.

All equipment tests and pre-commissioning tests must have been completed, terminated (in case cables were isolated for testing purpose) and documented.

The system must be formally declared ready for energization and handed over for operation in writing.

1.5 Inspection

Before the line is scheduled to be handed over for the pre-commissioning/ energization the same shall be inspected by representatives of EMPLOYER and Construction Agency as follows:

Such an inspection shall include:

I. Right of way/ way leave/ electrical clearance
II. Foundation and Revetments/ Protection Work
III. Tower and Tower accessories
IV. Hardware Fittings
V. Insulators
VI. Conductors and Earth wire

Turnkey Bidding Document

Kohalpur Nepalgunj 132 kV TLP

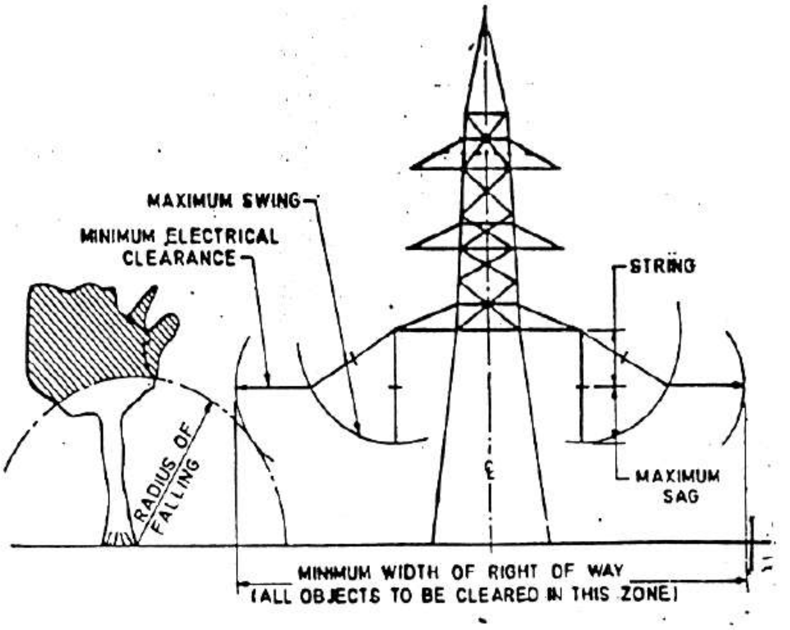
VII. Accessories for conductor and Earth wire

VIII. Aviation Warning Signals (Lights/ globules/ painting)

1.5.1 Right of Way/ Way Leave/ Clearance

Right of way/ Way leave clearance

Ensure that no tree/ tree branches are falling within the zone of minimum clearance specified as per Fig. 1.



NOTE — Portion of tree falling within clearance zone to be lopped or trimmed.

FIG. 1 LINE CLEARANCE (RIGHT-OF-WAY) REQUIREMENTS

Guidelines of forest/ environmental rules shall be followed to avoid excessive tree cutting i.e. all the trees should be cut from ROUTE level in the 3 meter corridor below each line Conductor/ Earth wires. In the balance corridor, Trees branches are only to be lopped to attain the specified clearance as per Table no 1.

CLEARANCE FOR RIGHT OF WAY

TRANSMISSION VOLTAGE IN KV	MINIMUM RIGHT OF WAY (IN MTRS)
132	27

1.5.2 Electrical Clearance

In case of line crossings, clearance between lowest conductor of line and top conductor of the other line shall be adequate as per CBIP Transmission Line Manual: Jumpers in the tension tower are properly intact with conductor and form a parabolic shape in order to achieve adequate clearance from super steel structure.

1.5.3 Ground clearance

Normally at the time of construction adequate clearance is provided between lowest conductor and ground, but due to delay in charging/ commissioning there are chances of dumping/ heaping soil, earth and concrete etc. or staking bricks etc. which may cause reduction in ground clearance. In such cases the stored materials shall be removed.

Ensure that there is no temporary or permanent construction of houses or shades below the line. If the same has been constructed they shall be removed before charging.

The ground profile at the time of commissioning shall be checked with the profile approved at the time of check survey.

Ground clearance of lowest conductors at critical points/ where ever the lowest conductor is touching the ground shall be checked in the field from any of the prevalent method and the values of ground clearance at these critical points shall be recorded in the prescribed format.

In case of hilly Terrain and for building clearance, the side clearance from conductors and jumpers at critical points shall also be checked and recorded for all phases of conductor/ earth wire towards hill/ building side.

1.5.4 Clearance for Telephone line crossings

The minimum clearances between the conductors of the power line and telecommunication lines are as per CBIP Transmission Line Manual.

1.6 Foundation and Revetments/ Protection Work

1.6.1 Foundation

There shall not be any damage/ uneven settlement of foundations. For this, tolerances in levels of all four stubs should not exceed the criteria provided in the Annexure-C of IS -5613 (Part -3/Section 2):1989.***

It is to be ensured that back filling of foundation is properly done. Soil shall be filled over all legs up to ground level.

Extra surface earth after foundation back filling shall be removed from legs of the tower beyond a lead distance of 30 metres. Any crack or break in chimney, if found, shall be repaired.

1.6.2 Revetments/ Protection

Cracks/ damages to revetments shall be repaired.

Wherever revetments are provided, weep holes shall have slope such as to flush out the deposited water away from tower platform.

In case of hilly terrain, the benching area should be levelled properly. The area around tower shall have proper slope for drainage of rain water.

1.7 Tower and Tower Accessories

1.7.1 Normal Tower

After completion of a transmission line, all the towers shall be thoroughly checked before charging the line. Special attention shall be given to the points as mentioned below:-

- Deformed/ Buckled/ missing/ Rusted Members and Nuts and Bolts

It is to be ensured that no members are bend, deformed or rusted have been used in towers and if so, the same shall be replaced.

If any members is found missing, a new member shall be Fixed as per erection drawing of Towers.

Nuts shall be sufficiently tightened for the required Torque specified in the Approved Drawing. Minimum 2/3 complete threads shall be projected outside the nut. All bolts shall have their nuts facing outside of the tower for Horizontal connection and Downwards for Vertical connections.

Nuts & bolts shall be properly tack welded/ punched as per the specification and proper zinc rich paint shall be applied. It shall be ensured that the circular length of each welding shall be at least 10mm.

It shall also be ensured that all extra blank holes provided on tower members are filled with correct size of nuts & bolts.

1.7.2 Special Towers

In addition to the above checks for towers, ladders and platforms provided in special towers shall be properly tightened and no foreign material shall be left out on such platforms.

1.7.3 Earthing of Towers

Ensure that proper earthing of tower has been done and earthing strip is neither damaged nor broken and is properly fixed to the stub.

In case of counter poise earthing, it is to be ensured that earth wire is sufficiently buried in the ground and no where it has drag out during cultivation. The length of counter-poise is normally 30 meters as per Technical Specification.

Before charging of the line, ensure that resistance is below 10 ohms. If the value (before stringing) has been recorded higher than 10 ohm earthing shall be changed to counterpoise type.

Earthing of special towers shall be verified as per approved drawings applicable for special towers/ special foundation. (In case of anchor foundation bolt/ anchor plate welded with last leg of special tower.)

1.7.4 Tower accessories

All the danger plates, number plates, circuit plates, and phase plates shall be in position & and as per the specification.

All plates shall be properly tightened.

It shall be ensured that phase plates are fixed in correct phase sequence. Especially at transposition towers, the phase plates in the correct phase sequence shall be provided at each towers or end tower as per the specification of the line.

It shall be ensured that the anti-climbing device (ACD) is provided, at the suitable height of tower. In case of barbed wire ACD, barbed wire shall be tightly fixed.

It shall be ensured that the step bolts (for normal towers) are provided up to the peak of tower. Any missing step bolts shall be replaced.

Fixing of birds guards (wherever applicable) shall be ensured.

1.8 Hardware Fittings

Tightening of all bolts and nuts are to be checked up to specified torque.

Check the fixing of all security clips (W/R type clips).

Surface condition of corona control rings and distance/ alignment between Tower side arcing horn (wherever applicable) and line side arcing horn/ corona control ring to be checked as per approved drawings.

To restrict the swing of jumpers, the provision of Pilot strings in case of Tension Towers shall be verified from the approved drawings.

1.9 Insulators

All the damaged/ broken insulator discs shall be replaced. Unusual deflection in suspension strings if observed shall be rectified using appropriate counter weights.

The insulators shall be cleaned before charging.

IR value of insulators of at least 5 insulators at random shall be checked by 5/10 kV Megger.

1.10 Conductors and Earth Wires

Surface of the conductors shall be free from scratches/ rubs. Ensure that conductor strands are not cut and opened up. Wherever strands are found cut/ damaged/ scratched, they must be repaired with repair sleeves/ repair protective rods in case the nos. of damaged strands are within specified limits (normally up to 1/6th nos. of strands in the outer layer).

1.11 Accessories for Conductor and Earth Wires

1.11.1 Joints

All joints on conductor/ earth wires shall be away from the tower at a distance of at least 30 metres or as provided in the Technical specification (TS).

Ensure that no more than one joint in a conductor is provided in one span.

Ensure that no mid span joint is provided in major crossings for main roads, railway crossing and major rivers etc. or as provided in Technical Specification.

Ensure that all mid span joints on conductors/ earth wire and repair sleeves of compression type are free from sharp edges, rust and dust. Wherever grease are specified the same shall be applied in the joints.

1.11.2 Clipping

Ensure that conductor is not over tightened in the suspension clamps

Spacers, vibration dampers and copper bonds.

Vibration Dampers (VD, shall be verified as per the damper placement chart. All loose/ displaced VD shall be properly tightened / relocated and missing VDs shall be provided.

1.11.3 Jumpers

Verify Electrical clearance of jumpers to tower body as per design.

All the jumpers shall be checked properly. In case, jumpers (conductor/ earth wire) are found loose, it shall be tightened adequately.

1.11.4 Foreign material

Ensure that all foreign materials via dead bird. Fallen tree branches, bird nests etc. on conductors, earth wires, Jumper, insulator string, cross arms are re-moved.

1.11.5 Others

It shall be ensured that all temporary/ local earthing, guys, T & P (Tools and Plants), foreign material and other loose material which were used during stringing/ tower erection have been removed.

In case there is any change in the ground profile before commissioning of line from the approved profile, the extra earth/ obstruction/ temporary sheds/ any other construction shall be removed.

1.12 Aviation Warning/ Obstruction Signals (Lights/ Globules/ Painting)

It shall be ensured that following measures have been taken in the line/ Towers falling within obstruction zone of civil aviation and defence establishments as per their requirement and the specification.

1.12.1 Day markers

Painting of Full/ Top portion of Towers with Red/ Orange and White Paints.

Globules on earth wires have been provided.

1.12.2 Night markers

It shall be ensured that proper aviation lights at the peak level/ at specified heights of towers have been provided along with Solar panels/ Battery banks/ Control cubicles and other accessories as per specification. The functioning of lights with simulation to be checked/ verified.

1.13 Statutory Requirement

The concerned authorities shall be informed before commissioning the lines and their approval obtained in accordance with Statutory Provisions.

1.14 Handing Over

The transmission line shall be inspected prior to energization and a formal handing over document to be jointly signed by the Employer and Employer's representative. However all contractual taking over has to be resolved separately as per the terms and conditions of the contract. The Handing over shall be limited to the completion of Erection and ready for Energization.

Any outstanding points or remaining activities are to be listed jointly. The remaining activities/ outstanding points are classified in the following category:

Details of the Sections:

A. List of outstanding activities remaining in any part of the line
B. A list of temporary arrangements introduced.
C. Check list records properly documented, completed and signed.
D. Soft copies of Profile, Route Alignment, Tower Design, Structural Drawings, Bill of Materials, Shop Drawings, Stringing charts (initial and final as applicable) etc. of all towers/ line submitted to the Employer.

With the outstanding activities mentioned above are solved or with only minor points without influence on the charging remain, handing over of the transmission line shall be accepted by the pre-commissioning team. This handing over for energization with or without remaining activities shall be made by the group head to the commissioning in charge in writing.

1.15 Protective System

Before energization it must be ascertained that all protective systems for the unit to be energized are operative.

This includes confirmation that the protections have been properly tested and that the tests have been documented.

It also includes verification by inspection or otherwise, if necessary by repetition of trip test, that the protections are actually functionally enabled. This verification serves to prevent that energization takes place of a unit where a protection has been disabled for test or other reason.

1.16 Switching Procedure

For each activity the instructions to the operators and the communications to the dispatchers will be made in writing or by confirmed telephone messages. The switching procedures first to be properly documented step by step and understood by everybody involved in the switching operation prior to the energisation. Any clarification required in the procedures must be resolved. The format established by the Employer for switching orders and operational data logging shall be followed.

The implication of this is that each and every activity must be listed and described, so that complete information is available for detail investigation, if required in future.

1.17 Testing and Measurement Procedures

1.17.1 Earth Resistance Measurement

Normally Earth tester is used for measuring:

a. Soil resistivity

Prior to the testing of soil resistivity and earth resistance the operation manual of the testing instrument available at site may be referred and procedures to be adopted for measurement of soil resistivity and earth resistance.

A typical Earth tester has 4 terminals. C1, P1, C2, P2 and 4 similar electrodes are driven in the ground at equal distances and connected to the instruments in the order of C1' P1 and P2, C2. Then the handle is rotated or button is pressed and the reading of the resistance is read on the instrument scale. If R is the resistance measured then the

Specific resistivity = $2\,\pi aR$

Where “a” is the distance between the electrode and R is the resistance in ohms measured on the instrument.

b. Earth resistance

In order to measure earth resistance of electrode of the substation it could be connected to C1 and the value of R could be read in the scale with the rotation of the handle of the instrument. This will give the earth resistance. The value as far as possible shall be below 10 Ohm. To improve the value, water shall be sprinkle at the earthing pit.

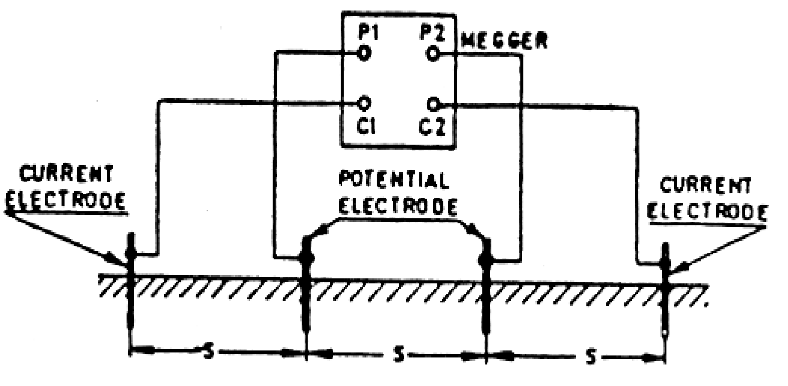


fig : 2 Test connection for a four terminal Megger

1.17.2 Other Tests

Before commissioning of the lines following tests may be carried out.

Insulation Resistance Test

This test may be carried out with the help of a 10 or 12 kV instrument preferably power driven to ascertain the insulation condition of the line. In case 5 kV instrument is used for insulation resistance measurement it shall be ensured that the induced voltage (CVT reading) is LESS than the instrument withstanding capacity otherwise it is likely that the instrument may be damaged.

This Test is to be carried out First prior to the continuity test.

Measurement of Insulation Resistance

One of the most common devices used for testing electrical insulation is Instrument Insulation Tester.

The DC test voltage is generated by a permanent magnet generator. This generator is turned either by hand or by an electric motor. In either case a slip clutch maintains the generator speed at a constant value so long as the slipping speed is exceeded. A constant voltage is important when the insulation under test has a high capacitance. Common generator output voltage are 500, 1000, 2500 and 5000 volts.

Many insulation tester have a "guard" terminal as well as "line" and "earth". The guard terminal is useful shall one wish to exclude part of the insulation under test from the measurement. This is possible since current flowing to the generator via the guard circuit does not pass through the deflecting coil.

Another use of the guard circuit is to shield the "line" lead between the insulation tester and the apparatus under test. This prevents leakage to ground from the "line" lead which would invalidate the insulation tester reading.

Insulation resistance is the ratio VDC/IDC.VDC is applied across two conductors separately by the insulation under test.

IDC is the current flowing through/over the insulation. For a healthy and clean insulation the insulation tester reading is in mega-Ohms to infinity. For dirty in, insulation and defective, moist insulation the insulation tester shows a very low insulation resistance value.

Insulation tester test gives clear indication about the health, cleanliness and dryness of the line/equipment insulation.

5 KV insulation tester or 10 KV insulation tester or 12 KV insulation tester may be used for the Transmission line keeping all safety requirements, Permit to work, clearance from statutory bodies and other conditions prevailing at the Sub-station where charging of the line is being co-ordinated.

Conductor Continuity Test

The objective of this test is to verify that each conductor of the overhead line properly connected electrically (the value of electrical resistance of line does not vary abnormally from that of a continuous conductor of the same size and length). The electrical resistance of the conductor shall be measured with a Whetstone bridge or other suitable instrument, if available taking the safety aspects of Equipment as well as testing Engineer.

A simple method of continuity test is illustrated below:

Once the insulation test is completed and the results confirms no short circuit carry the following:

SENDING END	RECEIVING END	RESULTS (OHMS)

CLOSE R-Ph GS	Insulation Resistance R- Ph	ZERO/LOW
OPEN Y – Ph GS	Insulation Resistance Y-Ph	HIGH
OPEN B-Ph GS	Insulation Resistance B-Ph	HIGH
OPEN R-Ph GS	Insulation Resistance R-Ph	HIGH
CLOSE Y – Ph GS	Insulation Resistance Y-Ph	ZERO/LOW
OPEN B-Ph GS	Insulation Resistance B-Ph	HIGH
OPEN R-Ph GS	Insulation Resistance R-Ph	HIGH
OPEN Y–Ph GS	Insulation Resistance Y-Ph	HIGH
CLOSE B-Ph GS	Insulation Resistance B-Ph	ZERO/LOW

Notes:

1. GS means GROUND SWITCH.
2. During above test all other GS shall remain open.

If the above test results are OK it confirms the continuity of the line.

The continuity Test of the line with proper phase indication or phase marking can be checked by continuity test as described below:

SENDING END	RECEIVING END INSULATION RESISTANCE BETWEEN	RESULTS (OHMS)
CONNECT R&Y PHASE B-PHASE & ALL GS OPEN	R PHASE & Y PH Y PHASE & B PH B PHASE & R PH	ZERO OR LOW HIGH HIGH
CONNECT R & B PHASE Y PHASE & ALL GS OPEN	R PHASE & Y PH Y PHASE & B PH B PHASE & R PH	HIGH HIGH ZERO OR LOW
CONNECT Y & B PHASE R-PHASE & ALL GS OPEN	R PHASE & Y PH Y PHASE & B PH B PHASE & R PH	HIGH ZERO OR LOW HIGH

If the test results are OK it confirms that marking of the phases are in order.

Phase Sequence

Once the line is charged from one end, without closing the Breaker at the other end the Phase sequence is to be checked from the CVT/ PT output by the help of Phase Sequence Meter.

In case there are other feeders available Phase sequence is to be RECHECKED by the measurement of secondary voltage of both the Feeders (New line & available charged line).

Let the secondary Voltage of CVT/ PT is 110 volts (ph to ph) for both the Circuit. In case of correct Phase Sequence the voltage reading shall be as follows:

NEW CIRCUIT	OLD CIRCUIT	VOLTAGE
R-Phase	R-Phase	0
R-Phase	Y-Phase	110
R-Phase	B-Phase	110
Y-Phase	R-Phase	110
Y-Phase	Y-Phase	0
Y-Phase	B-Phase	110
B-Phase	R-Phase	110
B-Phase	Y-Phase	110
B-Phase	B-Phase	0

In case the results are not matching the phase sequence in to be rechecked and reconfirmed before closing the breaker.

1.18 Energization

Execution of the energization is simply the last event in the switching sequence, switching of the close control button for the relevant circuit breaker.

1.19 De-Energization

Instructions about de-energization will be given only if this is part of the test. Otherwise de-energization will be considered part of regular operation.

1.20 Observation and Duration

Visual and audible inspection (look and listen) of the relevant equipment and reading of permanent instrumentation will be made.

The system shall be charged at least for 8 hours. During this time continuous monitoring and inspection will be maintained in control room, auxiliary systems areas and switch yards.

This will include frequent, scheduled inspection of all equipment and reading of all permanent instruments and recorders, and surge arrester counters, especially system parameters as per standard procedures adopted by the Employer.

1.21 Passing Criteria

Neither insulation breakdown nor protective system actions must occur. No irregular equipment behaviour (noise, vibration, high temperature) is permitted.

Corona discharges may not be “unreasonable”. Local discharges that may be attributable to sharp points shall be carefully located and recorded. After termination of the energization the equipment shall be closely inspected and the points rounded or covered.

No unscheduled changes of system nor of equipment parameters is permitted during the 8 hour energized condition.

Measurement of Line Parameters

The Contractor shall conduct measurement of Line parameters as per international practice.

High voltage Tests

The Contractor shall conduct high voltage tests as per international practice.

1.22 Documentation

Switching and operational activities will be recorded in regular manner in the operator’s log. Likewise all readings of permanent instruments, Copies of this log, notes on special observations from inspections and other measurements will constitute the test records.

VOLUME – II-A OF III
CHAPTER - 11
TECHNICAL SCHEDULE

Turnkey Bidding Document

Kohalpur Nepalgunj 132 kV TLP

TABLE OF CONTENTS

11 TECHNICAL SCHEDULE

11.1 Schedule A.1

System and Line Data

ITEM	DESCRIPTION	UNIT	DATA
1.	**System Data**		
1.1	System Nominal Voltage	kV	132
1.2	System Maximum Voltage	kV	145
1.3	System Nominal frequency	Hz	50
1.4	**Line Data**		
1.4.1	Kohalpur Nepalgunj 132 kV Double Circuit Tower	Km	10
1.4.2	Line Conductor		ACSR - BEAR
1.4.3	Ground Wire		OPGW

Altitude and Basic Insulation Level

The proposed 132 kV Transmission line traverses through plain landscape of Banke district of Nepal. The variations of altitudes of the proposed 132 kV transmission line ranges from approximately 146.13 m to 158.1 m above MSL.

132 kV Transmission Lines in different altitude zones shall be designed in compliance with the following Basic Insulation Levels (BIL)

Altitude Zone	Highest Voltage for Equipment U_m in kV (rms value)	Short-duration power frequency withstand voltage – kV (rms value)		Lightning Impulse withstand voltage – kV (peak value)	
		Required	Selected	Required	Selected
Altitude up to and including 2100 m	145	317	325	749.4	750

11.2 Schedule A.2

DESIGN DATA

ITEM	DESCRIPTION	UNIT	DATA
1.	**Temperature**		
1.1	Maximum ambient temperature	^{0}C	35
1.2	Minimum ambient temperature	^{0}C	0
1.3	Maximum temperature of conductor	^{0}C	85
1.4	Everyday temperature of conductor	^{0}C	32

Wind Load

ITEM	DESCRIPTION	UNIT	DATA
1.	**Temperature**		
1.1	Design Wind Speed (Vd)	m/s	47 (Wind Zone:4 as per IS:802)
1.2	Reliability Level		1 (50 yrs return period)
1.3	Risk Co-efficient (k1)		1
1.4	Terrain Roughness Co-efficient (K2)		1.08
But Gust factors corresponding to terrain category –II shall be considered for conductors/ earth wire, Tower and Insulator for arriving the wind load.			
The corresponding Design Wind Pressure on towers, conductors and insulators shall be obtained from the relation $Pd=0.6V^2$.			

11.3 Schedule A.3

MINIMUM CLEARANCES

The followings are the minimum clearances between live conductors and other objects, which correspond to the maximum conductor sag conditions at different altitude zones.

ITEM	DESCRIPTION	Clearance
1.	Normal ground for pedestrians only	6.5
2.	Residential areas	6.5
3.	Roads and streets	7.0
4.	Highways	7.5
5.	To metal clad or roofed buildings or building or	6.0

	structures upon which a man may stand	
6.	Power lines (above or below)	3.5
7.	Telecommunication lines	3.5
8.	River and other areas (above maximum flood)	6.5

For other objects not listed in the Schedule the requirements for minimum clearances shall comply also with NESC (NATIONAL ELECTRIC SAFETY CODE).

Approximately 0.5m shall be added to the clearance values above to allow for survey and drawings errors.

Crossing of houses, huts and other objects with soft roofing is not allowed.

11.4 Schedule A.4

TOWER TYPES

Altitude more than 900 to 2600m	Deviation Angle	Typical Use
QA	0 deg.-2 deg.	To be used as tangent Tower up to 2 deg deviation
QB	0 deg.-15 deg	a) Tension Tower with Angle deviation from 0 to 15 deg. b) Section tower c) To be designed for anti- cascading condition.
QC	15 deg.-30 deg	a) Tension Tower with Angle deviation from 15 to 30 deg b) Tension tower for uplift forces resulting from a uplift span as per weight span specified in Schedule-A4, Section-11. c) To be designed for anti-cascading condition.
QD/DD/DES	30 deg.-60 deg	a) Tension tower Angle deviation from 30 to 60 deg. b) Tension towers for uplift forces resulting from an uplift spam as per weight span specified in Schedule-A4, Section-11. c) Complete Dead end with 0 to 15 Degree deviation on both sides. d) For river crossing anchoring with longer wind span with 0 deg deviation on crossing span side and 0 to 30 deg deviations on other side.
QF	Above 60 deg and up to 90 deg.	a) Tension tower Angle deviation above 60 deg and up to 90 deg. b) Tension towers for uplift forces resulting from an uplift spam as per weight span specified in Schedule-A4, Section-11.

2.	DESIGN SPANS			WEIGHT SPAN (m)			
ITEM	TOWER TYPE DOUBLE CIRCUIT	BASIC SPAN (m)	WIND SPAN (m)	Normal Condition (Maximum)	Normal Condition (Minimum)	Broken Wire Condition (Maximum)	Broken Wire Condition (Minimum)
2.1	QA	350	350	488	208	192	104
2.2	QB	350	350	960	-960	576	-576
2.3	QC	350	350	960	-960	576	-576
2.4	QD/DD/ DDES	350	350	1460	-1460	876	-876
2.5	DF	350	350	2000	-2000	1200	-1200

11.5 Schedule A.5

TOWER OUTLINE CONFIGURATION

Refer Drawing No. DWG011.

11.6 Schedule A.6

FACTOR OF SAFETY

ITEM	DESCRIPTION	MINIMUM FACTOR OF SAFETY
1.	Tower Foundations	
1.1	All types of suspension (QA) and small angle (QB) towers	1.1
1.2	All types of other tension towers (QC, QD, DD/ DDES)	1.2
2.	Conductors and Insulators	
2.1	Conductors based on ultimate tensile strength	2.0
2.2	Conductors based on ultimate tensile strength at still air every –day temperatures	4.5
2.3	Compete insulator strings and fittings on minimum breaking load of insulator	3.3
2.4	Dead end compression clamps and compression splices based on conductor ultimate tensile strength	0.95
3.	Ground Wires	
3.1	Ground wire based on earth wire ultimate tensile strength	2.0

3.2	Ground wire at still air everyday temperature based on earth wire ultimate tensile strength	5.0
3.3	Complete tension assembly at ground wire maximum working tension	4.0
3.4	Complete suspension assembly at maximum vertical load	4.0

11.7 Schedule A.7

TOWER PARTICULARS

ITEM	DESCRIPTION	UNIT	MINIMUM VALUES
1.	Unit Stresses		
	The quality of steel used for support members and bolts		
1.1	Structural Steel:		
1.1.1	Structural Members		
	i. Tension based on net sectional area (MS)	kg/cm^2	2600
	ii. Tension based on net sectional area (HT)	kg/cm^2	3600
	iii. Axial compression based on gross sectional area	kg/cm^2	As per IS:802
1.1.2	Connection bolts		
	i. Shear on gross area (Class 5.6)	kg/cm^2	3160
	ii. Bearing (on Mild Steel) (Class 5.6)	kg/cm^2	4440
	iii. Tension on net area of threaded portion (Class 5.6)	kg/cm^2	2590
2	Slenderness Ratios (L/R)		
	The slenderness ratio of unsupported length of steel compression members to their least radius of gyration.		
2.1	Main members	NA	120
2.2	Braces	NA	200
2.3	Redundant members	NA	250
2.4	Members loaded in tension only	NA	400

11.8 Schedule A.8

TOWER MEMBERS PARTICULARS

The minimum thickness and diameter of material used in members and bolts shall be as follows:

ITEM	DESCRIPTION	UNIT	MAXIMUM VALUES
1.	Calculated members	mm	45x45x4
2.	Redundant members	mm	45x45x4
3.	Thickness of legs, members in cross arms and in ground wire peaks	mm	6
4.	Diameter of bolts for member carrying stress	mm	16
5.	Diameter of bolts for redundant members without calculated stress	mm	16
6.	Gusset plates	mm	6
7.	Stub angles	mm	8

11.9 Schedule A.9

LONG ROD POLYMERIC INSULATORS

The minimum thickness and diameter of material used in members and bolts shall be as follows:

ITEM	DESCRIPTION	UNIT		
			Altitude ≤ 1,000m	Altitude ≥2,160 m
1.	Insulator type		Composite Log Rod	
2.	Highest system voltage	kV	145	
3.	System frequency	Hz	50	
4.	Rated lightning impulse withstand voltage	kV_{peak}	750	950
5.	Rated power frequency withstand voltage(wet)	kV_{rms}	325	395
6.	Minimum Creepage distance as multiplied arcing distance	-	3.5	
7.	Minimum mechanical failing load			

ITEM	DESCRIPTION	UNIT		
			Altitude ≤ 1,000m	Altitude ≥2,160 m
7.1	Suspension rod	kN	90	
7.2	Tension rod	kN	160	
8	Factor of safety under maximum loading condition			
8.1	Insulator set		3.3	
8.2	Fittings		4.0	
9.	Overall length of insulator string		As per standards	
10.	Standards		IS/ IEC	

11.10 Schedule A.10

LINE CONDUCTOR

ITEM	DESCRIPTION	UNIT	DATA
1.	ACSR "BEAR"		
1.1	Conductor size	mm^2	326.1
1.2	Conductor type		ACSR BEAR
1.3	Number and size of wires		
1.3.1	Aluminum	No. Dia mm	30 3.38
	1st Aluminum Layer	No.	18
	2nd Aluminum Layer	No.	12
1.3.2	Steel	No. Dia mm	7 3.35
	Core Steel	No.	1
	1st Steel Layer	No.	6
1.4	Cross section		
1.4.1	Aluminum	mm^2	264.4
1.4.2	Steel	mm^2	61.7
1.4.3	Total	mm^2	326.1
1.5	Conductor diameter	mm	23.45
1.6	Ultimate strength	Kg	11,340
1.7	Standard mass of conductor	Kg/km	1214
1.8	Electrical D.C. resistance at 20 ®C	Ohm/km	0.1093
1.9	Standard un jointed length on reel	m	2,000
1.10	Modulus of Elasticity	kg/Sq mm	8,200
1.11	Mass of zinc coating	gm/sq. m	195
1.12	Co-efficient of Linear Expansion	per °C	17.8×10^{-6}
1.13	Direction of Lay of outer	-	Right Hand

ITEM	DESCRIPTION	UNIT	DATA
1.14	Standards	BS 215 PART 2 IEC 1089 / IS 398 PART 2	

11.11 Schedule A.11

OPTICAL FIBER GROUND WIRE (OPGW)

ITEM	DESCRIPTION	UNIT	DATA
1.	Outer diameter	mm	11.4
2.	Breaking load	kN	86.6
3.	Modulus of elasticity	kN/mm^2	162
4.	Coefficient of thermal expansion	1/degree K	3.0 X 10^{-6}
5.	Nominal short time current capacity at initial/final temperature 20/200 °C	kA	5.5
6.	DC resistance at 20 °C	Ohm/km	1.247
7.	Single mode fiber	ITU-T G.652	
8.	No. of single mode optical fibers		24
9.	**Fiber attenuation at**		
9.1	1310 nm at 20°C max.	dB/km	0.4
9.2	1550 nm at 20°C max.	dB/km	0.25
10.	Attenuation deviation at 1310 nm and 1550 nm	dB/km	0.1 (within -45°C to 80°C)
11.	Standards		
11.1	Aluminum alloy wires	IEC 104 type A	
11.2	Aluminum clad steel wire	IEC 1232	
11.3	Cable construction	IEC 1089	
11.4	Optical Unit	ITU-T (former CCIT) G 652	

11.12 Schedule A.12

MATERIAL FOR TOWER GROUNDING

ITEM	DESCRIPTION	DATA
1.	Ground rods	
1.1	Galvanized steel angle	50 x 50 x 5mm steel angles 2m long
2.	Ground wire	
2.1	Galvanized steel wire/ strip	$38mm^2$ / strip 7/2.6mm
3.	Connection of ground electrode with stub angle	
3.1	For connection of steel angle:	Steel wire as above

11.13 Schedule A.13

FOUNDATION APPLICATION SCHEDULE

FOUNDATION TYPE	APPLICATION	SOIL DESCRIPTION
I. "Spread Footing"	For use with all 132kV lattice tower types QA QB QC QD/ DDES DF	Soil capable of being excavated with vertical wall limit bearing capacity 2.5 kg/ sq.cm. Assume cone of earth 30 degrees. Dry Cohesive Material – Stiff clay. Some silt and sand. Not readily excavated by shovel alone. Cannot be moulded by finger pressure and intended by thumb. Blow count 8 to 10. Granular Material- Compacted sand. Some silt and gravel. Difficult to excavate by shovel alone. Relative density over 60%. Blow count 10 to 20.
II "Spread Footing"	For use with all 132kV lattice tower types DB DC DD/DDES DF	Soil capable of being excavated without appreciable sloughing. Limit Bearing Capacity 1.25 kg/sq. cm. Assume cone of earth 15 degrees. a) Cohesive Material – Soft to medium clay. Some silt and sand. Can be excavated by shovel alone and molded by medium finger pressure. Blow count 4 to 8. Granular Material – Loose to medium sand and silt. Easily excavated by shovel alone and moulded by medium finger pressure. Blow count 4 to 10, paddy fields. When the top layer of soil upto 1.5m each black cotton/Loose Silty Sandy soil and followed by normal dry cohesive ordinary soil. And where subsoil water table is met at 1.5m or below the ground level. b) For all the above soils and where subsoil water table is met less than 0.75m or below the ground level. Fully submerged soil consisting top layer of black cotton soil/Loose silty sandy soils followed by ordinary fine grained soil strata. c) Wet fissured/disintegrated rock, hard gravel, Kankar and limestone, Later it .
III "Spread Footing"	For use with all 132kV lattice tower types DB	Hard Rock/ordinary soil followed the hard rock.

DC DD/DDES DF

11.14 Schedule A.14

INSEPTION TESTS AT MANUFACTURE'S PLANT

ITEM	DESCRIPTION	DATA
1.	Rolled Steel Angles and Bolts	
1.1	Tensile strength test and chemical analysis, zinc coating test Full scale tower load test to destruction	Steel Mill Certificates IEC 652
2.	Insulators	
2.1	Temperature cycle test, mechanical failing load test	IEC 383 & IEC 575
2.2	Porosity test, continuity of zinc coating	BS 137
2.3	Electrical test on complete insulator strings	ANSI C-29.1
3.	Insulator Fittings	
3.1	Routine and sample mechanical tests	BS 3288
3.2	Galvanizing tests	BS 729
4.	Clamps and joints	
4.1	Mechanical and electrical type tests, galvanizing and mechanical routine tests	BS 3288 BS 729 ISO
5.	Dampers	
5.1	Fatigue resistant tests	
5.2	Test of clamp slippage resistance	BS 729
5.3	Galvanizing tests	ISO
6.	Line Conductor and earth wire	
6.1	Mechanical test, galvanizing test and resistivity test, ultimate tensile stress of complete conductor	IEC 209 BS 2677

VOLUME – II-A OF III
CHAPTER - 12
FORMS AND PROCEDURES

Turnkey Bidding Document

Kohalpur Nepalgunj 132 kV TLP

TABLE OF CONTENTS

FORM OF COMPLETION CERTIFICATE

Date:________________

IFB No:____________________

____

To: _________________________________

Dear Ladies and/or Gentlemen,

Pursuant to GCC Clause 24 (Completion of the Facilities) of the General Conditions of the Contract entered into between yourselves and the Employer dated _____________, relating to the ____________________, we hereby notify you that the following part(s) of the Facilities was (were) complete on the date specified below, and that, in accordance with the terms of the Contract, the Employer hereby takes over the said part(s) of the Facilities, together with the responsibility for care and custody and the risk of loss thereof on the date mentioned below.

1. Description of the Facilities or part thereof: ______________________________

2. Date of Completion: __________________

However, you are required to complete the outstanding items listed in the attachment hereto as soon as practicable.

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defect Liability Period.

Very truly yours,

____

Title

(Project Manager)

FORM OF OPERATIONAL ACCEPTANCE CERTIFICATE

Date: _______________

IFB No: _______________

____

To: _________________________________

Dear Ladies and/or Gentlemen,

Pursuant to GCC Sub-Clause 25.3 (Operational Acceptance) of the General Conditions of the Contract entered into between yourselves and the Employer dated _______________, relating to the ___________________________________, we hereby notify you that the Functional Guarantees of the following part(s) of the Facilities were satisfactorily attained on the date specified below.

1. Description of the Facilities or part thereof: _______________________________

2. Date of Operational Acceptance: _______________________

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defect Liability Period.

Very truly yours,

____

Title

(Project Manager)

CHANGE ORDER PROCEDURE AND FORMS

Date: ________________

IFB No: ________________

CONTENTS

ANNEXURES:

CHANGE ORDER PROCEDURE

1.1 General

This section provides samples of procedures and forms for implementing changes in the Facilities during the performance of the Contract in accordance with GCC Clause 39 (Change in the Facilities) of the General Conditions of the Contract.

1.2 Change Order Log

The Contractor shall keep an up-to-date Change Order Log to show the current status of Requests for Change and Changes authorized or pending. Entries of the Changes in the Change Order Log shall be made to ensure that the log is up-to-date. The Contractor shall attach a copy of the current Change Order Log in the monthly progress report to be submitted to the Employer.

1.3 References for Changes

a. Request for Change as referred to in GCC Clause 39 shall be serially numbered CR-X-nnn.

b. Estimate for Change Proposal as referred to in GCC Clause 39 shall be serially numbered CN-X-nnn.

c. Acceptance of Estimate as referred to in GCC Clause 39 shall be serially numbered CA-X-nnn.

d. Change Proposal as referred to in GCC Clause 39 shall be serially numbered CP-X-nnn.

e. Change Order as referred to in GCC Clause 39 shall be serially numbered CO-X-nnn.

Note:

(a) Requests for Change issued from the Employer's Home Office and the Site representatives of the Employer shall have the following respective references:

- Home Office CR-H-nnn
- Site CR-S-nnn

(b) The above number "nnn" is the same for Request for Change, Estimate for Change Proposal, Acceptance of Estimate, Change Proposal and Change Order.

ANNEXURE – 1: REQUEST FOR CHANGE PROPOSAL

General

This section provides samples of procedures and forms for implementing changes in the Facilities during the performance of the Contract in accordance with GCC Clause 39 (Change in the Facilities) of the General Conditions of the Contract.

(Employer's Letterhead)

To: ____________________________________ Date:

Attention: ______________________________________

Contract Name: _________________________________

Contract Number: _______________________________

Dear Ladies and/ or Gentlemen:

With reference to the captioned Contract, you are requested to prepare and submit a Change Proposal for the Change noted below in accordance with the following instructions within _______________ days of the date of this letter ____________________

1. Title of Change: ________________________

2. Change Request No. __________________

3. Originator of Change: Employer: _______________________________
   Contractor (by Application for Change Proposal No. ______:

4. Brief Description of Change: ____

5. Facilities and/or Item No. of equipment related to the requested Change: _____________

6. Reference drawings and/or technical documents for the request of Change:

   Drawing No./Document No. Description

7. Detailed conditions or special requirements on the requested Change: ________________

8. General Terms and Conditions:

(a) Please submit your estimate to us showing what effect the requested Change will have on the Contract Price.

(b) Your estimate shall include your claim for the additional time, if any, for completion of the requested change.

(c) If you have any opinion negative to the adoption of the requested Change in connection with the conformability to the other provisions of the Contract or the safety of the Plant or Facilities, please inform us of your opinion in your proposal of revised provisions.

(d) Any increase or decrease in the work of the Contractor relating to the services of its personnel shall be calculated.

(e) You shall not proceed with the execution of the work for the requested Change until we have accepted and confirmed the amount and nature in writing.

(Employer's Name)

(Signature)

(Name of signatory)

(Title of signatory)

ANNEXURE – 2: ESTIMATE FOR CHANGE PROPOSAL

(NOT APPLICABLE)

(Contractor's Letterhead)

To: ______________________________ Date: ________

Attention: _______________________________

Contract Name: _______________________________

Contract Number: _____________________________

Dear Ladies and/or Gentlemen:

With reference to your Request for Change Proposal, we are pleased to notify you of the approximate cost of preparing the below-referenced Change Proposal in accordance with GCC Sub-Clause 39.2.1 of the General Conditions of the Contract. We acknowledge that your agreement to the cost of preparing the Change Proposal, in accordance with GCC Sub-Clause 39.2.2, is required before estimating the cost for change work.

1. Title of Change: ________________________

2. Change Request No./Rev.: ____________________________

3. Brief Description of Change: __________________________

4. Scheduled Impact of Change: ___________________________

5. Cost for Preparation of Change Proposal: _____________

(a) Engineering (Amount)

(i) Engineer _____ hrs x _____ rate/hr = _________

(ii) Draftsperson _____ hrs x _____ rate/hr = _________

Sub-total ______ hrs _________

Total Engineering Cost

(b) Other Cost

Total Cost (a) + (b)

____

____

(Contractor's Name)

____

(Signature)

____

(Name of signatory)

____

(Title of signatory)

ANNEXURE – 3: ACCEPTANCE OF ESTIMATE

(NOT APPLICABLE)

(Employer's Letterhead)

To: ______________________________ Date:

Attention: ________________________________

Contract Name: _____________________________

Contract Number: ___________________________

Dear Ladies and/ or Gentlemen:

We hereby accept your Estimate for Change Proposal and agree that you should proceed with the preparation of the Change Proposal.

1. Title of Change: ___________________________
2. Change Request No./Rev.: _______________________________
3. Estimate for Change Proposal No./Rev.: _______________________________
4. Acceptance of Estimate No./Rev.: _______________________________
5. Brief Description of Change: _______________________________
6. Other Terms and Conditions: In the event that we decide not to order the Change accepted, you shall be entitled to compensation for the cost of preparation of Change Proposal described in your Estimate for Change Proposal mentioned in para. 3 above in accordance with GC Clause 39 of the General Conditions.

____

(Employer's Name)

____

(Signature)

____

(Name and Title of signatory)

ANNEXURE – 4: CHANGE PROPOSAL

(Contractor's Letterhead)

To: ______________________________ Date: __________

Attention: ______________________________

Contract Name: ______________________________

Contract Number: ______________________________

Dear Ladies and/or Gentlemen:

In response to your Request for Change Proposal No. ______________________________, we hereby submit our proposal as follows:

1. Title of Change: ______________________________
2. Change Proposal No./Rev.: ______________________________
3. Originator of Change: Employer: ______________________________
   Contractor: ______________________________
4. Brief Description of Change: ______________________________
5. Reasons for Change: ______________________________
6. Facilities and/ or Item No. of Equipment related to the requested Change: __________________
7. Reference drawings and/or technical documents for the requested Change:

   Drawing/ Document No. Description

8. Estimate of increase/ decrease to the Contract Price resulting from Change Proposal:[1]

(Amount)

(a) Direct material ____________________

(b) Major construction equipment ____________________

(c) Direct field labour (Total hrs) ____________________

(d) Subcontracts ____________________

[1] Costs shall be in the currencies of the Contract.

(e) Indirect material and labour ______________________

(f) Site supervision ______________________

(g) Head office technical staff salaries ______________________

Process engineer ______ hrs @________ rate/hr

____

Project engineer______ hrs @________ rate/hr ______________________

Equipment engineer______ hrs @________ rate/hr ______________________

Procurement______ hrs @________ rate/hr ______________________

Draftsperson______ hrs @________ rate/hr ______________________

Total ______ hrs

(h) Extraordinary costs (computer, travel, etc.) ______________________

(i) Fee for general administration, % of Items ______________________

(j) Taxes and customs duties ______________________

Total lump sum cost of Change Proposal

____

(Sum of items (a) to (j))

Cost to prepare Estimate for Change Proposal

(Amount payable if Change is not accepted)

9. Additional time for Completion required due to Change Proposal

10. Effect on the Functional Guarantees

11. Effect on the other terms and conditions of the Contract

12. Validity of this Proposal: within [Number] days after receipt of this Proposal by the Employer

13. Other terms and conditions of this Change Proposal:

(a) You are requested to notify us of your acceptance, comments or rejection of this detailed Change Proposal within ______________ days from your receipt of this Proposal.

(b) The amount of any increase and/or decrease shall be taken into account in the adjustment of the Contract Price.

(c) Contractor's cost for preparation of this Change Proposal:

____

(Contractor's Name)

____

(Signature)

____

(Name of signatory)

____

(Title of signatory)

ANNEXURE – 5: CHANGE ORDER - 1

(Employer's Letterhead)

To: ______________________________ Date: _________

Attention: ______________________________

Contract Name: ______________________________

Contract Number: ______________________________

Dear Ladies and/ or Gentlemen:

We approve the Change Order for the work specified in the Change Proposal (No. _______), and agree to adjust the Contract Price, Time for Completion and/or other conditions of the Contract in accordance with GCC Clause 39 of the General Conditions of the Contract.

1. Title of Change: ______________________________

2. Change Request No. /Rev.: ______________________________

3. Change Order No. /Rev.: ______________________________

4. Originator of Change: Employer: ______________________________

   Contractor: ______________________________

5. Authorized Price:

   Ref. No.: ______________________________ Date: ______________________________

6. Adjustment of Time for Completion

   None Increase _________ days Decrease _________ days

7. Other effects, if any

____

Authorized by: Date:

____

(Employer)

____

Accepted by: Date:

___________________ (Contractor)

ANNEXURE – 6: CHANGE ORDER - 2

(Employer's Letterhead)

To: ______________________________ Date: _________

Attention: ______________________________

Contract Name: ______________________________

Contract Number: [______________________________

Dear Ladies and/or Gentlemen:

We instruct you to carry out the work in the Change Order detailed below in accordance with GCC Clause 39 of the General Conditions of the Contract.

1. Title of Change: ______________________________

2. Employer's Request for Change Proposal No./Rev.: ______________________________
   dated: __________

3. Contractor's Change Proposal No./Rev.: ______________________________
   dated: __________

4. Brief Description of Change: ______________________________

5. Facilities and/or Item No. of equipment related to the requested Change:
   ____

6. Reference Drawings and/or technical documents for the requested Change:

   Drawing/Document No. Description

7. Adjustment of Time for Completion:

8. Other change in the Contract terms:

9. Other terms and conditions:

(Employer's Name)

(Signature)

(Name of signatory)

(Title of signatory)

ANNEXURE – 7: PENDING AGREEMENT CHANGE ORDER

(Contractor's Letterhead)

To: ______________________________ Date: ___________

Attention: ______________________________

Contract Name: ______________________________

Contract Number: ______________________________

Dear Ladies and/or Gentlemen:

We hereby propose that the below-mentioned work be treated as a Change in the Facilities.

1. Title of Change: ______________________________
2. Application for Change Proposal No./Rev.: ______________________________ dated: ______________________________
3. Brief Description of Change: ______________________________
4. Reasons for Change:
5. Order of Magnitude Estimation (in the currencies of the Contract):
6. Scheduled Impact of Change:
7. Effect on Functional Guarantees, if any:
8. Appendix:

____

(Contractor's Name)

____

(Signature)

____

(Name of signatory)

____

(Title of signatory)

VOLUME – II-A OF III
CHAPTER - 13
PAYMENT OF WORKS

Turnkey Bidding Document

Kohalpur Nepalgunj 132 kV TLP

TABLE OF CONTENTS

13 PAYMENT OF WORKS

This contract is a fixed price Turnkey Contract and the terms of payment is set out in Volume I of Bidding Document.

Invoices of materials, supplied, freight and insurance and erection work shall be submitted separately for the purpose of accounting.

This section provides general guidelines for interim progress payment of different equipment and works covered under this contract.

Interim Certificates for site work shall be restricted in scope to the following items:

a. Preliminary work
b. Steel towers and accessories
c. Concrete foundations
d. All support earthing systems
e. All line and earth conductors and their associated fittings and insulator set
f. Protection of tower footings

The Contractor shall submit to the Employer for approval a draft blank printed Form of Measurement Certificate at an early stage in the Contract.

All measurements for the purpose of payments shall be made jointly between representatives of the Contractor and the Employer.

The measurement of conductor and OPGW stringing is to be made along the centre line of the transmission lines without allowance for sag or scrap, and will be based on the horizontal distance involved. Measurement for supply part of conductor and OPGW is to be made as per actual length supplied.

The rates in the Price Schedule for the standard towers, foundations and for excavation in any type of ground, concrete etc., shall include all work irrespective of access conditions, slope of the ground, nature of the subsoil and the presence of water.

No extra payments will be made for the followings, which are not mentioned in the price schedule and required for execution of the work:

- Design, Engineering and project management services.
- Supply of Construction power and water.
- Deployment of man powers required for construction, erection testing and commissioning.
- Providing tools & tackles, consumables, construction machineries, vehicles, testing equipment, spare parts required for construction, erection, testing and commissioning.
- Excavation necessary solely for the installation of stub setting templates.
- Tower erection methods employed.
- Additional costs of access and transport of personnel, materials and erection equipment to the structure or along the route.
- Pumping out of water and flooding conditions.
- Shuttering, planking and close timbering of excavations.

- Lean Concrete made in tower foundation.
- Scaffolding necessary for stringing of conductors over existing overhead line, telecommunication lines, building, waterways, roads or railways.
- Delays arising from the necessity to switch out and earth existing overhead lines which have to be crossed over or under.
- And other items specifically mentioned in the document.

Costs of all of the above items are deemed to be included in the quoted price in price schedule.

Payment for various items as per the Price Schedule shall be as follows:

Table 13.1: Schedule for Interim Payment

S. No.	Description	Unit	Basis of Payment
1	Preliminary Work		
1.1	Check survey and Staking (Horizontal distance)	km	Based on km of line length
1.2	Detail Survey	km	Based on km of line length
1.3	Detail soil test	Location	Based on No. of Tower Locations
1.4	Measurement of Ground Electric resistance	Location	Based on No. of Tower Locations
1.5	Benching	Cu m	Based on Measured Value
2.	Galvanized steel tower		
2.1	Galvanized Steel Tower	No.	Based on no. of Tower
2.2	Galvanized Steel work for leg extension etc.	No.	Based on size and numbers supplied and erected
3	Tower accessories (Signs on tower)	Set / No.	Based on no. of Set / No.
4	Tower earthing (each set means one complete set for one tower footing)		
4.1	Pipe Type	Set	Based on no. of sets
4.2	Counterpoise type	No.	based on the set with Galvanized (earthing) steel wire

S. No.	Description	Unit	Basis of Payment
			length used
5	Conductor and accessory		
5.1	Supply of ACSR conductor and OPGW	km	Based on length of supply
5.2	Stringing of ACSR conductor and OPGW	km	Based on the both double circuit conductor km horizontal (all six wires) and OPGW distance
6	Foundations	No.	Based on no. and type of foundations
7	Protection of Tower Footing		
7.1	Stone masonry work	Cu m	Based on measured value
7.2	Gabion Wall	Cu m	Based on measured value
7.3	Back filling and leveling	Cu m	Based on measured value
7.4	R.C.C works	Cu m	Based on measured value

VOLUME – II-A OF III

CHAPTER - 14

TOWER DESIGN (QA, QD & DD TYPE)

TOWER DESIGN QA TYPE

Approved / Released For Fabrication/Construction
Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
To be resubmitted for approval after incorporating the comments
For information and record
Not approved
CAT I

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kV Transmission Line Project

Checked By: Date: 4/7/018
Recommended By: Date: 4/7/018
Approved By: Date:

श्रेणियां CAT 1
I. फेब्रीकेशन / निर्माण हेतु अनुमोदित।
II. फेब्रीकेशन / निर्माण हेतु अनुमोदित। बशर्ते दी गई टिप्पणियों एवं संशोधनों को सम्मिलित किया जाए। कृपया संशोधित दस्तावेज अनुमोदनार्थ प्रस्तुत करें।
III. टिप्पणियों को सम्मिलित कर पुनः अनुमोदनार्थ प्रस्तुत करें।
IV. सूचनार्थ एवं रिकार्ड हेतु।
V. अनुमोदित नहीं।

पावरग्रिड
(हस्ताक्षर)
अभि./उ.अभियंता
20/6/18
(तिथि)

पावर ग्रिड कारपोरेशन ऑफ इंडिया लि० अभियांत्रिकी (पारे.लाईन) गुरुग्राम, (हरियाणा)
This document is recommended for approval for construction of 400KV /132KV D/C TAMAKOSHI - BARHABISE - KATHMANDU in NEPAL

DATE	REV.	DESCRIPTION	DESIGNED	CHECKED	APPROVED
19.02.18	0	First submission for Approval	PBKR	RJR	CSR

REVISIONS

CLIENT :

NEPAL ELECTRICITY AUTHORITY
(An Undertaking of Government of Nepal)

CONTRACTOR :

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT : TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)

JOB No. O17123-T-TL

TOTAL NO. OF PAGES 18

	NAME	DATE
DSGN	PBKR	19.02.18
CHKD	RJR	19.02.18
APPD	CSR	19.02.18

TITLE :

FOUNDATION DESIGN & DRAWING OF TOWER TYPE QA +0M BE WET SOIL (DEPTH=3M) (132kV M/C BEAR) (WIND ZONE - 4)

DOC. No. O 1 7 1 2 3 - T - T L - 4 M - D C - 1 0 0 1B

CODE IS

REV. 0

RELEASED FOR: ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No**		**Date**
		O17123-T-TL-4M-DC-1001B		19.02.18
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE QA +0M BE WET SOIL (DEPTH=3M) (132kV M/C BEAR) (WIND ZONE - 4)	**DESIGNED**	**CHECKED**	**Sheet**
		PBKR	RJR	1 OF 18

Design Summary For Different Load Cases:

S.No.	Extension	LC	K-bar	L-bar	M-bar	N-bar	Chimney Interaction Ratio		FOS				SHEAR CHECK
							Compression	Tension	Uplift	Bearing	Sliding	Overturning	
1	+0m B.E	71	GOVERNS							1.49			SAFE
2	+0m B.E	72		GOVERNS	GOVERNS	GOVERNS			1.01				SAFE
3	+0m B.E	97					0.269						SAFE
4	+0m B.E	86						0.31					SAFE
5	+0m B.E	77									3.981		SAFE
6	+0m B.E	75										1.147	SAFE

Note: In addition to the governing load cases mentioned above, the foundation has been checked for reactions pertaining to all the load cases as mentioned in the reaction document

L&T CONSTRUCTION POWER TRANSMISSION AND DISTRIBUTION IC				
PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No O17123-T-TL-4M-DC-1001B		Date 19.02.18
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE QA +0M BE WET SOIL (DEPTH=3M) (132kV M/C BEAR) (WIND ZONE - 4)	DESIGNED PBKR	CHECKED RJR	Sheet 2 of 18

Input Parameters for Foundation Design :-

Sl.No	Description	Variable	Unit	Value
1	1st Slope of Tower Leg	Φ	Deg	7.303
2	Depth of lower Layer	Dl	m	1.350
3	Depth of Upper Layer (minimum)	Du	m	1.500
4	Depth of Upper Layer (maximum)	Du	m	3.000
5	Unit Weight of Soil in Lower layer	W_l	Kg/m³	940
6	Unit Weight of Soil in Upper layer	W_U	Kg/m³	1440
7	Angle of Repose in Lower Layer	α	Deg	15
8	Angle of Repose in Upper Layer	β	Deg	25
9	Limit Bearing Capacity of Soil	Lbcs	Kg/m²	13675
10	Factor of Safety applied on foundation loads	Fos	--	1.100
11	Total Depth of Foundation Below G.L (Including Pcc Pad)	D	m	3.000
12	Plinth Height in mm	Dp	m	0.225
13	Unit Weight of Concrete in Lower Layer	Wcl	Kg/m³	1400
14	Unit Weight of Concrete in Upper Layer	Wcu	Kg/m³	2400
15	Characteristic Strength of Concrete	Fck	N/mm²	20
16	Characteristic Strength of Steel	Fy	N/mm²	500
17	Cover To Chimney Reinforcement	Ccc	mm	50
18	Cover To Footing Slab Reinforcement	Ccs	mm	50
19	Slope of Tower Leg	Φ	Deg	10.273

Assumed Dimensions of Foundation Refer Figure- I				
1	Footing Width at the Bottom of Slab -I	B	m	3.080
2	Footing Width At Bottom of Slab - II	B'	m	3.080
3	Footing Width At Top of Slab - II	B1	m	2.780
4	Width of Footing At Bottom of Slab - III	B2	m	1.300
5	Width of Chimney	Bc	m	0.490
6	Depth of PCC Pad	Dpad	m	0.050
7	Depth of Slab -I Fom top of PCC Pad	D1	m	0.100
8	Depth of Slab -II from top of Slab-I	D2	m	0.150
9	Depth of Slab -III from top of Slab-II	D3	m	0.200
10	Height of Chimney Upto G.L From Top of Slab - III	Dc	m	2.500

Ultimate Foundation Loads in kg - Refer Doc. No. O17123-T-TL-4M-DC-1000

		QA+0M B E	
		Supp No. 2 LC-71	Supp No. 1 LC-72
Sr.No	Type of Load	CASE-1	CASE-2
1	Compression	69055	
2	Uplift	-	60189
3	Side Thrust (Transverse)	1267	1259
4	Side Thrust (Longitudinal)	1	9

(Over Load Factor 1.1 included)

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No		Date
		O17123-T-TL-4M-DC-1001 B		19.02.18
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE QA +0M BE WET SOIL (DEPTH=3M) (132kV M/C BEAR) (WIND ZONE - 4)	DESIGNED	CHECKED	Sheet
		PBKR	RJR	3 of 18

(1) CHECK FOR UPLIFT (REFER FIGURE - 2)

Sr. No.	Description	Expression	Value
(a)	Horizontal Offset of cone in Lower Layer	X = 1.35*Tan(15)	0.3617
(b)	Horizontal Offset of cone in Upper Layer	Y = 1.5 * Tan(25)	0.6995
(c)	Gross volume of soil in Lower Layer in M^3	{(3.08)^2 *1.35+(2*3.08*1.35*0.3617)+(PI/3 *1.35*(0.3617)^2)}	15.999
(d)	Volume of Concrete in Lower Layer in M^3	((3.08^2+2.78^2+3.08*2.78)*0.15/3)+(1.3^2*0.2)+(0.49^2*1)	1.867
(e)	Net Volume Lower Layer in M^3	(15.999-1.867)	14.133
(f)	$A1 = B*B + 4B*H1*\tan\phi1 + \pi H1^2*\tan^2\phi1$	(3.08^2 + 4 x 3.08 x 1.35 x tan(15)+3.142x1.35^2xtan(15)^2)	14.3540
	$A2 = B*B+4B*(H1*\tan\phi1+H2*\tan\phi2) + \pi((H1*\tan\phi1+H2*\tan\phi2)^2$	(3.08^2 + 4 x 3.08 x (0.3617+0.6995)+3.142x(0.3617+0.6995)^2)	26.098
(g)	Gross Volume of Soil in Upper Layer in M^3 (As per CBIP manual No.10). $V = (A1+A2+ sqrt(A1A2))*H_2/3$	(14.354 + 26.098 + sqrt (14.354 x 26.098)) x 1.5/3	29.903
(h)	Volume of Concrete in Upper Layer in M^3	(0.49^2*1.5)	0.360
(i)	Net Volume of Soil in Upper Layer in M^3	(29.903-0.36)	29.543
(j)	Weight of Soil Resisting Uplift in Kg	(14.133*940) + (29.543 * 1440)	55827
(k)	Weight of Concrete in Kg	(1.867*1400)+(0.36015*2400)+(0.1*3.08^2*1400)+(0.49^2*0.225*240	4936
(l)	Total Resistance against Uplift in Kg	(55826.94 + 4935.854)	60763
	Factor of Safety against Uplift		
		60762.79 / 60189.15	**1.01**
		Since F.O.S is > 1.00 , Foundation is Safe against Uplift	

(2) --- CHECK FOR DOWNTHRUST

(A) Bearing Pressure Due to Downthrust in Kg/m^2

Sr. No.	Description	Expression	Value
(a)	Downthrust acting perpendicular to footing (Y1)	(69055 * (COS(10.273)))	67948
(b)	Over Load due to Concrete (Kg)	(0.49^2 x 0.225x2400)+(0.49^2x1.5x(2400-1440))+[(0.49^2x1)+(1.3^2x0.2)+(3.08^2x0.1)+(3.08^2+2.78^2+3.08x2.78)x0.15/3]x(2400-1440)+3.08^2*0.05x(2400-1440))	3634
(c)	Total Downthrust acting normal to footing in Kg	(67947.99+3633.72)	71582
(d)	Bearing Pressure Due to Downthrust (Kg/m^2) (P/A)	(71581.71 / 3.08^2)	7546
(e)	Depth of Slab below chimney in M	(0.1+0.15+0.2)	0.450
(f)	Moment Due to Eccentricity (MX & MZ)	(67947.99 * Tan (7.303) *0.45)	3919
(g)	Bearing Pressure Due to Eccentricity in Kg/m^2 (Pe/Z)	(3919 / (3.08^3 / 6)	805
(h)	Bearing Pressure Due to Eccentricity in Kg/m^2 (Pe/Z)	(3919 / (3.08^3 / 6) + (3919 / (3.08^3 / 6))	1610
(i)	Total Bearing Pressure in Kg/m^2	(7546 + 1609.55)	9156
(j)	**Factor of Safety against Downthrust**	(13675 / 9155.55)	1.49
		Since F.O.S is > 1.00 , Foundation is Safe Against Downthrust	

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No**			**Date**
		017123-T-TL-4M-DC-1001B			19.02.18
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE QA +0M BE WET SOIL (DEPTH=3M) (132kV M/C BEAR) (WIND ZONE - 4)	**DESIGNED**	**CHECKED**		**Sheet**
		PBKR	RJR		4 of 18

Sr. No.	Description	Expression		Value
	(B) Bearing Pressure Due to Transverse Side Thrust in Kg/m^2			
(a)	Coefficient of Passive Earth Pressure in upper layer (Kp_1)	(1+ Sin (25)) / (1- Sin (25))		2.464
	Coefficient of Passive Earth Pressure in lower layer (Kp_2)	(1+ Sin (15)) / (1- Sin (15))		1.698
(b)	Depth of Chimey above Slab-III	Dc = 2.5		2.500
(c)	To find the depth of effective earth pressure He(=H_1+H_2), equating the passive pressure of soil to the side thrust			
		$1/2*Kp_1W_uH_1^2B_c+Kp_2W_uH_1H_2B_c+1/2*Kp_2W_LH_2^2B_C$=S T		
	Solving this equation for H_2 with			
	A=	$1/2*Kp_2W_LB_C$	=0.5*1.698*940*0.49	391.049
	B=	$Kp_2W_uH_1B_c$	=1.698*1440*(1.5-0.5)*0.49	1198.109
	C=	$1/2*Kp_1W_uH_1^2B_c$-S.T	=0.5*2.464*1440*(1.5-0.5)^2*0.49-126	-397.901
	H_2=	(-B+sqrt(B^2-4AC))/2A		0.302
	Depth of Effective earth pressure Zone (He) in M	(H2+H1)	=0.302+(1.5-0.5)	1.302
(d)	Since Effective Pressure Zone (He) is < (2.5- 0.5) , Therefore Soil Pressure will only be mobilised in 1.302 m Depth			
(e)	Resisting Soil Force in upper layer Kg (R1) =	0.5*2.464*1440*(1.5-0.5)^2*0.49		869.2992
	Resisting Soil Force in lower layer Kg (R2) =	1.698*1440*(1.5-0.5)*(1.302-1)*0.49		362
	Resisting Soil Force in lower layer Kg (R3) =	0.5*1.698*940*(1.302-1)^2*0.49		36
	Total Resisting Soil Force in Kg (R) =	869.2992+361.8288576+35.6652694776		1266.793
(f)	C.G of Resultant force in m	(869.2992*((1.5-0.5)/3+(1.302-(1.5-0.5)))+361.8288576*((1.302-(1.5-0.5))*0.5)+35.6652694776*((1.302-(1.5-		0.482
(g)	Moment @ Base Due to Side Thrust (Kg-m)	1267.2*(3-0.05+0.225)-1266.79*(0.482+(2.5-0.5-1.302)+0.45)		1958
(h)	Bearing Pressure due to SideThrust in Kg/m^2	(1958.49/ (3.08^3/ 6))		402
	(C) Bearing Pressure Due to Longitudinal Side Thrust in Kg/m^2			
(c)	To find the depth of effective earth pressure He(=H_1+H_2), equating the passive pressure of soil to the side thrust			
		$1/2*Kp_1W_uH_1^2B_c+Kp_2W_uH_1H_2B_c+1/2*Kp_2W_LH_2^2B_C$=S T		
	Solving this equation for H_2 with			
	A=	$1/2*Kp_2W_LB_C$	=0.5*1.698*940*0.49	391.049
	B=	$Kp_2W_uH_1B_c$	=1.698*1440*(1.5-0.5)*0.49	1198.109
	C=	$1/2*Kp_1W_uH_1^2B_c$-S.T	=0.5*2.464*1440*(1.5-0.5)^2*0.49-1.49	867.809
	H_2=	(-B+sqrt(B^2-4AC))/2A		0.000
	Depth of Effective earth pressure Zone (He) in M	He	SQRT(2*1.49/(2.464*1440*0.49))	0.041

(d)	Since Effective Pressure Zone (He) is < (2.5- 0.5) , Therefore Soil Pressure will only be mobilised in 0.041 m Depth		
(e)	Resisting Soil Force in upper layer Kg (R1) =	0 5*2 464*1440*(0.041)^2*0.49	1.461292
	Resisting Soil Force in lower layer Kg (R2) =	0	0
	Resisting Soil Force in lower layer Kg (R3) =	0	0
	Total Resisting Soil Force in Kg (R) =	1 46129195552+0+0	1.461
(f)	C.G of Resultant force in m	0.041/3	0.014
(g)	Moment @ Base Due to Side Thrust (Kg-m)	1.49*(3-0.05+0.225)-1.46*(0.0136666666666667+(2.5-0.5-0.041)+0.45)	1
(h)	Bearing Pressure due to SideThrust in Kg/m^2	(1.19/ (3.08^3/ 6))	0
	(D) Total Bearing Pressure		
(i)	Total Bearing Pressure due to Downthrust & Side Thrust in Kg/m^2	Pmax = (9156 + 402 + 0)	9558
		Pmin = (7546 - 1610 - 402 - 0)	5534
(j)	**Factor of Safety against Bearing**	(13675*1.25 / 9557.55)	**1.79**
	(Limit bearing pressure is increased by 25% as per IS code.)	**Since F.O.S in bearing is >1.00, Foundation is Safe In Bearing**	

(3) STRUCTURAL DESIGN OF FOUNDATION

Sr. No.	Description	Expression	Value
A)	**Design Base Slab Reinforcement** *(Refer Fig-5 for base pressure distribution)*		
(a)	Design bearing pressure (Kg/m2)	= {(P/A+(0.5*Pe/Z)) + Max. of (Bearing pressure due to S.T (T),S T (L) }	
(b)	Maximum , Pmax in Kg/m^2	= (7546 + 804.775 +402)	8753
(c)	Minimum , Pmin in Kg/m^2	= (7546 - 804.775 -402)	6339
(d)	Maximum pressure Pmax in N/mm2	8752.775*9.81/1000000	0.085865
(e)	Minimum pressure Pmin in N/mm2	6339.225*9 81/1000000	0.062188
(f)	Total Depth of At Section X-X in 'm'	(0 1 + 0.15 +0.2)	0.450
(g)	Effective Depth of Slab (dactual) at Section X-X in mm	(450 - (10 + 10 / 2 + 50))	385
(h)	Total Depth of At Section Y-Y in M	(0 1 + 0 15)	0.250
(i)	Effective Depth of Slab (dactual) in mm	(250 - (10 + 10 / 2 + 50))	185
(j)	Distance from the edge of the footing to Section X-X in 'm'	(3 08-0 49)/2	1.295
(k)	Distance from the edge of the footing to Section Y-Y in 'm'	(3.08-1.3)/2	0 890

	L&T CONSTRUCTION POWER TRANSMISSION AND DISTRIBUTION IC			
PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No O17123-T-TL-4M-DC-1001 B		Date 19.02.18
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE QA +0M BE WET SOIL (DEPTH=3M) (132kV M/C BEAR) (WIND ZONE - 4)	DESIGNED PBKR	CHECKED RJR	Sheet 6 of 18

(l)	Pressure at a distanced=385mmfrom section X-X	(8753-6339)/3.08*(3.08-1.295+0.385)+6339		8040
(m)	Pressure at a distanced=185mmfrom section Y-Y	(8753-6339)/3.08*(3.08-0.89+0.185)+6339		8200
(n)	The pressure at section X-X (Pxx in Kg/m^2)	(8753-6339)/3.08*(3.08-1.295)+6339		7738
(o)	The pressure at section Y-Y (Pyy in Kg/m^2)	(8753-6339)/3.08*(3.08-0.89)+6339		8055
(p)	Bending Moment at face of chimney at Section X-X in kg-m	7738*3.08*(3.08-0.49)^2/8+(8753-7738)*3.08*1.295/2*2/3*1.295		21731
(q)	Bending Moment at face of chimney at Section X-X in N-mm	(21731.475*9.81*1000)		2.1319E+08
	No and Diameter of Bars to be used in Base Slab	No of Bars required for base slab	Diameter of Bar in mm	Area of Bars (Ast) in mm^2
	MKD "K"	18	10	1413.72
	Value of Xumax /d to be used in slab design	Fy = 500 (Xumax / d) = 0.46 & For Fy = 415 (Xumax/d) = 0.48		
	Effective Depth Required for slab (Dreqd) in mm	Sqrt (2.132E+08/ (0.36 * 20 * 0.46*(1-(0.42*0.46)) * 1.3 * 1000)		248
	Breadth at section -XX in M = 1.3	**Since (dreqd) < than (dactual), Slab depth is O.K**		
	Moment of Resistance at Section - XX Mrx in N-mm	(Mrx =0.87 *500 * Ast *385 * [1-(Ast *500 / 20 * 1300*385]		
	Total Reinforcement Ast required in mm2	= 8.365 Ast^2 - 167475 Ast + 2.132E+08 = 0		
	where Ast = Reinforcement Reqd. for moment Mrx	Solving the above Quadratic equation for Ast We Get Ast =		1366.17
	Minimum steel area required , mm2/m	0.12/100 x 1300 x 450		702.0
	Bending Moment at Section - YY (Refer Fig -5)			
	Bending Moment at junction of slabs at Section Y-Y in kg-m	8055*3.08*(0.89)^2/2+(8753-8055)*3.08*0.89/2*2/3*0.89		10393
	Bending Moment at junction of slabs at Section Y-Y in N-mm	(10393.353*9.81*1000)		1.0196E+08
	Effective Depth Required for slab (Dreqd) in mm	Sqrt (1.020E+08/ (0.36 * 20 * 0.46*(1-(0.42*0.46)) * 3.08 * 1000)		111
	Breadth at section -YY in M = 3.08	**Since (dreqd) < than (dactual), Slab depth is O.K**		
	Moment of Resistance at Section - YY Mry in N-mm	(Mry =0.87 *500 * Ast *185 * [1-(Ast *500 / 20 * 3080*185]		
	Total Reinforcement Ast required in mm2	= 3.531 Ast^2 - 80475 Ast + 1.020E+08 = 0		
	where Ast = Reinforcement Reqd for moment Mry	Solving the above Quadratic equation for Ast We Get Ast =		1346.51
	Minimum steel area required , mm2	0.12/100 x 3080 x 250		924.00
	Maximum of the above area of steel is provided as Slab Reinforcement	(Ast = Maximum of (1366.17 , 702 , 1346.51, 924))		1366.17
	Total No of bars required for slab	(1366.17 / (Pi / 4 * 10 ^ 2)) (No of bars required = 17.395		18
		(Let us Provide 18 Nos of 10mm diameter rod as slab reinforcement)		
	Hence the specing between rod is (mm)	**175**		**O.K.**

L&T CONSTRUCTION POWER TRANSMISSION AND DISTRIBUTION IC				
PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No O17123-T-TL-4M-DC-1001 B		Date 19.02.18
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE QA +0M BE WET SOIL (DEPTH=3M) (132kV M/C BEAR) (WIND ZONE - 4)	DESIGNED PBKR	CHECKED RJR	Sheet 7 of 18

Sr. No.	Description	Expression	Value
B)	**Check for One Way Shear At Section - XX : - (Due to Downthrust) (Refer Fig -3)**		
(a)	At Section - XX		
	Pmax in kg/m2	8752.775	8753
	Pmin in kg/m2	8039.681	8040
(b)	Total Shear force at Section - XX/m run in N	((0.5*(8753+8040)*((3.08-0.49)/2-0.385))*9.81	74954
(c)	Effective Area of Cross Section per m run in mm^2	385*1000	385000
(d)	Nominal Shear Stress Tv in N/mm^2 /m	(74953.964 / 385000)	0.195
(e)	Total Effective Area of Cross Section in mm^2	((1300*200)+0.5*(2780+3080)*150+3080*(100-50-5))	838100
(f)	Percentage Slab reinforcement (p)	p = (100 * 1366.17)/838100	0.169
(g)	Permissible Shear Stress Tc in N/mm^2	(Refer clause no 4.10 of Sp-16- 1980 Design Aids for IS 456	
(h)	Permissible Shear Stress Tc in N/mm^2	{ 0.85 x { Sqrt (0.8 x Fck) }x{{sqrt(1+5Ct)}-1}]/(6xCt)	
(i)	Where Coefficient Ct is given by	Ct = (0.8 x 20 / (6.89 x0.169)	13.741
(j)	Permissible Shear Stress Tc in N/mm^2	(((0.85*((0.8 * 20)^0.5*(((1+5 * 13.741)^0.5-1)) / (6 *13.741)))	0.303
		(Since Tc > than Tv Shear Reinforcement is not required)	
C)	**Check for One Way Shear At Section - YY : - (Due to Downthrust) (Refer Fig -3)**		
(a)	At Section - YY		
	Pmax in kg/m2	8752.775	8753
	Pmin in kg/m2	8200.323	8200
(b)	Total Shear force at Section - YY/m run in N	((0.5*(8753+8200)*((3.08-1.3)/2-0.185))*9.81	58624
(c)	Effective Area of Cross Section per m run in mm^2	185*1000	185000
(d)	Nominal Shear Stress Tv in N/mm^2 /m	(58624.235 / 185000)	0.317
(e)	Total Effective Area of Cross Section in mm^2	((0.5*(2780+3080)*150+3080*(100-50-5))	578100
(f)	Percentage Slab reinforcement (p)	p = (100 * 1366.17)/578100	0.245
(g)	Where Coefficient Ct is given by	Ct = (0.8 x 20 / (6.89 x 0.245)	9.478
(h)	Permissible Shear Stress Tc in N/mm^2	(((0.85*((0.8 * 20)^0.5*(((1+5* 9.478)^0.5-1))/(6 *9.478)))	0.356
		(Since Tc > than Tv Shear Reinforcement is not required)	
D)	**Check for Two Way Shear At Section - XX : - (Due to Downthrust) (Refer Fig -3)**		
(a)	Pressure at Section XX in N/mm2	8752.775*9.81/1000000	0.0858647
(b)	Shear At Section - XX in N	((0.086*[3080^2-(490+385)^2])	748807
(c)	Effective Area of Cross Section in mm^2	(490 + 385)*4 *385	1347500
(d)	Nominal Shear Stress Tv in N/mm^2	(748807 / 1347500)	0.556
	Allowable Shear Stress (Tcmax) in N/mm^2	(As per Clause 31.6.3.1 of IS 456 - 2000)	
	Tcmax = Ks * Tc	Where (Ks = 0.5 + B^1) Not > Tc = 0.25 *Sqrt(Fck)	
(e)	Allowable Shear Stress in concrete (Tcmax) in N/mm^2	Min of (0.5 + (0.49 / 0.49) ,1) * (0.25 * SQRT (20))	1.118
		(Since Tcmax > than Tv Shear Reinforcement is not required)	

Sr. No.	Description	Expression	Value
E)	**Check for Two Way Shear At Section - YY : - (Due to Downthrust) (Refer Fig -3)**		
(a)	Pressure at Section YY in N/mm2	8752.775*9.81/1000000	0.0858647
(b)	Shear At Section - YY in N	((0.086*[3080^2-(1300+185)^2])	625196
(c)	Effective Area of Cross Section in mm^2	(1300 + 185)*4 *185	1098900
(d)	Nominal Shear Stress Tv in N/mm^2	(625196 / 1098900)	0.569
(e)	Allowable Shear Stress in concrete (Tcmax) in N/mm^2	Min of (0.5 + (0.49 / 0.49) ,1) * (0.25 * SQRT (20))	1.118
		(Since Tcmax > than Tv Shear Reinforcement is not required)	
F)	**Design of Slab for Uplift Reinforcement at Section - YY : -**		
(a)	Bearing Pressure due to Uplift in Kg/m^2	(60189.15) / { 3.08 ^2 - 0.49^2)}	6510
(b)	Bending Moment/m width @ - YY (Mux) in N-mm	(6509.539 * (3.08 - 1.3)^2 / 8 * 3.08) * 9.81* 1000)	7.790E+07
(c)	Moment of Resistance at Section - YY Muy in N-mm	(Muy =0.87 *500*Astuy *185 * [1-(Astuy *500 / 20 * 3080*185)]	
(d)	Uplift Reinforcement @ - YY (Astuy in mm2)	= 3.531 Astuy^2 - 80475 Astuy + 7.790E+07 = 0	
(e)	Astuy = Reinforcement for Uplift @ - YY /M-width	Solving the above Quadratic equation for Astuy We Get Astuy =	1012.99
	Minimum steel area required , mm2	0.12/100 x 3080 x 250	924
(f)	No and Diameter of Bars to be used in Base Slab	Diameter of Bar in mm / No of Bars required for Uplift force @ YY	
	At Section - YY for Uplift Reinforcement	10 / (1012.985 / (Pi /4 *10^2)) =	13.000
	(Let us Provide 13 Nos of 10mm diameter rod as Uplift Reinforcement at Section - YY MKD, 'M')		
	Hence the speacing between rod is (mm)	**223**	**O.K.**
G)	**Design of Slab for Uplift Reinforcement at Section - XX : -**		

It may be noted that reinforcement provided at section Y-Y for uplift falls in tension zone and thus would also contribute in moment capacity of section at section X-X. This is because under uplift, compression occurs at the face of the base slab having more width (more area of compression flange) and sectionbehaves as a highly under reinforced section. From the equilibrium of internal and external forces on the slab section and using stress and strains of concrete and steel as per IS:456, the following equation (Moment of resistance) can be obtained

$$Xu/d_1 = (p_3/100)x(d_2/d_1)x(fs/0.36f_{ck}) + (p_4/100)x(0.87f_y/0.36f_{ck})$$

where:- p_3 = (100 A_{s3} / Bd_2) and p_4 = (100 A_{s4}/ B_{d4}); fs= Design yield stress of steel at d_2 from MCE calculated for strain in steel at that level(arrived through interpolation from strain diagram)

A_{s3} = Area of reinforcement at the top of bottom-most step. A_{s4} = Area of reinforcement at the top of the topmost step

Moment of resistance of slab section at the face of the chimney:

$$M_u = [0.87f_y * (p_3/100) * (d_2/d_1) * (d_2/d_1 - 0.416 Xu/d_1) + (0.87f_y) * (p_4/100) * (1-0.416Xu/d_1)] * Bd_1^2$$

Substituting the value of Xu/d1 in the above equation, we get the second order degree equation which can be resolve as follows:-

$$A = 0.416*(0.87*f_y)^2/(0.36*f_{ck})$$

$$B = 0.416*((0.87*f_y)/(0.36*f_{ck})) * ((fs*(p_3/100)*(d_2/d_1)) + ((0.416*fs*(p_3/100)*(d_2/d_1))*((0.87*f_y)/(0.36*f_{ck})) - 0.87*f_y$$

$$C = (M_{ux}/B*d_1*d_1) - (fs*(p_3/100)*(d_2/d_1)^2) + (0.416*(p_3/100)*(d_2/d_1)) * ((fs)/(0.36*f_{ck}))*((fs*(p_3/100)*(d_2/d_1))$$

L&T CONSTRUCTION POWER TRANSMISSION AND DISTRIBUTION IC				
PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No O17123-T-TL-4M-DC-1001B		Date 19.02.18
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE QA +0M BE WET SOIL (DEPTH=3M) (132kV M/C BEAR) (WIND ZONE - 4)	DESIGNED PBKR	CHECKED RJR	Sheet 9 of 18

(a)	Bearing Pressure due to Uplift in Kg/m^2	(60189.15) / (3.08 ^2 - 0.49^2))	6510
(b)	Bending Moment @ - XX (Mux) in N-mm	(6509.539 * (3.08 - 0.49)^2 / 8 * 3.08) * 9.81* 1000)	1.649E+08
(c)	Strain in reinforcement at d_2 from Bottom of slab-I (By linear interpolation from Strain Diagram)		1.879E-04
(d)	Design yield stress of reinforcement at d_2 from Bottom of slab-I (fs in N/mm2) [Refer Fig 3 of SP-16]		37.587
	A = 0.416* (0.87*f_y)^2/(0.36*f_{ck})	A=((0.416*(0.87*500)^2/(0.36*20))	10933
	B = 0.416*((0.87*f_y)/(0.36*f_{ck})) *((fs*(p_3/100)*(d_2/d_1))	B=0.416*((0.87*500)/(0.36*20))*((37.587*0.0018*(185/385))	
	+ ((0.416*fs*(p_3/100)*(d_2/d_1))*((0.87*f_y)/(0.36*f_{ck}))	+((0.416*37.587*0.0018*(185/385))*((0.87*500)/(0.36*20))	-433.373
	- 0.87*f_y	-0.87*500	
	C= (M_{ux}/B*d_1*d_1) - (fs*(p_3/100)*(d_2/d_1)^2)	C=(164922343.868/3080*385*385)-(37.587*0.0018*(185/385)^2)	
	+ (0.416*(p_3/100)*(d_2/d_1)) * ((fs)/(0.36*f_{ck}))	+(0.416*0.0018*(185/385))*((37.587)/(0.36*20))	0.35379
	((fs(p_3/100)*(d_2/d_1))	*((37.587*0.0018*(185/385))	
	Therefore by resolving the above equation, we get,		
	ps4/100	ps4/100 = (-b - SQRT(b^2-4ac))/2*a	
		ps4/100=433.373-SQRT(187812.313-4*10933*0.354))/(2*10933))	0.000834
		Therfore, ps4 =	0.08
	Therefore reinforcement Ast4 in mm2	Ast4=((0.083*3080*385)/100)	417.37
	Minimum steel area required , mm2	0.12/100 x 1300 x 450	702
(c)	No and Diameter of Bars to be used in Base Slab	Diameter of Bar in mm	No of Bars required for Uplift force @ XX
	At Section - XX for Uplift Reinforcement	10	(702 / (Pi /4 *10^2)) = 9.000
	(Let us Provide 9 Nos of 10mm diameter rod as Uplift Reinforcement at Section - XX, MKD 'N')		
	Hence the spcacing between rod is (mm)	150	**O.K.**

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No: O17123-T-TL-4M-DC-1001B	Date: 19.02.18
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE QA +0M BE WET SOIL (DEPTH=3M) (132kV M/C BEAR) (WIND ZONE - 4)	DESIGNED: PBKR / CHECKED: RJR	Sheet: 10 of 18

(4) CHECK FOR SLIDING (Refer Figure - 4)

Sr. No	Description	Expression	Value
(a)	Coefficient of Passive Earth Pressure in Lower layer	(1+ Sin (15)) / (1- Sin (15))	1.698
(b)	Coefficient of Passive Earth Pressure in Upper layer	(1+ Sin (25)) / (1- Sin (25))	2.464
(c)	Facial Area in upper layer of Chimney in m^2	A1 = (0.49 * (1.5 -0.5))	0.490
(d)	Facial Area in lower layer of Chimney in m^2	A1 = (0.49 * (2.5 -1.5))	0.490
(e)	Facial Area in Portion of Slab- III in m^2	A2 = (0.2 * 1.3)	0.260
(f)	Facial Area in Portion of Slab- II in m^2	A3 = (0.15 * (3.08 + 2.78 / 2))	0.440
(g)	Facial Area in Portion of Slab- I in m^2	A4 = (0.1 * 3.08)	0.308
(h)	Earth Pressures in Upper Layer in Kg /m^2	(P1u = (2.464 * 1440 * (1.5-0.5)))	3548
(i)	Earth Pressures in Lower Layer 1 in Kg /m^2	(P1l = (1.698 * 1440 * (1.5-0.5)))	2445
(j)	Earth Pressures in Lower Layer 2 in Kg /m^2	(P2 = (2445.12 + (1.698 * 940 *(1.35 - 0.15 - 0.2))	4041
(k)	Earth Pressures in Lower Layer 3 in Kg /m^2	(P3 = (4041.24 + (1.698 * 940 * 0.2))	4360
(l)	Earth Pressures in Lower Layer 4 in Kg /m^2	(P4 = (4360.464 + (1.698 * 940 * 0.15))	4600
(m)	Earth Pressures in Lower Layer 5 in Kg /m^2	(P5 = (4599.882 + (1.698 * 940 * 0.1))	4759
(n)	Lateral Force in Lower Layer -1 in Kg	(F1 = 0.49 / 2 * (3548.16))	869
(o)	Lateral Force in Lower Layer -2 in Kg	(F2 = 0.49 / 2 * (2445.12+4041.24))	1589
(p)	Lateral Force in Lower Layer -3 in Kg	(F3 = 0.26 / 2 * (4041.24+4360.464))	1092
(q)	Lateral Force in Lower Layer -4 in Kg	(F4 = 0.4395 / 2 * (4360.464+4599.882))	1969
(r)	Lateral Force in Lower Layer -5 in Kg	(F5 = 0.308 / 2 * (4599.882+4759.494))	1441
		Total Lateral Force in Kg	**6961**
	Factor of Safety Against Sliding : -		
		(6961.059 / 1267.2)	5.49
		Since F.O.S >1.00 foundation is Safe against sliding	

(5) CHECK FOR OVERTURNING

Sr. No	Description	Expression	Value
(a)	Maximum Transverse Side Thrust in Kg	(1267.2)	1267
(b)	Maximum Longidutinal Side Thrust in Kg	(9.05)	9
(c)	Resultant Side Thrust (R) in Kg	(Sqrt (1267.2^2 + 9.05^2))	1267
(d)	Total Overturning Moment in Kg-m	(60189.15 * Cos (10.273) * (3.08 / 2 - 3.08 / 6) + 1267.232 * (3 + 0.225 - 0.05) - 4935.854 * (3.08 / 2 - 3.08 / 6)	59760
(e)	Total Resisting Moment in Kg-m	(0.5 * 55826.94 * 5 / 6 * 3.08)	71645
(f)	Factor of Safety Against Overturning	(71644.573 / 59759.568)	1.20
		Since F.O.S >1.00 foundation is Safe against Overturning	

3.0 DESIGN OF CHIMNEY (Chimney Design with Stub contribution)

3.1 **Loading:Compression with biaxial bending**

Puc= (69055+0.49^2*(0.225+2.5)*2400)*9.81/1000

Puc= **692.83 KN**

Mux= (1267.2*(2.5+0.225)-1266.793*(2.5-0.5)/3)*9.81/1000

Mux= **25.59 KN-m**

Muy= (1.49*(2.5+0.225)-1.461*(2.5-0.5)/3)*9.81/1000

Muy= **0.03 KN-m**

Material Property:

fy= 500 N/mm^2

fys= 250 N/mm^2

fck= 20 N/mm^2

Geometric Property:

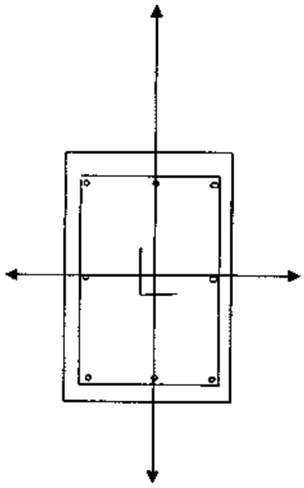
D= 490 mm

Clear cover 50 mm

Dia of reinf 16 mm and 20 mm

No. of reinf= 4 nos. and 4 nos.

d' = 60 mm



TRIAL-I Say Neutral Axis at a distance from MCE = Xu = **232.3904** mm

MCE: Most Compressed Edge of concrete

Location	Distance from MCE	Strain	Stress (f_{si} f_{ci})	Area	Force	Distance from NA	Distance from CG	Moment
	mm		N/mm^2	mm^2	KN	mm	mm	KN-m
MCE	0.0	0.00350	-	-	-	232.3904	245	-
R1	60.0	0.00260	395.44	829.38	327.97	172.3904	185	60.67
R2	245.0	0.00019	37.98	402.12	-15.27	-12.6096	0	0.00
Stub	245.0	0.00019	37.98	2512.00	-95.41	-12.6096	0	0.00
R3	430.0	0.00298	415.15	829.38	-344.32	-197.61	-185	63.70
		Total		**4572.88**	**-127.04**			**124.37**

Concrete force incompression, F = 0.36*fck*xu*d

Concrete force incompression,F = **819.87** KN

Total axial Capacity = Concrete force in compression + Summation of all internal forces induced by the rebar & the stub

Total axial capacity = 819.87 + -127.04 = **692.83** KN ≥ **692.83** KN

Moment due to compression force in concrete = F*(C.G - 0.416Xu)

= 121.6077 kN-m

Total Moment capacity = Moment due to compression force in concrete + Moment due to rebar & the stub

Total Moment capacity = 245.98 kN-m

Puz= 3363.57583 Pu/Puz= 0.205981

Interaction formula = **0.102** **OK**

3.2 **Loading:Tension with biaxial bending**

Put= **590 KN**

Mux= **25.37 KN-m**

Muy= **0.23 KN-m**

Material Property:

fy= 500 N/mm2

fys= 250 N/mm2

fck= 20 N/mm2

Geometric Property:

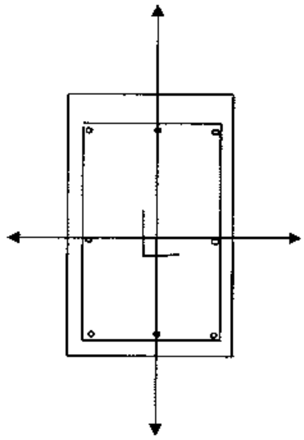
D= 490 mm

clear cover 50 mm

Dia of reinf 16 mm and 20 mm

No. of reinf= 4 nos. and 4 nos.

d' = 60 mm



TRIAL-I Say Neutral Axis at a distance from MCE = Xu = **155.1097** mm

MCE: Most Compressed Edge of concrete

Location	Distance from MCE	Strain	Stress (f_{si} f_{ci})	Area	Force	Distance from NA	Distance from CG	Moment
-	mm		N/mm2	mm2	KN	mm	mm	KN-m
MCE	0	0.00350	-	-	-	155.1097	245	-
R1	60	0.00215	372.08	829.38	308.60	95.10965	185	57.09
R2	245	0.00203	372.50	402.12	-149.79	-89.8903	0	0.00
Stub	245	0.00203	372.50	2512.00	-935.71	-89.8903	0	0.00
R3	430	0.00620	435.00	829.38	-360.78	-274.89	-185	66.74
		Total		**4572.88**	**-1137.69**			**123.84**

Concrete force incompression, F = 0.36*fck*xu*d

Concrete force incompression,F = **547.23** KN

Total axial Capacity = Concrete force in compression + Summation of all internal forces induced by the rebar & the stub

Total axial capacity = 547.23 + -1137.69 = **590.46** KN ≥ **590.46** KN

Moment due to tension force in concrete = F*(C.G - 0.416Xu)

= 98.761 kN-m

Total Moment capacity = Moment due to compression force in concrete + Moment due to rebar & the stub

Total Moment capacity = 222.60 kN-m

Pu/Puz= 1

Interaction formula = **0.115** **OK**

Design of Lateral ties

Minimum Diameter of Lateral Ties in mm =1/4 of largest dia. of Longitudinal bar = 0.25*20

= 5 mm

Hence provide lateral ties of dia = 6 mm

As per Clause 26.5.3.2 of IS 456 - 2000 Pitch of lateral Ties shall be least of the following

(i) Least lateral dimension of compression member = 0.49*1000 = 490 mm

(ii) 16 times smallest diameter of longitudinal bars = 16*16 = 256 mm

(iii) 300mm = 300 = 300 mm

So, provide the lateral ties at a distance of 250 mm c/c

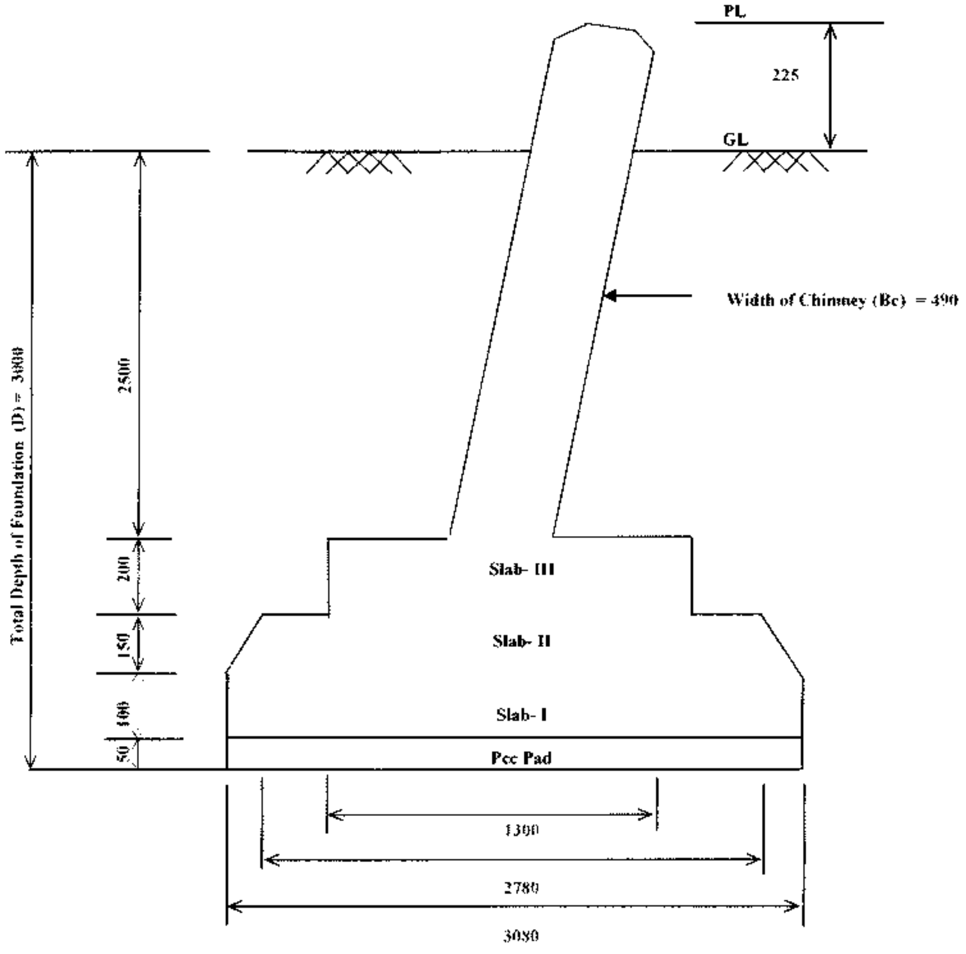


FIGURE - 1

Note :

All Dimensions are in Millimeters

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No** O17123-T-TL-4M-DC-1001B		**Date** 19.02.18
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE QA +0M BE WET SOIL (DEPTH=3M) (132kV M/C BEAR) (WIND ZONE - 4)	**DESIGNED** PBKR	**CHECKED** RJR	**Sheet** 14 of 18

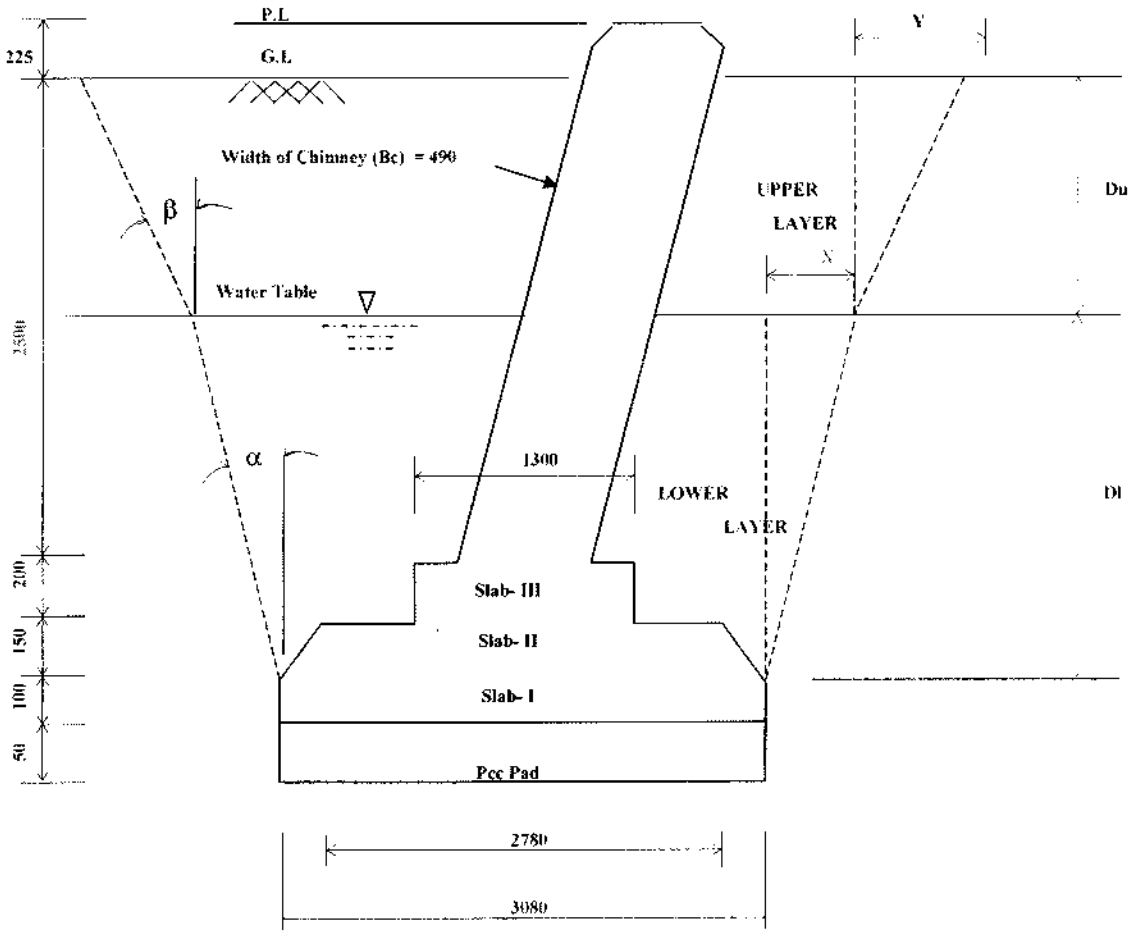


FIGURE - 2

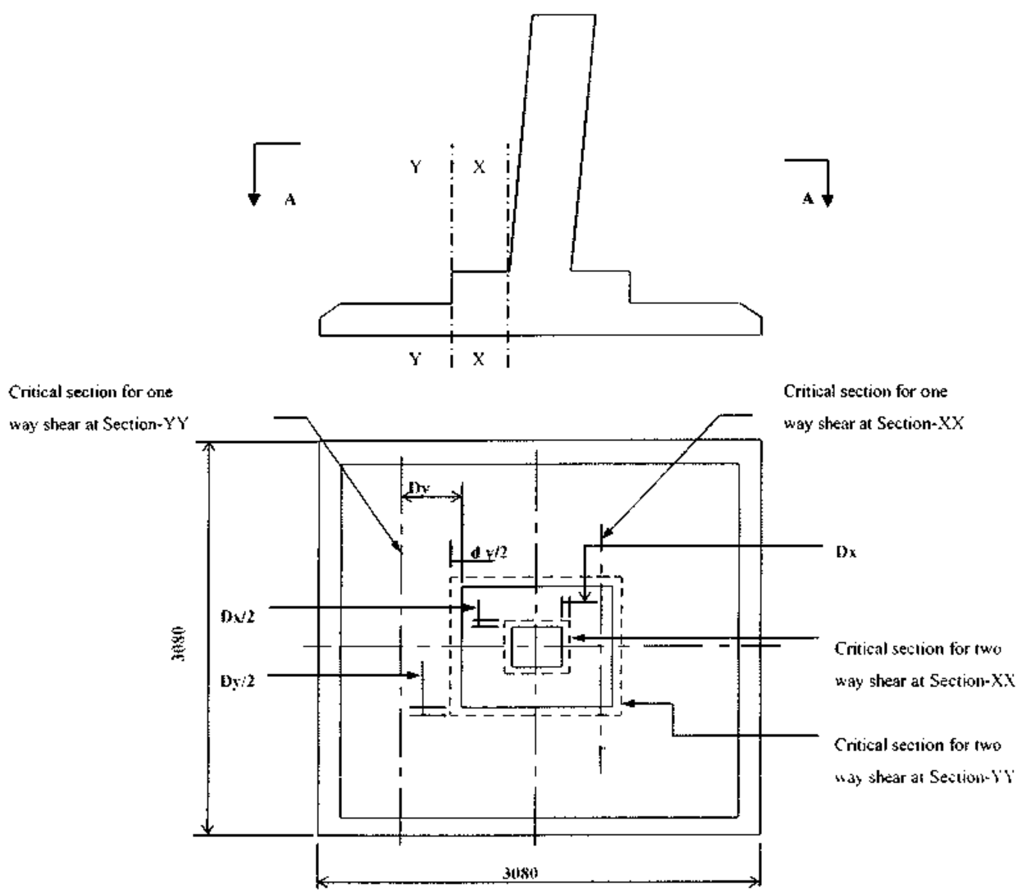
Note :

All dimensions are in Millimetres

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No** O17123-T-TL-4M-DC-1001B	**Date** 19.02.18

		DESIGNED	**CHECKED**	**Sheet**
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE QA +0M BE WET SOIL (DEPTH=3M) (132kV M/C BEAR) (WIND ZONE - 4)	PBKR	RJR	15 of 18

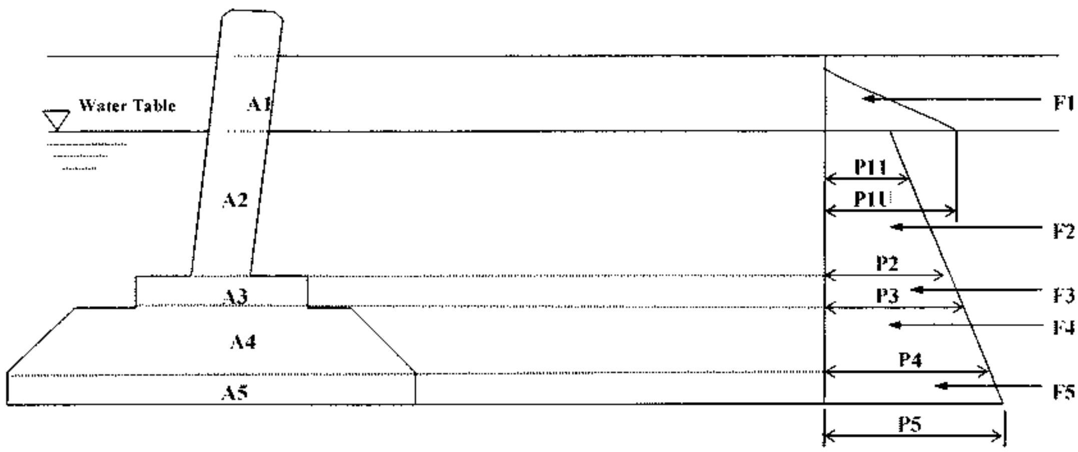


SECTION A-A

FIGURE - 3

Note :

All Dimensions are in Millimeters



EARTH PRESSURE DISTRIBUTION

FIGURE - 4

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No O17123-T-TL-4M-DC-1001B		Date 19.02.18
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE QA +0M BE WET SOIL (DEPTH=3M) (132kV M/C BEAR) (WIND ZONE - 4)	DESIGNED PBKR	CHECKED RJR	Sheet 17 of 18

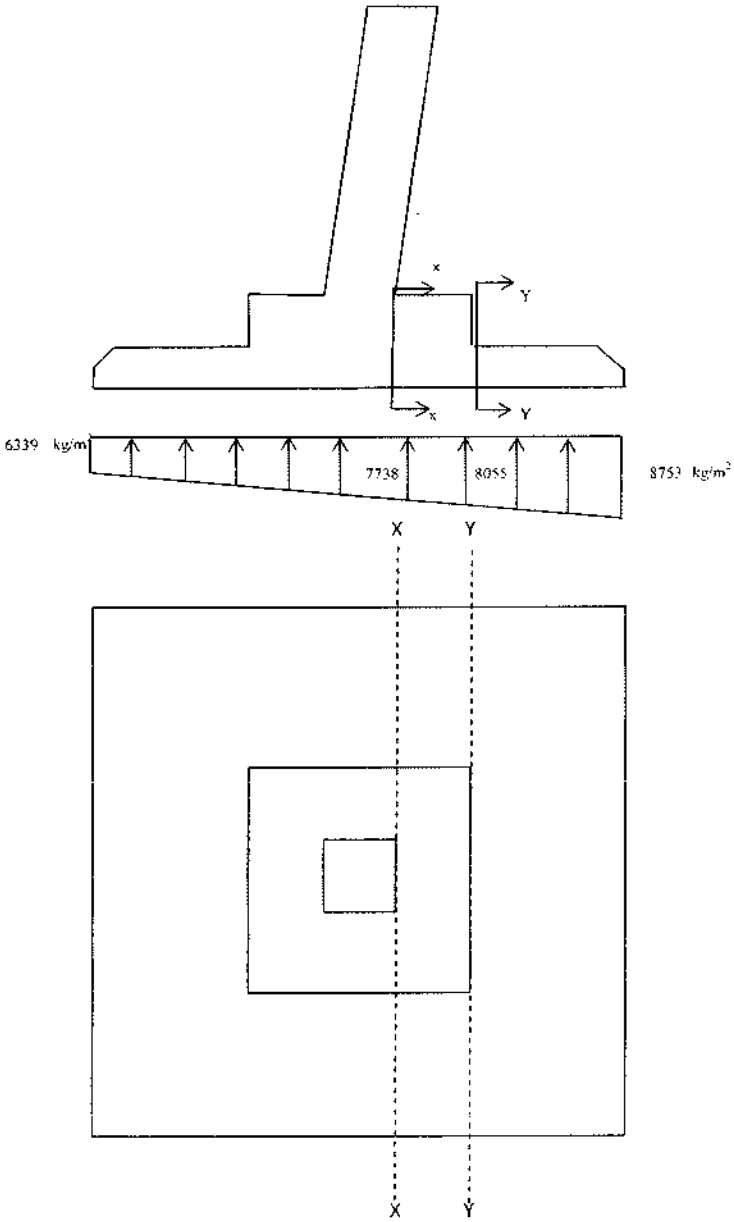
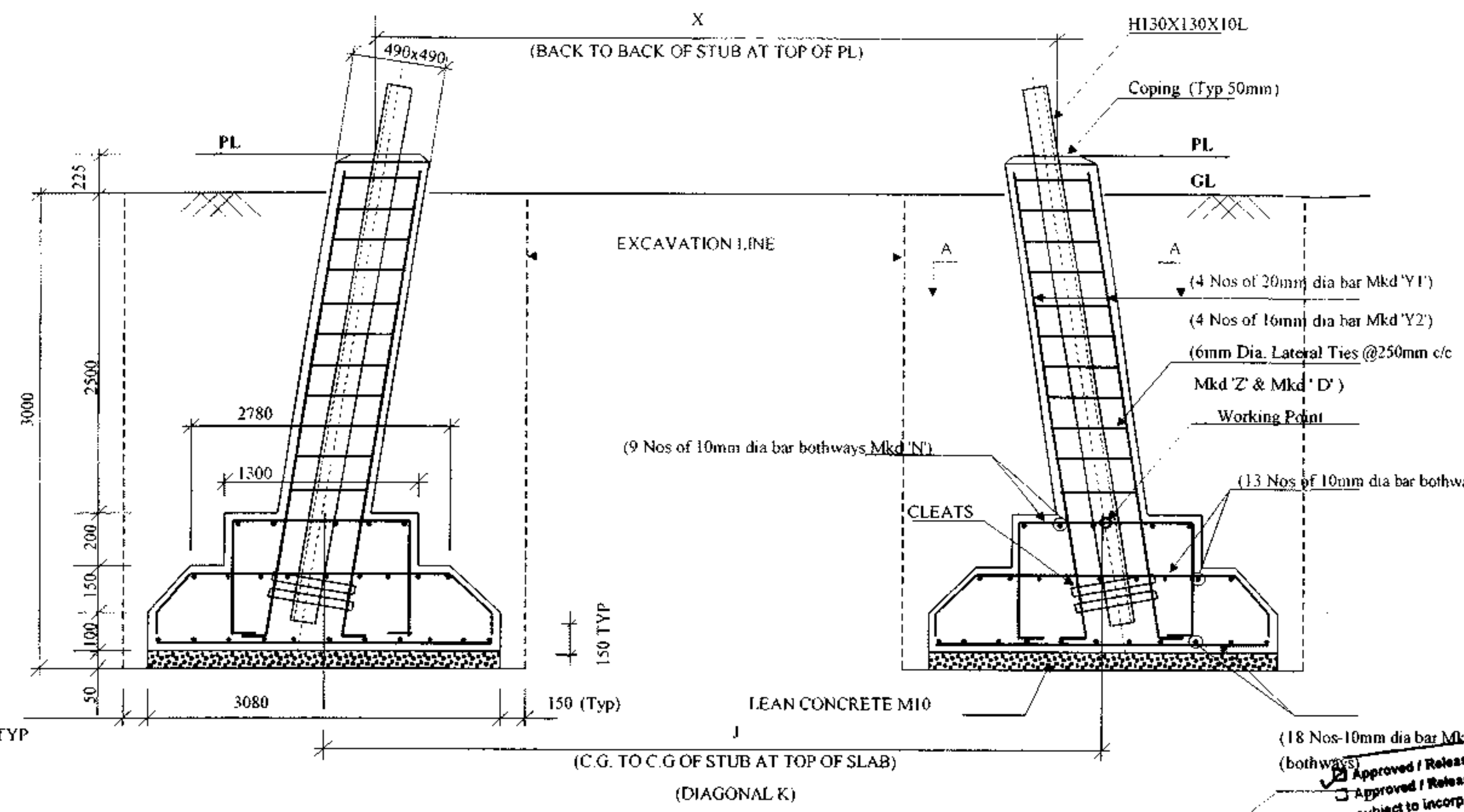
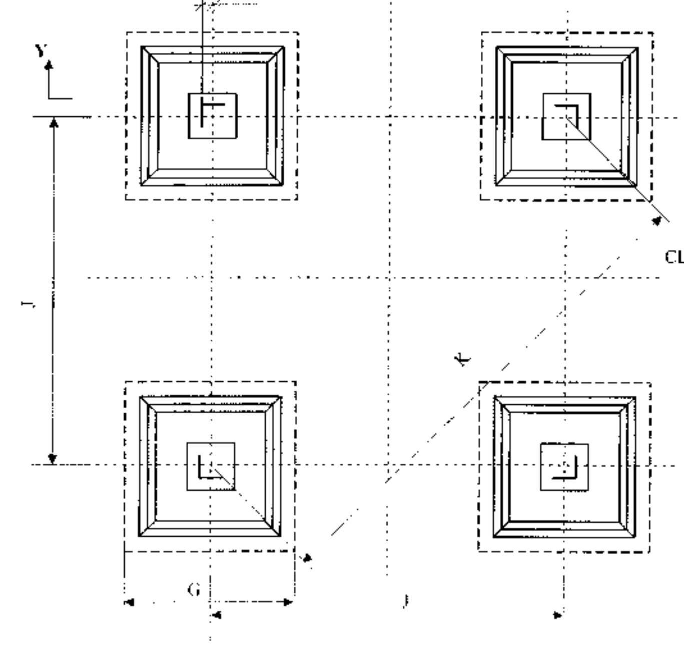
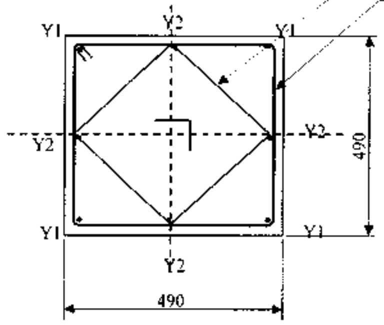


FIGURE -5





PLAN
DETAILS OF FOUNDATION



SECTION A - A

SOIL TYPE	Basic Body/ Leg Extn	FOUNDATION					EXCAVATION		
		X (Back to Back) in mm	J in mm (C/C)	K in mm	Volume of Concrete Per Tower in M^3		Width in mm	Volume per Tower in M^3	Reinforce-ment Per Tower in kg
					M20	M10			
WET	QA+0MBE	7372	7998	10877	12.92	1.90	3380	137	799

11311

BAR BENDING SCHEDULE

Mkd No	SKETCH	Dia in MM	Length in MM	Nos/ Leg	Unit Wt in Kg/m	Wt/ Leg Kg	Total Wt/Tower Kg
K	2980	10	2980	36	0.617	66.2	264.8
M	141 2680 141 25 25	10	3012	26	0.617	48.3	193.2
N	1200 325 100 100 325	10	2050	18	0.617	22.8	91.2
Y1	3035 300	20	3335	4	2.466	32.9	131.6
[illegible]	3039 300	16	3339	4	1.578	21.1	84.4
[illegible]	390 390	6	1710	13	0.222	4.9	19.6
D	276	6	1253	13	0.222	3.6	14.4
			Total weight of steel required in Kg =				799

THIS FOUNDATION HAS BEEN DESIGNED FOR
THE FOLLOWING PARAMETERS:

TYPE OF SOIL:	WET	(3m Depth)
UNIT WEIGHT:	940/1440	kg/m3
LIMIT BEARING CAPACITY:		13675 Kg/m2
ANGLE OF REPOSE:	15/25 Deg	
WATER TABLE:	1.50 m to 3.0 m from GL	

NOTES

1. ALL DIMENSIONS ARE IN MM. UNLESS OTHER WISE SPECIFIED
2. CONCRETE GRADE IS M 20 UNLESS OTHERWISE SPECIFIED.
3. CONCRETE COVER IS 50mm UNLESS OTHERWISE STATED.
4. MIX PROPERTIES CONFIRMING TO IS 456-2000.
5. STEEL USED IS Fe500 CONFORMING TO IS 1786 -2008
6. DURING PLACEMENT OF REINFORCEMENT BARS,THE BAR SPACING HAS TO READJUSTED TO PROVIDE PROPER CLEARANCE FOR CLEATS
7. FOR FOUNDATION DESIGN REFER DOCUMENT O17123-T-TL-4M-DC-1001B
8. SST DRAWINGS SHALL BE REFERED FOR THE VALUES OF X (INDICATED IN THE TABLE) FOR CONSTRUCTION PURPOSE.
9. FOR SPLICING, LAP LENGTH TO BE PROVIDED IS 57d. d= DIA OF LARGER BAR.

Approved / Released For Fabrication/Construction
Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
To be resubmitted for approval after incorporating the comments
For information and record
Not approved CAT I

Nepal Electricity Author...
Tamakoshi-Kathmandu 220/40...
Transmission Line Project
Checked By: Date: 4/7/018
Recommended By: Date: 4/7/018
Approved By: Date:

LEG SLOPE

श्रेणी I. फेब्रिकेशन / निर्माण हेतु अनुमोदित
II. फेब्रिकेशन / निर्माण हेतु अनुमोदित बशर्ते दी गई टिप्पणियों एवं आशोधनों को सम्मिलित किया जाए। कृपया आशोधित दस्तावेज अनुमोदनार्थ प्रस्तुत करें।
III. टिप्पणियों को सम्मिलित कर पुनः अनुमोदनार्थ प्रस्तुत करें।
IV. सूचनार्थ एवं रिकार्ड हेतु।
V. अनुमोदित नहीं।
CAT 1
पावरग्रिड
(हस्ताक्षर)
(तिथि) 20/6/18
पावर ग्रिड कारपोरेशन ऑफ इण्डिया लि.

CLIENT : **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONTRACTOR **L&T CONSTRUCTION**
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT. TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)

TITLE : FOUNDATION DESIGN & DRAWING OF TOWER TYPE QA +0M BE WET SOIL (DEPTH=3M) (132kV M/C BEAR) (WIND ZONE - 4)

	NAME	DATE
DSND	PBKR	19.02.18
DRWN	PBKR	19.02.18
CHKD	RJR	19.02.18
APPD	CSR	19.02.18
SCALE	NTS	

Document No	REV.
O17123-T-TL-4M-DC-1001B	0

Rev No	DATE	DESCRIPTION	PREP	CHKD	APPD
0	19.02.18	First submission for Approval	PBKR	RJR	CSR

L&T Construction
Power Transmission & Distribution

CLIENT : **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

ONSULTANT पावरग्रिड **POWER GRID CORPORATION OF INDIA LTD**

PROJECT : TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

LOA No. : 073/74-201 Dated: 24.04.2017

DRG. No. : O17123-T-TL-4M-GA-0101A

BOM No. : BOM/LE17D124/132kV/QA/001A

NO OF SHEETS: 2

श्रेणियां CAT-I
I. फेब्रीकेशन / निर्माण हेतु अनुमोदित।
II. फेब्रीकेशन / निर्माण हेतु अनुमोदित। बशर्ते की गई टिप्पणियां एवं आशोधनों को सम्मिलित किया जाए। कृपया आशोधित दस्तावेज अनुमोदनार्थ प्रस्तुत करें।
III. टिप्पणियों को सम्मिलित कर पुनः अनुमोदनार्थ प्रस्तुत करें।
IV. सूचनार्थ एवं रिकार्ड हेतु।
V. अनुमोदित नहीं।
पावरग्रिड (हस्ताक्षर) (तिथि) 21/06/19
पावर ग्रिड कारपोरेशन ऑफ इंडिया लि० अभियांत्रिकी (पारे.लाईन) गुरुग्राम, (हरियाणा)
This document is recommended for approval for construction of 400kV /132kV D/C TAMAKOSHI - BARHABISE - KATHMANDU in NEPAL

CAT I

- [x] Approved / Released For Fabrication/Construction
- [ ] Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
- [ ] To be resubmitted for approval after incorporating the comments
- [ ] For information / record
- [ ] Not approved

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kV Transmission Line Project
Checked By: Date: 17/7/2019
Recommended By: Date: 11
Approved By: Date:

BILL OF MATERIAL
2M STUB EXTENDER FOR TOWER TYPE - "QA" (132kV, WZ-4)
ONE CORNER ONLY

WEIGHT OF STRUCTURE	
HT MEMBERS: BOM/LE17D124/QA2RC	50.181
MS MEMBERS INCLUDING PACK WASHERS AND ACCESSORIES ETC.	-
WEIGHT OF BOLTS & NUTS.SPRING WASHERS: BOM/LE17D124/QA2RB	2.416
TOTAL WEIGHT OF STRUCTURE:	52.597 Kgs

THIS STUB EXTENDER SHALL COMPLETE WITH EXISTING STANDARD STUB OF QA TYPE TOWER FOR 3M DEPTH FOUNDATION

0	29.05.19	FIRST SUBMISSION FOR APPROVAL	KMK	BSR	CSR
REV.	DATE	DESCRIPTION	CHKD.	REVED.	APPD.

PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY	DATE
ALEX	KMK	BSR	CSR	29.05.19

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 29-May-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/QA2RC

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
	BOM OF 2M STUB EXTENDER FOR TOWER TYPE-"QA" (132kV WZ-4) ONE CORNER							
1	N1MQA2E1H	L130X130X10H-E350A	2027.00	19.700	1	39.932	39.932	
2	N1MQA2E2H	L120X120X8H-E350A	376.00	14.700	1	5.527	5.527	
3	N1MQA2E3H	8MM PLATE H-E350A	100.00 X 376.00	62.800	2	2.361	4.722	
				Total Weight :			**50.181**	

Associated Parts

Part Code	Type of Association	Associated with	Total Weight

No Association Part

Raw Material Involved	Standard Material	Total Weight (In Kg)
BOM OF 2M STUB EXTENDER FOR TOWER TYPE-"QA" (132kV WZ-4) ONE CORNER		
8MM PLATE H-E350A	HT	4.722
L120X120X8H-E350A	HT	5.527
L130X130X10H-E350A	HT	39.932
	Total	50.181
	HT	**50.181**

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 29-May-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/QA2RB

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
	BOLTS & NUTS OF 2M STUB EXTENDER FOR TOWER TYPE-"QA" (132kV WZ-4) ONE CORNER							
1	QA2RB1	M16x50MM LONG (IS:12427)		0.142	16	0.142	2.272	
2	QA2RB2	M16x3.5MM SPRING WASHER IS3063		0.009	16	0.009	0.144	
				Total Weight :			**2.416**	

Associated Parts

Part Code	Type of Association	Associated with	Total Weight

No Association Part

Raw Material Involved	Standard Material	Total Weight (In Kg)
BOLTS & NUTS OF 2M STUB EXTENDER FOR TOWER TYPE-"QA" (132kV WZ-4) ONE CORNER		
M16x3.5MM SPRING WASHER IS3063		0.144
M16x50MM LONG (IS:12427)		2.272
	Total	2.416

** -- Item Welded with another item
*** -- Item Assembled with another item

L&T Construction
Power Transmission & Distribution

CLIENT: **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONSULTANT: पावरग्रिड **POWER GRID CORPORATION OF INDIA LTD**

PROJECT: **TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE**

LOA No.: **073/74-201 Dated: 24.04.2017**

DRG. No.: **O17123-T-TL-4M-GA-0103**

BOM No.: **BOM/LE17D124/132kV/QA/003**

NO OF SHEETS: 4

This document is recommended for approval for construction of 400kV/132kV D/C TAMAKOSHI - BARHABISE - KATHMANDU in NEPAL
05/03/19

BILL OF MATERIAL
+0M BODY EXTN. FOR TOWER TYPE - "QA" (132kV, WZ-4)

☑ Approved / Released For Fabrication/Construction
☐ Approved subject to incorporation of comments, modification as noted. Revised drawings/designs required
☐ To be resubmitted for approval after incorporating the comments
☐ For information and record
☐ Not approved

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kv Transmission Line Project
Checked By: Date: 17/03/2019
Recommended By: Date:
Approved By: Date:

WEIGHT OF STRUCTURE	
HT MEMBERS: BOM/LE17D124/PQA0E	581.348
MS MEMBERS INCLUDING PACK WASHERS AND ACCESSORIES ETC. BOM/LE17D124/PQA0E = 594.872 BOM/LE17D124/PQA0W = 0.312	595.184
WEIGHT OF BOLTS & NUTS.SPRING WASHERS: BOM/LE17D124/PQA0B	54.544
TOTAL WEIGHT OF STRUCTURE:	1231.076 Kgs

SUCCESSFULLY TESTED AT CPRI - BENGALURU
ON 11th OF JANUARY 2019

REV.	DATE	DESCRIPTION	CHKD.	REVED.	APPD.
0	28.01.19	SUBMISSION FOR APPROVAL AFTER SUCCESSFUL TESTING	PU	BSR	CSR

PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY	DATE
ALEX	PU	BSR	CSR	28.01.19

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 28-Jan-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQA0E

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Unit/Ass Weight	Total Weight
	BODY EXTN. +0M FOR TOWER TYPE-"QA" (132kV, WZ-4)						
1	N1MQA21SH	L130X130X10H-E350A	5000.00	19.700	2	98.500	197.000
2	N1MQA22H	L130X130X10H-E350A	5000.00	19.700	2	98.500	197.000
3	N1MQA23H	L120X120X8H-E350A	376.00	14.700	4	5.527	22.108
4	N1MQA24H	8MM PLATE H-E350A	100.00 X 376.00	62.800	8	2.361	18.888
5	N1MQA25L	L65X65X4-E250A	6131.00	4.000	2	24.524	49.048
6	N1MQA25R	L65X65X4-E250A	6131.00	4.000	2	24.524	49.048
7	N1MQA26L	L60X60X4-E250A	6131.00	3.700	2	22.685	45.370
8	N1MQA26R	L60X60X4-E250A	6131.00	3.700	2	22.685	45.370
9	N1MQA27L	L45X45X4-E250A	1048.00	2.700	4	2.830	11.320
10	N1MQA27R	L45X45X4-E250A	1048.00	2.700	4	2.830	11.320
11	N1MQA28L	L45X45X4-E250A	1884.00	2.700	4	5.087	20.348
12	N1MQA28R	L45X45X4-E250A	1884.00	2.700	4	5.087	20.348
13	N1MQA29LH	L45X45X4H-E350A	2045.00	2.700	3	5.522	16.566
14	N1MQA29RH	L45X45X4H-E350A	2045.00	2.700	3	5.522	16.566
15	N1MQA29AH	L45X45X4H-E350A	2045.00	2.700	1	5.522	5.522
16	N1MQA29BH	L45X45X4H-E350A	2045.00	2.700	1	5.522	5.522
17	N1MQA30L	L50X50X4-E250A	2360.00	3.000	3	7.080	21.240
18	N1MQA30R	L50X50X4-E250A	2360.00	3.000	3	7.080	21.240
19	N1MQA30AL	L50X50X4-E250A	2360.00	3.000	1	7.080	7.080
20	N1MQA30AR	L50X50X4-E250A	2360.00	3.000	1	7.080	7.080
21	N1MQA31L	L45X30X4-E250A	1735.00	2.200	4	3.817	15.268
22	N1MQA31R	L45X30X4-E250A	1735.00	2.200	4	3.817	15.268
23	N1MQA31A	5MM PLATE-E250A	105.00 X 174.00	39.250	8	0.717	5.736
24	N1MQA32	6MM PLATE-E250A	144.00 X 220.00	47.100	4	1.492	5.968
25	N1MQA33	L50X50X4-E250A	6035.00	3.000	4	18.105	72.420
26	N1MQA34H	L45X45X4H-E350A	1392.00	2.700	4	3.758	15.032
27	N1MQA35	L45X45X4-E250A	2861.00	2.700	4	7.725	30.900
28	N1MQA35X	L45X45X4-E250A	2861.00	2.700	4	7.725	30.900
29	N1MQA36	L45X45X4-E250A	3877.00	2.700	8	10.468	83.744
30	N1MQA37H	5MM PLATE H-E350A	110.00 X 130.00	39.250	8	0.561	4.488
31	N1MQA38	5MM PLATE-E250A	110.00 X 130.00	39.250	8	0.561	4.488
32	N1MQA39L	5MM PLATE-E250A	110.00 X 157.00	39.250	4	0.678	2.712
33	N1MQA39R	5MM PLATE-E250A	110.00 X 157.00	39.250	4	0.678	2.712

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 28-Jan-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQA0E

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Unit/Ass Weight	Total Weight
34	N1MQA40H	L50X50X4H-E350A	3444.00	3.000	4	10.332	41.328
35	N1MQA40XH	L50X50X4H-E350A	3444.00	3.000	4	10.332	41.328
36	N1MQA41	L45X45X4-E250A	738.00	2.700	4	1.993	7.972
37	N1MQA42	L45X45X4-E250A	738.00	2.700	4	1.993	7.972
				Total Weight :			**1176.220**

Associated Parts

Part Code	Type of Association	Associated with	Total Weight

No Association Part

Raw Material Involved	Standard Material	Total Weight (In Kg)
BODY EXTN. +0M FOR TOWER TYPE-"QA" (132kV, WZ-4)		
5MM PLATE H-E350A	HT	4.488
5MM PLATE-E250A	MS	15.648
6MM PLATE-E250A	MS	5.968
8MM PLATE H-E350A	HT	18.888
L120X120X8H-E350A	HT	22.108
L130X130X10H-E350A	HT	394.000
L45X30X4-E250A	MS	30.536
L45X45X4-E250A	MS	224.824
L45X45X4H-E350A	HT	59.208
L50X50X4-E250A	MS	129.060
L50X50X4H-E350A	HT	82.656
L60X60X4-E250A	MS	90.740
L65X65X4-E250A	MS	98.096
Total		1176.220
HT		**581.348**
MS		**594.872**

** – Item Welded with another item
*** – Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 28-Jan-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQA0B

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Unit/Ass Weight	Total Weight
	BOLTS & NUTS OF +0M BODY EXTN. FOR TOWER TYPE-"QA" (132kV, WZ-4)						
1	PQA0B1	M16X35MM LONG (IS:12427)		0.119	128	0.119	15.232
2	PQA0B2	M16X40MM LONG (IS:12427)		0.126	144	0.126	18.144
3	PQA0B3	M16X45MM LONG (IS:12427)		0.134	16	0.134	2.144
4	PQA0B4	M16X50MM LONG (IS:12427)		0.142	64	0.142	9.088
5	PQA0B5	M16x3.5MM SPRING WASHER IS3063		0.009	352	0.009	3.168
6	PQA0B6	M16x175LG SB (50 OD) 2N+1SP		0.423	16	0.423	6.768
				Total Weight :			**54.544**

Associated Parts

Part Code	Type of Association	Associated with	Total Weight
	No Association Part		

Raw Material Involved	Standard Material	Total Weight (In Kg)
BOLTS & NUTS OF +0M BODY EXTN. FOR TOWER TYPE-"QA" (132kV, WZ-4)		
M16x175LG SB (50 OD) 2N+1SP		6.768
M16x3.5MM SPRING WASHER IS3063		3.168
M16X35MM LONG (IS:12427)		15.232
M16X40MM LONG (IS:12427)		18.144
M16X45MM LONG (IS:12427)		2.144
M16X50MM LONG (IS:12427)		9.088
Total		54.544

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 28-Jan-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQA0W

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Unit/Ass Weight	Total Weight
	PACK WASHERS OF +0M BODY EXTN. FOR TOWER TYPE-"QA" (132kV, WZ-4)						
1	PQA0W1	M16x4MM ROUND PACK WASHER IS2016		0.014	12	0.014	0.168
2	PQA0W2	M16x5MM ROUND PACK WASHER IS2016		0.018	8	0.018	0.144
				Total Weight :			**0.312**

Associated Parts

Part Code	Type of Association	Associated with	Total Weight
	No Association Part		

Raw Material Involved	Standard Material	Total Weight (In Kg)
PACK WASHERS OF +0M BODY EXTN. FOR TOWER TYPE-"QA" (132kV, WZ-4)		
M16x4MM ROUND PACK WASHER IS2016		0.168
M16x5MM ROUND PACK WASHER IS2016		0.144
	Total	0.312

** -- Item Welded with another item
*** -- Item Assembled with another item

L&T Construction
Power Transmission & Distribution

CLIENT : **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONSULTANT : पावरग्रिड **POWER GRID CORPORATION OF INDIA LTD**

PROJECT : TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

LOA No. : 073/74-201 Dated: 24.04.2017

DRG. No. : O17123-T-TL-4M-GA-0104 (SHEET 1 To 9)

BOM No. : BOM/LE17D124/132kV/QA/004

NO OF SHEETS: 18

CAT-I

05/03/19

This document is recommended for approval ... of 400kV/132kV D/C TAMAKOSHI - BARHABISE - KATHMANDU in NEPAL

BILL OF MATERIAL
BASIC BODY FOR TOWER TYPE - "QA" (132kV, WZ-4)

Approved / Released For Fabrication/Construction
Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
To be resubmitted for approval after incorporating the comments
For information and record
Not approved

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kv Transmission Line Project
Checked By: Date: 17/03/2019
Recommended By: Date:
Approved By: Date:

WEIGHT OF STRUCTURE	
HT MEMBERS: BOM/LE17D124/PQABS	3286.148
MS MEMBERS INCLUDING PACK WASHERS AND ACCESSORIES ETC. BOM/LE17D124/PQABS = 3283.916 BOM/LE17D124/PQABW = 6.174 BOM/LE17D124/PQAHR = 24.360	3314.450
WEIGHT OF BOLTS & NUTS,SPRING WASHERS: BOM/LE17D124/PQABB	430.694
TOTAL WEIGHT OF STRUCTURE:	7031.292 Kgs

SUCCESSFULLY TESTED AT CPRI - BENGALURU
ON 11th OF JANUARY 2019

REV.	DATE	DESCRIPTION	CHKD.	REVED.	APPD.
0	28.01.19	SUBMISSION FOR APPROVAL AFTER SUCCESSFUL TESTING	PU	BSR	CSR

PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY	DATE
ALEX	PU	BSR	CSR	28.01.19

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABS

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
	BASIC BODY FOR TOWER TYPE-"QA" (132kV, WZ-4)							
1	N1MQA60SH	L130X130X10H-E350A	6650.00	19.700	2	131.005	262.010	
2	N1MQA61H	L130X130X10H-E350A	6650.00	19.700	2	131.005	262.010	
3	N1MQA62SH	L120X120X10H-E350A	4729.00	18.200	2	86.068	172.136	
4	N1MQA63H	L120X120X10H-E350A	4729.00	18.200	2	86.068	172.136	
5	N1MQA64H	L120X120X8H-E350A	376.00	14.700	4	5.527	22.108	
6	N1MQA65H	8MM PLATE H-E350A	100.00 X 376.00	62.800	8	2.361	18.888	
7	N1MQA66H	L110X110X8H-E350A	376.00	13.400	4	5.038	20.152	
8	N1MQA67H	8MM PLATE H-E350A	100.00 X 376.00	62.800	8	2.361	18.888	
9	N1MQA68	L55X55X4-E250A	5200.00	3.300	2	17.160	34.320	
10	N1MQA68X	L55X55X4-E250A	5200.00	3.300	2	17.160	34.320	
11	N1MQA69	L60X60X4-E250A	5200.00	3.700	2	19.240	38.480	
12	N1MQA69X	L60X60X4-E250A	5200.00	3.700	2	19.240	38.480	
13	N1MQA70	L55X55X4-E250A	3204.00	3.300	2	10.573	21.146	
14	N1MQA70X	L55X55X4-E250A	3204.00	3.300	2	10.573	21.146	
15	N1MQA71	L60X60X4-E250A	3204.00	3.700	2	11.855	23.710	
16	N1MQA71X	L60X60X4-E250A	3204.00	3.700	2	11.855	23.710	
17	N1MQA72	L50X50X4-E250A	286.00	3.000	8	0.858	6.864	
18	N1MQA73	5MM PLATE-E250A	50.00 X 286.00	39.250	16	0.561	8.976	
19	N1MQA74	L45X45X4-E250A	917.00	2.700	4	2.476	9.904	
20	N1MQA74X	L45X45X4-E250A	917.00	2.700	4	2.476	9.904	
21	N1MQA75	L45X45X4-E250A	1953.00	2.700	4	5.273	21.092	
22	N1MQA75X	L45X45X4-E250A	1953.00	2.700	4	5.273	21.092	
23	N1MQA76	L45X45X4-E250A	1784.00	2.700	4	4.817	19.268	
24	N1MQA76X	L45X45X4-E250A	1784.00	2.700	4	4.817	19.268	
25	N1MQA77	5MM PLATE-E250A	102.00 X 124.00	39.250	8	0.496	3.968	
26	N1MQA78	L45X45X4-E250A	2713.00	2.700	8	7.325	58.600	
27	N1MQA79	L50X50X4-E250A	2483.00	3.000	4	7.449	29.796	
28	N1MQA79X	L50X50X4-E250A	2483.00	3.000	4	7.449	29.796	
29	N1MQA80	5MM PLATE-E250A	108.00 X 130.00	39.250	8	0.551	4.408	
30	N1MQA81	L45X45X4-E250A	1331.00	2.700	4	3.594	14.376	
31	N1MQA81X	L45X45X4-E250A	1331.00	2.700	4	3.594	14.376	
32	N1MQA82	L60X60X4-E250A	5966.00	3.700	2	22.074	44.148	
33	N1MQA82X	L60X60X4-E250A	5966.00	3.700	2	22.074	44.148	

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 15-Feb-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABS

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
34	N1MQA83	L45X30X4-E250A	953.00	2.200	2	2.097	4.194	
35	N1MQA83X	L45X30X4-E250A	953.00	2.200	2	2.097	4.194	
36	N1MQA84	5MM PLATE-E250A	100.00 X 136.00	39.250	4	0.534	2.136	
37	N1MQA85	L45X45X4-E250A	1616.00	2.700	2	4.363	8.726	
38	N1MQA85X	L45X45X4-E250A	1616.00	2.700	2	4.363	8.726	
39	N1MQA86	L45X45X4-E250A	2343.00	2.700	4	6.326	25.304	
40	N1MQA87	L45X30X4-E250A	1428.00	2.200	2	3.142	6.284	
41	N1MQA87X	L45X30X4-E250A	1428.00	2.200	2	3.142	6.284	
42	N1MQA88	L45X30X4-E250A	880.00	2.200	4	1.936	7.744	
43	N1MQA89H	L55X55X5H-E350A	3154.00	4.100	2	12.931	25.862	
44	N1MQA90	L65X65X4-E250A	5936.00	4.000	2	23.744	47.488	
45	N1MQA90X	L65X65X4-E250A	5936.00	4.000	2	23.744	47.488	
46	N1MQA91	L45X30X4-E250A	954.00	2.200	2	2.099	4.198	
47	N1MQA91X	L45X30X4-E250A	954.00	2.200	2	2.099	4.198	
48	N1MQA92	5MM PLATE-E250A	105.00 X 137.00	39.250	4	0.565	2.260	
49	N1MQA93	L45X45X4-E250A	1629.00	2.700	2	4.398	8.796	
50	N1MQA93X	L45X45X4-E250A	1629.00	2.700	2	4.398	8.796	
51	N1MQA94	L45X45X4-E250A	2294.00	2.700	4	6.194	24.776	
52	N1MQA95	L45X30X4-E250A	1399.00	2.200	2	3.078	6.156	
53	N1MQA95X	L45X30X4-E250A	1399.00	2.200	2	3.078	6.156	
54	N1MQA96	L45X30X4-E250A	907.00	2.200	4	1.995	7.980	
55	N1MQA97H	L60X60X5H-E350A	3333.00	4.500	2	14.999	29.998	
56	N1MQA98	L45X45X4-E250A	1182.00	2.700	4	3.191	12.764	
57	N1MQA99	L45X45X4-E250A	2323.00	2.700	4	6.272	25.088	
58	N1MQA100	L45X45X4-E250A	2357.00	2.700	4	6.364	25.456	
59	N1MQA101	L45X45X4-E250A	3201.00	2.700	4	8.643	34.572	
60	N1MQA102	L45X45X4-E250A	3224.00	2.700	4	8.705	34.820	
61	N1MQA104	5MM PLATE-E250A	110.00 X 158.00	39.250	12	0.682	8.184	
62	N1MQA106	5MM PLATE-E250A	110.00 X 152.00	39.250	12	0.656	7.872	
63	N1MQA107H	L45X45X4H-E350A	1902.00	2.700	4	5.135	20.540	
64	N1MQA108H	5MM PLATE H-E350A	110.00 X 152.00	39.250	4	0.656	2.624	
65	N1MQA109H	5MM PLATE H-E350A	110.00 X 158.00	39.250	4	0.682	2.728	
66	N1MQA110	L45X45X4-E250A	1267.00	2.700	2	3.421	6.842	
67	N1MQA111	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 15-Feb-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABS

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
68	N1MQA112	5MM PLATE-E250A	110.00 X 155.00	39.250	2	0.669	1.338	
69	N1MQA113	L45X45X4-E250A	1271.00	2.700	2	3.432	6.864	
70	N1MQA114	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	
71	N1MQA115	5MM PLATE-E250A	110.00 X 150.00	39.250	2	0.648	1.296	
72	N1MQA116	L45X45X4-E250A	1335.00	2.700	2	3.605	7.210	
73	N1MQA117	5MM PLATE-E250A	110.00 X 150.00	39.250	2	0.648	1.296	
74	N1MQA118	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	
75	N1MQA119	L45X45X4-E250A	1333.00	2.700	2	3.599	7.198	
76	N1MQA120	5MM PLATE-E250A	110.00 X 155.00	39.250	2	0.669	1.338	
77	N1MQA121	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	
78	N1MQA122	5MM PLATE-E250A	95.00 X 188.00	39.250	2	0.701	1.402	
79	N1MQA140SH	L110X110X10H-E350A	4000.00	16.600	2	66.400	132.800	
80	N1MQA141H	L110X110X10H-E350A	4000.00	16.600	2	66.400	132.800	
81	N1MQA142SH	L100X100X8H-E350A	4100.00	12.100	2	49.610	99.220	
82	N1MQA143H	L100X100X8H-E350A	4100.00	12.100	2	49.610	99.220	
83	N1MQA144SH	L100X100X8H-E350A	4050.00	12.100	2	49.005	98.010	
84	N1MQA145H	L100X100X8H-E350A	4050.00	12.100	2	49.005	98.010	
85	N1MQA146H	L100X100X7H-E350A	346.00	10.700	4	3.702	14.808	
86	N1MQA147H	8MM PLATE H-E350A	85.00 X 346.00	62.800	8	1.847	14.776	
87	N1MQA148H	L90X90X6H-E350A	316.00	8.200	4	2.591	10.364	
88	N1MQA149H	6MM PLATE H-E350A	85.00 X 316.00	47.100	8	1.265	10.120	
89	N1MQA150	2MM PLATE-E250A	75.00 X 155.00	15.700	8	0.183	1.464	
90	N1MQA151H	L90X90X6H-E350A	306.00	8.200	4	2.509	10.036	
91	N1MQA152H	6MM PLATE H-E350A	80.00 X 306.00	47.100	8	1.153	9.224	
92	N1MQA153	L65X65X5-E250A	3319.00	4.900	2	16.263	32.526	
93	N1MQA153X	L65X65X5-E250A	3319.00	4.900	2	16.263	32.526	
94	N1MQA157	L45X30X4-E250A	671.00	2.200	2	1.476	2.952	
95	N1MQA158	L50X50X4-E250A	3083.00	3.000	2	9.249	18.498	
96	N1MQA159H	6MM PLATE H-E350A	133.00 X 135.00	47.100	4	0.846	3.384	
97	N1MQA160H	L65X65X5H-E350A	4008.00	4.900	2	19.639	39.278	
98	N1MQA160XH	L65X65X5H-E350A	4008.00	4.900	2	19.639	39.278	
99	N1MQA161	L45X30X4-E250A	1011.00	2.200	2	2.224	4.448	
100	N1MQA161X	L45X30X4-E250A	1011.00	2.200	2	2.224	4.448	
101	N1MQA162	L45X30X4-E250A	1373.00	2.200	4	3.021	12.084	

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABS

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
102	N1MQA163	L45X30X4-E250A	1068.00	2.200	2	2.350	4.700	
103	N1MQA163X	L45X30X4-E250A	1068.00	2.200	2	2.350	4.700	
104	N1MQA164H	6MM PLATE H-E350A	135.00 X 330.00	47.100	4	2.098	8.392	
105	N1MQA165	L50X50X4-E250A	2906.00	3.000	2	8.718	17.436	
106	N1MQA166	L45X30X4-E250A	642.00	2.200	2	1.412	2.824	
107	N1MQA167	L50X50X4-E250A	3083.00	3.000	2	9.249	18.498	
108	N1MQA167X	L50X50X4-E250A	3083.00	3.000	2	9.249	18.498	
109	N1MQA167A	5MM PLATE-E250A	112.00 X 176.00	39.250	2	0.774	1.548	
110	N1MQA168	L45X30X4-E250A	799.00	2.200	2	1.758	3.516	
111	N1MQA168X	L45X30X4-E250A	799.00	2.200	2	1.758	3.516	
112	N1MQA169	L45X30X4-E250A	615.00	2.200	4	1.353	5.412	
113	N1MQA170	L45X30X4-E250A	818.00	2.200	2	1.800	3.600	
114	N1MQA170X	L45X30X4-E250A	818.00	2.200	2	1.800	3.600	
115	N1MQA171	L45X30X4-E250A	669.00	2.200	2	1.472	2.944	
116	N1MQA172	L50X50X4-E250A	2824.00	3.000	2	8.472	16.944	
117	N1MQA173H	6MM PLATE H-E350A	125.00 X 137.00	47.100	4	0.807	3.228	
118	N1MQA174H	L65X65X5H-E350A	3818.00	4.900	2	18.708	37.416	
119	N1MQA174XH	L65X65X5H-E350A	3818.00	4.900	2	18.708	37.416	
120	N1MQA175	L45X30X4-E250A	963.00	2.200	2	2.119	4.238	
121	N1MQA175X	L45X30X4-E250A	963.00	2.200	2	2.119	4.238	
122	N1MQA176	L45X30X4-E250A	1373.00	2.200	4	3.021	12.084	
123	N1MQA177	L45X30X4-E250A	1022.00	2.200	2	2.248	4.496	
124	N1MQA177X	L45X30X4-E250A	1022.00	2.200	2	2.248	4.496	
125	N1MQA178H	6MM PLATE H-E350A	125.00 X 341.00	47.100	4	2.008	8.032	
126	N1MQA179	L50X50X4-E250A	2647.00	3.000	2	7.941	15.882	
127	N1MQA180	L45X30X4-E250A	639.00	2.200	2	1.406	2.812	
128	N1MQA181	L60X60X4-E250A	2844.00	3.700	2	10.523	21.046	
129	N1MQA181X	L60X60X4-E250A	2844.00	3.700	2	10.523	21.046	
130	N1MQA182	5MM PLATE-E250A	116.00 X 174.00	39.250	2	0.792	1.584	
131	N1MQA183	L45X30X4-E250A	669.00	2.200	2	1.472	2.944	
132	N1MQA184	L50X50X4-E250A	2566.00	3.000	2	7.698	15.396	
133	N1MQA185H	6MM PLATE H-E350A	125.00 X 142.00	47.100	4	0.836	3.344	
134	N1MQA186H	L60X60X5H-E350A	3640.00	4.500	2	16.380	32.760	
135	N1MQA186XH	L60X60X5H-E350A	3640.00	4.500	2	16.380	32.760	

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 15-Feb-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABS

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
136	N1MQA187	L45X30X4-E250A	916.00	2.200	2	2.015	4.030	
137	N1MQA187X	L45X30X4-E250A	916.00	2.200	2	2.015	4.030	
138	N1MQA188	L45X30X4-E250A	1373.00	2.200	4	3.021	12.084	
139	N1MQA189	L45X30X4-E250A	979.00	2.200	2	2.154	4.308	
140	N1MQA189X	L45X30X4-E250A	979.00	2.200	2	2.154	4.308	
141	N1MQA190H	6MM PLATE H-E350A	165.00 X 336.00	47.100	4	2.611	10.444	
142	N1MQA191	L50X50X4-E250A	2389.00	3.000	2	7.167	14.334	
143	N1MQA192	L60X60X4-E250A	3345.00	3.700	2	12.377	24.754	
144	N1MQA192X	L60X60X4-E250A	3345.00	3.700	2	12.377	24.754	
145	N1MQA193	L45X30X4-E250A	711.00	2.200	2	1.564	3.128	
146	N1MQA194	6MM PLATE-E250A	135.00 X 143.00	47.100	4	0.909	3.636	
147	N1MQA195	L65X65X5-E250A	3083.00	4.900	2	15.107	30.214	
148	N1MQA196H	L55X55X5H-E350A	3962.00	4.100	2	16.244	32.488	
149	N1MQA196XH	L55X55X5H-E350A	3962.00	4.100	2	16.244	32.488	
150	N1MQA197	L45X30X4-E250A	1001.00	2.200	2	2.202	4.404	
151	N1MQA197X	L45X30X4-E250A	1001.00	2.200	2	2.202	4.404	
152	N1MQA198	L45X30X4-E250A	1338.00	2.200	4	2.944	11.776	
153	N1MQA199	L45X30X4-E250A	1055.00	2.200	2	2.321	4.642	
154	N1MQA199X	L45X30X4-E250A	1055.00	2.200	2	2.321	4.642	
155	N1MQA200	L50X50X4-E250A	3096.00	3.000	2	9.288	18.576	
156	N1MQA201	L45X30X4-E250A	670.00	2.200	2	1.474	2.948	
157	N1MQA202	L50X50X4-E250A	3113.00	3.000	2	9.339	18.678	
158	N1MQA202X	L50X50X4-E250A	3113.00	3.000	2	9.339	18.678	
159	N1MQA203	5MM PLATE-E250A	112.00 X 170.00	39.250	2	0.747	1.494	
160	N1MQA204	L45X30X4-E250A	705.00	2.200	2	1.551	3.102	
161	N1MQA205	6MM PLATE-E250A	125.00 X 165.00	47.100	4	0.971	3.884	
162	N1MQA206	L55X55X4-E250A	2824.00	3.300	2	9.319	18.638	
163	N1MQA207H	L60X60X5H-E350A	3776.00	4.500	2	16.992	33.984	
164	N1MQA207XH	L60X60X5H-E350A	3776.00	4.500	2	16.992	33.984	
165	N1MQA208	L45X30X4-E250A	953.00	2.200	2	2.097	4.194	
166	N1MQA208X	L45X30X4-E250A	953.00	2.200	2	2.097	4.194	
167	N1MQA209	L45X30X4-E250A	1341.00	2.200	4	2.950	11.800	
168	N1MQA210	L45X30X4-E250A	1010.00	2.200	2	2.222	4.444	
169	N1MQA210X	L45X30X4-E250A	1010.00	2.200	2	2.222	4.444	

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABS

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
170	N1MQA211H	6MM PLATE H-E350A	125.00 X 313.00	47.100	4	1.843	7.372	
171	N1MQA212	L50X50X4-E250A	2831.00	3.000	2	8.493	16.986	
172	N1MQA213	L45X30X4-E250A	670.00	2.200	2	1.474	2.948	
173	N1MQA214	L50X50X4-E250A	2876.00	3.000	2	8.628	17.256	
174	N1MQA214X	L50X50X4-E250A	2876.00	3.000	2	8.628	17.256	
175	N1MQA215	5MM PLATE-E250A	113.00 X 161.00	39.250	2	0.714	1.428	
176	N1MQA216	L45X30X4-E250A	704.00	2.200	2	1.549	3.098	
177	N1MQA217H	6MM PLATE H-E350A	125.00 X 319.00	47.100	4	1.878	7.512	
178	N1MQA218	L50X50X4-E250A	2566.00	3.000	2	7.698	15.396	
179	N1MQA219H	L55X55X5H-E350A	3598.00	4.100	2	14.752	29.504	
180	N1MQA219XH	L55X55X5H-E350A	3598.00	4.100	2	14.752	29.504	
181	N1MQA220	L45X30X4-E250A	907.00	2.200	2	1.995	3.990	
182	N1MQA220X	L45X30X4-E250A	907.00	2.200	2	1.995	3.990	
183	N1MQA221	L45X30X4-E250A	1344.00	2.200	4	2.957	11.828	
184	N1MQA222	L45X30X4-E250A	967.00	2.200	2	2.127	4.254	
185	N1MQA222X	L45X30X4-E250A	967.00	2.200	2	2.127	4.254	
186	N1MQA223H	6MM PLATE H-E350A	125.00 X 320.00	47.100	4	1.884	7.536	
187	N1MQA224H	L50X50X4H-E350A	2574.00	3.000	2	7.722	15.444	
188	N1MQA225	L45X30X4-E250A	1110.00	2.200	2	2.442	4.884	
189	N1MQA226	5MM PLATE-E250A	110.00 X 158.00	39.250	2	0.682	1.364	
190	N1MQA227	5MM PLATE-E250A	110.00 X 155.00	39.250	2	0.669	1.338	
191	N1MQA228	L45X30X4-E250A	1122.00	2.200	2	2.468	4.936	
192	N1MQA229	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	
193	N1MQA230	5MM PLATE-E250A	110.00 X 147.00	39.250	2	0.635	1.270	
194	N1MQA231	L45X30X4-E250A	1018.00	2.200	2	2.240	4.480	
195	N1MQA232	5MM PLATE-E250A	110.00 X 155.00	39.250	2	0.669	1.338	
196	N1MQA233	5MM PLATE-E250A	110.00 X 158.00	39.250	2	0.682	1.364	
197	N1MQA234	L45X30X4-E250A	1029.00	2.200	2	2.264	4.528	
198	N1MQA235	5MM PLATE-E250A	110.00 X 147.00	39.250	2	0.635	1.270	
199	N1MQA236	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	
200	N1MQA237	L45X30X4-E250A	1010.00	2.200	2	2.222	4.444	
201	N1MQA238	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	
202	N1MQA239	5MM PLATE-E250A	110.00 X 155.00	39.250	2	0.669	1.338	
203	N1MQA240	L45X30X4-E250A	1016.00	2.200	2	2.235	4.470	

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABS

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
204	N1MQA241	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	
205	N1MQA242	5MM PLATE-E250A	110.00 X 150.00	39.250	2	0.648	1.296	
206	N1MQA243	L45X30X4-E250A	932.00	2.200	2	2.050	4.100	
207	N1MQA244	5MM PLATE-E250A	110.00 X 155.00	39.250	2	0.669	1.338	
208	N1MQA245	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	
209	N1MQA246	L45X30X4-E250A	937.00	2.200	2	2.061	4.122	
210	N1MQA247	5MM PLATE-E250A	110.00 X 150.00	39.250	2	0.648	1.296	
211	N1MQA248	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	
212	N1MQA249	L45X30X4-E250A	918.00	2.200	2	2.020	4.040	
213	N1MQA250	5MM PLATE-E250A	110.00 X 158.00	39.250	2	0.682	1.364	
214	N1MQA251	5MM PLATE-E250A	110.00 X 150.00	39.250	2	0.648	1.296	
215	N1MQA252	L45X30X4-E250A	921.00	2.200	2	2.026	4.052	
216	N1MQA253	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	
217	N1MQA254	5MM PLATE-E250A	110.00 X 147.00	39.250	2	0.635	1.270	
218	N1MQA255	L45X30X4-E250A	841.00	2.200	2	1.850	3.700	
219	N1MQA256	5MM PLATE-E250A	110.00 X 150.00	39.250	2	0.648	1.296	
220	N1MQA257	5MM PLATE-E250A	110.00 X 158.00	39.250	2	0.682	1.364	
221	N1MQA258	L45X30X4-E250A	845.00	2.200	2	1.859	3.718	
222	N1MQA259	5MM PLATE-E250A	110.00 X 147.00	39.250	2	0.635	1.270	
223	N1MQA260	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	
224	N1MQA261	5MM PLATE-E250A	85.00 X 168.00	39.250	2	0.560	1.120	
225	N1MQA280SH	L75X75X6H-E350A	4050.00	6.800	2	27.540	55.080	
226	N1MQA281H	L75X75X6H-E350A	4050.00	6.800	2	27.540	55.080	
227	N1MQA282SH	L65X65X5H-E350A	5377.00	4.900	2	26.347	52.694	
228	N1MQA283H	L65X65X5H-E350A	5377.00	4.900	2	26.347	52.694	
229	N1MQA284S	L55X55X5-E250A	3839.00	4.100	2	15.740	31.480	
230	N1MQA285	L55X55X5-E250A	3839.00	4.100	2	15.740	31.480	
231	N1MQA286H	L70X70X5H-E350A	356.00	5.300	4	1.887	7.548	
232	N1MQA287H	6MM PLATE H-E350A	70.00 X 356.00	47.100	8	1.174	9.392	
233	N1MQA288	2MM PLATE-E250A	50.00 X 175.00	15.700	8	0.137	1.096	
234	N1MQA289	L45X30X4-E250A	678.00	2.200	2	1.492	2.984	
235	N1MQA290	L50X50X4-E250A	2594.00	3.000	2	7.782	15.564	
236	N1MQA290X	L50X50X4-E250A	2594.00	3.000	2	7.782	15.564	
237	N1MQA290A	L45X30X4-E250A	1142.00	2.200	4	2.512	10.048	

** — Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No.: BOM/LE17D124/PQABS

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
238	N1MQA291H	L50X50X4H-E350A	2321.00	3.000	2	6.963	13.926	
239	N1MQA292H	6MM PLATE H-E350A	129.00 X 190.00	47.100	4	1.154	4.616	
240	N1MQA293H	L60X60X5H-E350A	3516.00	4.500	2	15.822	31.644	
241	N1MQA293XH	L60X60X5H-E350A	3516.00	4.500	2	15.822	31.644	
242	N1MQA294	L45X30X4-E250A	882.00	2.200	2	1.940	3.880	
243	N1MQA294X	L45X30X4-E250A	882.00	2.200	2	1.940	3.880	
244	N1MQA295	L45X30X4-E250A	1398.00	2.200	4	3.076	12.304	
245	N1MQA296	L45X30X4-E250A	951.00	2.200	2	2.092	4.184	
246	N1MQA296X	L45X30X4-E250A	951.00	2.200	2	2.092	4.184	
247	N1MQA297H	6MM PLATE H-E350A	145.00 X 377.00	47.100	4	2.575	10.300	
248	N1MQA298H	L55X55X4H-E350A	2140.00	3.300	2	7.062	14.124	
249	N1MQA299	L45X45X4-E250A	2366.00	2.700	2	6.388	12.776	
250	N1MQA299X	L45X45X4-E250A	2366.00	2.700	2	6.388	12.776	
251	N1MQA300H	L50X50X4H-E350A	2061.00	3.000	2	6.183	12.366	
252	N1MQA301H	6MM PLATE H-E350A	100.00 X 158.00	47.100	4	0.744	2.976	
253	N1MQA302H	L60X60X5H-E350A	3358.00	4.500	2	15.111	30.222	
254	N1MQA302XH	L60X60X5H-E350A	3358.00	4.500	2	15.111	30.222	
255	N1MQA303	L45X30X4-E250A	840.00	2.200	2	1.848	3.696	
256	N1MQA303X	L45X30X4-E250A	840.00	2.200	2	1.848	3.696	
257	N1MQA304	L45X30X4-E250A	1398.00	2.200	4	3.076	12.304	
258	N1MQA305	L45X30X4-E250A	914.00	2.200	2	2.011	4.022	
259	N1MQA305X	L45X30X4-E250A	914.00	2.200	2	2.011	4.022	
260	N1MQA306H	6MM PLATE H-E350A	140.00 X 209.00	47.100	4	1.378	5.512	
261	N1MQA307H	L55X55X4H-E350A	1880.00	3.300	2	6.204	12.408	
262	N1MQA308	L45X45X4-E250A	2116.00	2.700	2	5.713	11.426	
263	N1MQA308X	L45X45X4-E250A	2116.00	2.700	2	5.713	11.426	
264	N1MQA309H	L45X45X4H-E350A	1805.00	2.700	2	4.874	9.748	
265	N1MQA310	L45X30X4-E250A	1974.00	2.200	2	4.343	8.686	
266	N1MQA310X	L45X30X4-E250A	1974.00	2.200	2	4.343	8.686	
267	N1MQA311	L45X30X4-E250A	1637.00	2.200	2	3.601	7.202	
268	N1MQA311X	L45X30X4-E250A	1637.00	2.200	2	3.601	7.202	
269	N1MQA312	L45X30X4-E250A	676.00	2.200	2	1.487	2.974	
270	N1MQA312A	L45X30X4-E250A	261.00	2.200	2	0.574	1.148	
271	N1MQA313H	6MM PLATE H-E350A	109.00 X 176.00	47.100	2	0.904	1.808	

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABS

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
272	N1MQA314H	8MM PLATE H-E350A	164.00 X 381.00	62.800	1	3.924	3.924	
273	N1MQA315	L50X50X4-E250A	2628.00	3.000	2	7.884	15.768	
274	N1MQA315X	L50X50X4-E250A	2628.00	3.000	2	7.884	15.768	
275	N1MQA316H	6MM PLATE H-E350A	133.00 X 375.00	47.100	4	2.349	9.396	
276	N1MQA317H	L55X55X4H-E350A	2321.00	3.300	2	7.659	15.318	
277	N1MQA318H	L60X60X5H-E350A	3468.00	4.500	2	15.606	31.212	
278	N1MQA318XH	L60X60X5H-E350A	3468.00	4.500	2	15.606	31.212	
279	N1MQA319	L45X30X4-E250A	872.00	2.200	2	1.918	3.836	
280	N1MQA319X	L45X30X4-E250A	872.00	2.200	2	1.918	3.836	
281	N1MQA320	L45X30X4-E250A	1366.00	2.200	4	3.005	12.020	
282	N1MQA321	L45X30X4-E250A	937.00	2.200	2	2.061	4.122	
283	N1MQA321X	L45X30X4-E250A	937.00	2.200	2	2.061	4.122	
284	N1MQA322H	6MM PLATE H-E350A	135.00 X 363.00	47.100	4	2.308	9.232	
285	N1MQA323H	L50X50X4H-E350A	2318.00	3.000	2	6.954	13.908	
286	N1MQA324	L50X50X4-E250A	2403.00	3.000	2	7.209	14.418	
287	N1MQA324X	L50X50X4-E250A	2403.00	3.000	2	7.209	14.418	
288	N1MQA325H	6MM PLATE H-E350A	100.00 X 340.00	47.100	4	1.601	6.404	
289	N1MQA326H	L50X50X4H-E350A	2061.00	3.000	2	6.183	12.366	
290	N1MQA327H	L60X60X5H-E350A	3316.00	4.500	2	14.922	29.844	
291	N1MQA327XH	L60X60X5H-E350A	3316.00	4.500	2	14.922	29.844	
292	N1MQA328	L45X30X4-E250A	831.00	2.200	2	1.828	3.656	
293	N1MQA328X	L45X30X4-E250A	831.00	2.200	2	1.828	3.656	
294	N1MQA329	L45X30X4-E250A	1371.00	2.200	4	3.016	12.064	
295	N1MQA330	L45X30X4-E250A	902.00	2.200	2	1.984	3.968	
296	N1MQA330X	L45X30X4-E250A	902.00	2.200	2	1.984	3.968	
297	N1MQA331H	6MM PLATE H-E350A	100.00 X 190.00	47.100	4	0.895	3.580	
298	N1MQA332H	L50X50X4H-E350A	2048.00	3.000	2	6.144	12.288	
299	N1MQA333	L45X45X4-E250A	2156.00	2.700	2	5.821	11.642	
300	N1MQA333X	L45X45X4-E250A	2156.00	2.700	2	5.821	11.642	
301	N1MQA333AH	5MM PLATE H-E350A	100.00 X 114.00	39.250	4	0.447	1.788	
302	N1MQA334H	L45X45X4H-E350A	1806.00	2.700	2	4.876	9.752	
303	N1MQA335	L45X30X4-E250A	1950.00	2.200	2	4.290	8.580	
304	N1MQA335X	L45X30X4-E250A	1950.00	2.200	2	4.290	8.580	
305	N1MQA336	L45X30X4-E250A	1650.00	2.200	2	3.630	7.260	

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABS

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
306	N1MQA336X	L45X30X4-E250A	1650.00	2.200	2	3.630	7.260	
307	N1MQA337	L45X30X4-E250A	698.00	2.200	2	1.536	3.072	
308	N1MQA337A	L45X30X4-E250A	282.00	2.200	2	0.620	1.240	
309	N1MQA338	L45X30X4-E250A	811.00	2.200	2	1.784	3.568	
310	N1MQA339	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	
311	N1MQA340	5MM PLATE-E250A	110.00 X 150.00	39.250	2	0.648	1.296	
312	N1MQA341	L45X30X4-E250A	811.00	2.200	2	1.784	3.568	
313	N1MQA342	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	
314	N1MQA343	5MM PLATE-E250A	110.00 X 150.00	39.250	2	0.648	1.296	
315	N1MQA344	L45X30X4-E250A	752.00	2.200	2	1.654	3.308	
316	N1MQA345	5MM PLATE-E250A	110.00 X 150.00	39.250	2	0.648	1.296	
317	N1MQA346	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	
318	N1MQA347	L45X30X4-E250A	753.00	2.200	2	1.657	3.314	
319	N1MQA348	5MM PLATE-E250A	110.00 X 150.00	39.250	2	0.648	1.296	
320	N1MQA349	5MM PLATE-E250A	110.00 X 160.00	39.250	2	0.691	1.382	
321	N1MQA370L	L70X70X5-E250A	3376.00	5.300	2	17.893	35.786	
322	N1MQA370R	L70X70X5-E250A	3376.00	5.300	2	17.893	35.786	
323	N1MQA371L	L50X50X4-E250A	3395.00	3.000	2	10.185	20.370	
324	N1MQA371R	L50X50X4-E250A	3395.00	3.000	2	10.185	20.370	
325	N1MQA372L	6MM PLATE-E250A	206.00 X 289.00	47.100	2	2.804	5.608	
326	N1MQA372R	6MM PLATE-E250A	206.00 X 289.00	47.100	2	2.804	5.608	
327	N1MQA373L	L45X45X4-E250A	1637.00	2.700	2	4.420	8.840	
328	N1MQA373R	L45X45X4-E250A	1637.00	2.700	2	4.420	8.840	
329	N1MQA374L	L45X30X4-E250A	695.00	2.200	2	1.529	3.058	
330	N1MQA374R	L45X30X4-E250A	695.00	2.200	2	1.529	3.058	
331	N1MQA375L	50X6 FLAT-E250A	182.00	2.400	2	0.437	0.874	
332	N1MQA375A	6MM PLATE-E250A	147.00 X 242.00	47.100	2	1.676	3.352	
333	N1MQA375R	50X6 FLAT-E250A	182.00	2.400	2	0.437	0.874	
334	N1MQA376H	L50X50X4H-E350A	4430.00	3.000	1	13.290	13.290	
335	N1MQA376XH	L50X50X4H-E350A	4430.00	3.000	1	13.290	13.290	
336	N1MQA377	L50X50X4-E250A	2223.00	3.000	2	6.669	13.338	
337	N1MQA377X	L50X50X4-E250A	2223.00	3.000	2	6.669	13.338	
338	N1MQA378H	5MM PLATE H-E350A	97.00 X 124.00	39.250	4	0.472	1.888	
339	N1MQA379	5MM PLATE-E250A	120.00 X 184.00	39.250	2	0.867	1.734	

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 15-Feb-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABS

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
340	N1MQA380H	6MM PLATE H-E350A	100.00 X 127.00	47.100	4	0.598	2.392	
341	N1MQA381H	L45X45X4H-E350A	1547.00	2.700	2	4.177	8.354	
342	N1MQA381AH	L45X45X4H-E350A	1547.00	2.700	2	4.177	8.354	
343	N1MQA382H	L45X45X4H-E350A	1766.00	2.700	2	4.768	9.536	
344	N1MQA383H	L75X75X5H-E350A	407.00	5.700	2	2.320	4.640	
345	N1MQA384H	L110X110X10H-E350A	148.00	16.600	4	2.457	9.828	
346	N1MQA385H	L45X45X4H-E350A	1722.00	2.700	2	4.649	9.298	
347	N1MQA386	L45X30X4-E250A	460.00	2.200	2	1.012	2.024	
348	N1MQA400L	L70X70X5-E250A	3421.00	5.300	2	18.131	36.262	
349	N1MQA400R	L70X70X5-E250A	3421.00	5.300	2	18.131	36.262	
350	N1MQA401L	L50X50X4-E250A	3399.00	3.000	2	10.197	20.394	
351	N1MQA401R	L50X50X4-E250A	3399.00	3.000	2	10.197	20.394	
352	N1MQA402L	6MM PLATE-E250A	203.00 X 282.00	47.100	2	2.696	5.392	
353	N1MQA402R	6MM PLATE-E250A	203.00 X 282.00	47.100	2	2.696	5.392	
354	N1MQA403L	L45X45X4-E250A	1641.00	2.700	2	4.431	8.862	
355	N1MQA403R	L45X45X4-E250A	1641.00	2.700	2	4.431	8.862	
356	N1MQA404L	L45X30X4-E250A	694.00	2.200	2	1.527	3.054	
357	N1MQA404R	L45X30X4-E250A	694.00	2.200	2	1.527	3.054	
358	N1MQA405L	50X6 FLAT-E250A	180.00	2.400	2	0.432	0.864	
359	N1MQA405R	50X6 FLAT-E250A	180.00	2.400	2	0.432	0.864	
360	N1MQA406	6MM PLATE-E250A	146.00 X 245.00	47.100	2	1.685	3.370	
361	N1MQA407H	L50X50X4H-E350A	3912.00	3.000	1	11.736	11.736	
362	N1MQA407XH	L50X50X4H-E350A	3912.00	3.000	1	11.736	11.736	
363	N1MQA408H	5MM PLATE H-E350A	133.00 X 134.00	39.250	4	0.700	2.800	
364	N1MQA409H	6MM PLATE H-E350A	104.00 X 163.00	47.100	4	0.798	3.192	
365	N1MQA410H	L45X45X4H-E350A	2634.00	2.700	2	7.112	14.224	
366	N1MQA410XH	L45X45X4H-E350A	2634.00	2.700	2	7.112	14.224	
367	N1MQA411H	L45X45X4H-E350A	1631.00	2.700	2	4.404	8.808	
368	N1MQA412H	L75X75X5H-E350A	377.00	5.700	2	2.149	4.298	
369	N1MQA413H	L110X110X10H-E350A	148.00	16.600	4	2.457	9.828	
370	N1MQA414H	L45X45X4H-E350A	1589.00	2.700	2	4.290	8.580	
371	N1MQA415	L45X30X4-E250A	432.00	2.200	2	0.950	1.900	
372	N1MQA430L	L70X70X5-E250A	3421.00	5.300	2	18.131	36.262	
373	N1MQA430R	L70X70X5-E250A	3421.00	5.300	2	18.131	36.262	

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABS

Order Ref: REF/LE17D124.

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
374	N1MQA431L	L50X50X4-E250A	3411.00	3.000	2	10.233	20.466	
375	N1MQA431R	L50X50X4-E250A	3411.00	3.000	2	10.233	20.466	
376	N1MQA432L	6MM PLATE-E250A	207.00 X 279.00	47.100	2	2.720	5.440	
377	N1MQA432R	6MM PLATE-E250A	207.00 X 279.00	47.100	2	2.720	5.440	
378	N1MQA433L	L45X45X4-E250A	1645.00	2.700	2	4.442	8.884	
379	N1MQA433R	L45X45X4-E250A	1645.00	2.700	2	4.442	8.884	
380	N1MQA434L	L45X30X4-E250A	694.00	2.200	2	1.527	3.054	
381	N1MQA434R	L45X30X4-E250A	694.00	2.200	2	1.527	3.054	
382	N1MQA435L	50X6 FLAT-E250A	178.00	2.400	2	0.427	0.854	
383	N1MQA435R	50X6 FLAT-E250A	178.00	2.400	2	0.427	0.854	
384	N1MQA436	6MM PLATE-E250A	146.00 X 249.00	47.100	2	1.712	3.424	
385	N1MQA437H	L45X45X4H-E350A	3550.00	2.700	1	9.585	9.585	
386	N1MQA437XH	L45X45X4H-E350A	3550.00	2.700	1	9.585	9.585	
387	N1MQA438H	5MM PLATE H-E350A	133.00 X 134.00	39.250	4	0.700	2.800	
388	N1MQA439H	6MM PLATE H-E350A	105.00 X 160.00	47.100	4	0.791	3.164	
389	N1MQA440H	L45X45X4H-E350A	2480.00	2.700	2	6.696	13.392	
390	N1MQA440XH	L45X45X4H-E350A	2480.00	2.700	2	6.696	13.392	
391	N1MQA441H	L45X45X4H-E350A	1499.00	2.700	2	4.047	8.094	
392	N1MQA442H	L75X75X5H-E350A	349.00	5.700	2	1.989	3.978	
393	N1MQA443H	L110X110X10H-E350A	148.00	16.600	4	2.457	9.828	
394	N1MQA444	L45X45X4-E250A	1456.00	2.700	2	3.931	7.862	
395	N1MQA445	L45X30X4-E250A	404.00	2.200	2	0.889	1.778	
396	N1MQA460L	L70X70X5-E250A	3432.00	5.300	2	18.190	36.380	
397	N1MQA460R	L70X70X5-E250A	3432.00	5.300	2	18.190	36.380	
398	N1MQA461L	L50X50X4-E250A	3369.00	3.000	2	10.107	20.214	
399	N1MQA461R	L50X50X4-E250A	3369.00	3.000	2	10.107	20.214	
400	N1MQA462L	6MM PLATE-E250A	214.00 X 258.00	47.100	2	2.600	5.200	
401	N1MQA462R	6MM PLATE-E250A	214.00 X 258.00	47.100	2	2.600	5.200	
402	N1MQA463L	L45X30X4-E250A	1618.00	2.200	2	3.560	7.120	
403	N1MQA463R	L45X30X4-E250A	1618.00	2.200	2	3.560	7.120	
404	N1MQA464L	L45X30X4-E250A	672.00	2.200	2	1.478	2.956	
405	N1MQA464R	L45X30X4-E250A	672.00	2.200	2	1.478	2.956	
406	N1MQA465L	50X6 FLAT-E250A	175.00	2.400	2	0.420	0.840	
407	N1MQA465R	50X6 FLAT-E250A	175.00	2.400	2	0.420	0.840	

** -- Item Welded with another item
*** -- Item Assembled with another item

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABS

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
408	N1MQA466	6MM PLATE-E250A	146.00 X 255.00	47.100	2	1.754	3.508	
409	N1MQA467H	L45X45X4H-E350A	3186.00	2.700	1	8.602	8.602	
410	N1MQA467XH	L45X45X4H-E350A	3186.00	2.700	1	8.602	8.602	
411	N1MQA468H	5MM PLATE H-E350A	104.00 X 120.00	39.250	4	0.490	1.960	
412	N1MQA469H	6MM PLATE H-E350A	106.00 X 161.00	47.100	4	0.804	3.216	
413	N1MQA470H	L45X45X4H-E350A	2323.00	2.700	2	6.272	12.544	
414	N1MQA470XH	L45X45X4H-E350A	2323.00	2.700	2	6.272	12.544	
415	N1MQA471	L45X45X4-E250A	1368.00	2.700	2	3.694	7.388	
416	N1MQA472H	L75X75X5H-E350A	327.00	5.700	2	1.864	3.728	
417	N1MQA473H	L110X110X10H-E350A	148.00	16.600	4	2.457	9.828	
418	N1MQA474	L45X45X4-E250A	1330.00	2.700	2	3.591	7.182	
419	N1MQA475	L45X30X4-E250A	377.00	2.200	2	0.829	1.658	
420	N1MQA490L	L70X70X5-E250A	3383.00	5.300	2	17.930	35.860	
421	N1MQA490R	L70X70X5-E250A	3383.00	5.300	2	17.930	35.860	
422	N1MQA491L	L50X50X4-E250A	3354.00	3.000	2	10.062	20.124	
423	N1MQA491R	L50X50X4-E250A	3354.00	3.000	2	10.062	20.124	
424	N1MQA492L	6MM PLATE-E250A	209.00 X 249.00	47.100	2	2.451	4.902	
425	N1MQA492R	6MM PLATE-E250A	209.00 X 249.00	47.100	2	2.451	4.902	
426	N1MQA493L	L45X30X4-E250A	1608.00	2.200	2	3.538	7.076	
427	N1MQA493R	L45X30X4-E250A	1608.00	2.200	2	3.538	7.076	
428	N1MQA494L	L45X30X4-E250A	671.00	2.200	2	1.476	2.952	
429	N1MQA494R	L45X30X4-E250A	671.00	2.200	2	1.476	2.952	
430	N1MQA495L	50X6 FLAT-E250A	175.00	2.400	2	0.420	0.840	
431	N1MQA495R	50X6 FLAT-E250A	175.00	2.400	2	0.420	0.840	
432	N1MQA496	6MM PLATE-E250A	146.00 X 256.00	47.100	2	1.760	3.520	
433	N1MQA497H	L45X45X4H-E350A	2981.00	2.700	1	8.049	8.049	
434	N1MQA497XH	L45X45X4H-E350A	2981.00	2.700	1	8.049	8.049	
435	N1MQA498H	6MM PLATE H-E350A	103.00 X 159.00	47.100	4	0.771	3.084	
436	N1MQA499H	L45X45X4H-E350A	2180.00	2.700	2	5.886	11.772	
437	N1MQA499XH	L45X45X4H-E350A	2180.00	2.700	2	5.886	11.772	
438	N1MQA500	L45X45X4-E250A	1237.00	2.700	2	3.340	6.680	
439	N1MQA501H	L75X75X5H-E350A	304.00	5.700	2	1.733	3.466	
440	N1MQA502H	L110X110X10H-E350A	148.00	16.600	4	2.457	9.828	
441	N1MQA503	L45X45X4-E250A	1189.00	2.700	2	3.210	6.420	

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 15-Feb-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABS

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
442	N1MQA504	L45X30X4-E250A	345.00	2.200	2	0.759	1.518	
443	N1MQA520L	L70X70X5-E250A	3313.00	5.300	2	17.559	35.118	
444	N1MQA520R	L70X70X5-E250A	3313.00	5.300	2	17.559	35.118	
445	N1MQA521L	L50X50X4-E250A	3278.00	3.000	2	9.834	19.668	
446	N1MQA521R	L50X50X4-E250A	3278.00	3.000	2	9.834	19.668	
447	N1MQA522L	6MM PLATE-E250A	210.00 X 249.00	47.100	2	2.463	4.926	
448	N1MQA522R	6MM PLATE-E250A	210.00 X 249.00	47.100	2	2.463	4.926	
449	N1MQA523L	L45X30X4-E250A	1566.00	2.200	2	3.445	6.890	
450	N1MQA523R	L45X30X4-E250A	1566.00	2.200	2	3.445	6.890	
451	N1MQA524L	L45X30X4-E250A	648.00	2.200	2	1.426	2.852	
452	N1MQA524R	L45X30X4-E250A	648.00	2.200	2	1.426	2.852	
453	N1MQA525L	50X6 FLAT-E250A	173.00	2.400	2	0.415	0.830	
454	N1MQA525R	50X6 FLAT-E250A	173.00	2.400	2	0.415	0.830	
455	N1MQA526	6MM PLATE-E250A	146.00 X 261.00	47.100	2	1.795	3.590	
456	N1MQA527	L45X45X4-E250A	2607.00	2.700	1	7.039	7.039	
457	N1MQA527X	L45X45X4-E250A	2607.00	2.700	1	7.039	7.039	
458	N1MQA528H	6MM PLATE H-E350A	99.00 X 152.00	47.100	4	0.709	2.836	
459	N1MQA529	L45X45X4-E250A	2021.00	2.700	2	5.457	10.914	
460	N1MQA529X	L45X45X4-E250A	2021.00	2.700	2	5.457	10.914	
461	N1MQA530	L45X45X4-E250A	1101.00	2.700	2	2.973	5.946	
462	N1MQA531H	L75X75X5H-E350A	284.00	5.700	2	1.619	3.238	
463	N1MQA532H	L110X110X10H-E350A	148.00	16.600	4	2.457	9.828	
464	N1MQA533	L45X45X4-E250A	1062.00	2.700	2	2.867	5.734	
465	N1MQA534	L45X30X4-E250A	324.00	2.200	2	0.713	1.426	

Total Weight : 6570.064

Associated Parts

Part Code	Type of Association	Associated with	Total Weight

No Association Part

Raw Material Involved	Standard Material	Total Weight (In Kg)
BASIC BODY FOR TOWER TYPE-"QA" (132kV, WZ-4)		
2MM PLATE-E250A	MS	2.560
50X6 FLAT-E250A	MS	10.204
5MM PLATE H-E350A	HT	16.588

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABS

Order Ref: REF/LE17D124

5MM PLATE-E250A	MS	101.750
6MM PLATE H-E350A	HT	159.688
6MM PLATE-E250A	MS	91.220
8MM PLATE H-E350A	HT	56.476
L100X100X7H-E350A	HT	14.808
L100X100X8H-E350A	HT	394.460
L110X110X10H-E350A	HT	324.568
L110X110X8H-E350A	HT	20.152
L120X120X10H-E350A	HT	344.272
L120X120X8H-E350A	HT	22.108
L130X130X10H-E350A	HT	524.020
L45X30X4-E250A	MS	632.586
L45X45X4-E250A	MS	641.796
L45X45X4H-E350A	HT	257.400
L50X50X4-E250A	MS	685.416
L50X50X4H-E350A	HT	130.350
L55X55X4-E250A	MS	129.570
L55X55X4H-E350A	HT	41.850
L55X55X5-E250A	MS	62.960
L55X55X5H-E350A	HT	149.846
L60X60X4-E250A	MS	304.276
L60X60X5H-E350A	HT	409.330
L65X65X4-E250A	MS	94.976
L65X65X5-E250A	MS	95.266
L65X65X5H-E350A	HT	258.776
L70X70X5-E250A	MS	431.336
L70X70X5H-E350A	HT	7.548
L75X75X5H-E350A	HT	23.348
L75X75X6H-E350A	HT	110.160
L90X90X6H-E350A	HT	20.400
	Total	6570.064
	HT	**3286.148**
	MS	**3283.916**

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABB

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
	BOLTS & NUTS OF BASIC BODY FOR TOWER TYPE-"QA" (132kV, WZ-4)							
1	PQABB1	M16X35MM LONG (IS:12427)		0.119	1012	0.119	120.428	
2	PQABB2	M16X40MM LONG (IS:12427)		0.126	927	0.126	116.802	
3	PQABB3	M16X45MM LONG (IS:12427)		0.134	415	0.134	55.610	
4	PQABB4	M16X50MM LONG (IS:12427)		0.142	316	0.142	44.872	
5	PQABB5	M16X55MM LONG (IS:12427)		0.150	8	0.150	1.200	
6	PQABB6	M16x3.5MM SPRING WASHER IS3063		0.009	2678	0.009	24.102	
7	PQABB7	M16x175LG SB (50 OD) 2N+1SP		0.423	160	0.423	67.680	
				Total Weight :			**430.694**	

Associated Parts

Part Code	Type of Association	Associated with	Total Weight

No Association Part

Raw Material Involved	Standard Material	Total Weight (In Kg)
BOLTS & NUTS OF BASIC BODY FOR TOWER TYPE-"QA" (132kV, WZ-4)		
M16x175LG SB (50 OD) 2N+1SP		67.680
M16x3.5MM SPRING WASHER IS3063		24.102
M16X35MM LONG (IS:12427)		120.428
M16X40MM LONG (IS:12427)		116.802
M16X45MM LONG (IS:12427)		55.610
M16X50MM LONG (IS:12427)		44.872
M16X55MM LONG (IS:12427)		1.200
	Total	430.694

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 15-Feb-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQABW

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
	PACK WASHERS OF BASIC BODY FOR TOWER TYPE-"QA" (132kV, WZ-4)							
1	PQABW1	M16x4MM ROUND PACK WASHER IS2016		0.014	26	0.014	0.364	
2	PQABW2	M16x5MM ROUND PACK WASHER IS2016		0.018	79	0.018	1.422	
3	PQABW3	M16x6MM ROUND PACK WASHER IS2016		0.021	64	0.021	1.344	
4	PQABW4	M16x8MM ROUND PACK WASHER IS2016		0.028	74	0.028	2.072	
5	PQABW5	M16x10MM ROUND PACK WASHER IS2016		0.036	27	0.036	0.972	
				Total Weight :			**6.174**	

Associated Parts

Part Code	Type of Association	Associated with	Total Weight

No Association Part

Raw Material Involved	Standard Material	Total Weight (In Kg)
PACK WASHERS OF BASIC BODY FOR TOWER TYPE-"QA" (132kV, WZ-4)		
M16x10MM ROUND PACK WASHER IS2016		0.972
M16x4MM ROUND PACK WASHER IS2016		0.364
M16x5MM ROUND PACK WASHER IS2016		1.422
M16x6MM ROUND PACK WASHER IS2016		1.344
M16x8MM ROUND PACK WASHER IS2016		2.072
	Total	6.174

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 15-Feb-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/PQAHR

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt.	Total Wt	Per Piece Ass.Wt
	HANGER ROD OF 20MM DIA FOR TOWER TYPE-"QA" (132kV, WZ-4)							
1	PQAHR1	20MM DIA HANGER ROD		2.030	12	2.030	24.360	
				Total Weight :			**24.360**	

Associated Parts

Part Code	Type of Association	Associated with	Total Weight

No Association Part

Raw Material Involved	Standard Material	Total Weight (In Kg)
HANGER ROD OF 20MM DIA FOR TOWER TYPE-"QA" (132kV, WZ-4)		
20MM DIA HANGER ROD		24.360
	Total	24.360

** -- Item Welded with another item
*** -- Item Assembled with another item

L&T Construction
Power Transmission & Distribution

CLIENT: **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

PROJECT: **TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE**

LOA No.: **073/74-201 Dated: 24.04.2017**

DRG. No.: O17123-T-TL-4M-GA-0101

BOM No.: BOM/LE17D124/132kV/QA/001 | NO OF SHEETS: 4

CAT 1+

9/5/18

पावर ग्रिड कारपोरेशन ऑफ इंडिया लि०
This document is recommended for approval for construction of 400KV/132kV D/C TAMAKOSHI - BARHABISE - KATHMANDU in NEPAL

BILL OF MATERIAL
STUB & CLEATS FOR TOWER TYPE - "QA" (132kV, WZ-4)

WEIGHT OF STRUCTURE	
HT MEMBERS: BOM/LE17D124/PQASC/SQASC/R-0	308.728
MS MEMBERS INCLUDING PACK WASHERS AND ACCESSORIES ETC.	-
WEIGHT OF BOLTS & NUTS,SPRING WASHERS: BOM/LE17D124/PQASB/SQASB/R-0	4.576
TOTAL WEIGHT OF STRUCTURE:	313.304 Kgs

CAT - I+

☐ Approved / Released For Fabrication/Construction
☐ Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
☐ To be resubmitted for approval after incorporating the comments
☐ For information and record
☐ Not approved

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kv Transmission Line Project

Checked By: Date: 2018/5/18
Approved By: Date:

0	01.03.18	FIRST SUBMISSION FOR APPROVAL	PU	BSR	CSR
REV.	DATE	DESCRIPTION	CHKD.	REVED.	APPD.

PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY	DATE
ALEX	PU	BSR	CSR	01.03.18

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000   FAX : 044 - 22705494

BILL OF MATERIAL

Project   LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref.   -   Date 01-03-2018
Drg No.   -   -   Page 1 of 1
BOM No.   BOM/LE17D124/PQASC/SQASC/R-0

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
STUB & CLEATS FOR TOWER TYPE-"QA" (132kV, WZ-4)							
1	N1MQA1H	L130x130x10H-E350A	3566.00	19.700	4	70.250	281.000
2	N1MQA2LH	L50x50x6H-E350A	165.00	4.500	8	0.743	5.944
3	N1MQA2RH	L50x50x6H-E350A	165.00	4.500	8	0.743	5.944
4	N1MQA3H	L50x50x6H-E350A	220.00	4.500	16	0.990	15.840
						TOTAL WEIGHT :	**308.728**

*** - Item welded with another item

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	01-03-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/PQASC/SQASC/R-0		

Srl No	Section Invloved	Section Weight
STUB & CLEATS FOR TOWER TYPE-"QA" (132kV, WZ-4)		
1	L130x130x10H-E350A	281.000
2	L50x50x6H-E350A	27.728
	Total	308.728

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION

TRANSMISSION LINE DESIGN

MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.

PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Order Ref. -

Drg No. -

BOM No. BOM/LE17D124/PQASB/SQASB/R-0

Date 01-03-2018

Page 1 of 1

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BOLTS & NUTS OF STUB & CLEATS FOR TOWER TYPE-"QA" (132kV, WZ-4)							
1	SQASB1	M16x45MM LONG (IS:12427)		0.134	32	0.134	4.288
2	SQASB2	M16x3.5mm SPR. WSR-IS3063		0.009	32	0.009	.288

TOTAL WEIGHT : 4.576

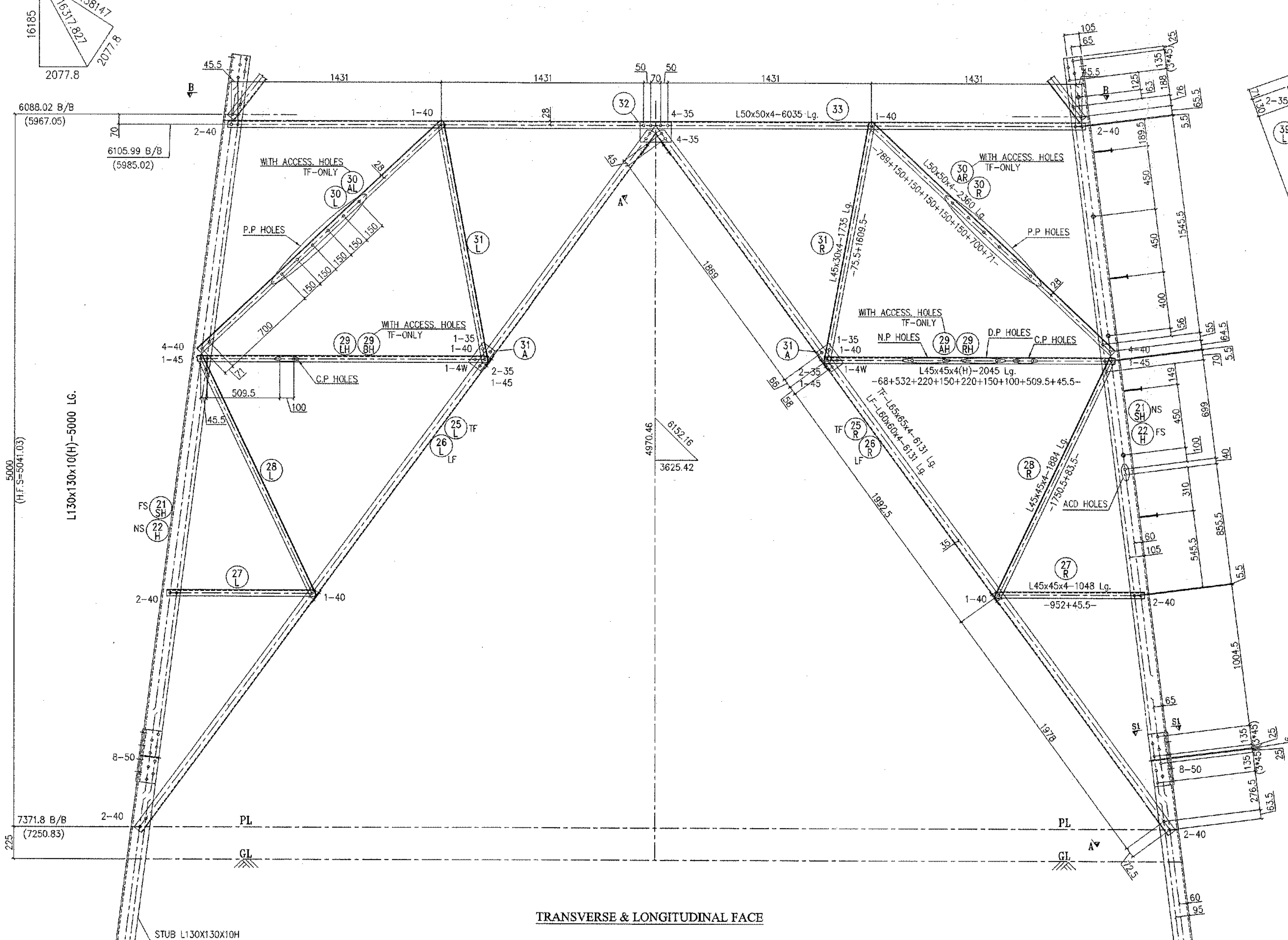
*** - Item welded with another item

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

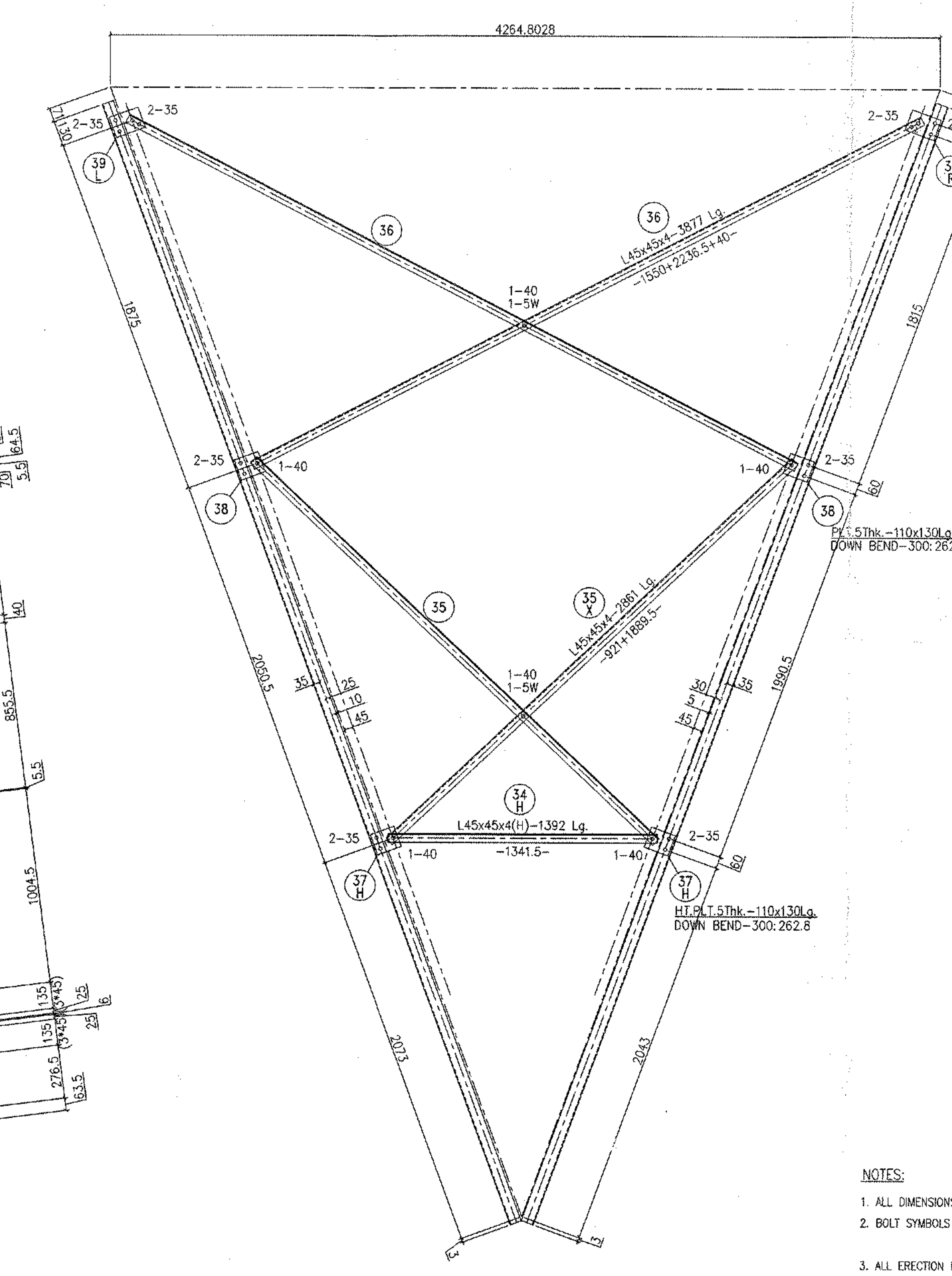
Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	01-03-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/PQASB/SQASB/R-0		

Srl No	Section Invloved	Section Weight
	BOLTS & NUTS OF STUB & CLEATS FOR TOWER TYPE-"QA" (132kV, WZ-4)	
1	M16x3.5mm SPR. WSR-IS3063	.288
2	M16x45MM LONG (IS:12427)	4.288
	Total	4.576

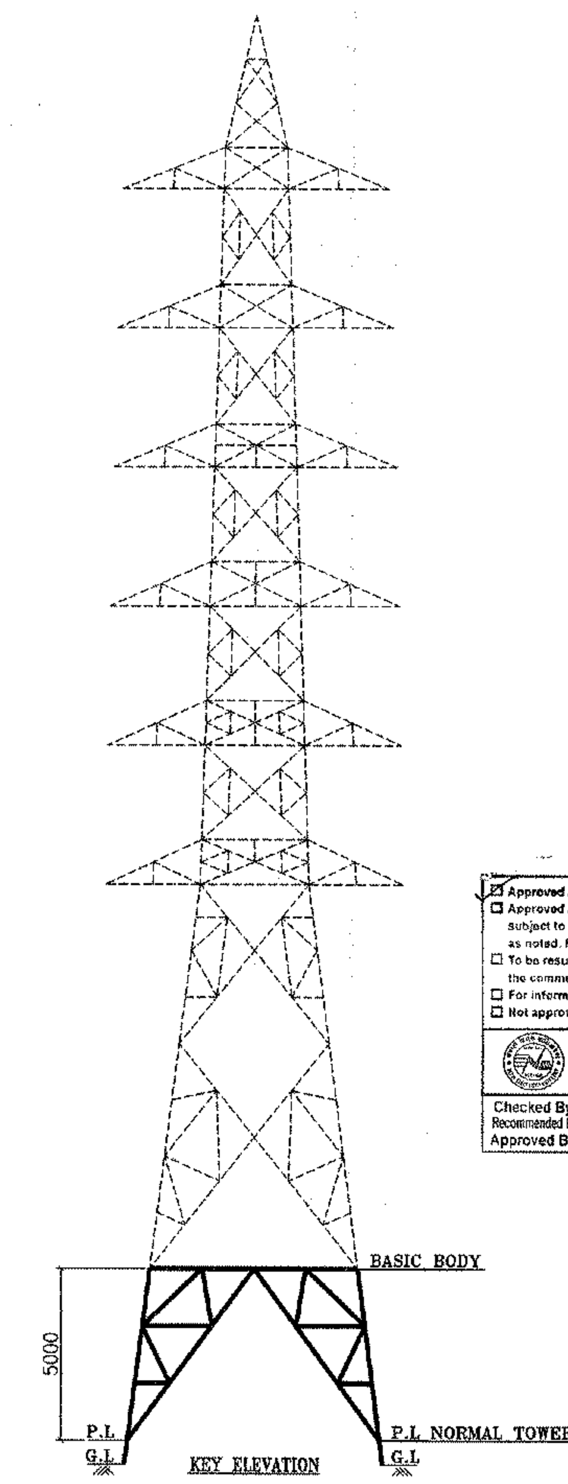
THIS IS PROPRIETARY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH NEPAL ELECTRICITY AUTHORITY(NEA). UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM NEA IN WRITING.



TRANSVERSE & LONGITUDINAL FACE

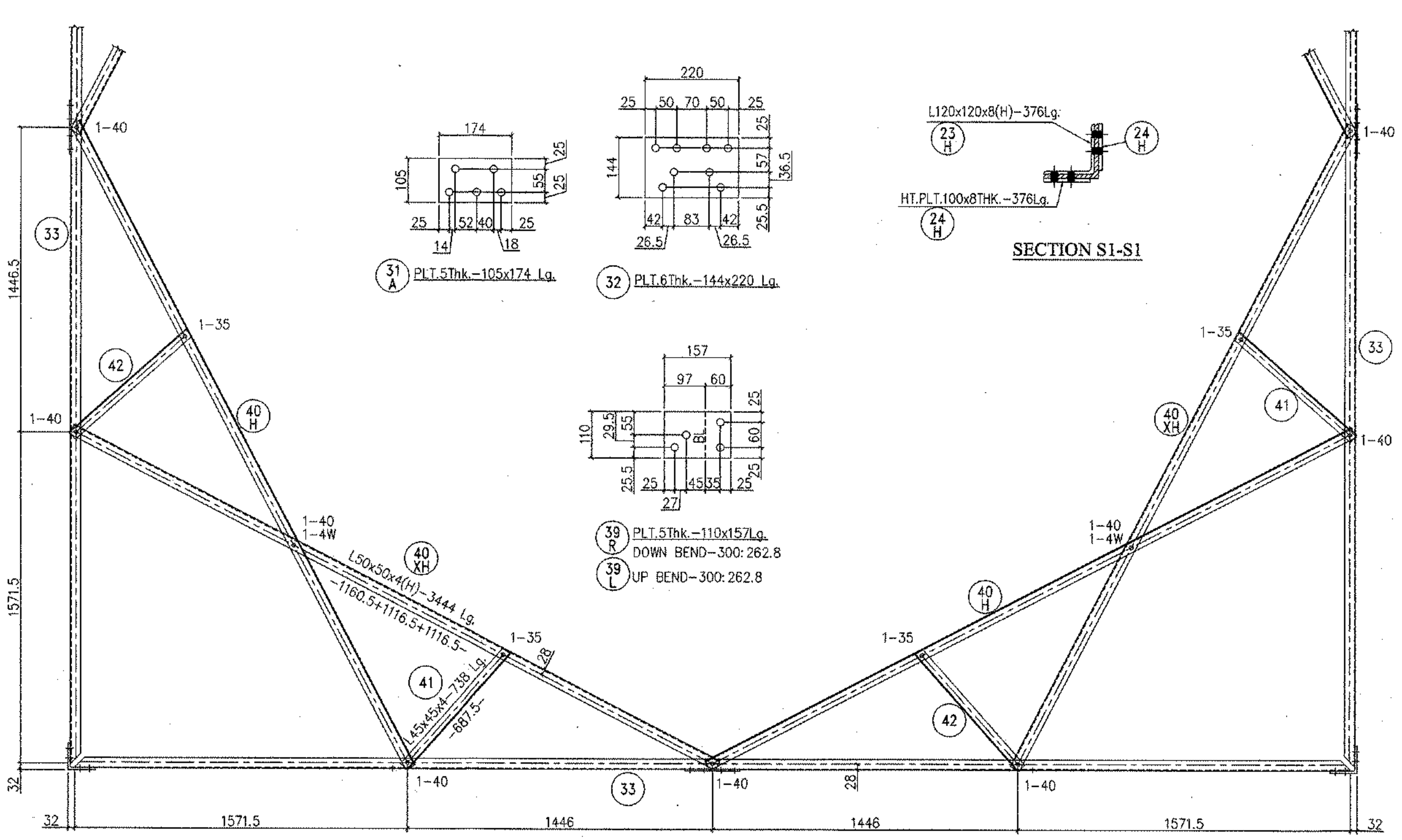


VIEW A-A



KEY ELEVATION

PLAN OF LEGS POSITION



PLT.5Thk.-105x174 Lg.

PLT.6Thk.-144x220 Lg.

PLT.5Thk.-110x157Lg. DOWN BEND-300:262.8 UP BEND-300:262.8

SECTION S1-S1

VIEW B-B

NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. BOLT SYMBOLS 16ø = 17.5ø HOLES
   16ø = 17.5ø HOLES FOR STEP BOLTS
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH "H1MQA"
4. STRUCTURAL STEEL SHALL BE AS PER IS 2062-2011
   (i) MILD STEEL - GRADE E250 QUALITY A - UNLESS OTHERWISE SPECIFIED.
   (ii) "H" STANDS FOR HIGH TENSILE STEEL - GRADE E350 QUALITY A
5. BOLTS & NUTS SHALL CONFORM TO IS : 12427-2001 (R-2007) FOR DIMENSIONS AND IS : 1367 (PART 3)-2002 FOR MECHANICAL PROPERTIES
6. GALVANISING SHALL CONFORM TO IS:2629-1985 (R-2006) & IS:4759-1996 (R-2006)
7. SPRING WASHER SHALL BE CONFORM TO IS 3063-1994 (R-2004)
8. STEP BOLTS SHALL BE PROVIDED ON THE DIAGONALLY OPPOSITE LEGS.

SUCCESSFULLY TESTED AT CPRI - BENGALURU ON 11th OF JANUARY 2019

PART NO. 21 TO 42

CAT-I

REQUIREMENT OF BOLTS, NUTS & WASHERS

SIZE	QTY.	GRADE	REMARKS
16ø x 35mm Lg.	128	5.6	BOLTS & NUTS
16ø x 40mm Lg.	144	5.6	BOLTS & NUTS
16ø x 45mm Lg.	16	5.6	BOLTS & NUTS
16ø x 50mm Lg.	64	5.6	BOLTS & NUTS
16ø x 3.5 THK	352	–	SPRING WASHERS
16ø x 4 THK	12	–	PACK WASHERS
16ø x 5 THK	8	–	PACK WASHERS
16ø x 6 THK	–	–	PACK WASHERS
16ø x 175LG	16	–	STEP BOLTS

DATE	REV.NO.	DESCRIPTION	DESIGNED	CHECKED	DRAWN	CHECKED	APPROVED
28.01.19	1	SUBMISSION AFTER SUCCESSFUL TESTING	PBKR	RJR	ALEX	PU/BSR	CSR
01.03.18	0	FIRST SUBMISSION FOR APPROVAL BEFORE PROTO	PBKR	RJR	BRK/RP	SVR/BSR	CSR

REVISIONS

CLIENT: NEPAL ELECTRICITY AUTHORITY (An Undertaking of Government of Nepal)

CONSULTANT: POWER GRID CORPORATION OF INDIA LTD

CONTRACTOR: L&T Construction Power Transmission & Distribution

PROJECT: TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

JOB No.: O17123-T-TL

TITLE: G.A OF +0M BODY EXTN. FOR TOWER TYPE – "QA (0°-2°)" (132kV M/C LINE, WZ-4)

	NAME	DATE
DSGN	PBKR	29.12.17
DRWN	BRK/RP	24.01.18
CHKD	SVR/BSR	24.01.18
APPD	CSR	24.01.18

SCALE 1 : 20

DRG No. 0 1 7 1 2 3 - T - T L - 4 M - G A - 0 1 0 3

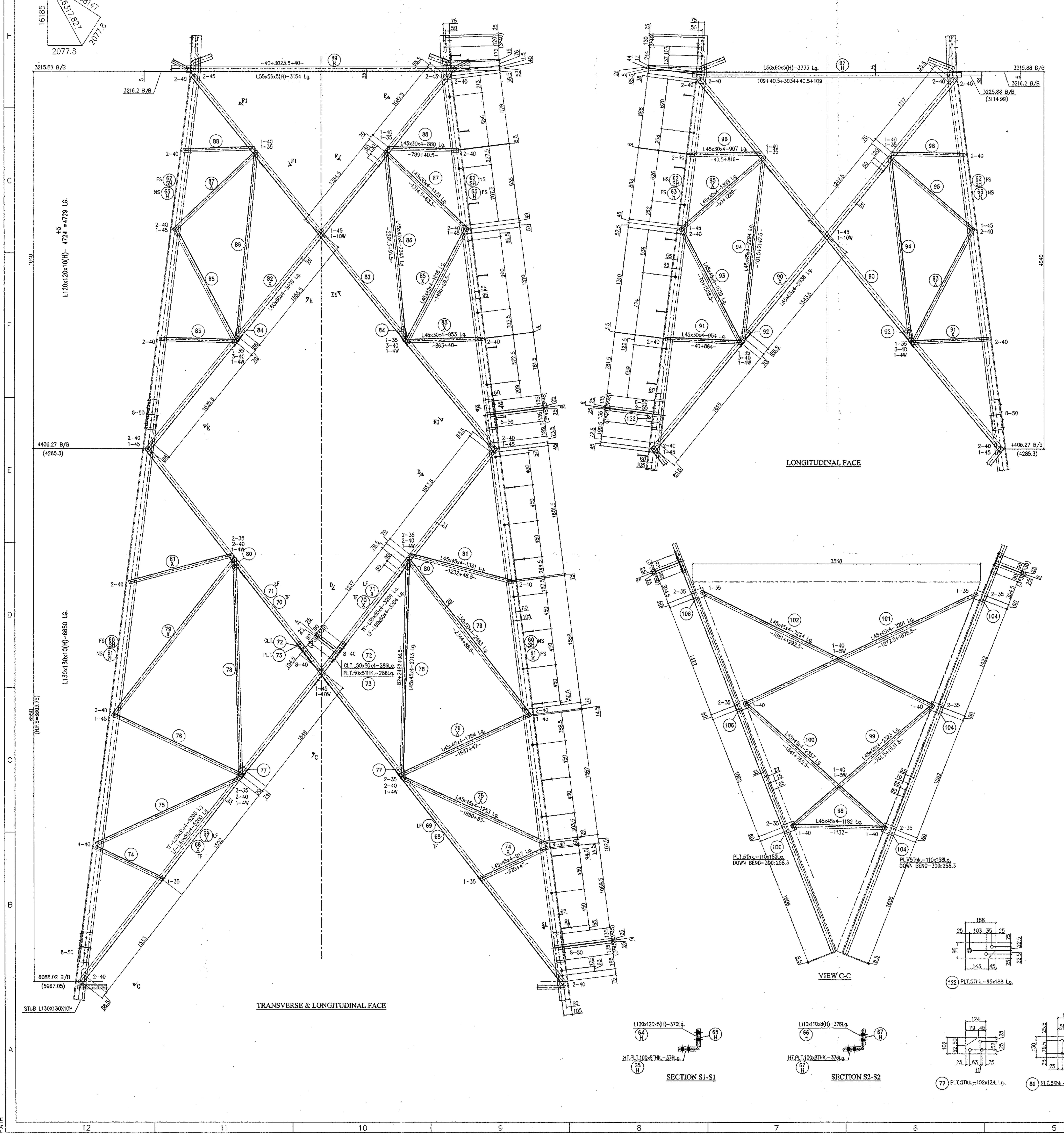
SHEET 01 OF 01 | SIZE A1 | REV. 1

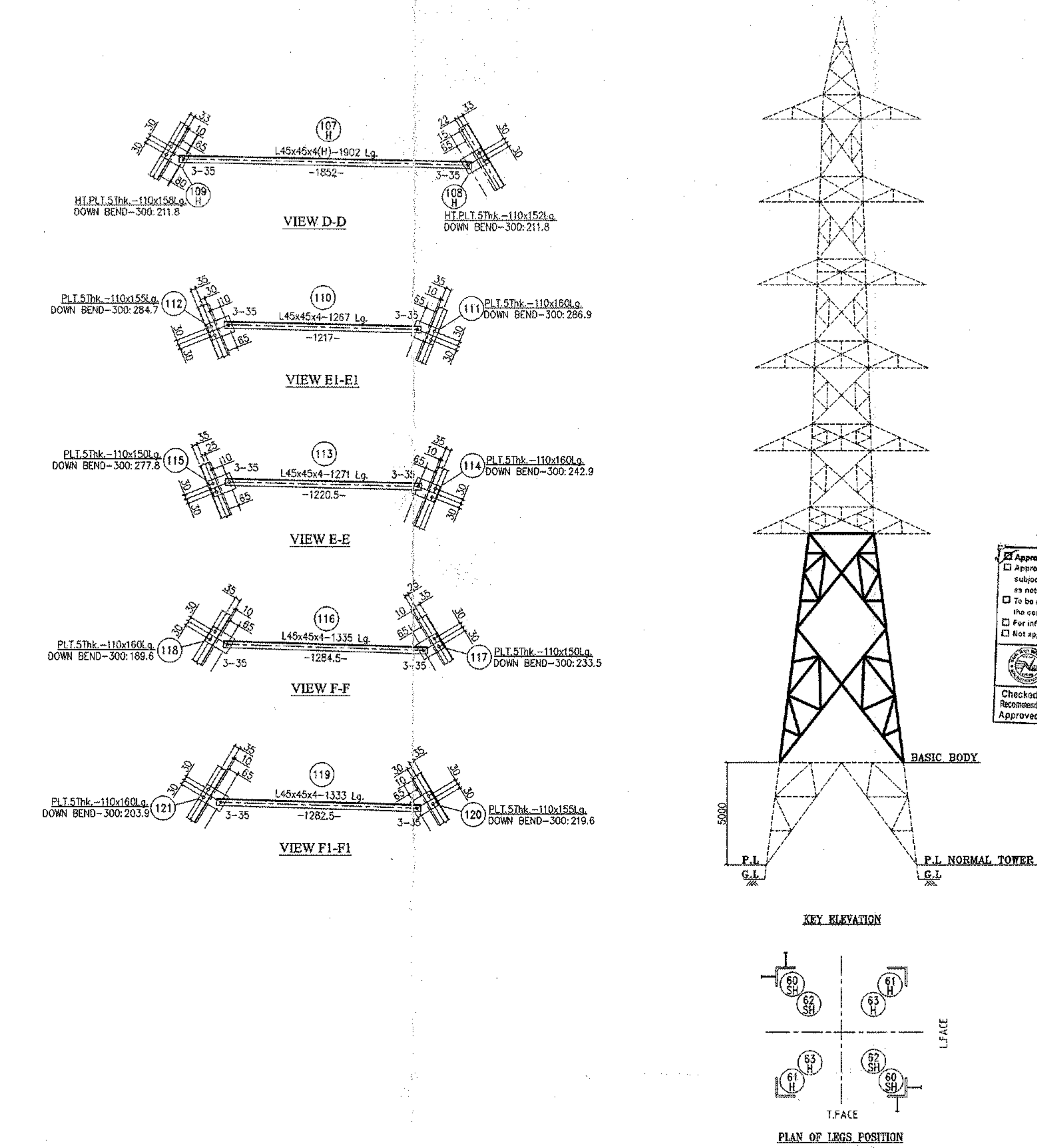
RELEASED FOR: ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

☑ Approved / Released For Fabrication/Construction
☐ Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawing/design required
☐ To be resubmitted for approval after incorporating the comments
☐ For information and record
☐ Not approved

Nepal Electricity Authority Tamakoshi-Kathmandu 220/400 kV Transmission Line Project

Checked By / Recommended By / Approved By / Date: (4-05) 2019





REQUIREMENT OF BOLTS, NUTS & WASHERS			
SIZE	QTY.	GRADE	REMARKS
16ø x 35mm Lg.	184	5.6	BOLTS & NUTS
16ø x 40mm Lg.	320	5.6	BOLTS & NUTS
16ø x 45mm Lg.	40	5.6	BOLTS & NUTS
16ø x 50mm Lg.	124	5.6	BOLTS & NUTS
16ø x 55mm Lg.	4	5.6	BOLTS & NUTS
16ø x 60mm Lg.	–	5.6	BOLTS & NUTS
16ø x 3.5 THK	672	–	SPRING WASHERS
16ø x 4 THK	24	–	PACK WASHERS
16ø x 5 THK	8	–	PACK WASHERS
16ø x 10 THK	8	–	PACK WASHERS
16ø x 175LG	50	–	STEP BOLTS

NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. BOLT SYMBOLS 16ø = 17.5ø HOLES
   16ø = 17.5ø HOLES FOR STEP BOLTS
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH "N1MQA"
4. STRUCTURAL STEEL SHALL BE AS PER IS 2062-2011
   (i) MILD STEEL – GRADE E250 QUALITY A – UNLESS OTHERWISE SPECIFIED.
   (ii) "H" STANDS FOR HIGH TENSILE STEEL – GRADE E350 QUALITY A
5. BOLTS & NUTS SHALL CONFORM TO IS : 12427-2001 (R-2007) FOR DIMENSIONS AND IS : 1367 (PART 3)-2002 FOR MECHANICAL PROPERTIES
6. GALVANISING SHALL CONFORM TO IS:2629-1985 (R-2006) & IS:4759-1996 (R-2006)
7. SPRING WASHER SHALL BE CONFORM TO IS 3063-1994 (R-2004)
8. STEP BOLTS SHALL BE PROVIDED ON THE DIAGONALLY OPPOSITE LEGS.

CAT-I

SUCCESSFULLY TESTED AT
CPRI - BENGALURU
ON 11th OF JANUARY 2019

PART NO. 60 TO 122

PART NO. 103 & 105 NOT USED

DATE	REV.NO.	DESCRIPTION	DESIGNED (STRUCTURAL)	CHECKED (STRUCTURAL)	DRAWN (DETAILING)	CHECKED (DETAILING)	APPROVED
28.01.19	1	SUBMISSION AFTER SUCCESSFUL TESTING	PBKR	RJR	ALEX	PU/BSR	CSR
01.03.18	0	FIRST SUBMISSION FOR APPROVAL BEFORE PROTO	PBKR	RJR	BRK/RP	SVR/BSR	CSR

REVISIONS

CLIENT: **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONSULTANT: **POWER GRID CORPORATION OF INDIA LTD**

CONTRACTOR: **L&T Construction**
Power Transmission & Distribution

PROJECT:
TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

JOB No.: O17123-T-TL

	NAME	DATE
DSGN	PBKR	29.12.17
DRWN	BRK/RP	24.01.18
CHKD	SVR/BSR	24.01.18
APPD	CSR	24.01.18

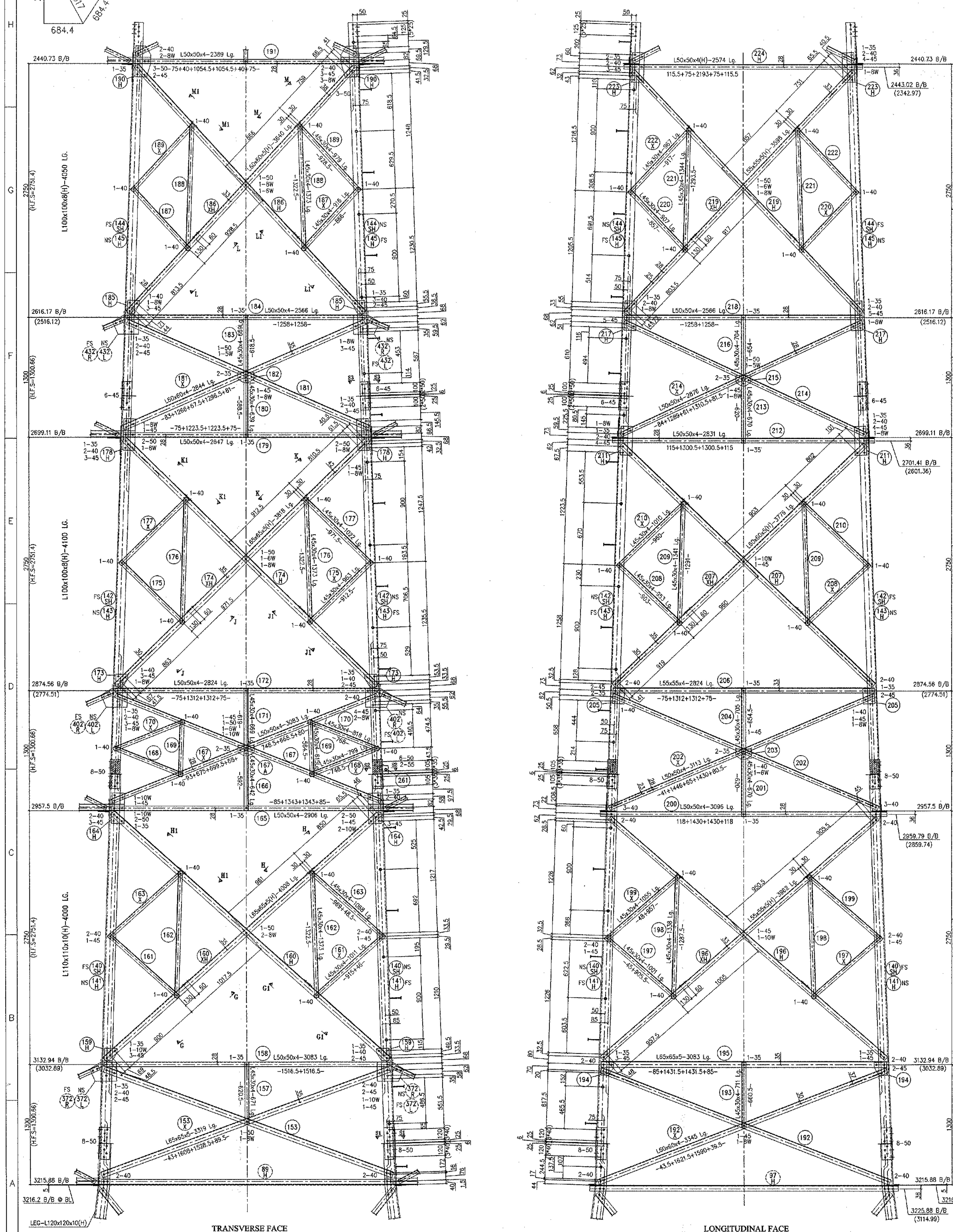
TITLE: G.A OF BODY PART FOR TOWER TYPE –"QA (0°-2°)" (132kV M/C LINE, WZ-4)

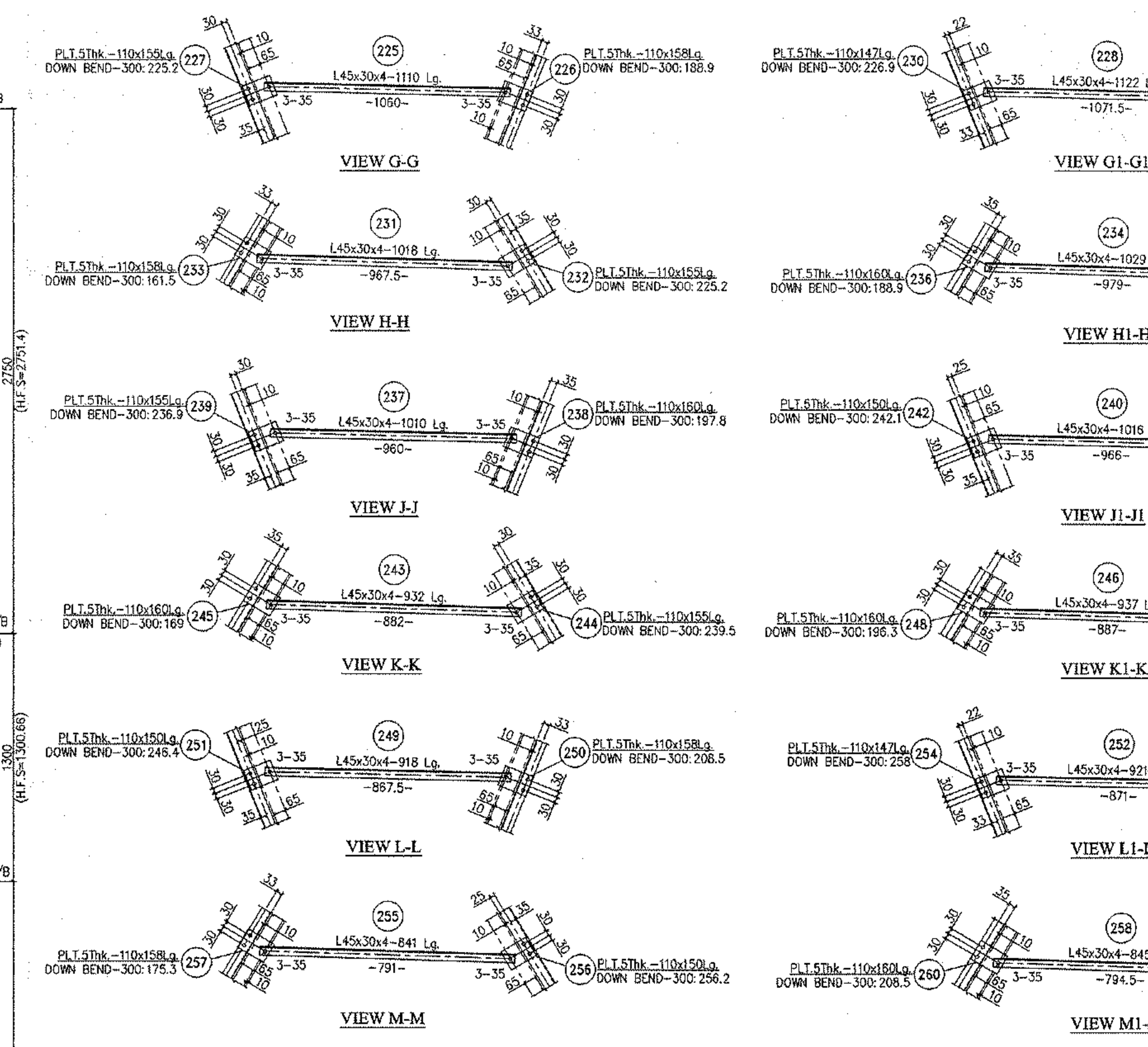
SCALE 1 : 25

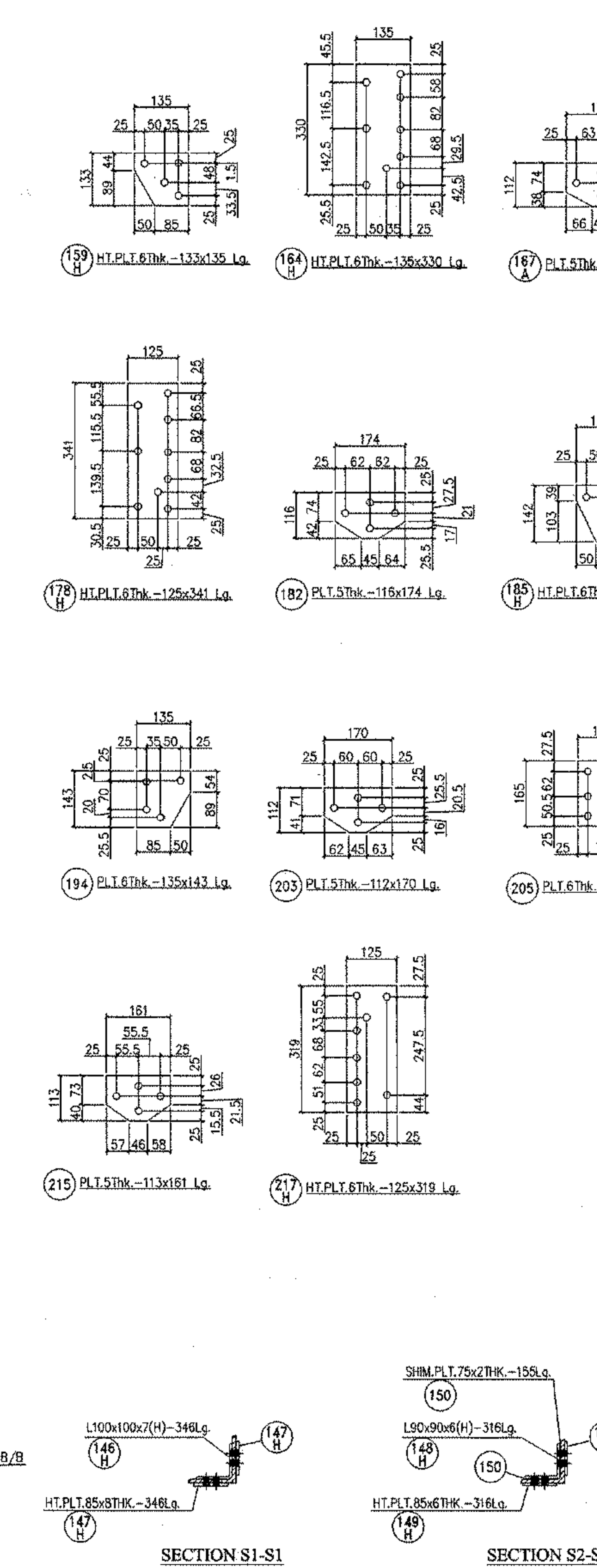
DRG No. 0 1 7 1 2 3 - T - T L - 4 M - G A - 0 1 0 4 — SHEET 01 OF 09 — SIZE A1 — REV. 1

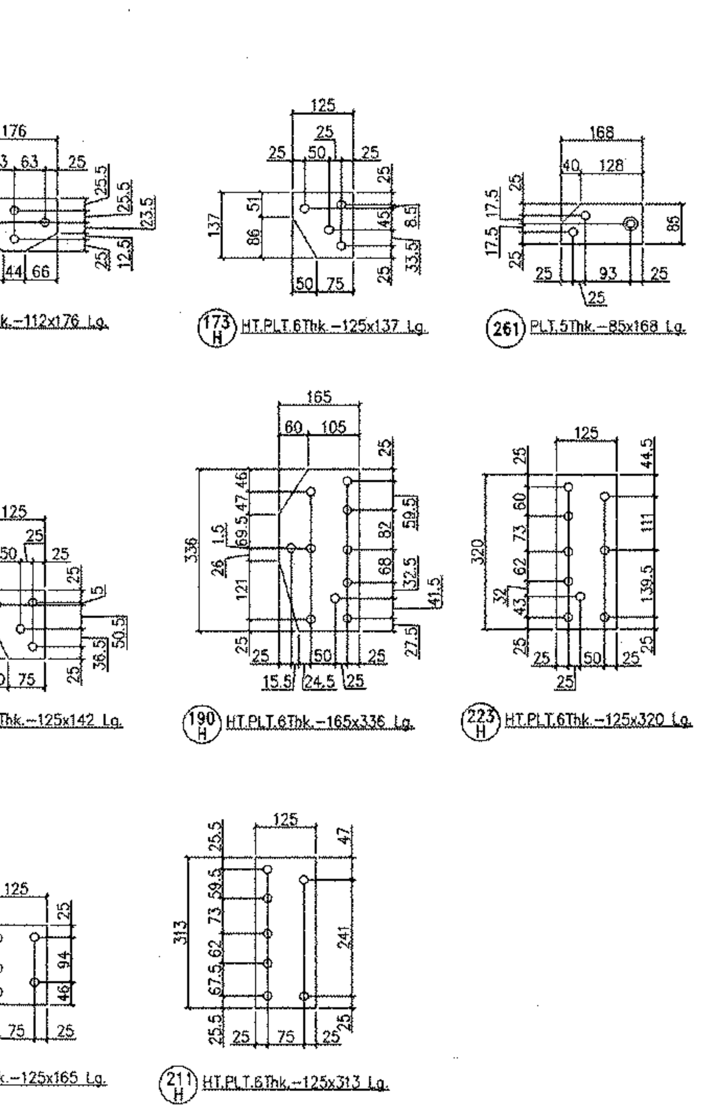
RELEASED FOR ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

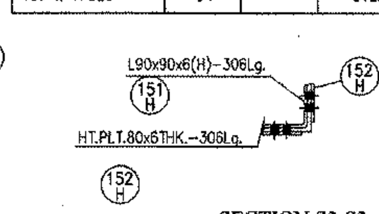
THIS IS PROPRIETARY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH NEPAL ELECTRICITY AUTHORITY(NEA). UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM NEA IN WRITING.



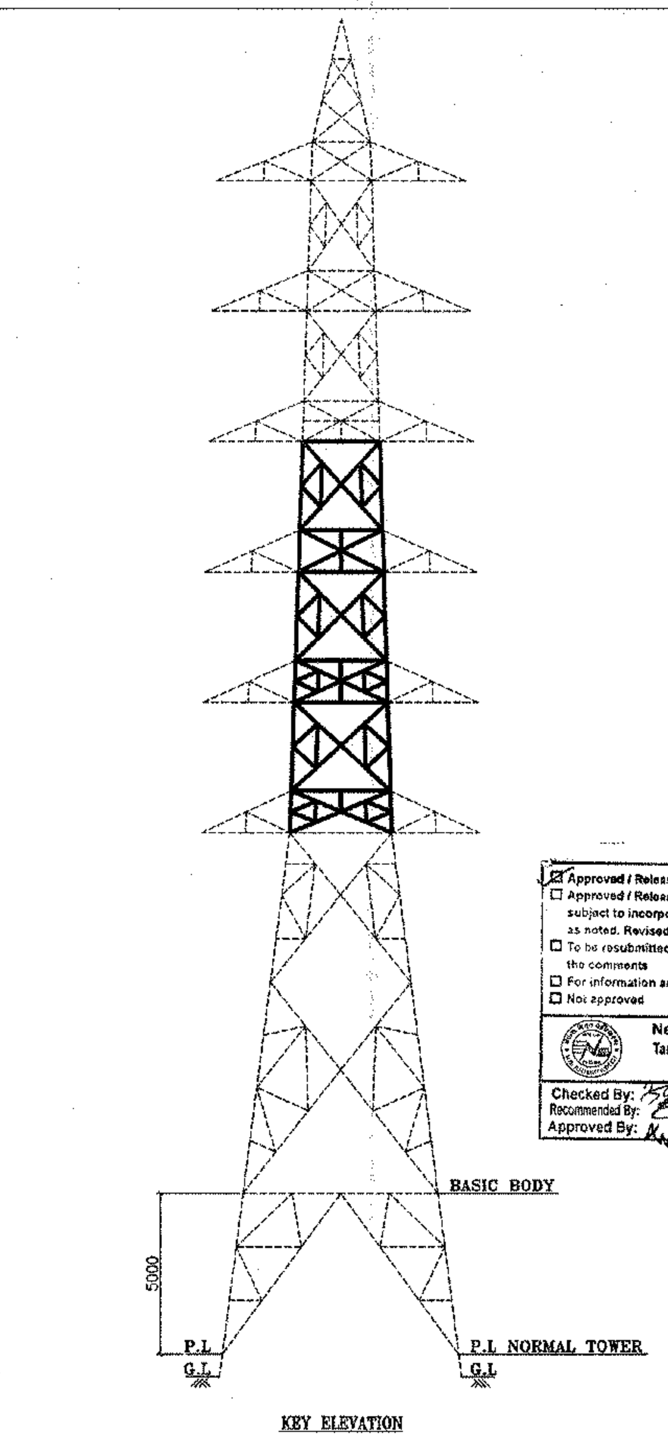


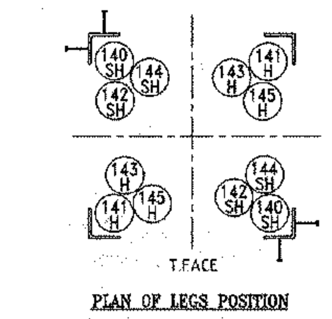






REQUIREMENT OF BOLTS, NUTS & WASHERS			
SIZE	QTY.	GRADE	REMARKS
16ø x 35mm Lg.	228	5.6	BOLTS & NUTS
16ø x 40mm Lg.	232	5.6	BOLTS & NUTS
16ø x 45mm Lg.	248	5.6	BOLTS & NUTS
16ø x 50mm Lg.	168	5.6	BOLTS & NUTS
16ø x 55mm Lg.	4	5.6	BOLTS & NUTS
16ø x 60mm Lg.	–	5.6	BOLTS & NUTS
16ø x 3.5 THK	880	–	SPRING WASHERS
16ø x 4 THK	–	–	PACK WASHERS
16ø x 5 THK	4	–	PACK WASHERS
16ø x 6 THK	10	–	PACK WASHERS
16ø x 8 THK	60	–	PACK WASHERS
16ø x 10 THK	18	–	PACK WASHERS
16ø x 175LG	54	–	STEP BOLTS





NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. BOLT SYMBOLS 16ø = 17.5ø HOLES
   16ø = 17.5ø HOLES FOR STEP BOLTS
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH "N1MQA"
4. STRUCTURAL STEEL SHALL BE AS PER IS 2062–2011
   (i) MILD STEEL – GRADE E250 QUALITY A – UNLESS OTHERWISE SPECIFIED.
   (ii) "H" STANDS FOR HIGH TENSILE STEEL – GRADE E350 QUALITY A
5. BOLTS & NUTS SHALL CONFORM TO IS : 12427–2001 (R–2007) FOR DIMENSIONS AND IS : 1367 (PART 3)–2002 FOR MECHANICAL PROPERTIES
6. GALVANISING SHALL CONFORM TO IS:2629–1985 (R–2006) & IS:4759–1996 (R–2006)
7. SPRING WASHER SHALL BE CONFORM TO IS 3063–1994 (R–2004)
8. STEP BOLTS SHALL BE PROVIDED ON THE DIAGONALLY OPPOSITE LEGS.

CAT-I

SUCCESSFULLY TESTED AT
CPRI - BENGALURU
ON 11th OF JANUARY 2019

PART NO. 140 TO 261

PART NO. 154 TO 156 NOT USED.

28.01.19	1	SUBMISSION AFTER SUCCESSFUL TESTING	PBKR	RJR	ALEX	PU/BSR	CSR
01.03.18	0	FIRST SUBMISSION FOR APPROVAL BEFORE PROTO	PBKR	RJR	BRK/RP	SVR/BSR	CSR
DATE	REV.NO.	DESCRIPTION	DESIGNED (STRUCTURAL)	CHECKED (STRUCTURAL)	DRAWN (DETAILING)	CHECKED (DETAILING)	APPROVED

REVISIONS

CLIENT: **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONSULTANT: **POWER GRID CORPORATION OF INDIA LTD**

CONTRACTOR: **L&T Construction**
Power Transmission & Distribution

PROJECT:
TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

JOB No.: O17123-T-TL

	NAME	DATE
DSGN	PBKR	29.12.17
DRWN	BRK/RP	02.02.18
CHKD	SVR/BSR	02.02.18
APPD	CSR	02.02.18

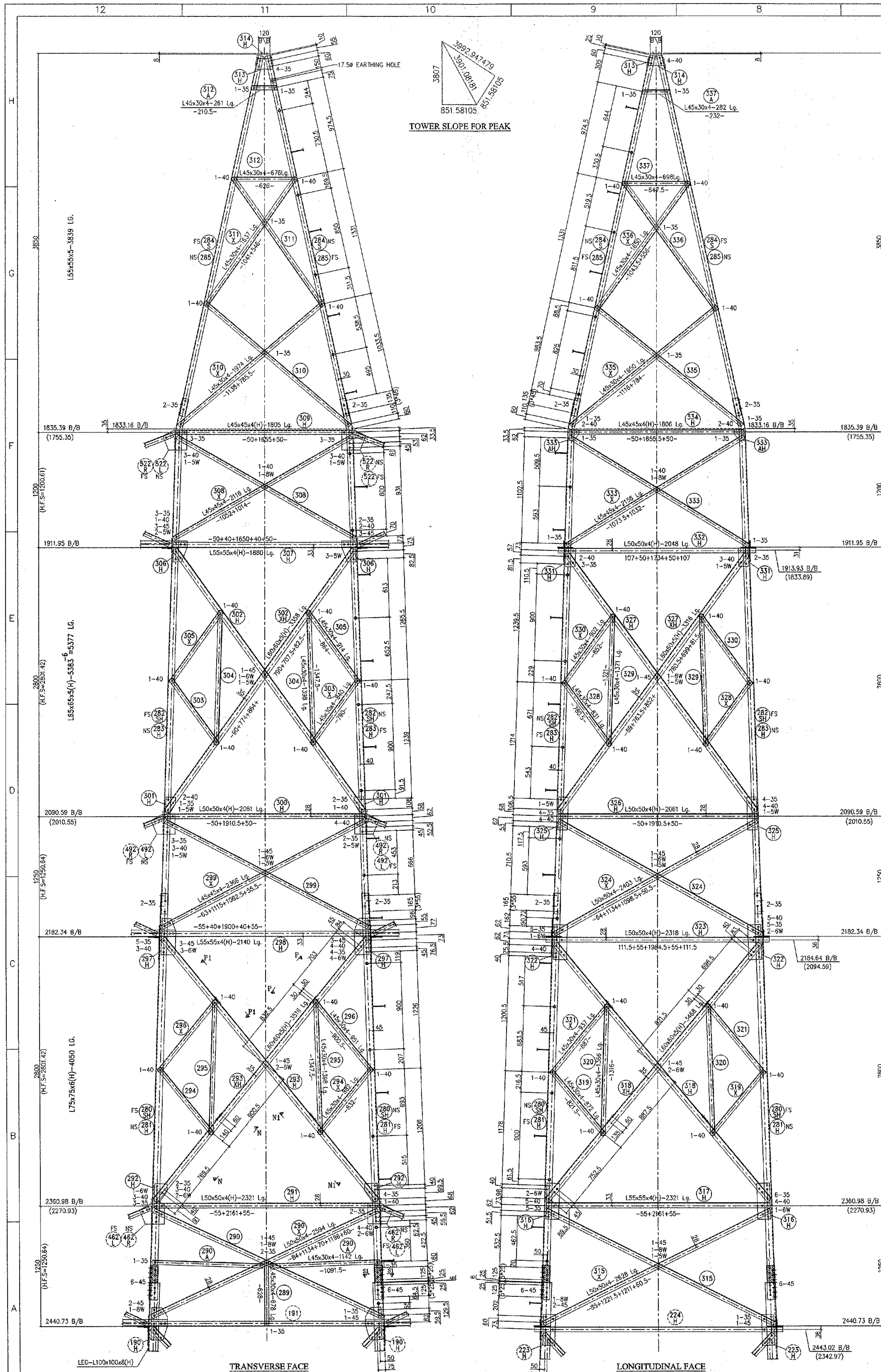
TITLE: G.A OF CAGE PART-1
FOR TOWER TYPE – "QA (0°–2°)"
(132kV M/C LINE, WZ-4)

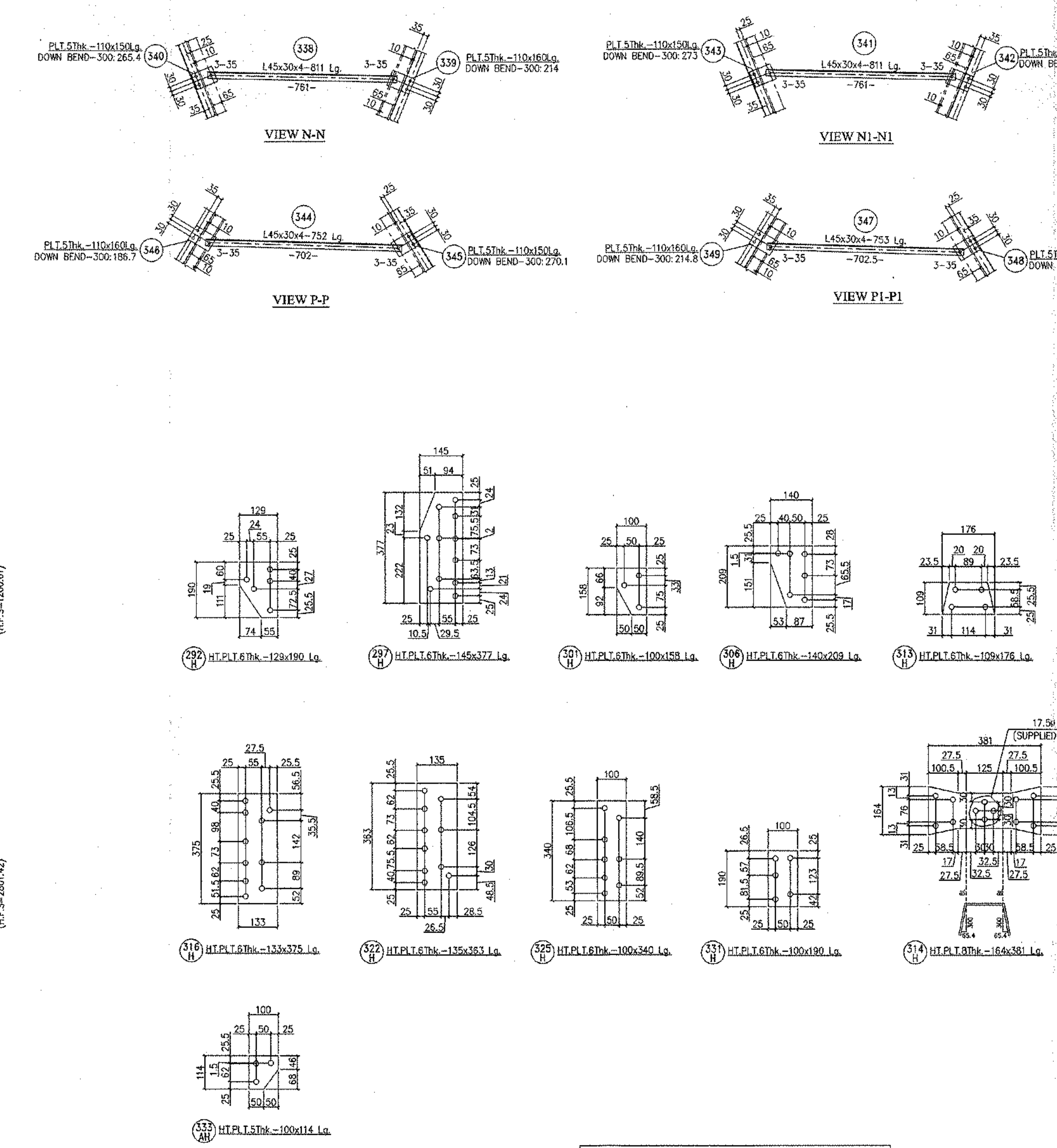
SCALE 1 : 25

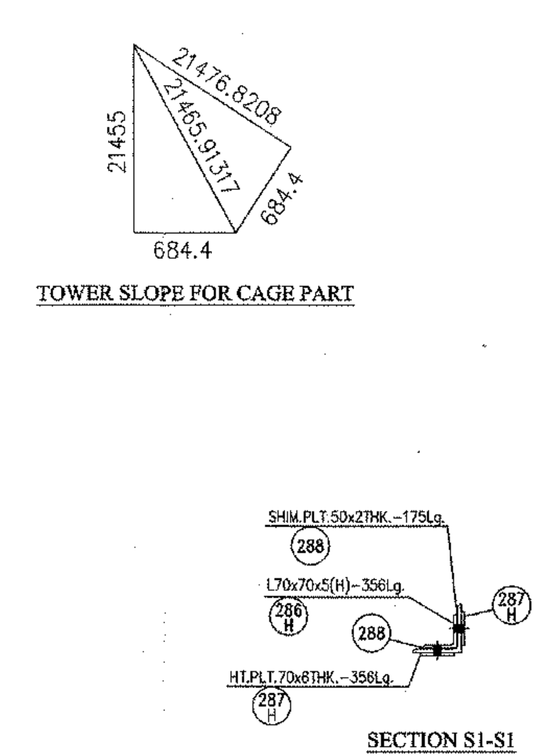
DRG No. O17123-T-TL-4M-GA-0104 SHEET 02 OF 09 | SIZE A1 | REV. 1

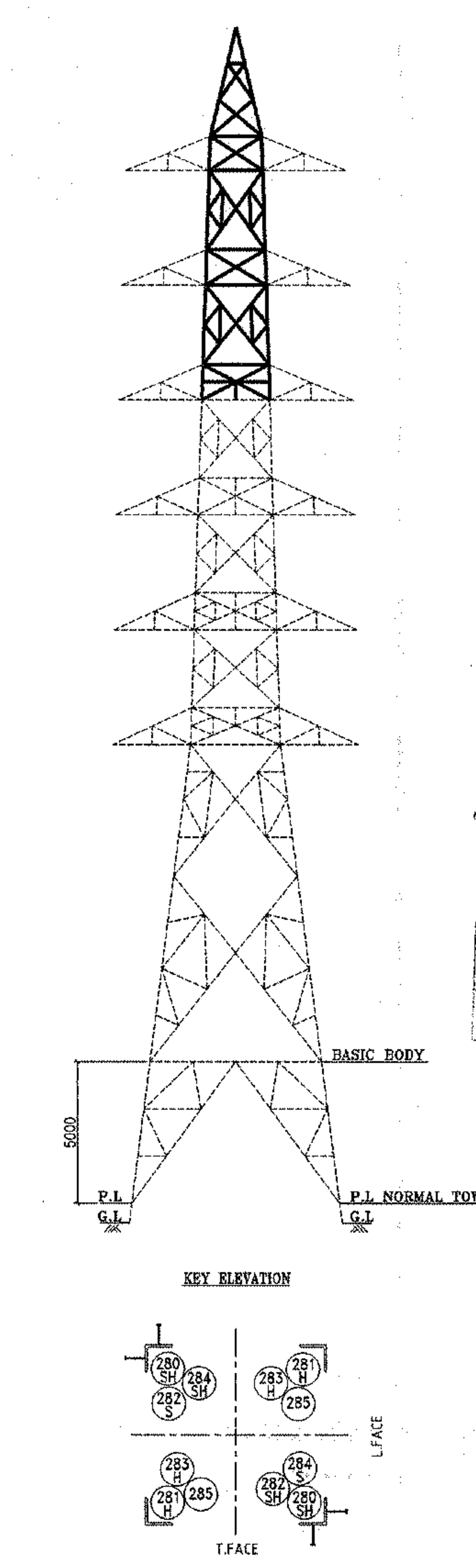
RELEASED FOR ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

THIS IS PROPRIETARY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH NEPAL ELECTRICITY AUTHORITY(NEA). UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM NEA IN WRITING.









REQUIREMENT OF BOLTS, NUTS & WASHERS			
SIZE	QTY.	GRADE	REMARKS
16ø x 35mm Lg.	278	5.6	BOLTS & NUTS
16ø x 40mm Lg.	220	5.6	BOLTS & NUTS
16ø x 45mm Lg.	100	5.6	BOLTS & NUTS
16ø x 50mm Lg.	-	5.6	BOLTS & NUTS
16ø x 3.5 THK	598	-	SPRING WASHERS
16ø x 4 THK	-	-	PACK WASHERS
16ø x 5 THK	38	-	PACK WASHERS
16ø x 6 THK	52	-	PACK WASHERS
16ø x 8 THK	12	-	PACK WASHERS
16ø x 10 THK	-	-	PACK WASHERS
16ø x 175LG	56	-	STEP BOLTS

NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. BOLT SYMBOLS 16ø = 17.5ø HOLES
   16ø = 17.5ø HOLES FOR STEP BOLTS
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH "N1MQA"
4. STRUCTURAL STEEL SHALL BE AS PER IS 2062-2011
   (i) MILD STEEL - GRADE E250 QUALITY A - UNLESS OTHERWISE SPECIFIED.
   (ii) "H" STANDS FOR HIGH TENSILE STEEL - GRADE E350 QUALITY A
5. BOLTS & NUTS SHALL CONFORM TO IS : 12427-2001 (R-2007) FOR DIMENSIONS AND IS : 1367 (PART 3)-2002 FOR MECHANICAL PROPERTIES
6. GALVANISING SHALL CONFORM TO IS:2629-1985 (R-2006) & IS:4759-1996 (R-2006)
7. SPRING WASHER SHALL BE CONFORM TO IS 3063-1994 (R-2004)
8. STEP BOLTS SHALL BE PROVIDED ON THE DIAGONALLY OPPOSITE LEGS.

CAT-I

SUCCESSFULLY TESTED AT CPRI - BENGALURU ON 11th OF JANUARY 2019

PART NO. 280 TO 349

DATE	REV.NO.	DESCRIPTION	DESIGNED (STRUCTURAL)	CHECKED (STRUCTURAL)	DRAWN (DETAILING)	CHECKED (DETAILING)	APPROVED
28.01.19	1	SUBMISSION AFTER SUCCESSFUL TESTING	PBKR	RJR	ALEX	PU/BSR	CSR
01.03.18	0	FIRST SUBMISSION FOR APPROVAL BEFORE PROTO	PBKR	RJR	BRK/RP	SVR/BSR	CSR

REVISIONS

CLIENT: **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONSULTANT: **POWER GRID CORPORATION OF INDIA LTD**

CONTRACTOR: **L&T Construction**
Power Transmission & Distribution

PROJECT: **TAMAKOSHI - KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE**

JOB No.: O17123-T-TL

TITLE: G.A OF CAGE PART-2 & PEAK FOR TOWER TYPE - "QA (0°-2°)" (132kV M/C LINE, WZ-4)

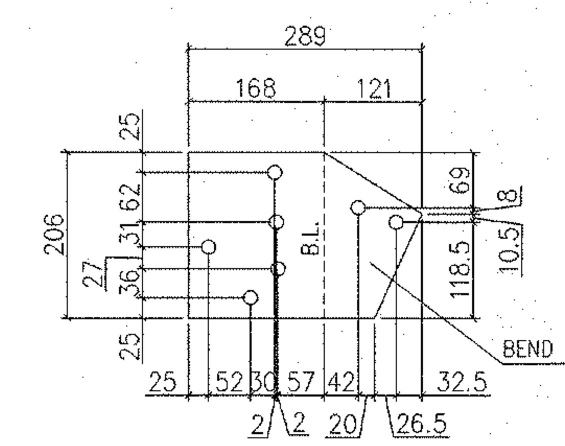
	NAME	DATE
DSGN	PBKR	29.12.17
DRWN	BRK/RP	02.02.18
CHKD	SVR/BSR	02.02.18
APPD	CSR	02.02.18

SCALE 1 : 25

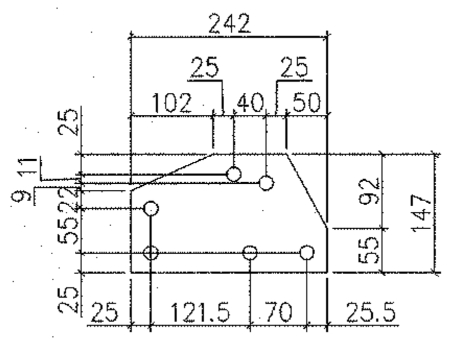
DRG No. O 1 7 1 2 3 - T - T L - 4 M - G A - 0 1 0 4
SHEET 03 OF 09
SIZE A1 REV. 1

RELEASED FOR ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

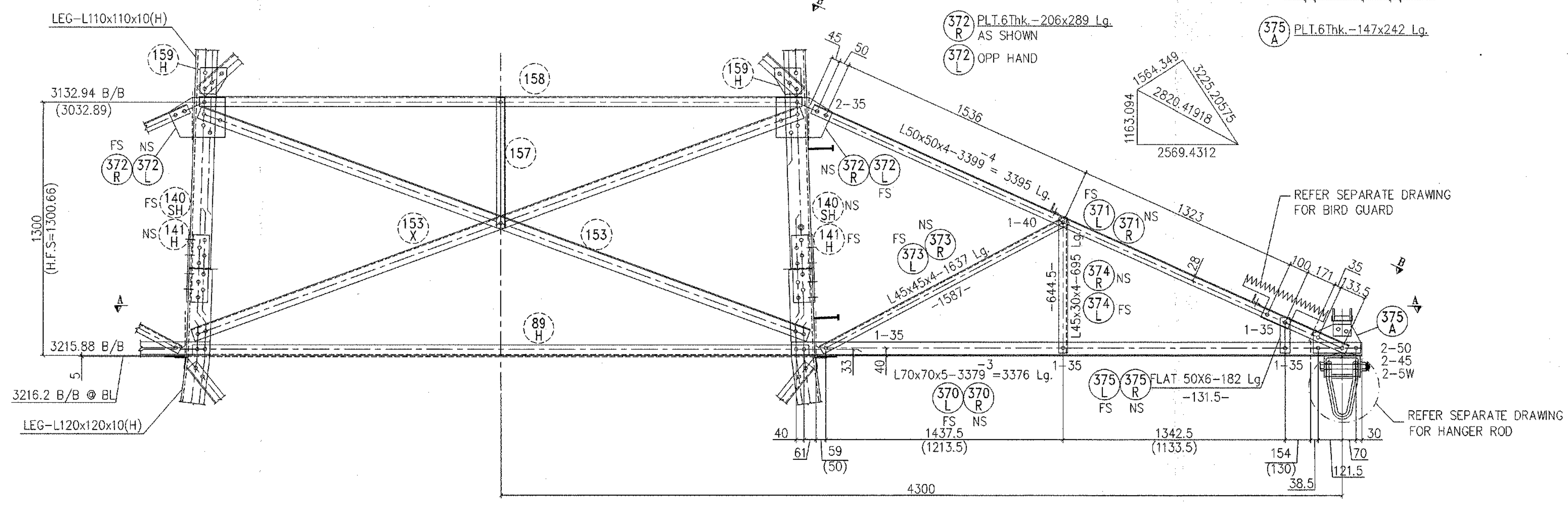
THIS IS PROPRIETARY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH NEPAL ELECTRICITY AUTHORITY(NEA). UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM NEA IN WRITING.



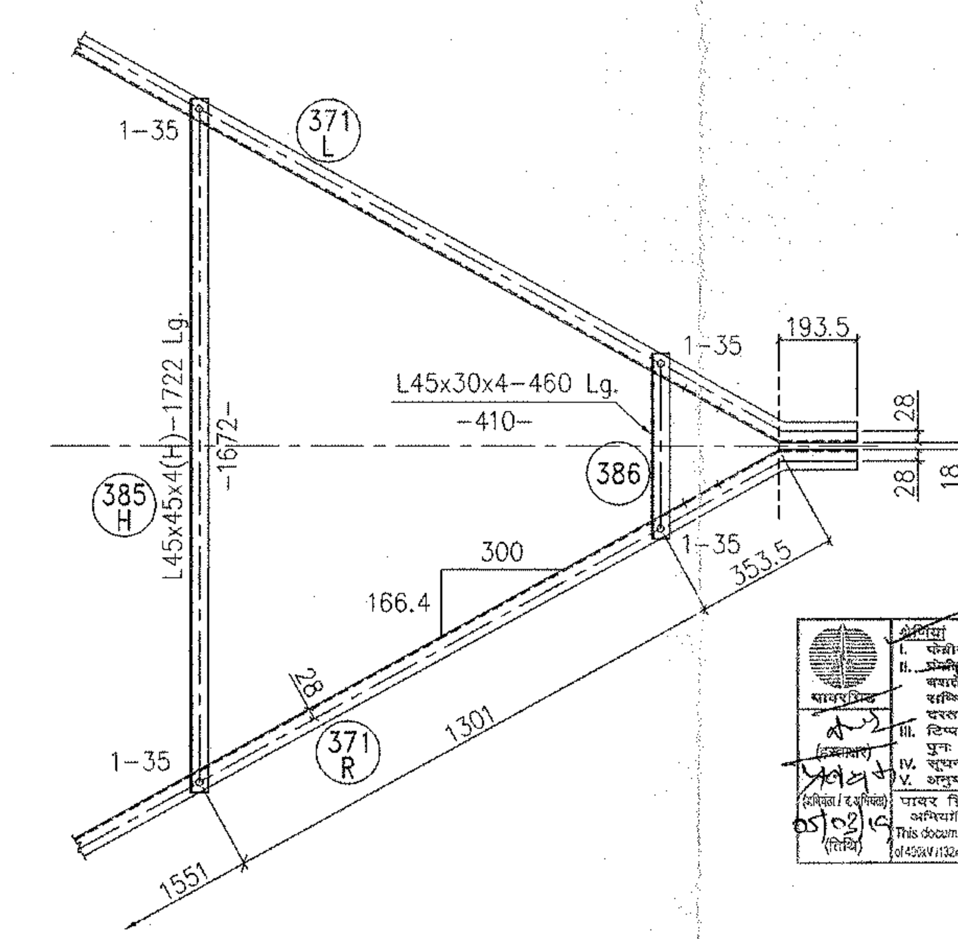
372 R PLT.6Thk.–206x289 Lg. AS SHOWN
372 L OPP HAND



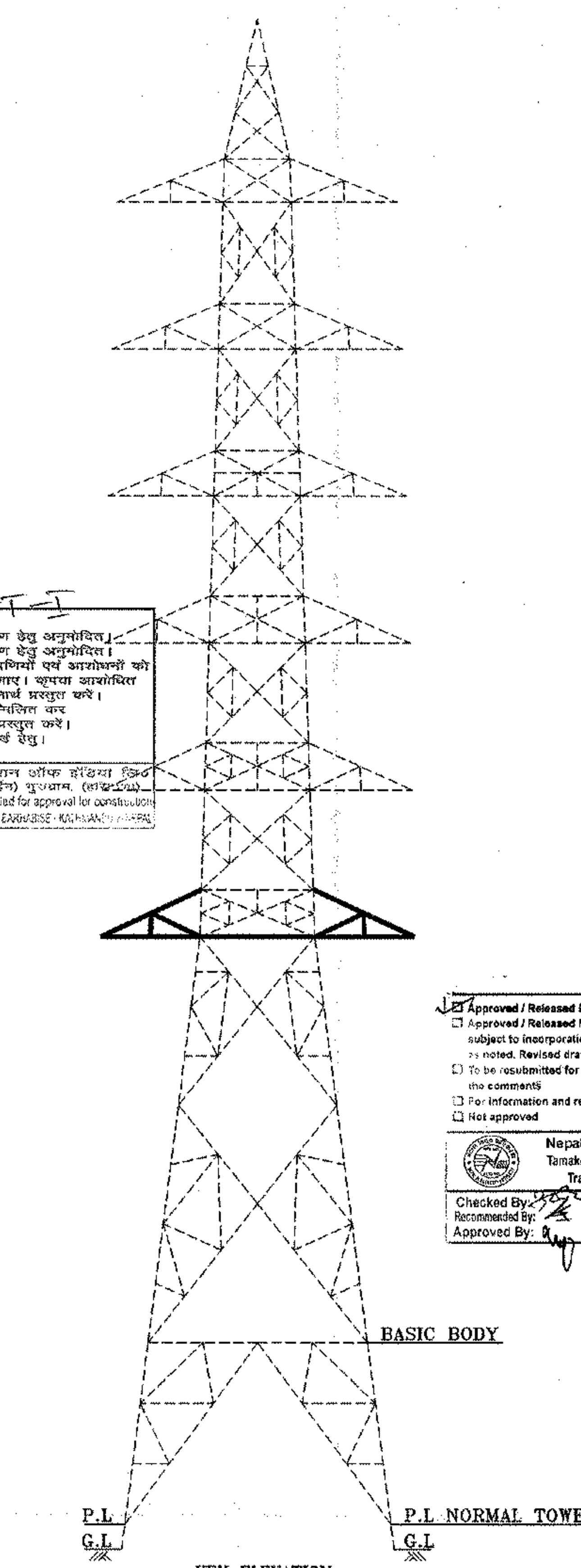
375 A PLT.6Thk.–147x242 Lg.



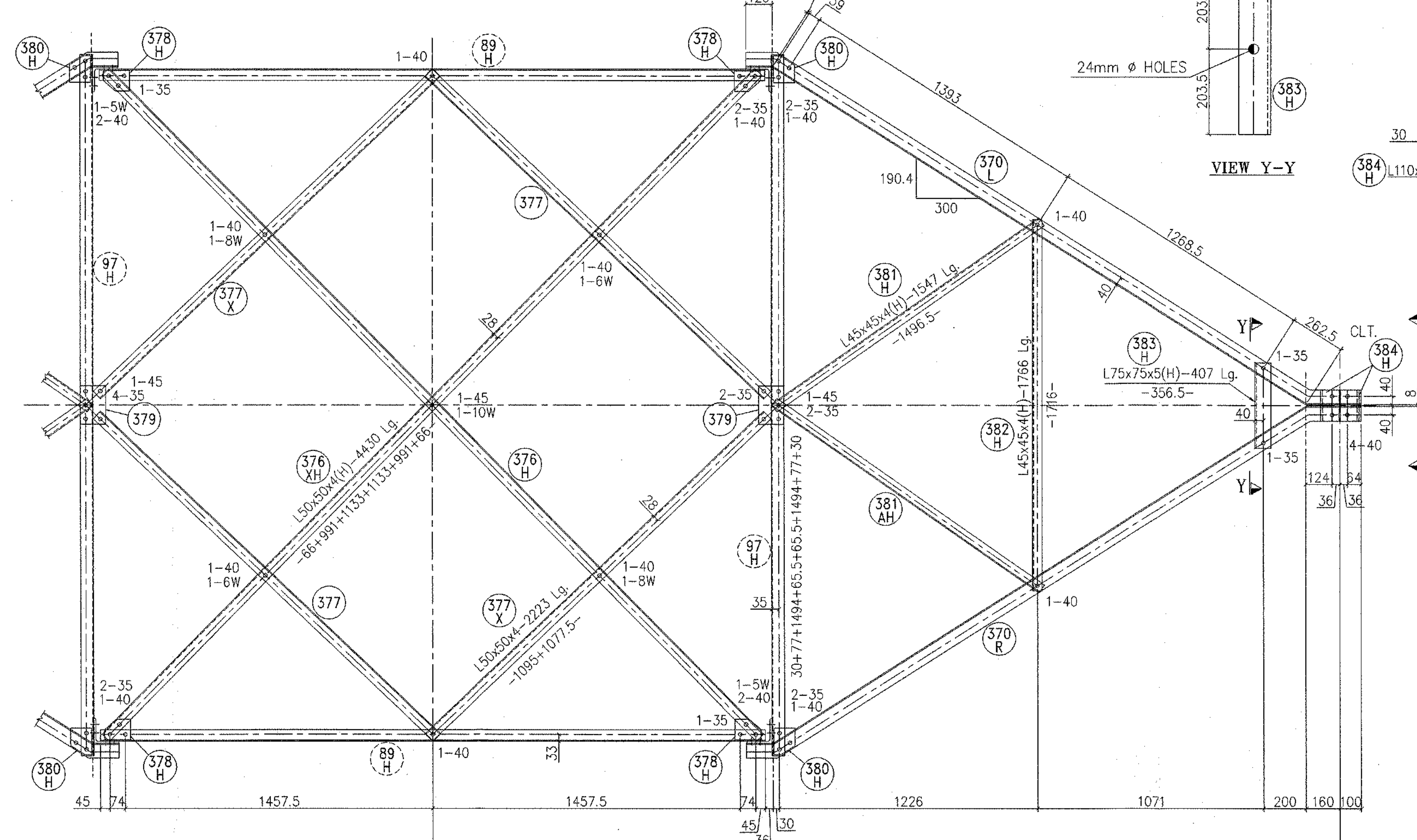
ELEVATION OF CROSS ARM-1



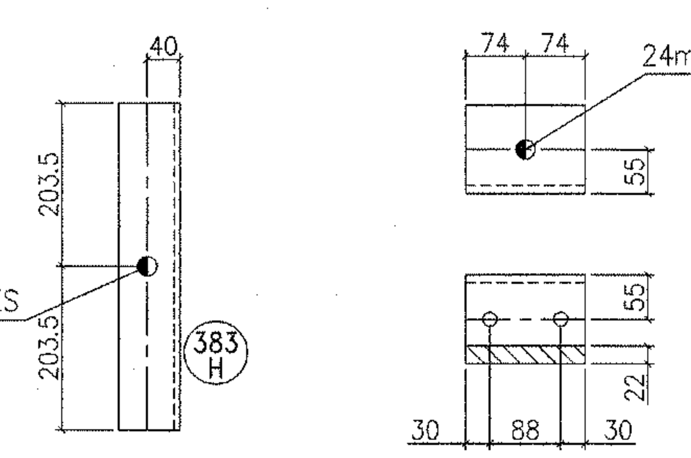
TOP PLAN OF CROSS ARM-1
(VIEW B-B)



KEY ELEVATION

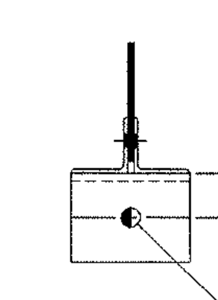


BOTTOM PLAN OF CROSS ARM-1
(VIEW A-A)

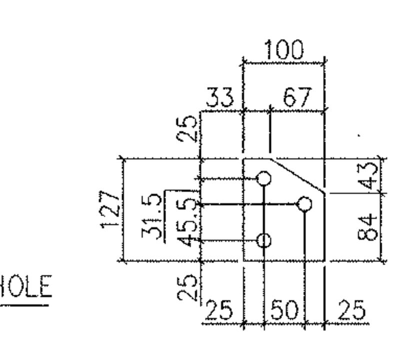


VIEW Y–Y

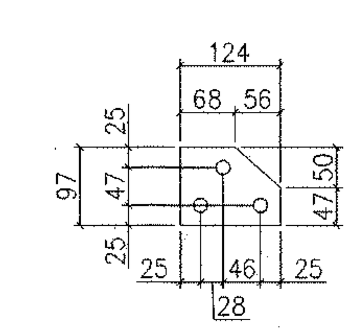
384 H L110x110x10(H)–148 Lg.



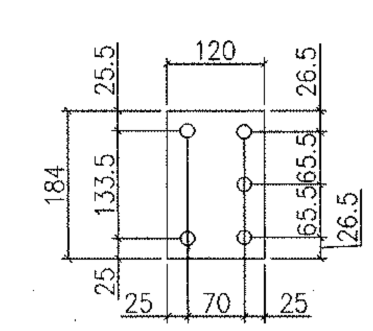
VIEW X–X



380 H HT.PLT.6Thk.–100x127 Lg.



378 H HT.PLT.5Thk.–97x124 Lg.



379 PLT.5Thk.–120x184 Lg.

REQUIREMENT OF BOLTS, NUTS & WASHERS			
SIZE	QTY.	GRADE	REMARKS
16ø x 35mm Lg.	58	5.6	BOLTS & NUTS
16ø x 40mm Lg.	32	5.6	BOLTS & NUTS
16ø x 45mm Lg.	7	5.6	BOLTS & NUTS
16ø x 50mm Lg.	4	5.6	BOLTS & NUTS
16ø x 55mm Lg.	–	5.6	BOLTS & NUTS
16ø x 3.5 THK	101	–	SPRING WASHERS
16ø x 4 THK	–	–	PACK WASHERS
16ø x 5 THK	6	–	PACK WASHERS
16ø x 6 THK	2	–	PACK WASHERS
16ø x 8 THK	2	–	PACK WASHERS
16ø x 10 THK	1	–	PACK WASHERS
16ø x 175LG	–	–	STEP BOLTS

NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. BOLT SYMBOLS 16ø = 17.5ø HOLES
   16ø = 17.5ø HOLES FOR STEP BOLTS
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH "N1MQA"
4. STRUCTURAL STEEL SHALL BE AS PER IS 2062–2011
   (i) MILD STEEL – GRADE E250 QUALITY A – UNLESS OTHERWISE SPECIFIED.
   (ii) "H" STANDS FOR HIGH TENSILE STEEL – GRADE E350 QUALITY A
5. BOLTS & NUTS SHALL CONFORM TO IS : 12427–2001 (R–2007) FOR DIMENSIONS AND IS : 1367 (PART 3)–2002 FOR MECHANICAL PROPERTIES
6. GALVANISING SHALL CONFORM TO IS:2629–1985 (R–2006) & IS:4759–1996 (R–2006)
7. SPRING WASHER SHALL BE CONFORM TO IS 3063–1994 (R–2004)
8. STEP BOLTS SHALL BE PROVIDED ON THE DIAGONALLY OPPOSITE LEGS.

SUCCESSFULLY TESTED AT CPRI - BENGALURU ON 11th OF JANUARY 2019

PART NO. 370 TO 386

DATE	REV.NO.	DESCRIPTION	DESIGNED (STRUCTURAL)	CHECKED (STRUCTURAL)	DRAWN (DETAILING)	CHECKED (DETAILING)	APPROVED
28.01.19	1	SUBMISSION AFTER SUCCESSFUL TESTING	PBKR	RJR	ALEX	PU/BSR	CSR
01.03.18	0	FIRST SUBMISSION FOR APPROVAL BEFORE PROTO	PBKR	RJR	MR/RP	SVR/BSR	CSR

REVISIONS

CLIENT: **NEPAL ELECTRICITY AUTHORITY** (An Undertaking of Government of Nepal)

CONSULTANT: **POWER GRID CORPORATION OF INDIA LTD**

CONTRACTOR: **L&T Construction** Power Transmission & Distribution

PROJECT: **TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE**

JOB No.: O17123-T-TL

	NAME	DATE
DSGN	PBKR	29.12.17
DRWN	MR/RP	03.02.18
CHKD	SVR/BSR	03.02.18
APPD	CSR	03.02.18

TITLE: G.A OF CROSS ARM-1 FOR TOWER TYPE – "QA (0°-2°)" (132kV M/C LINE, WZ-4)

SCALE 1 : 15

DRG No. 0 1 7 1 2 3 - T - T L - 4 M - G A - 0 1 0 4 SHEET 04 OF 09 SIZE A1 REV. 1

RELEASED FOR ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

TOWER DESIGN QD TYPE

THIS IS PROPRIETORY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH NEPAL ELECTRICITY AUTHORITY (NEA), UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM NEA IN WRITING

☑ Approved / Released For Fabrication/Construction
☐ Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
☐ To be resubmitted for approval after incorporating the comments
☐ For information and record CAT I
☐ Not approved

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kv Transmission Line Project

Checked By: Date: 4/7/018
Recommended By: Date: 4/7/018
Approved By: Date:

पावरग्रिड
(हस्ताक्षर)
(अभि./व. अभि.)
20/6/18
(तिथि)

श्रेणियाँ CAT 1
I. फेब्रीकेशन / निर्माण हेतु अनुमोदित।
II. फेब्रीकेशन / निर्माण हेतु अनुमोदित। बशर्ते दी गई टिप्पणियों एवं आशोधनों को सम्मिलित किया जाए। कृपया आशोधित दस्तावेज अनुमोदनार्थ प्रस्तुत करें।
III. टिप्पणियों को सम्मिलित कर पुनः अनुमोदनार्थ प्रस्तुत करें।
IV. सूचनार्थ एवं रिकार्ड हेतु।
V. अनुमोदित नहीं।
पावर ग्रिड कारपोरेशन ऑफ इंडिया लि० अभियांत्रिकी (पारे.लाईन) गुरुग्राम, (हरियाणा)
This document is recommended for approval for construction of 400KV /132KV D/C TAMAKOSHI - BARHABISE - KATHMANDU in NEPAL

DATE	REV.	DESCRIPTION	DESIGNED	CHECKED	APPROVED
19.03.2018	0	First submission for Approval	MDJ	RJR	CSR

REVISIONS

CLIENT: **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONTRACTOR: **L&T CONSTRUCTION**
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT: **TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)**

JOB No. **O17123-T-TL**

TOTAL NO. OF PAGES: 18

	NAME	DATE
DSGN	MDJ	19.03.2018
CHKD	RJR	19.03.2018
APPD	CSR	19.03.2018

TITLE:

FOUNDATION DESIGN & DRAWING OF TOWER TYPE "QD/DE" +0M BE WET SOIL (DEPTH=3M) (132kV D/C BEAR) (WIND ZONE - 4)

DOC. No. O 1 7 1 2 3 - T - T L - 4 M - D C - 4 0 0 18 | CODE IS | REV. 0

RELEASED FOR: ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No**		**Date**
		O17123-T-TL-4M-DC-4001B		19.03.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE "QD/DE" +0M BE WET SOIL (DEPTH=3M) (132kV D/C BEAR) (WIND ZONE - 4)	**DESIGNED**	**CHECKED**	**Sheet**
		MDJ	RJR	1 OF 18

Design Summary For Different Load Cases:

S.No.	Extension	LC	K-bar	L-bar	M-bar	N-bar	Chimney Interaction Ratio		FOS				SHEAR CHECK
							Compression	Tension	Uplift	Bearing	Sliding	Overturning	
1	+0m B.E	903	GOVERNS							1.88			SAFE
2	+0m B.E	974		GOVERNS	GOVERNS	GOVERNS			1.01				SAFE
3	+0m B.E	1260					0.43						SAFE
4	+0m B.E	938						0.46					SAFE
5	+0m B.E	1297									2.27	1.23	SAFE

Note: In addition to the governing load cases mentioned above, the foundation has been checked for reactions pertaining to all the load cases as mentioned in the reaction document.

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No O17123-T-TL-4M-DC-4001B	Date 19.03.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE "QD/DE" +0M BE WET SOIL (DEPTH=3M) (132kV D/C BEAR) (WIND ZONE - 4)	DESIGNED: MDJ / CHECKED: RJR	Sheet 2 of 18

Input Parameters for Foundation Design :-

Sl.No	Description	Variable	Unit	Value
1	1st Slope of Tower Leg	Φ	Deg	12.613
2	Depth of lower Layer	Dl	m	1.350
3	Depth of Upper Layer (minimum)	Du	m	1.500
4	Depth of Upper Layer (maximum)	Du	m	3.000
5	Unit Weight of Soil in Lower layer	W_L	Kg/m^3	940
6	Unit Weight of Soil in Upper layer	W_U	Kg/m^3	1440
7	Angle of Repose in Lower Layer	α	Deg	15
8	Angle of Repose in Upper Layer	β	Deg	25
9	Limit Bearing Capacity of Soil	Lbcs	Kg/m^2	13675
10	Factor of Safety applied on foundation loads	Fos	--	1.100
11	Total Depth of Foundation Below G.L (Including Pcc Pad)	D	m	3.000
12	Plinth Height in mm	Dp	m	0.225
13	Unit Weight of Concrete in Lower Layer	Wcl	Kg/m^3	1400
14	Unit Weight of Concrete in Upper Layer	Wcu	Kg/m^3	2400
15	Characteristic Strength of Concrete	Fck	N/mm^2	20
16	Characteristic Strength of Steel	Fy	N/mm^2	500
17	Cover To Chimney Reinforcement	Ccc	mm	50
18	Cover To Footing Slab Reinforcement	Ccs	mm	50
19	Slope of Tower Leg	Φ	Deg	17.560

Assumed Dimensions of Foundation Refer Figure- I				
1	Footing Width at the Bottom of Slab -I	B	m	5.660
2	Footing Width At Bottom of Slab - II	B^1	m	5.660
3	Footing Width At Top of Slab - II	B1	m	5.260
4	Width of Footing At Bottom of Slab - III	B2	m	2.520
5	Width of Chimney	Bc	m	0.600
6	Depth of PCC Pad	Dpad	m	0.050
7	Depth of Slab -I Fom top of PCC Pad	D1	m	0.100
8	Depth of Slab -II from top of Slab-I	D2	m	0.200
9	Depth of Slab -III from top of Slab-II	D3	m	0.370
10	Height of Chimney Upto G.L From Top of Slab - III	Dc	m	2.280

Ultimate Foundation Loads in kg - Refer Doc. No. O17123-T-TL-4M-DC-4000

		QD/DE +0M B.E	
		Supp No 2 LC-903	Supp No. 4 LC-974
Sr.No	Type of Load	CASE-1	CASE-2
1	Compression	174326	
2	Uplift	-	161530
3	Side Thrust (Transverse)	3034	2159
4	Side Thrust (Longitudinal)	5129	4117

(Over Load Factor 1.1 included)

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No O17123-T-TL-4M-DC-4001B		Date 19.03.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE "QD/DE" +0M BE WET SOIL (DEPTH=3M) (132kV D/C BEAR) (WIND ZONE - 4)	DESIGNED MDJ	CHECKED RJR	Sheet 3 of 18

(1) CHECK FOR UPLIFT (REFER FIGURE - 2)

Sr. No.	Description	Expression	Value
(a)	Horizontal Offset of cone in Lower Layer	X = 1.35*Tan(15)	0.3617
(b)	Horizontal Offset of cone in Upper Layer	Y = 1.5 * Tan(25)	0.6995
(c)	Gross volume of soil in Lower Layer in M^3	{(5.66)^2 *1.35+(2*5.66*1.35*0.3617)+(PI/ 3 *1.35*(0.3617)^2)}	48.961
(d)	Volume of Concrete in Lower Layer in M^3	((5.66^2+5.26^2+5.66*5.26)*0.2/3)+(2.52^2*0.37)+(0.6^2*0.78)	8.595
(e)	Net Volume Lower Layer in M^3	(48.961-8.595)	40.365
(f)	$A1 = B*B + 4B*H1*\tan\phi1 + \pi H1^2*\tan^2\phi1$	(5.66^2 + 4 x 5.66 x 1.35 x tan(15)+3.142x1.35^2xtan(15)^2)	40.6360
	$A2 = B*B+4B*(H1*\tan\phi1 + H2*\tan\phi2) + \pi((H1*\tan\phi1 + H2*\tan\phi2)^2$	(5.66^2 + 4 x 5.66 x (0.3617+0.6995)+3.142x(0.3617+0.6995)^2)	59.599
(g)	Gross Volume of Soil in Upper Layer in M^3 (As per CBIP manual No.10), $V = (A1+A2+ sqrt(A1A2))*H_2/3$	(40.636 + 59.599 + sqrt (40.636 x 59.599)) x 1.5/3	74.724
(h)	Volume of Concrete in Upper Layer in M^3	(0.6^2*1.5)	0.540
(i)	Net Volume of Soil in Upper Layer in M^3	(74.724-0.54)	74.184
(j)	Weight of Soil Resisting Uplift in Kg	(40.365*940) + (74.184 * 1440)	144768
(k)	Weight of Concrete in Kg	(8.595*1400)+(0.54*2400)+(0.1*5.66^2*1400)+(0.6^2*0.225*2400)	18009
(l)	Total Resistance against Uplift in Kg	(144768.06 + 18008.993)	162777
	Factor of Safety against Uplift		
		162777.05 / 161529.69	**1.01**
		Since F.O.S is > 1.00 , Foundation is Safe against Uplift	

(2) --- CHECK FOR DOWNTHRUST

(A) Bearing Pressure Due to Downthrust in Kg/m^2

Sr. No.	Description	Expression	Value
(a)	Downthrust acting perpendicular to footing (Y1)	(174326.14 * (COS(17.56)))	166203
(b)	Over Load due to Concrete (Kg)	(0.6^2 x 0.225x2400)+(0.6^2x1.5x(2400-1440))+[(0.6^2x0.78)+(2.52^2x0.37)+(5.66^2x0.1)+(5.66^2+5.26^2+5.66x5.26)x0.2/3]x(2400-1440)+5.66^2*0.05x(2400-1440))	13578
(c)	Total Downthrust acting normal to footing in Kg	(166202.81+13577.54)	179780
(d)	Bearing Pressure Due to Downthrust (Kg/m^2) (P/A)	(179780.35 / 5.66^2)	5612
(e)	Depth of Slab below chimney in M	(0.1+0.2+0.37)	0.670
(f)	Moment Due to Eccentricity (MX & MZ)	(166202.81 * Tan (12.613) *0.67)	24918
(g)	Bearing Pressure Due to Eccentricity in Kg/m^2 (Pe/Z)	(24918 / (5.66^3 / 6)	825
(h)	Bearing Pressure Due to Eccentricity in Kg/m^2 (Pe/Z)	(24918 / (5.66^3 / 6) + (24918 / (5.66^3 / 6))	1649
(i)	Total Bearing Pressure in Kg/m^2	(5612 + 1649.09)	7261
(j)	**Factor of Safety against Downthrust**	(13675 / 7261.09)	**1.88**
		Since F.O.S is > 1.00 , Foundation is Safe Against Downthrust	

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No** O17123-T-TL-4M-DC-4001B		**Date** 19.03.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE "QD/DE" +0M BE WET SOIL (DEPTH=3M) (132kV D/C BEAR) (WIND ZONE - 4)	**DESIGNED** MDJ	**CHECKED** RJR	**Sheet**

Sr. No.	Description	Expression		Value
	(B) Bearing Pressure Due to Transverse Side Thrust in Kg/m^2			
(a)	Coefficient of Passive Earth Pressure in upper layer (Kp_1)	(1+ Sin (25)) / (1- Sin (25))		2.464
	Coefficient of Passive Earth Pressure in lower layer (Kp_2)	(1+ Sin (15)) / (1- Sin (15))		1.698
(b)	Depth of Chimey above Slab-III	Dc = 2.28		2.280
(c)	To find the depth of effective earth pressure He(=H_1+H_2), equating the passive pressure of soil to the side thrust			
		$1/2*Kp_1W_uH_1^2B_c+Kp_2W_uH_1H_2B_c+1/2*Kp_2W_LH_2^2B_C=S.T$		
	Solving this equation for H_2 with			
	A=	$1/2*Kp_2W_LB_C$	=0.5*1.698*940*0.6	478.836
	B=	$Kp_2W_uH_1B_c$	=1.698*1440*(1.5-0.5)*0.6	1467.072
	C=	$1/2*Kp_1W_uH_1^2B_c$-S.T	=0.5*2.464*1440*(1.5-0.5)^2*0.6-3034	-1969.892
	H_2=	(-B+sqrt(B^2-4AC))/2A		1.010
	Depth of Effective earth pressure Zone (He) in M	(H2+H1)	=1.01+(1.5-0.5)	2.010
(d)	Since Effective Pressure Zone (He) >(2.28- 0.5)Therefore Soil Pressure will only be mobilised in (2.28 - 0.5)			
(e)	Resisting Soil Force in upper layer Kg (R1) =	0.5*2.464*1440*(1.5-0.5)^2*0.6		1064.448
	Resisting Soil Force in lower layer Kg (R2) =	1.698*1440*(1.5-0.5)*(2.28-1.5)*0.6		1144
	Resisting Soil Force in lower layer Kg (R3) =	0.5*1.698*940*(2.28-1.5)^2*0.6		291
	Total Resisting Soil Force in Kg (R) =	1064.448+1144.31616+291.3238224		2500.088
(f)	C.G of Resultant force in m	(1064.448*((1.5-0.5)/3+(2.28-1.5))+1144.31616*((2.28-1.5)*0.5)+291.3238224*((2.28-		0.683
(g)	Moment @ Base Due to Side Thrust (Kg-m)	3034.34*(3-0.05+0.225)-2500.09*(0.683+0.67)		6251
(h)	Bearing Pressure due to SideThrust in Kg/m^2	(6251.41/ (5.66^3/ 6))		207
	(C) Bearing Pressure Due to Longitudinal Side Thrust in Kg/m^2			
(c)	To find the depth of effective earth pressure He(=H_1+H_2), equating the passive pressure of soil to the side thrust			
		$1/2*Kp_1W_uH_1^2B_c+Kp_2W_uH_1H_2B_c+1/2*Kp_2W_LH_2^2B_C=S.T$		
	Solving this equation for H_2 with			
	A=	$1/2*Kp_2W_LB_C$	=0.5*1.698*940*0.6	478.836
	B=	$Kp_2W_uH_1B_c$	=1.698*1440*(1.5-0.5)*0.6	1467.072
	C=	$1/2*Kp_1W_uH_1^2B_c$-S.T	=0.5*2.464*1440*(1.5-0.5)^2*0.6-512	-4064.942
	H_2=	(-B+sqrt(B^2-4AC))/2A		1.760
	Depth of Effective earth pressure Zone (He) in M	(H2+H1)	=1.76+(1.5-0.5)	2.760

(d)	Since Effective Pressure Zone (He) >(2.28- 0.5)Therefore Soil Pressure will only be mobilised in (2.28 - 0.5)		
(e)	Resisting Soil Force in upper layer Kg (R1) =	0.5*2.464*1440*(1.5-0.5)^2*0.6	1064.448
	Resisting Soil Force in lower layer Kg (R2) =	1.698*1440*(1.5-0.5)*(2.28-1.5)*0.6	1144
	Resisting Soil Force in lower layer Kg (R3) =	0.5*1.698*940*(2.28-1.5)^2*0.6	291
	Total Resisting Soil Force in Kg (R) =	1064.448+1144.31616+291.3238224	2500.088
(f)	C G of Resultant force in m	(1064.448*((1.5-0.5)/3+(2.28-1.5))+1144.31616*((2.28-1.5)*0.5)+291.3238224*((2.28-	0.683
(g)	Moment @ Base Due to Side Thrust (Kg-m)	5129.39*(3-0.05+0.225)-2500.09*(0.683+0.67)	12903
(h)	Bearing Pressure due to SideThrust in Kg/m^2	(12903.19/ (5.66^3/ 6))	427
	(D) Total Bearing Pressure		
(i)	Total Bearing Pressure due to Downthrust & Side Thrust in Kg/m^2	Pmax = (7261 + 207 + 427)	7895
		Pmin = (5612 - 1649 - 207 - 427)	3329
(j)	**Factor of Safety against Bearing**	(13675*1.25 / 7895.09)	**2.17**
	(Limit bearing pressure is increased by 25% as per IS code.)	**Since F.O.S in bearing is >1.00, Foundation is Safe In Bearing**	

(3) STRUCTURAL DESIGN OF FOUNDATION

Sr. No.	Description	Expression	Value
A)	**Design Base Slab Reinforcement** *(Refer Fig-5 for base pressure distribution)*		
(a)	Design bearing pressure (Kg/m2)	= {(P/A+(0.5*Pe/Z)) + Max. of (Bearing pressure due to S.T (T),S.T (L) }	
(b)	Maximum , Pmax in Kg/m^2	= (5612 + 824.5465 +427)	6864
(c)	Minimum , Pmin in Kg/m^2	= (5612 - 824.5465 -427)	4360
(d)	Maximum pressure Pmax in N/mm2	6863.546*9.81/1000000	0.067331
(e)	Minimum pressure Pmin in N/mm2	4360.454*9.81/1000000	0.042776
(f)	Total Depth of At Section X-X in 'm'	(0.1 + 0.2 +0.37)	0.670
(g)	Effective Depth of Slab (dactual) at Section X-X in mm	(670 - (12 + 12 / 2 + 50))	602
(h)	Total Depth of At Section Y-Y in M	(0.1 + 0.2)	0.300
(i)	Effective Depth of Slab (dactual) in mm	(300 - (12 + 12 / 2 + 50))	232
(j)	Distance from the edge of the footing to Section X-X in 'm'	(5.66-0.6)/2	2.53
(k)	Distance from the edge of the footing to Section Y-Y in 'm'	(5.66-2.52)/2	1.570

	L&T CONSTRUCTION POWER TRANSMISSION AND DISTRIBUTION IC		
PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No O17123-T-TL-4M-DC-4001B	Date 19.03.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE "QD/DE" +0M BE WET SOIL (DEPTH=3M) (132kV D/C BEAR) (WIND ZONE - 4)	DESIGNED: MDI / CHECKED: RJR	Sheet 6 of 18

(l)	Pressure at a distanced=602mmfrom section X-X	(6864-4360)/5.66*(5.66-2.53+0.602)+4360		6011
(m)	Pressure at a distanced=232mmfrom section Y-Y	(6864-4360)/5.66*(5.66-1.57+0.232)+4360		6272
(n)	The pressure at section X-X (Pxx in Kg/m^2)	(6864-4360)/5.66*(5.66-2.53)+4360		5745
(o)	The pressure at section Y-Y (Pyy in Kg/m^2)	(6864-4360)/5.66*(5.66-1.57)+4360		6169
(p)	Bending Moment at face of chimney at Section X-X in kg-m	5745*5.66*(5.66-0.6)^2/8+(6864-5745)*5.66*2.53/2*2/3*2.53		117574
(q)	Bending Moment at face of chimney at Section X-X in N-mm	(117574.072*9.81*1000)		1.1534E+09
	No and Diameter of Bars to be used in Base Slab	No of Bars required for base slab	Diameter of Bar in mm	Area of Bars (Ast) in mm^2
	MKD "K"	44	12	4976.28
	Value of Xumax /d to be used in slab design	Fy = 500 (Xumax / d) = 0.46 & For Fy = 415 (Xumax/d) = 0.48		
	Effective Depth Required for slab (Dreqd) in mm	Sqrt (1.153E+09/ (0.36 * 20 * 0.46*(1-(0.42*0.46)) * 2.52 * 1000)		414
	Breadth at section -XX in M = 2.52	**Since (dreqd) < than (dactual), Slab depth is O.K**		
	Moment of Resistance at Section - XX Mrx in N-mm	(Mrx =0.87 *500 * Ast *602 * [1-(Ast *500 / 20 * 2520*602]		
	Total Reinforcement Ast required in mm2	= 4.315 Ast^2 - 261870 Ast + 1.153E+09 = 0		
	where Ast = Reinforcement Reqd. for moment Mrx	Solving the above Quadratic equation for Ast We Get Ast =		4781.20
	Minimum steel area required , mm2/m	0.12/100 x 2520 x 670		2026.1
	Bending Moment at Section - YY (Refer Fig -5)			
	Bending Moment at junction of slabs at Section Y-Y in kg-m	6169*5.66*(1.57)^2/2+(6864-6169)*5.66*1.57/2*2/3*1.57		46263
	Bending Moment at junction of slabs at Section Y-Y in N-mm	(46263.364*9.81*1000)		4.5384E+08
	Effective Depth Required for slab (Dreqd) in mm	Sqrt (4.538E+08/ (0.36 * 20 * 0.46*(1-(0.42*0.46)) * 5.66 * 1000)		173
	Breadth at section -YY in M = 5.66	**Since (dreqd) < than (dactual), Slab depth is O.K**		
	Moment of Resistance at Section - YY Mry in N-mm	(Mry =0.87 *500 * Ast *232 * [1-(Ast *500 / 20 * 5660*232]		
	Total Reinforcement Ast required in mm2	= 1.921 Ast^2 - 100920 Ast + 4.538E+08 = 0		
	where Ast = Reinforcement Reqd. for moment Mry	Solving the above Quadratic equation for Ast We Get Ast =		4966.71
	Minimum steel area required , mm2	0.12/100 x 5660 x 300		2037.60
	Maximum of the above area of steel is provided as Slab Reinforcement	(Ast = Maximum of (4781.2 , 2026.08 , 4966.71, 2037.6))		4966.71
	Total No of bars required for slab	(4966.71 / (Pi / 4 * 12 ^ 2)) (No of bars required = 43.915		44
		(Let us Provide 44 Nos of 12mm diameter rod as slab reinforcement)		
	Hence the speacing between rod is (mm)	**129**		**O.K.**

Sr. No.	Description	Expression	Value
B)	**Check for One Way Shear At Section - XX : - (Due to Downthrust) (Refer Fig -3)**		
(a)	At Section - XX		
	Pmax in kg/m2	6863.546	6864
	Pmin in kg/m2	6010.903	6011
(b)	Total Shear force at Section - XX/m run in N	(0.5*(6864+6011)*((5.66-0.6)/2-0.602))*9.81	121752
(c)	Effective Area of Cross Section per m run in mm^2	602*1000	602000
(d)	Nominal Shear Stress Tv in N/mm^2 /m	(121751.607 / 602000)	0.202
(e)	Total Effective Area of Cross Section in mm^2	((2520*370)+0.5*(5260+5660)*200+5660*(100-50-6))	2273440
(f)	Percentage Slab reinforcement (p)	p = (100 * 4966.71)/2273440	0.219
(g)	Permissible Shear Stress Tc in N/mm^2	(Refer clause no 4.10 of Sp-16- 1980 Design Aids for IS 456	
(h)	Permissible Shear Stress Tc in N/mm^2	[0.85 x { Sqrt (0.8 x Fck) }x{ {sqrt(1+5Ct)}-1}]/(6xCt)	
(i)	Where Coefficient Ct is given by	Ct = (0.8 x 20 / (6.89 x0.219)	10.604
(j)	Permissible Shear Stress Tc in N/mm^2	(((0.85*((0.8 * 20)^0.5*(((1+5 * 10.604)^0.5-1)) / (6 *10.604)))	0.339
		(Since Tc > than Tv Shear Reinforcement is not required)	
C)	**Check for One Way Shear At Section - YY : - (Due to Downthrust) (Refer Fig -3)**		
(a)	At Section - YY		
	Pmax in kg/m2	6863.546	6864
	Pmin in kg/m2	6271.826	6272
(b)	Total Shear force at Section - YY/m run in N	(0.5*(6864+6272)*((5.66-2.52)/2-0.232))*9.81	86206
(c)	Effective Area of Cross Section per m run in mm^2	232*1000	232000
(d)	Nominal Shear Stress Tv in N/mm^2 /m	(86206.004 / 232000)	0.372
(e)	Total Effective Area of Cross Section in mm^2	((0.5*(5260+5660)*200+5660*(100-50-6))	1341040
(f)	Percentage Slab reinforcement (p)	p = (100 * 4966.71)/1341040	0.371
(g)	Where Coefficient Ct is given by	Ct = (0.8 x 20 / (6.89 x 0.371)	6.259
(h)	Permissible Shear Stress Tc in N/mm^2	(((0.85*((0.8 * 20)^0.5*(((1+5* 6.259)^0.5-1))/(6 *6.259)))	0.424
		(Since Tc > than Tv Shear Reinforcement is not required)	
D)	**Check for Two Way Shear At Section - XX : - (Due to Downthrust) (Refer Fig -3)**		
(a)	Pressure at Section XX in N/mm2	6863.546*9.81/1000000	0.0673314
(b)	Shear At Section - XX in N	((0.067*[5660^2-(600+602)^2])	2059721
(c)	Effective Area of Cross Section in mm^2	(600 + 602)*4 *602	2894416
(d)	Nominal Shear Stress Tv in N/mm^2	(2059721 / 2894416)	0.712
	Allowable Shear Stress (Tcmax) in N/mm^2	(As per Clause 31.6.3.1 of IS 456 - 2000)	
	Tcmax = Ks * Tc	Where (Ks = 0.5 + B[1]) Not > Tc = 0.25 *Sqrt(Fck)	

Sr. No.	Description	Expression		Value
(e)	Allowable Shear Stress in concrete (Tcmax) in N/mm^2	Min of (0.5 + (0.6 / 0.6) ,1) * (0.25 * SQRT (20))		1.118
		(Since Tcmax > than Tv Shear Reinforcement is not required)		
Sr. No.	**Description**	**Expression**		**Value**
E)	**Check for Two Way Shear At Section - YY : - (Due to Downthrust) (Refer Fig -3)**			
(a)	Pressure at Section YY in N/mm2	6863.546*9.81/1000000		0.0673314
(b)	Shear At Section - YY in N	((0.067*[5660^2-(2520+232)^2])		1647067
(c)	Effective Area of Cross Section in mm^2	(2520 + 232)*4 *232		2553856
(d)	Nominal Shear Stress Tv in N/mm^2	(1647067 / 2553856)		0.645
(e)	Allowable Shear Stress in concrete (Tcmax) in N/mm^2	Min of (0.5 + (0.6 / 0.6) ,1) * (0.25 * SQRT (20))		1.118
		(Since Tcmax > than Tv Shear Reinforcement is not required)		
F)	**Design of Slab for Uplift Reinforcement at Section - YY : -**			
(a)	Bearing Pressure due to Uplift in Kg/m^2	(161529.69) / { 5.66 ^2 - 0.6^2)}		5099
(b)	Bending Moment/m width @ - YY (Mux) in N-mm	(5099.499 * (5.66 - 2.52)^2 / 8 * 5.66) * 9.81* 1000)		3.490E+08
(c)	Moment of Resistance at Section - YY Muy in N-mm	(Muy =0.87 *500*Astuy *232 * [1-(Astuy *500 / 20 * 5660*232)]		
(d)	Uplift Reinforcement @ - YY (Astuy in mm2)	= 1.921 Astuy^2 - 100920 Astuy + 3.490E+08 = 0		
(e)	Astuy = Reinforcement for Uplift @ - YY /M-width	Solving the above Quadratic equation for Astuy We Get Astuy =		3721.52
	Minimum steel area required , mm2	0.12/100 x 5660 x 300		2037.6
(f)	No and Diameter of Bars to be used in Base Slab	Diameter of Bar in mm	No of Bars required for Uplift force @ YY	
	At Section - YY for Uplift Reinforcement	12	(3721.521 / (Pi /4 *12^2)) =	33.000
	(Let us Provide 33 Nos of 12mm diameter rod as Uplift Reinforcement at Section - YY MKD. 'M')			
	Hence the spcacing between rod is (mm)	**161**		**O.K.**
G)	**Design of Slab for Uplift Reinforcement at Section - XX : -**			

It may be noted that reinforcement provided at section Y-Y for uplift falls in tension zone and thus would also contribute in moment capacity of section at section X-X. This is because under uplift, compression occurs at the face of the base slab having more width (more area of compression flange) and sectionbehaves as a highly under reinforced section. From the equilibrium of internal and external forces on the slab section and using stress and strains of concrete and steel as per IS:456, the following equation (Moment of resistance) can be obtained

$Xu/d_1 = (p_3/100)x(d_2/d_1)x(fs/0.36f_{ck}) + (p_4/100)x(0.87f_y/0.36f_{ck})$

where:- $p_3 = (100\ A_{s3} / Bd_2)$ and $p_4 = (100\ A_{s4}/ B_{dt})$; fs= Design yield stress of steel at d_2 from MCE calculated for strain in steel at that level(arrived through interpolation from strain diagram)

A_{s3} = Area of reinforcement at the top of bottom-most step, A_{s4} = Area of reinforcement at the top of the topmost step

Moment of resistance of slab section at the face of the chimney:

$M_u = [0.87f_y * (p_3/100) * (d_2/d_1) * (d_2/d_1 - 0.416\ Xu/d_1) + (0.87f_y) * (p_4/100) * (1-0.416Xu/d_1)] * Bd_1^2$

Substituting the value of Xu/d1 in the above equation, we get the second order degree equation which can be resolve as follows:-

$A = 0.416* (0.87*f_y)^2/(0.36*f_{ck})$

$B = 0.416*((0.87*f_y)/(0.36*f_{ck})) * ((fs*(p_3/100)*(d_2/d_1)) + ((0.416*fs*(p_3/100)*(d_2/d_1))*((0.87*f_y)/(0.36*f_{ck})) - 0.87*f_y$

$C= (M_{u}/B*d_1*d_1) - (fs*(p_3/100)*(d_2/d_1)^2) + (0.416*(p_3/100)*(d_2/d_1)) * ((fs)/(0.36*f_{ck}))*((fs*(p_3/100)*(d_2/d_1))$

	L&T CONSTRUCTION POWER TRANSMISSION AND DISTRIBUTION IC			
PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No O17123-T-TL-4M-DC-4001B		Date 19.03.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE "QD/DE" +0M BE WET SOIL (DEPTH=3M) (132kV D/C BEAR) (WIND ZONE - 4)	DESIGNED MDJ	CHECKED RJR	Sheet 9 of 18

(a)	Bearing Pressure due to Uplift in Kg/m^2	(161529.69) / { 5.66 ^2 - 0.6^2)}	5099
(b)	Bending Moment @ - XX (Mux) in N-mm	(5099.499 * (5.66 - 0.6)^2 / 8 * 5.66) * 9.81* 1000)	9.062E+08
(c)	Strain in reinforcement at d_2 from Bottom of slab-I (By linear interpolation from Strain Diagram)		-5.422E-04
(d)	Design yield stress of reinforcement at d_2 from Bottom of slab-I (fs in N/mm2) [Refer Fig.3 of SP-16]		0
	$A = 0.416*(0.87*f_y)^2/(0.36*f_{ck})$	A=((0.416*(0.87*500)^2/(0.36*20))	10933
	$B = 0.416*((0.87*f_y)/(0.36*f_{ck}))*((fs*(p_3/100)*(d_2/d_1))$	B=0.416*((0.87*500)/(0.36*20))*((0*0.0028*(232/602))	
	$+((0.416*fs*(p_3/100)*(d_2/d_1))*((0.87*f_y)/(0.36*f_{ck}))$	+((0.416*0*0.0028*(232/602))*((0.87*500)/(0.36*20))	-435.000
	$-0.87*f_y$	-0.87*500	
	$C=(M_{uy}/B*d_1*d_1)-(fs*(p_3/100)*(d_2/d_1)^2)$	C=(906199871.4/5660*602*602)-(0*0.0028*(232/602)^2)	
	$+(0.416*(p_3/100)*(d_2/d_1))*((fs)/(0.36*f_{ck}))$	+(0.416*0.0028*(232/602))*((0)/(0.36*20))	0.44179
	$*((fs*(p_3/100)*(d_2/d_1))$	*((0*0.0028*(232/602))	
	Therefore by resolving the above equation, we get,		
	ps4/100	ps4/100 = (-b - SQRT(b^2-4ac))/2*a	
		ps4/100=435-SQRT(189225-4*10933*0.442))/(2*10933))	0.001043
		Therfore, ps4 =	0.10
	Therefore reinforcement Ast4 in mm2	Ast4=((0.104*5660*602)/100)	1582.19
	Minimum steel area required , mm2	0.12/100 x 2520 x 670	2026.08

(c)	No and Diameter of Bars to be used in Base Slab	Diameter of Bar in mm	No of Bars required for Uplift force @ XX	
	At Section - XX for Uplift Reinforcement	12	(1582.189 / (Pi /4 *12^2)) =	18.000
	(Let us Provide 18 Nos of 12mm diameter rod as Uplift Reinforcement at Section - XX, MKD 'N')			
	Hence the spcacing between rod is (mm)	**142**		**O.K.**

L&T CONSTRUCTION POWER TRANSMISSION AND DISTRIBUTION IC				
PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No O17123-T-TL-4M-DC-4001B		Date 19.03.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE "QD/DE" +0M BE WET SOIL (DEPTH=3M) (132kV D/C BEAR) (WIND ZONE - 4)	DESIGNED MDJ	CHECKED RJR	Sheet 10 of 18

(4) CHECK FOR SLIDING (Refer Figure - 4)

Sr. No	Description	Expression	Value
(a)	Coefficient of Passive Earth Pressure in Lower layer	(1+ Sin (15)) / (1- Sin (15))	1.698
(b)	Coefficient of Passive Earth Pressure in Upper layer	(1+ Sin (25)) / (1- Sin (25))	2.464
(c)	Facial Area in upper layer of Chimney in m^2	A1 = (0.6 * (1.5 -0.5))	0.600
(d)	Facial Area in lower layer of Chimney in m^2	A1 = (0.6 * (2.28 -1.5))	0.468
(e)	Facial Area in Portion of Slab- III in m^2	A2 = (0.37 * 2.52)	0.932
(f)	Facial Area in Portion of Slab- II in m^2	A3 = (0.2 * (5.66 + 5.26 / 2))	1.092
(g)	Facial Area in Portion of Slab- I in m^2	A4 = (0.1 * 5.66)	0.566
(h)	Earth Pressures in Upper Layer in Kg /m^2	(P1u = (2.464 * 1440 * (1.5-0.5)))	3548
(i)	Earth Pressures in Lower Layer 1 in Kg /m^2	(P1l = (1.698 * 1440 * (1.5-0.5)))	2445
(j)	Earth Pressures in Lower Layer 2 in Kg /m^2	(P2 = (2445.12 + (1.698 * 940 *(1.35 - 0.2 - 0.37))	3690
(k)	Earth Pressures in Lower Layer 3 in Kg /m^2	(P3 = (3690.0936 + (1.698 * 940 * 0.37))	4281
(l)	Earth Pressures in Lower Layer 4 in Kg /m^2	(P4 = (4280.658 + (1.698 * 940 * 0.2))	4600
(m)	Earth Pressures in Lower Layer 5 in Kg /m^2	(P5 = (4599.882 + (1.698 * 940 * 0.1))	4759
(n)	Lateral Force in Lower Layer -1 in Kg	(F1 = 0.6 / 2 * (3548.16))	1064
(o)	Lateral Force in Lower Layer -2 in Kg	(F2 = 0.468 / 2 * (2445.12+3690.0936))	1436
(p)	Lateral Force in Lower Layer -3 in Kg	(F3 = 0.9324 / 2 * (3690.0936+4280.658))	3716
(q)	Lateral Force in Lower Layer -4 in Kg	(F4 = 1.092 / 2 * (4280.658+4599.882))	4849
(r)	Lateral Force in Lower Layer -5 in Kg	(F5 = 0.566 / 2 * (4599.882+4759.494))	2649
		Total Lateral Force in Kg	**13714**
	Factor of Safety Against Sliding : -		
		(13713.531 / 5129.39)	**2.67**
		Since F.O.S >1.00 foundation is Safe against sliding	

(5) CHECK FOR OVERTURNING

Sr. No	Description	Expression	Value
(a)	Maximum Transverse Side Thrust in Kg	(3034.34)	3034
(b)	Maximum Longidutinal Side Thrust in Kg	(5129.39)	5129
(c)	Resultant Side Thrust (R) in Kg	(Sqrt (3034.34^2 + 5129.39^2))	5960
(d)	Total Overturning Moment in Kg-m	(161529.69 * Cos (17.56) * (5.66 / 2 - 5.66 / 6) + 5959.686 * (3 + 0.225 - 0.05) - 18008.993 * (5.66 / 2 - 5.66 / 6)	275497
(e)	Total Resisting Moment in Kg-m	(0.5 * 144768.06 * 5 / 6 * 5.66)	341411
(f)	Factor of Safety Against Overturning	(341411.342 / 275496.71)	1.24
		Since F.O.S >1.00 foundation is Safe against Overturning	

3.0 DESIGN OF CHIMNEY (Chimney Design with Stub contribution)

3.1 **Loading:Compression with biaxial bending**

Puc= (174326.14+0.6^2*(0.225+2.28)*2400)*9.81/1000

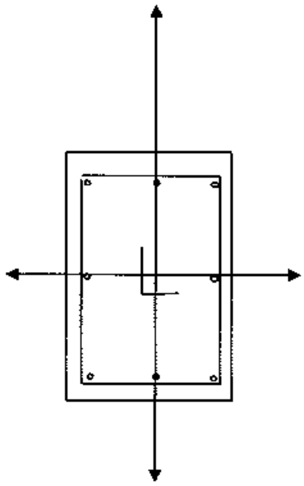
Puc= **1731.37 KN**

Mux= (3034.34*(2.28+0.225)-2500.088*(2.28-0.5)/3)*9.81/1000

Mux= 60.01 KN-m

Muy= (5129.39*(2.28+0.225)-2500.088*(2.28-0.5)/3)*9.81/1000

Muy= **111.50 KN-m**



Material Property:

fy= 500 N/mm^2

fys= 250 N/mm^2

fck= 20 N/mm^2

Geometric Property:

D= 600 mm

Clear cover 50 mm

Dia of reinf 20 mm and 25 mm

No. of reinf= 4 nos. and 4 nos.

d' = 62.5 mm

TRIAL-I Say Neutral Axis at a distance from MCE = Xu = **326.158** mm

MCE: Most Compressed Edge of concrete

Location	Distance from MCE	Strain	Stress (f_{si}, f_{ci})	Area	Force	Distance from NA	Distance from CG	Moment
	mm		N/mm^2	mm^2	KN	mm	mm	KN-m
MCE	0.0	0.00350	-	-	-	326.158	300	-
R1	62.5	0.00283	402.84	1295.91	522.04	263.658	237.5	123.99
R2	300.0	0.00028	47.22	628.32	29.67	26.158	0	0.00
Stub	300.0	0.00028	47.22	5810.00	274.35	26.158	0	0.00
R3	537.5	0.00227	388.68	1295.91	-503.69	-211.342	-237.5	119.63
		Total		**9030.13**	**322.37**			**243.61**

Concrete force incompression, F = 0.36*fck*xu*d

Concrete force incompression,F = **1409.00** KN

Total axial Capacity = Concrete force in compression + Summation of all internal forces induced by the rebar & the stub

Total axial capacity = 1409.00 + 322.37 = **1731.37** KN ≥ **1731.37** KN

Moment due to compression force in concrete = F*(C.G - 0.416Xu)

= 231.5244 kN-m

Total Moment capacity = Moment due to compression force in concrete + Moment due to rebar & the stub

Total Moment capacity = 475.14 kN-m

Puz= 5455.653484 Pu/Puz= 0.317354

Interaction formula = **0.261** **OK**

L&T CONSTRUCTION POWER TRANSMISSION AND DISTRIBUTION IC				
PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No		Date
		O17123-T-TL-4M-DC-4001B		19.03.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE "QD/DE" +0M BE WET SOIL (DEPTH=3M) (132kV D/C BEAR) (WIND ZONE - 4)	DESIGNED	CHECKED	Sheet
		MDJ	RJR	12 of 18

3.2 **Loading:Tension with biaxial bending**

Put= **1585 KN**

Mux= **38.51 KN-m**

Muy= **86.63 KN-m**

Material Property:

fy= 500 N/mm2

fys= 250 N/mm2

fck= 20 N/mm2

Geometric Property:

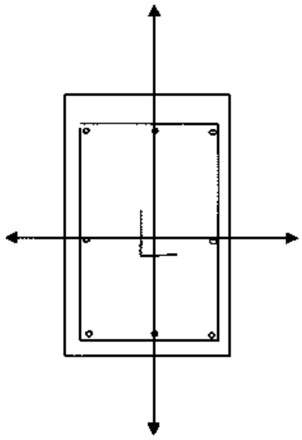
D= 600 mm

clear cover 50 mm

Dia of reinf 20 mm and 25 mm

No. of reinf= 4 nos. and 4 nos.

d' = 62.5 mm



TRIAL-I Say Neutral Axis at a distance from MCE = Xu = **192.938** mm

MCE: Most Compressed Edge of concrete

Location	**Distance from MCE**	**Strain**	**Stress (f_{si} f_{ci})**	**Area**	**Force**	**Distance from NA**	**Distance from CG**	**Moment**
	mm		N/mm2	mm2	KN	mm	mm	KN-m
MCE	0	0.00350	-	-	-	192.938	300	-
R1	62.5	0.00237	385.18	1295.91	499.16	130.438	237.5	118.55
R2	300	0.00194	365.55	628.32	-229.68	-107.062	0	0.00
Stub	300	0.00194	365.55	5810.00	-2123.85	-107.062	0	0.00
R3	537.5	0.00625	435.00	1295.91	-563.72	-344.562	-237.5	133.88
		Total		**9030.13**	**-2418.10**			**252.43**

Concrete force incompression, F = 0.36*fck*xu*d

Concrete force incompression,F = **833.49** KN

Total axial Capacity = Concrete force in compression + Summation of all internal forces induced by the rebar & the stub

Total axial capacity = 833.49 + -2418.10 = **1584.61** KN ≥ **1584.61** KN

Moment due to tension force in concrete = F*(C.G - 0.416Xu)

= 183.1492 kN-m

Total Moment capacity = Moment due to compression force in concrete + Moment due to rebar & the stub

Total Moment capacity = 435.58 kN-m

Pu/Puz= 1

Interaction formula = **0.287** **OK**

Design of Lateral ties

Minimum Diameter of Lateral Ties in mm =1/4 of largest dia. of Longitudinal bar = 0.25*25

= 6.25 mm

Hence provide lateral ties of dia = 8 mm

As per Clause 26.5.3.2 of IS 456 - 2000 Pitch of lateral Ties shall be least of the following

(i) Least lateral dimension of compression member = 0.6*1000 = 600 mm

(ii) 16 times smallest diameter of longitudinal bars = 16*20 = 320 mm

(iii) 300mm = 300 = 300 mm

So, provide the lateral ties at a distance of 300 mm c/c

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No** O17123-T-TL-4M-DC-4001B		**Date** 19.03.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE "QD/DE" +0M BE WET SOIL (DEPTH=3M) (132kV D/C BEAR) (WIND ZONE - 4)	**DESIGNED** MDJ	**CHECKED** RJR	**Sheet** 13 of 18

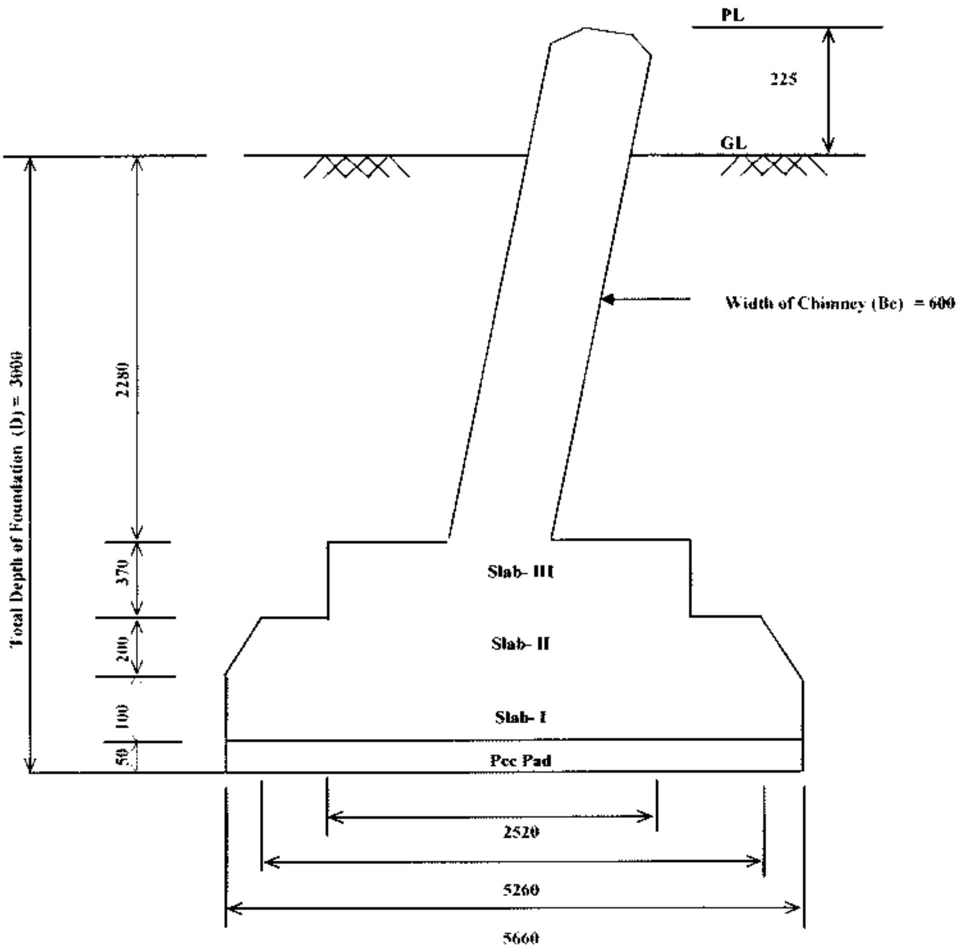


FIGURE - 1

Note :

All Dimensions are in Millimeters

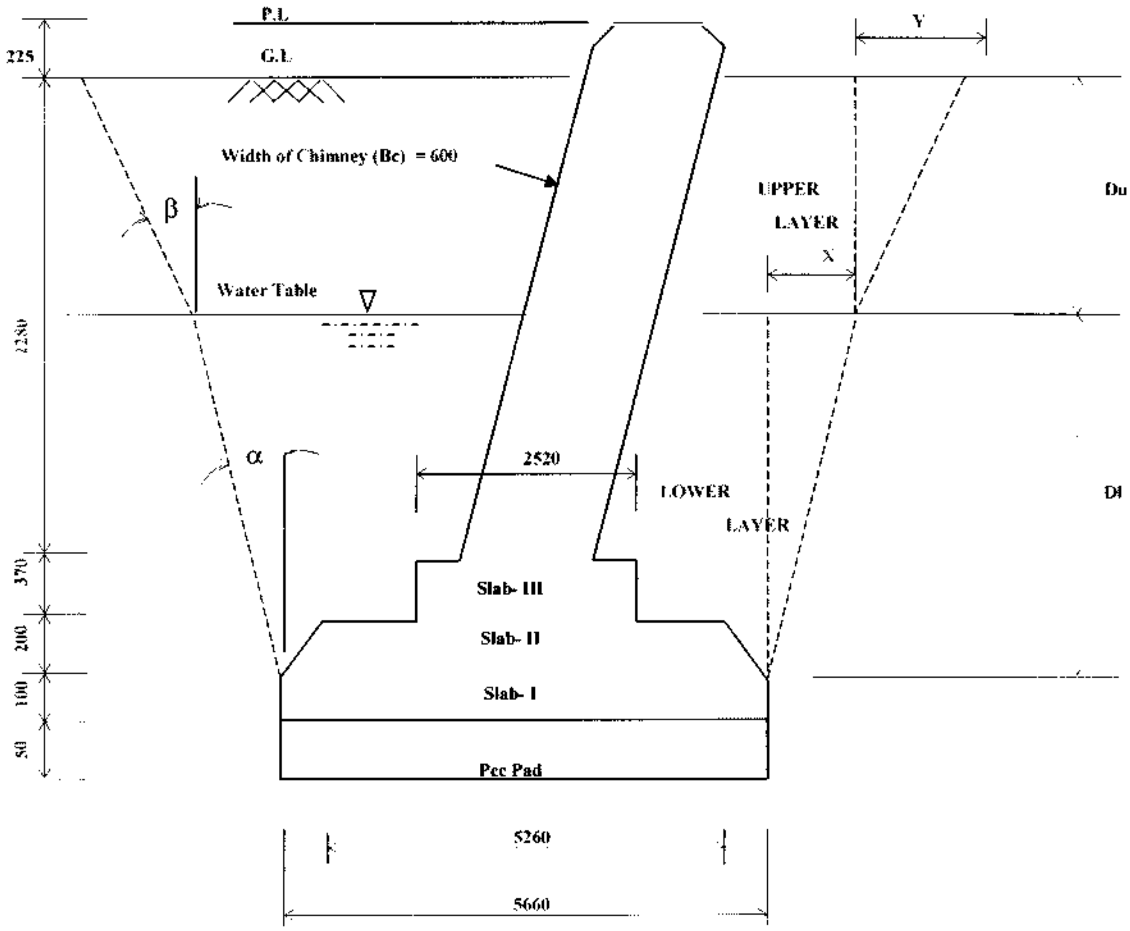


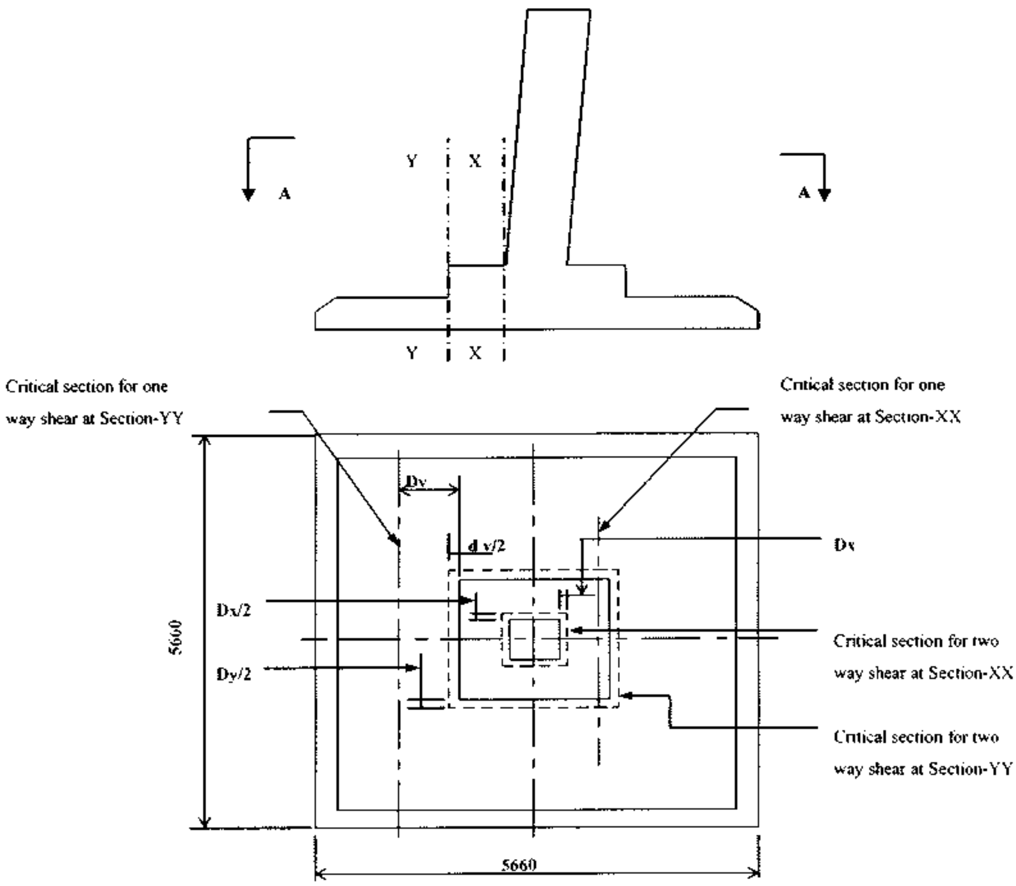
FIGURE - 2

Note :

All dimensions are in Millimetres

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No** O17123-T-TL-4M-DC-4001B		**Date** 19.03.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE "QD/DE" +0M BE WET SOIL (DEPTH=3M) (132kV D/C BEAR) (WIND ZONE - 4)	**DESIGNED** MDJ	**CHECKED** RJR	**Sheet** 15 of 18



SECTION A-A

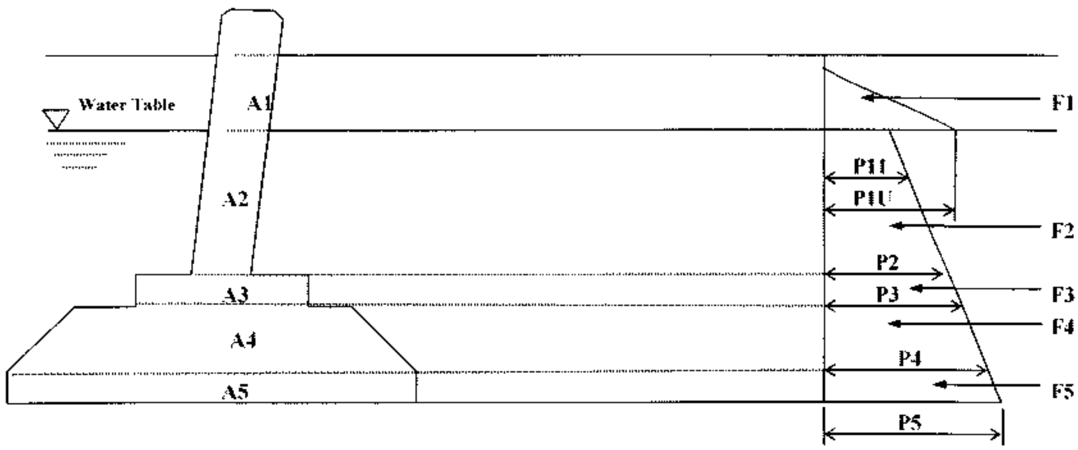
FIGURE - 3

Note :

All Dimensions are in Millimeters

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No** O17123-T-TL-4M-DC-4001B		**Date** 19.03.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE "QD/DE" +0M BE WET SOIL (DEPTH=3M) (132kV D/C BEAR) (WIND ZONE - 4)	**DESIGNED** MDJ	**CHECKED** RJR	**Sheet** 16 of 18



EARTH PRESSURE DISTRIBUTION

FIGURE - 4

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No** O17123-T-TL-4M-DC-4001B	**Date** 19.03.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE "QD/DE" +0M BE WET SOIL (DEPTH=3M) (132kV D/C BEAR) (WIND ZONE - 4)	**DESIGNED** MDJ	**CHECKED** RJR

Sheet
17 of 18

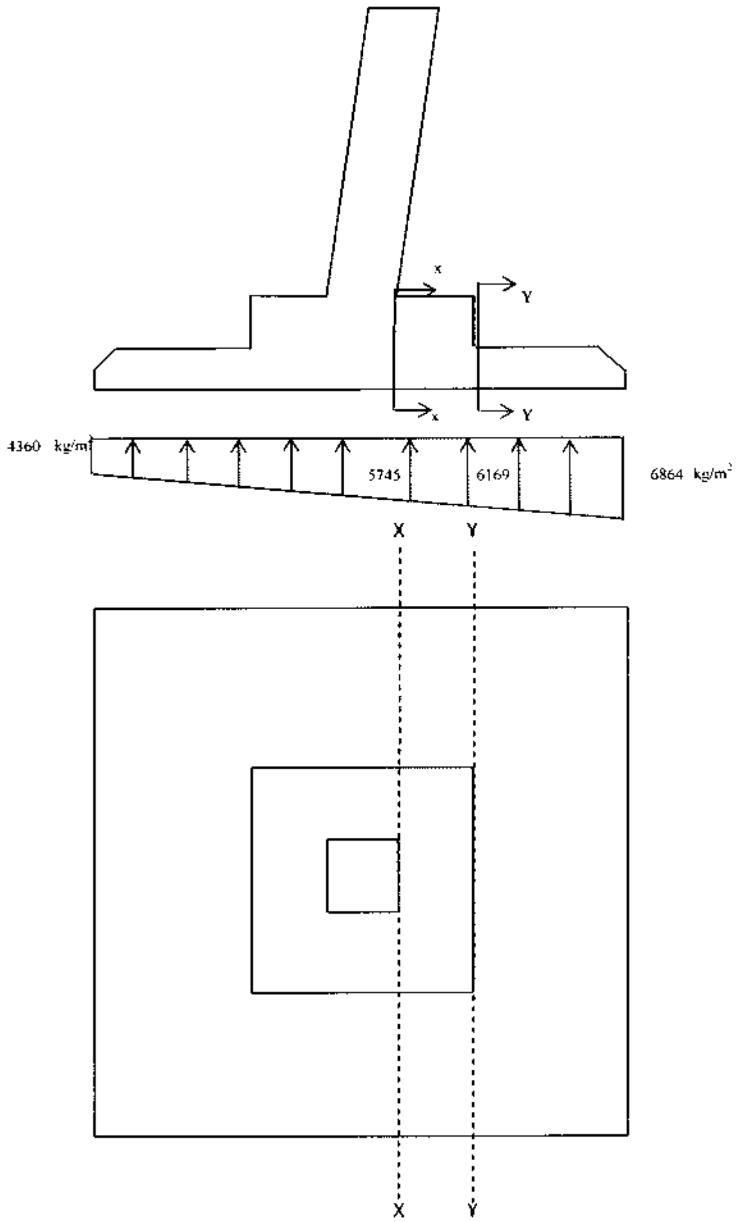
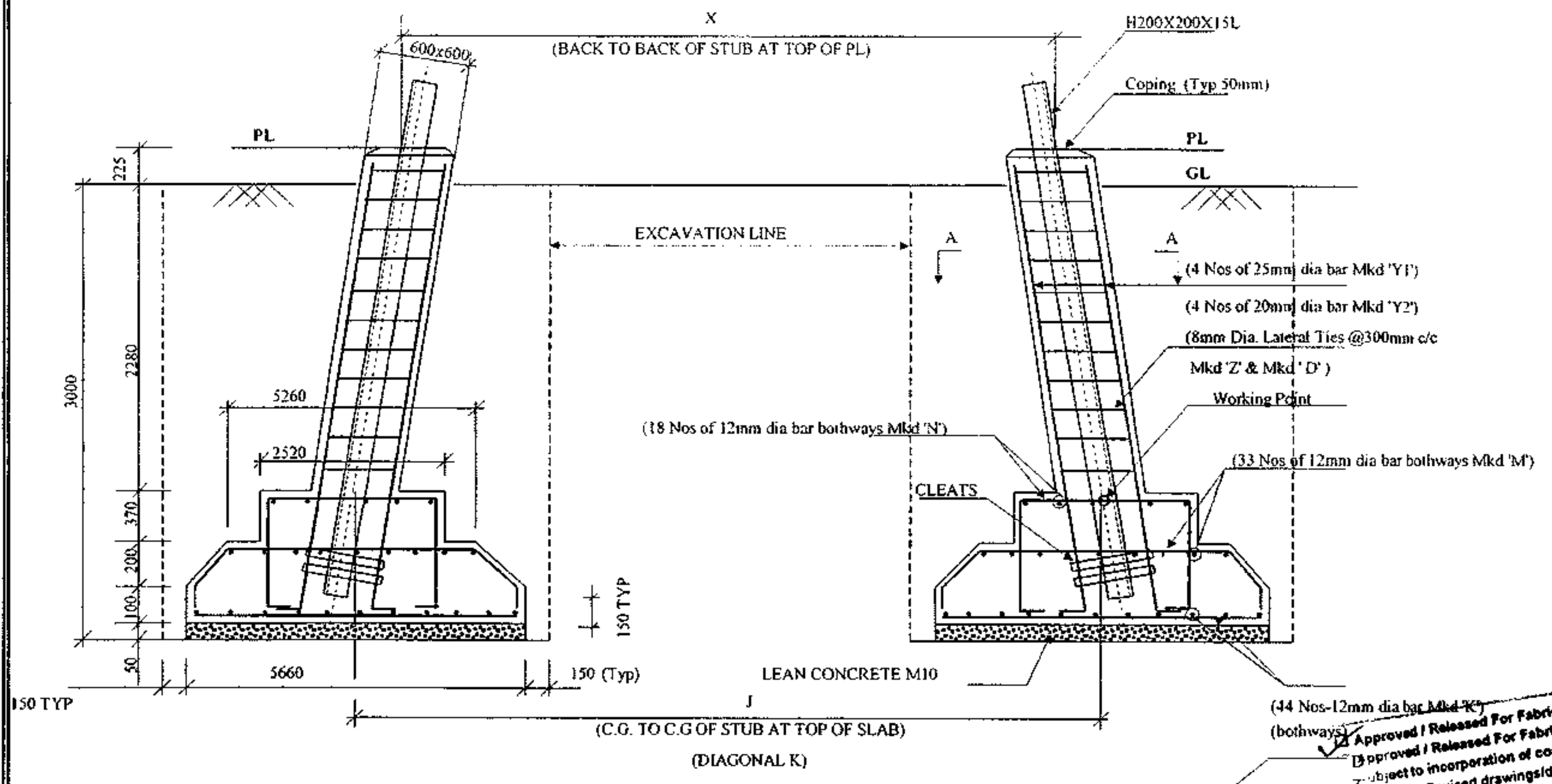
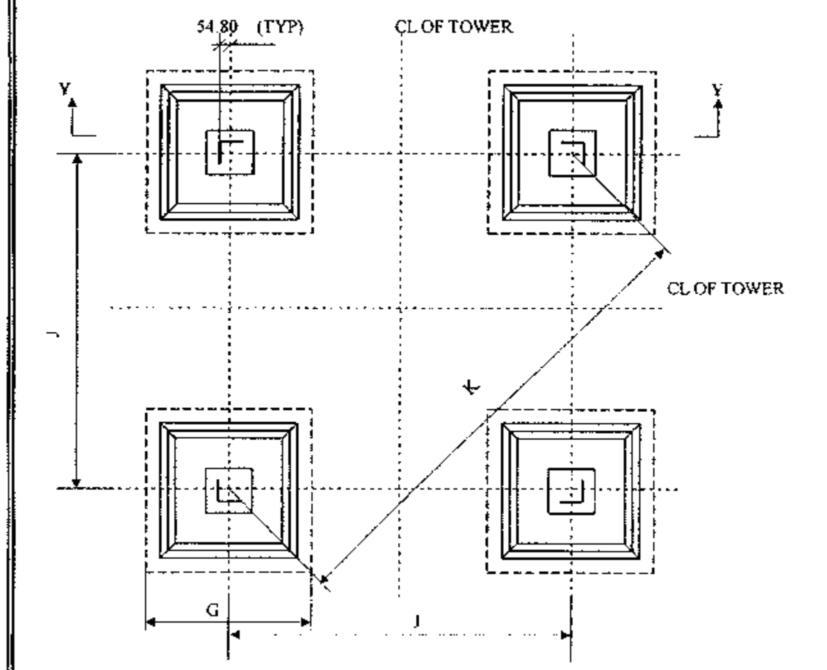


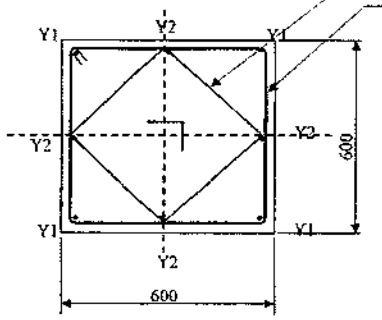
FIGURE -5

SOIL TYPE	Basic Body/ Leg Extn	FOUNDATION X (Back to Back) in mm	J in mm (C/C)	K in mm	Volume of Concrete Per Tower in M^3 M20	M10	EXCAVATION Width in mm	Volume per Tower in M^3	Reinforcement Per Tower in kg
WET	QD+0MBE	11010	12021	17001	49.68	6.41	5960	426.26	3931





PLAN
DETAILS OF FOUNDATION



SECTION A - A

NOTES

1. ALL DIMENSIONS ARE IN MM. UNLESS OTHER WISE SPECIFIED
2. CONCRETE GRADE IS M 20 UNLESS OTHERWISE SPECIFIED.
3. CONCRETE COVER IS 50mm UNLESS OTHERWISE STATED.
4. MIX PROPERTIES CONFIRMING TO IS 456-2000.
5. STEEL USED IS Fe500 CONFORMING TO IS 1786 -2008
6. DURING PLACEMENT OF REINFORCEMENT BARS,THE BAR SPACING HAS TO READJUSTED TO PROVIDE PROPER CLEARANCE FOR CLEATS
7. FOR FOUNDATION DESIGN REFER DOCUMENT:O17123-T-TL-4M-DC-4001B
8. SST DRAWINGS SHALL BE REFERED FOR THE VALUES OF X (INDICATED IN THE TABLE) FOR CONSTRUCTION PURPOSE
9. FOR SPLICING, LAP LENGTH TO BE PROVIDED IS 57d, d= DIA OF LARGER BAR.

BAR BENDING SCHEDULE

Mkd No	SKETCH	Dia in MM	Length in MM	Nos/ Leg	Unit Wt in Kg/m	Wt/ Leg Kg	Total Wt/Tower Kg
K	5560	12	5560	88	0.888	434.5	1738.0
M	212 20 5160 212 20	12	5624	66	0.888	329.6	1318.4
N	540 100 2420 100 540	12	3700	36	0.888	118.3	473.2
Y1	300 3026	25	3326	4	3.853	51.3	205.2
Y2	300 3031	20	3331	4	2.466	32.9	131.6
Z	500 500	8	2150	11	0.395	9.3	37.2
D	354	8	1564	11	0.395	6.8	27.2
			Total weight of steel required in Kg =				3931

THIS FOUNDATION HAS BEEN DESIGNED FOR
THE FOLLOWING PARAMETERS:
TYPE OF SOIL: WET (3m Depth)
UNIT WEIGHT: 940/1440 kg/m3
LIMIT BEARING CAPACITY: 13675 Kg/m2
ANGLE OF REPOSE: 15/25 Deg
WATER TABLE: 1.50 m to 3.0 m from GL

LEG SLOPE 0.22376

Approved / Released For Fabrication/Construction
Approved / Released For Fabrication/Construction subject to incorporation of comments, modification
Revised drawings/designs required to be resubmitted for approval after incorporating comments
For information and record
Not approved
CAT I
Nepal Electricity Authority
Tamakoshi-Kathmandu 220 ... Transmission Line Project
Checked By:
Recommended By:
Approved By:
Date: 4/7/018
Date: 4/7/018
Date:

निर्माण हेतु अनुमोदित।
निर्माण हेतु अनुमोदित एवं आवश्यक टिप्पणियाँ
कृपया संशोधित
अनुमोदनार्थ प्रस्तुत करें।
टिप्पणियों को सम्मिलित कर
अनुमोदनार्थ प्रस्तुत करें।
सूचनार्थ एवं रिकार्ड हेतु।
अनुमोदित नहीं।
CAT 1
20/6/18

CLIENT : NEPAL ELECTRICITY AUTHORITY
(An Undertaking of Government of Nepal)

CONTRACTOR : L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT: TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)

TITLE : FOUNDATION DESIGN & DRAWING OF TOWER TYPE "QD/DE" +0M BE WET SOIL (DEPTH=3M) (132kV D/C BEAR) (WIND ZONE - 4)

	NAME	DATE
DSND	MDJ	19.03.2018
DRWN	MDJ	19.03.2018
CHKD	RJR	19.03.2018
APPD	CSR	19.03.2018
SCALE	NTS	

Document No	REV.
O17123-T-TL-4M-DC-4001B	0

Rev No	DATE	DESCRIPTION	PREP	CHKD	APPD
0	19.03.2018	First submission for Approval	MDJ	RJR	CSR

L&T Construction
Power Transmission & Distribution

CLIENT : **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONSULTANT पावरग्रिड **POWER GRID CORPORATION OF INDIA LTD**

PROJECT : TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

LOA No. : 073/74-201 Dated: 24.04.2017

DRG. No. : O17123-T-TL-4M-GA-0401B

BOM No. : BOM/LE17D124/132kV/QD/001B

NO OF SHEETS: 2

CAT-I

श्रेणियां
I. फेब्रीकेशन / निर्माण हेतु अनुमोदित।
II. फेब्रीकेशन / निर्माण हेतु अनुमोदित। बशर्ते दी गई टिप्पणियों एवं आशोधनों को सम्मिलित किया जाए। कृपया आशोधित दस्तावेज अनुमोदनार्थ प्रस्तुत करें।
III. टिप्पणियों को सम्मिलित कर पुनः अनुमोदनार्थ प्रस्तुत करें।
IV. सूचनार्थ एवं रिकार्ड हेतु।
V. अनुमोदित नहीं।
पावरग्रिड (हस्ताक्षर) (नाम / क्र.संख्या) (तिथि) 24/06/19
पावर ग्रिड कारपोरेशन ऑफ इंडिया लि० ... (पा.ग्रा.लाईन) गुरुग्राम, (हरियाणा)
This document is recommended for approval for construction of 400kV/132kV D/C TAMAKOSHI - BARHABISE - KATHMANDU in NEPAL

CAT I

Approved / Released For Fabrication/Construction
Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
To be resubmitted for approval after incorporating the comments
For information
Not approved

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kV
Transmission Line Project
Checked By: Date: 17/7/2019
Recommended By: Date: 11
Approved By: Date:

BILL OF MATERIAL
2M STUB EXTENDER FOR TOWER TYPE - "QD/DE" (132kV, WZ-4)
(FOR +0M EXTN.) ONE CORNER ONLY

WEIGHT OF STRUCTURE	
HT MEMBERS: BOM/LE17D124/QD2RC	128.407
MS MEMBERS INCLUDING PACK WASHERS AND ACCESSORIES ETC.	-
WEIGHT OF BOLTS & NUTS,SPRING WASHERS: BOM/LE17D124/QD2RB	5.536
TOTAL WEIGHT OF STRUCTURE:	133.943 Kgs

THIS STUB EXTENDER SHALL COMPLETE WITH EXISTING STANDARD STUB OF QD TYPE TOWER FOR 3M DEPTH FOUNDATION

REV.	DATE	DESCRIPTION	CHKD.	REVED.	APPD.
0	29.05.19	FIRST SUBMISSION FOR APPROVAL	KMK	BSR	CSR

PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY	DATE
ALEX	KMK	BSR	CSR	29.05.19

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 29-May-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/QD2RC

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
	BOM OF 2M STUB EXTENDER (FOR +0M EXTN.) FOR TOWER TYPE-"QD/DE" (132kV WZ-4) ONE CORNER							
1	N1MQD2E1H	L200X200X15H-E350A	2088.00	45.600	1	95.213	95.213	
2	N1MQD2E2H	L150X150X12H-E350A	606.00	27.300	1	16.544	16.544	
3	N1MQD2E3H	10MM PLATE H-E350A	175.00 X 606.00	78.500	2	8.325	16.650	
				Total Weight :			**128.407**	

Associated Parts

Part Code	Type of Association	Associated with	Total Weight

No Association Part

Raw Material Involved	Standard Material	Total Weight (In Kg)
BOM OF 2M STUB EXTENDER (FOR +0M EXTN.) FOR TOWER TYPE-"QD/DE" (132kV WZ-4) ONE CORNER		
10MM PLATE H-E350A	HT	16.650
L150X150X12H-E350A	HT	16.544
L200X200X15H-E350A	HT	95.213
	Total	128.407
	HT	**128.407**

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 29-May-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/QD2RB

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
	BOLTS & NUTS OF 2M STUB EXTENDER (FOR +0M EXTN.) FOR TOWER TYPE-"QD/DE" (132kV WZ-4) ONE CORNER							
1	QD2RB1	M16x65MM LONG (IS:12427)		0.164	32	0.164	5.248	
2	QD2RB2	M16x3.5MM SPRING WASHER IS3063		0.009	32	0.009	0.288	
				Total Weight :			**5.536**	

Associated Parts

Part Code	Type of Association	Associated with	Total Weight

No Association Part

Raw Material Involved	Standard Material	Total Weight (In Kg)
BOLTS & NUTS OF 2M STUB EXTENDER (FOR +0M EXTN.) FOR TOWER TYPE-"QD/DE" (132kV WZ-4) ONE CORNER		
M16x3.5MM SPRING WASHER IS3063		0.288
M16x65MM LONG (IS:12427)		5.248
	Total	5.536

** -- Item Welded with another item
*** -- Item Assembled with another item

L&T Construction
Power Transmission & Distribution

CLIENT : **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONSULTANT : पावरग्रिड **POWER GRID CORPORATION OF INDIA LTD**

PROJECT : TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

LOA No. : 073/74-201 Dated: 24.04.2017

DRG. No. : O17123-T-TL-4M-GA-0403

BOM No. : BOM/LE17D124/132kV/QD/003

NO OF SHEETS: 8

BILL OF MATERIAL

CAT I +0M BODY EXTN. FOR TOWER TYPE - "QD/DE" (132kV, WZ-4)

☐ Approved / Released For Fabrication/Construction
☐ Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
☐ To be resubmitted for approval after incorporating the comments
☐ For information and record
☐ Not approved

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kV Transmission Line Project
Checked By: Date: 27/05/2019
Recommended By:
Approved By: Date:

WEIGHT OF STRUCTURE	
HT MEMBERS: BOM/LE17D124/PQD0E/SQD0H/R-0	1829.104
MS MEMBERS INCLUDING PACK WASHERS AND ACCESSORIES ETC. BOM/LE17D124/PQD0E/SQD0M/R-0 = 748.080 BOM/LE17D124/PQD0B/SQD0W/R-0 = 0.776	748.856
WEIGHT OF BOLTS & NUTS,SPRING WASHERS: BOM/LE17D124/PQD0B/SQD0B/R-0	95.474 △1
TOTAL WEIGHT OF STRUCTURE:	2673.434 Kgs △1

SUCCESSFULLY TESTED AT L&T-TLRTS-KANCHIPURAM ON 24th OF AUGUST 2018

REV.	DATE	DESCRIPTION	CHKD.	REVED.	APPD.
1	18.12.18	STEP BOLT WEIGHT REVISED	PU	BSR	CSR
0	27.08.18	SUBMISSION FOR APPROVAL AFTER SUCCESSFUL TESTING	PU	BSR	CSR

PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY	DATE
ALEX	PU	BSR	CSR	27.08.18

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/PQD0E//R-0

Date 27-08-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
+0M BODY EXTN. FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
1	N1MQD21SH	L200x200x15H-E350A	5235.00		45.600	2	238.716	477.432
2	N1MQD22H	L200x200x15H-E350A	5235.00		45.600	2	238.716	477.432
3	N1MQD23H	L150x150x12H-E350A	606.00		27.300	4	16.544	66.176
4	N1MQD24H	10MM PLATE H-E350A	175.00 X	606.00	78.500	8	8.325	66.600
5	N1MQD25L	L80x80x6-E250A	2800.00		7.300	2	20.440	40.880
6	N1MQD25R	L80x80x6-E250A	2800.00		7.300	2	20.440	40.880
7	N1MQD26LH	L90x90x6H-E350A	2800.00		8.200	2	22.960	45.920
8	N1MQD26RH	L90x90x6H-E350A	2800.00		8.200	2	22.960	45.920
9	N1MQD27L	L80x80x6-E250A	4615.00		7.300	2	33.690	67.380
10	N1MQD27R	L80x80x6-E250A	4615.00		7.300	2	33.690	67.380
11	N1MQD28LH	L90x90x6H-E350A	4615.00		8.200	2	37.843	75.686
12	N1MQD28RH	L90x90x6H-E350A	4615.00		8.200	2	37.843	75.686
13	N1MQD29L	L65x65x5-E250A	286.00		4.900	2	1.401	2.802
14	N1MQD29R	L65x65x5-E250A	286.00		4.900	2	1.401	2.802
15	N1MQD30LH	L70x70x5H-E350A	286.00		5.300	2	1.516	3.032
16	N1MQD30RH	L70x70x5H-E350A	286.00		5.300	2	1.516	3.032
17	N1MQD31	5MM PLATE-E250A	70.00 X	286.00	39.250	8	0.786	6.288
18	N1MQD32H	5MM PLATE H-E350A	70.00 X	286.00	39.250	8	0.786	6.288
19	N1MQD33L	L50x50x4-E250A	1482.00		3.000	4	4.446	17.784
20	N1MQD33R	L50x50x4-E250A	1482.00		3.000	4	4.446	17.784
21	N1MQD34	5MM PLATE-E250A	120.00 X	139.00	39.250	8	0.655	5.240
22	N1MQD35L	L55x55x4-E250A	2059.00		3.300	4	6.795	27.180
23	N1MQD35R	L55x55x4-E250A	2059.00		3.300	4	6.795	27.180
24	N1MQD36LH	L60x60x4H-E350A	2913.00		3.700	3	10.778	32.334
25	N1MQD36RH	L60x60x4H-E350A	2913.00		3.700	3	10.778	32.334
26	N1MQD36AH	L60x60x4H-E350A	2913.00		3.700	1	10.778	10.778
27	N1MQD36BH	L60x60x4H-E350A	2913.00		3.700	1	10.778	10.778
28	N1MQD37	5MM PLATE-E250A	110.00 X	120.00	39.250	8	0.518	4.144
29	N1MQD37AH	5MM PLATE H-E350A	120.00 X	124.00	39.250	8	0.584	4.672
30	N1MQD38L	L55x55x4-E250A	2018.00		3.300	3	6.659	19.977
31	N1MQD38R	L55x55x4-E250A	2018.00		3.300	3	6.659	19.977
32	N1MQD38AL	L55x55x4-E250A	2018.00		3.300	1	6.659	6.659

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION

TRANSMISSION LINE DESIGN

MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.

PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Order Ref. -

Drg No. - -

BOM No. BOM/LE17D124/PQD0E//R-0

Date 27-08-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
+0M BODY EXTN. FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
33	N1MQD38AR	L55x55x4-E250A	2018.00		3.300	1	6.659	6.659
34	N1MQD39L	L45x45x4-E250A	2054.00		2.700	4	5.546	22.184
35	N1MQD39R	L45x45x4-E250A	2054.00		2.700	4	5.546	22.184
36	N1MQD40L	L45x45x4-E250A	1785.00		2.700	4	4.820	19.280
37	N1MQD40R	L45x45x4-E250A	1785.00		2.700	4	4.820	19.280
38	N1MQD41H	8MM PLATE H-E350A	242.00 X	290.00	62.800	4	4.407	17.628
39	N1MQD42H	L55x55x5H-E350A	4700.00		4.100	4	19.270	77.080
40	N1MQD43H	L55x55x5H-E350A	3931.00		4.100	4	16.117	64.468
41	N1MQD44H	L50x50x5H-E350A	286.00		3.800	4	1.087	4.348
42	N1MQD45H	5MM PLATE H-E350A	50.00 X	286.00	39.250	8	0.561	4.488
43	N1MQD46	5MM PLATE-E250A	108.00 X	122.00	39.250	8	0.517	4.136
44	N1MQD47H	L50x50x4H-E350A	2017.00		3.000	4	6.051	24.204
45	N1MQD48	L45x45x4-E250A	3768.00		2.700	4	10.174	40.696
46	N1MQD48X	L45x45x4-E250A	3768.00		2.700	4	10.174	40.696
47	N1MQD49	L45x45x4-E250A	5405.00		2.700	8	14.594	116.752
48	N1MQD50	L45x45x4-E250A	1604.00		2.700	8	4.331	34.648
49	N1MQD51H	5MM PLATE H-E350A	110.00 X	145.00	39.250	8	0.626	5.008
50	N1MQD52L	5MM PLATE-E250A	150.00 X	210.00	39.250	4	1.236	4.944
51	N1MQD52R	5MM PLATE-E250A	150.00 X	210.00	39.250	4	1.236	4.944
52	N1MQD53L	5MM PLATE-E250A	110.00 X	173.00	39.250	4	0.747	2.988
53	N1MQD53R	5MM PLATE-E250A	110.00 X	173.00	39.250	4	0.747	2.988
54	N1MQD54H	L60x60x4H-E350A	4900.00		3.700	4	18.130	72.520
55	N1MQD54XH	L60x60x4H-E350A	4900.00		3.700	4	18.130	72.520
56	N1MQD54AH	L75x75x5H-E350A	412.00		5.700	4	2.348	9.392
57	N1MQD55	L45x45x4-E250A	1064.00		2.700	4	2.873	11.492
58	N1MQD56	L45x45x4-E250A	1064.00		2.700	4	2.873	11.492
59	N1MQD57H	L60x60x4H-E350A	2929.00		3.700	4	10.837	43.348
60	N1MQD58	L45x45x4-E250A	776.00		2.700	4	2.095	8.380

TOTAL WEIGHT : 2577.184

*** - Item welded with another item

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/PQD0E/P/R-0

Date 27-08-2018

Srl No	Section Invloved	Section Weight
±0M BODY EXTN. FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)		
1	L45x45x4-E250A	347.084
2	L50x50x4-E250A	35.568
3	L55x55x4-E250A	107.632
4	L65x65x5-E250A	5.604
5	L80x80x6-E250A	216.520
6	L50x50x5H-E350A	4.348
7	L55x55x5H-E350A	141.548
8	L60x60x4H-E350A	274.612
9	L70x70x5H-E350A	6.064
10	L75x75x5H-E350A	9.392
11	L90x90x6H-E350A	243.212
12	L150x150x12H-E350A	66.176
13	L200x200x15H-E350A	954.864
14	L50x50x4H-E350A	24.204
15	5MM PLATE H-E350A	20.456
16	8MM PLATE H-E350A	17.628
17	10MM PLATE H-E350A	66.600
18	5MM PLATE-E250A	35.672
	Total	2577.184

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	18-12-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/PQD0B/SQD0B/R-0		

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BOLTS & NUTS OF +0M BODY EXTN. FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)							
1	SQD0B1	M16x35MM LONG(IS:12427)		0.119	164	0.119	19.516
2	SQD0B2	M16x40MM LONG (IS:12427)		0.126	212	0.126	26.712
3	SQD0B3	M16x45MM LONG (IS:12427)		0.134	116	0.134	15.544
4	SQD0B4	M16x50MM LONG (IS:12427)		0.142	8	0.142	1.136
5	SQD0B5	M16x65MM LONG (IS:12427)		0.164	128	0.164	20.992
6	SQD0B6	M16x3.5mm SPR. WSR-IS3063		0.009	628	0.009	5.652
7	SQD0B7	M16x175LG SB (50OD) 2N+1SP		0.423	14	0.423	5.922

TOTAL WEIGHT : 95.474

*** - Item welded with another item

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION

TRANSMISSION LINE DESIGN

MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.

PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	18-12-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/PQD0B/SQD0B/R-0		

Srl No	Section Invloved	Section Weight
	BOLTS & NUTS OF +0M BODY EXTN. FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)	
1	M16x3.5mm SPR. WSR-IS3063	5.652
2	M16x175LG SB (50OD) 2N+1SP	5.922
3	M16x35MM LONG(IS:12427)	19.516
4	M16x40MM LONG (IS:12427)	26.712
5	M16x45MM LONG (IS:12427)	15.544
6	M16x50MM LONG (IS:12427)	1.136
7	M16x65MM LONG (IS:12427)	20.992
	Total	95.474

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg.No. - -
BOM No. BOM/LE17D124/PQD0B/SQD0W/R-0

Date 27-08-2018

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
PACK WASHERS OF +0M BODY EXTN. FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)							
1	SQD0W1	M16x4MM ROUND P.WASHER IS2016		0.014	16	0.014	.224
2	SQD0W2	M16x5MM ROUND P.WASHER IS2016		0.018	12	0.018	.216
3	SQD0W3	M16x6MM ROUND P.WASHER IS2016		0.021	16	0.021	.336

TOTAL WEIGHT : .776

*** - Item welded with another item

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	27-08-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/PQD0B/SQD0W/R-0		

Srl No	Section Invloved	Section Weight
	PACK WASHERS OF +0M BODY EXTN. FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)	
1	M16x4MM ROUND P.WASHER IS2016	.224
2	M16x5MM ROUND P.WASHER IS2016	.216
3	M16x6MM ROUND P.WASHER IS2016	.336
	Total	.776

L&T Construction
Power Transmission & Distribution

CLIENT :	**NEPAL ELECTRICITY AUTHORITY** (An Undertaking of Government of Nepal)
CONSULTANT :	**POWER GRID CORPORATION OF INDIA LTD**
PROJECT :	**TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE**
LOA No. :	**073/74-201 Dated: 24.04.2017**
DRG. No. :	**O17123-T-TL-4M-GA-0404 (SHEET 1 To 9)**
BOM No. :	**BOM/LE17D124/132kV/QD/004** — NO OF SHEETS: 23

BILL OF MATERIAL

BASIC BODY FOR TOWER TYPE - "QD/DE" (132kV, WZ-4)

CAT I

Approved / Released For Fabrication/Construction
Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
To be resubmitted for approval after incorporating the comments
For information and record
Not approved

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kV Transmission Line Project
Checked By: Date: 27/03/2019
Recommended By: Date:
Approved By: Date:

WEIGHT OF STRUCTURE	
HT MEMBERS: BOM/LE17D124/PQDBS/SQDBH/R-0	10679.077
MS MEMBERS INCLUDING PACK WASHERS AND ACCESSORIES ETC. BOM/LE17D124/PQDBS/SQDBM/R-0 = 2695.252 BOM/LE17D124/PQDBB/SQDBW/R-0 = 9.866	2705.118
WEIGHT OF BOLTS & NUTS,SPRING WASHERS: BOM/LE17D124/PQDBB/SQDBB/R-0	626.945 △1
TOTAL WEIGHT OF STRUCTURE:	**14011.14 Kgs** △1

SUCCESSFULLY TESTED AT L&T-TLRTS-KANCHIPURAM ON 24th OF AUGUST 2018

REV.	DATE	DESCRIPTION	CHKD.	REVED.	APPD.
1	18.12.18	STEP BOLT WEIGHT REVISED	PU	BSR	CSR
0	27.08.18	SUBMISSION FOR APPROVAL AFTER SUCCESSFUL TESTING	PU	BSR	CSR

PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY	DATE
ALEX	PU	BSR	CSR	27.08.18

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/PQDBS//R-0

Date 27-08-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
1	N1MQD70SH	L200x200x15H-E350A	3570.00		45.600	2	162.792	325.584
2	N1MQD71H	L200x200x15H-E350A	3570.00		45.600	2	162.792	325.584
3	N1MQD72SH	L200x200x15H-E350A	6163.00		45.600	2	281.033	562.066
4	N1MQD73H	L200x200x15H-E350A	6163.00		45.600	2	281.033	562.066
5	N1MQD74H	L150x150x12H-E350A	606.00		27.300	8	16.544	132.352
6	N1MQD75H	10MM PLATE H-E350A	175.00 X	606.00	78.500	16	8.325	133.200
7	N1MQD76L	L90x90x6-E250A	4849.00		8.200	2	39.762	79.524
8	N1MQD76R	L90x90x6-E250A	4849.00		8.200	2	39.762	79.524
9	N1MQD77LH	L90x90x6H-E350A	4849.00		8.200	2	39.762	79.524
10	N1MQD77RH	L90x90x6H-E350A	4849.00		8.200	2	39.762	79.524
11	N1MQD78L	L60x60x4-E250A	2473.00		3.700	4	9.150	36.600
12	N1MQD78R	L60x60x4-E250A	2473.00		3.700	4	9.150	36.600
13	N1MQD79	L45x45x4-E250A	1771.00		2.700	8	4.782	38.256
14	N1MQD80L	L65x65x4-E250A	2197.00		4.000	4	8.788	35.152
15	N1MQD80R	L65x65x4-E250A	2197.00		4.000	4	8.788	35.152
16	N1MQD81H	L90x90x6H-E350A	5500.00		8.200	2	45.100	90.200
17	N1MQD81XH	L90x90x6H-E350A	5500.00		8.200	2	45.100	90.200
18	N1MQD82H	L90x90x6H-E350A	2929.00		8.200	2	24.018	48.036
19	N1MQD82XH	L90x90x6H-E350A	2929.00		8.200	2	24.018	48.036
20	N1MQD83H	L70x70x5H-E350A	286.00		5.300	4	1.516	6.064
21	N1MQD84H	5MM PLATE H-E350A	70.00 X	286.00	39.250	8	0.786	6.288
22	N1MQD85H	L45x45x4H-E350A	1143.00		2.700	4	3.086	12.344
23	N1MQD87H	L55x55x4H-E350A	2022.00		3.300	4	6.673	26.692
24	N1MQD88H	L60x60x4H-E350A	2235.00		3.700	4	8.270	33.080
25	N1MQD90	L50x50x4-E250A	2448.00		3.000	4	7.344	29.376
26	N1MQD91H	L50x50x4H-E350A	1776.00		3.000	2	5.328	10.656
27	N1MQD91XH	L50x50x4H-E350A	1776.00		3.000	2	5.328	10.656
28	N1MQD93H	L90x90x7H-E350A	4474.00		9.600	2	42.950	85.900
29	N1MQD93AH	8MM PLATE H-E350A	185.00 X	201.00	62.800	4	2.335	9.340
30	N1MQD94H	L90x90x7H-E350A	5500.00		9.600	2	52.800	105.600
31	N1MQD94XH	L90x90x7H-E350A	5500.00		9.600	2	52.800	105.600
32	N1MQD95H	L90x90x7H-E350A	2897.00		9.600	2	27.811	55.622

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/PQDBS//R-0

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
33	N1MQD95XH	L90x90x7H-E350A	2897.00		9.600	2	27.811	55.622
34	N1MQD96H	L70x70x6H-E350A	346.00		6.300	4	2.180	8.720
35	N1MQD97H	5MM PLATE H-E350A	70.00 X	346.00	39.250	8	0.951	7.608
36	N1MQD98H	L45x45x4H-E350A	1127.00		2.700	4	3.043	12.172
37	N1MQD100H	L55x55x4H-E350A	2035.00		3.300	4	6.716	26.864
38	N1MQD101H	L60x60x4H-E350A	2203.00		3.700	4	8.151	32.604
39	N1MQD103	L50x50x4-E250A	2388.00		3.000	4	7.164	28.656
40	N1MQD104H	L50x50x4H-E350A	1822.00		3.000	2	5.466	10.932
41	N1MQD104XH	L50x50x4H-E350A	1822.00		3.000	2	5.466	10.932
42	N1MQD106H	L90x90x7H-E350A	4765.00		9.600	2	45.744	91.488
43	N1MQD107H	8MM PLATE H-E350A	225.00 X	294.00	62.800	4	4.154	16.616
44	N1MQD108	5MM PLATE-E250A	120.00 X	191.00	39.250	4	0.900	3.600
45	N1MQD109H	L60x60x4H-E350A	3013.00		3.700	4	11.148	44.592
46	N1MQD110LH	5MM PLATE H-E350A	110.00 X	182.00	39.250	4	0.786	3.144
47	N1MQD110RH	5MM PLATE H-E350A	110.00 X	182.00	39.250	4	0.786	3.144
48	N1MQD111	L45x45x4-E250A	1288.00		2.700	2	3.478	6.956
49	N1MQD112	L45x45x4-E250A	2666.00		2.700	2	7.198	14.396
50	N1MQD113	L45x45x4-E250A	2605.00		2.700	2	7.034	14.068
51	N1MQD114	L45x45x4-E250A	3432.00		2.700	2	9.266	18.532
52	N1MQD115	L45x45x4-E250A	3399.00		2.700	2	9.177	18.354
53	N1MQD116	5MM PLATE-E250A	110.00 X	175.00	39.250	6	0.756	4.536
54	N1MQD118	5MM PLATE-E250A	110.00 X	165.00	39.250	6	0.712	4.272
55	N1MQD120	L45x45x4-E250A	1288.00		2.700	2	3.478	6.956
56	N1MQD121	L45x45x4-E250A	2627.00		2.700	2	7.093	14.186
57	N1MQD122	L45x45x4-E250A	2644.00		2.700	2	7.139	14.278
58	N1MQD123	L45x45x4-E250A	3411.00		2.700	2	9.210	18.420
59	N1MQD124	L45x45x4-E250A	3422.00		2.700	2	9.239	18.478
60	N1MQD125	5MM PLATE-E250A	110.00 X	165.00	39.250	6	0.712	4.272
61	N1MQD127	5MM PLATE-E250A	110.00 X	175.00	39.250	6	0.756	4.536
62	N1MQD129H	L45x45x4H-E350A	1938.00		2.700	2	5.233	10.466
63	N1MQD130H	5MM PLATE H-E350A	110.00 X	165.00	39.250	2	0.712	1.424
64	N1MQD131H	5MM PLATE H-E350A	110.00 X	175.00	39.250	2	0.756	1.512

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/PQDBS//R-0

Date 27-08-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
65	N1MQD132H	L45x45x4H-E350A	1941.00		2.700	2	5.241	10.482
66	N1MQD133H	5MM PLATE H-E350A	110.00 X	165.00	39.250	2	0.712	1.424
67	N1MQD134H	5MM PLATE H-E350A	110.00 X	175.00	39.250	2	0.756	1.512
68	N1MQD160SH	L150x150x18H-E350A	4000.00		40.100	2	160.400	320.800
69	N1MQD161H	L150x150x18H-E350A	4000.00		40.100	2	160.400	320.800
70	N1MQD162SH	L150x150x14H-E350A	4000.00		31.500	2	126.000	252.000
71	N1MQD163H	L150x150x14H-E350A	4000.00		31.500	2	126.000	252.000
72	N1MQD164SH	L130x130x12H-E350A	4036.00		23.500	2	94.846	189.692
73	N1MQD165H	L130x130x12H-E350A	4036.00		23.500	2	94.846	189.692
74	N1MQD166H	L150x150x12H-E350A	476.00		27.300	4	12.995	51.980
75	N1MQD167H	10MM PLATE H-E350A	150.00 X	476.00	78.500	8	5.605	44.840
76	N1MQD168	3MM PLATE-E250A	100.00 X	230.00	23.550	8	0.542	4.336
77	N1MQD169H	L130x130x10H-E350A	472.00		19.700	4	9.298	37.192
78	N1MQD170H	10MM PLATE H-E350A	130.00 X	472.00	78.500	8	4.817	38.536
79	N1MQD171	4MM PLATE-E250A	100.00 X	225.00	31.400	8	0.707	5.656
80	N1MQD172H	L120x120x8H-E350A	380.00		14.700	4	5.586	22.344
81	N1MQD173H	8MM PLATE H-E350A	110.00 X	380.00	62.800	8	2.625	21.000
82	N1MQD174	2MM PLATE-E250A	85.00 X	185.00	15.700	8	0.247	1.976
83	N1MQD175L	L75x75x6-E250A	2436.00		6.800	2	16.565	33.130
84	N1MQD175R	L75x75x6-E250A	2436.00		6.800	2	16.565	33.130
85	N1MQD176LH	L100x100x8H-E350A	2469.00		12.100	2	29.875	59.750
86	N1MQD176RH	L100x100x8H-E350A	2469.00		12.100	2	29.875	59.750
87	N1MQD177H	L100x100x7H-E350A	4389.00		10.700	2	46.962	93.924
88	N1MQD179	8MM PLATE-E250A	75.00 X	90.00	62.800	8	0.424	3.392
89	N1MQD180H	8MM PLATE H-E350A	165.00 X	225.00	62.800	4	2.331	9.324
90	N1MQD181	8MM PLATE-E250A	50.00 X	93.00	62.800	4	0.292	1.168
91	N1MQD182H	L110x110x8H-E350A	5030.00		13.400	2	67.402	134.804
92	N1MQD182XH	L110x110x8H-E350A	5030.00		13.400	2	67.402	134.804
93	N1MQD183	L45x45x4-E250A	1236.00		2.700	4	3.337	13.348
94	N1MQD184	L45x30x4-E250A	1352.00		2.200	4	2.974	11.896
95	N1MQD185	L45x45x4-E250A	1313.00		2.700	2	3.545	7.090
96	N1MQD185X	L45x45x4-E250A	1313.00		2.700	2	3.545	7.090

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/PQDBS//R-0

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
97	N1MQD186	L75x75x6-E250A	4074.00		6.800	2	27.703	55.406
98	N1MQD187H	8MM PLATE H-E350A	170.00 X	293.00	62.800	4	3.128	12.512
99	N1MQD188	8MM PLATE-E250A	50.00 X	93.00	62.800	4	0.292	1.168
100	N1MQD189L	L70x70x5-E250A	2243.00		5.300	2	11.888	23.776
101	N1MQD189R	L70x70x5-E250A	2243.00		5.300	2	11.888	23.776
102	N1MQD190LH	L100x100x6H-E350A	2298.00		9.200	2	21.142	42.284
103	N1MQD190RH	L100x100x6H-E350A	2298.00		9.200	2	21.142	42.284
104	N1MQD191H	L100x100x7H-E350A	3948.00		10.700	2	42.244	84.488
105	N1MQD192H	8MM PLATE H-E350A	155.00 X	178.00	62.800	4	1.733	6.932
106	N1MQD193H	L100x100x8H-E350A	4673.00		12.100	2	56.543	113.086
107	N1MQD193XH	L100x100x8H-E350A	4673.00		12.100	2	56.543	113.086
108	N1MQD194	L45x45x4-E250A	1143.00		2.700	4	3.086	12.344
109	N1MQD195	L45x30x4-E250A	1355.00		2.200	4	2.981	11.924
110	N1MQD196	L45x45x4-E250A	1226.00		2.700	2	3.310	6.620
111	N1MQD196X	L45x45x4-E250A	1226.00		2.700	2	3.310	6.620
112	N1MQD197	L65x65x5-E250A	3634.00		4.900	2	17.807	35.614
113	N1MQD198H	8MM PLATE H-E350A	155.00 X	280.00	62.800	4	2.726	10.904
114	N1MQD199	L45x30x4-E250A	958.00		2.200	2	2.108	4.216
115	N1MQD200	5MM PLATE-E250A	107.00 X	237.00	39.250	2	0.995	1.990
116	N1MQD201H	L90x90x6H-E350A	4014.00		8.200	2	32.915	65.830
117	N1MQD201XH	L90x90x6H-E350A	4014.00		8.200	2	32.915	65.830
118	N1MQD202	L45x30x4-E250A	957.00		2.200	2	2.105	4.210
119	N1MQD202X	L45x30x4-E250A	957.00		2.200	2	2.105	4.210
120	N1MQD203H	L50x50x4H-E350A	1898.00		3.000	2	5.694	11.388
121	N1MQD203XH	L50x50x4H-E350A	1898.00		3.000	2	5.694	11.388
122	N1MQD204	L45x30x4-E250A	1034.00		2.200	2	2.275	4.550
123	N1MQD204X	L45x30x4-E250A	1034.00		2.200	2	2.275	4.550
124	N1MQD205H	8MM PLATE H-E350A	150.00 X	230.00	62.800	4	2.167	8.668
125	N1MQD206H	L100x100x7H-E350A	3928.00		10.700	2	42.030	84.060
126	N1MQD206XH	L100x100x7H-E350A	3928.00		10.700	2	42.030	84.060
127	N1MQD207	L45x30x4-E250A	973.00		2.200	2	2.141	4.282
128	N1MQD207X	L45x30x4-E250A	973.00		2.200	2	2.141	4.282

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/PQDBS//R-0

Date 27-08-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
129	N1MQD208	L45x30x4-E250A	1023.00		2.200	4	2.251	9.004
130	N1MQD209	L45x30x4-E250A	1026.00		2.200	2	2.257	4.514
131	N1MQD209X	L45x30x4-E250A	1026.00		2.200	2	2.257	4.514
132	N1MQD210	L75x75x6-E250A	3223.00		6.800	2	21.916	43.832
133	N1MQD211H	8MM PLATE H-E350A	158.00 X	210.00	62.800	4	2.084	8.336
134	N1MQD212H	L90x90x7H-E350A	265.00		9.600	2	2.544	5.088
135	N1MQD213	L75x75x6-E250A	2479.00		6.800	2	16.857	33.714
136	N1MQD213X	L75x75x6-E250A	2479.00		6.800	2	16.857	33.714
137	N1MQD213A	8MM PLATE-E250A	145.00 X	155.00	62.800	4	1.411	5.644
138	N1MQD214H	L80x80x6H-E350A	2516.00		7.300	2	18.367	36.734
139	N1MQD214XH	L80x80x6H-E350A	2516.00		7.300	2	18.367	36.734
140	N1MQD215H	L90x90x6H-E350A	4389.00		8.200	2	35.990	71.980
141	N1MQD216	L100x100x7-E250A	4994.00		10.700	2	53.436	106.872
142	N1MQD216X	L100x100x7-E250A	4994.00		10.700	2	53.436	106.872
143	N1MQD217	L45x45x4-E250A	1229.00		2.700	2	3.318	6.636
144	N1MQD217X	L45x45x4-E250A	1229.00		2.700	2	3.318	6.636
145	N1MQD218	L45x30x4-E250A	1316.00		2.200	4	2.895	11.580
146	N1MQD219	L45x45x4-E250A	1302.00		2.700	2	3.515	7.030
147	N1MQD219X	L45x45x4-E250A	1302.00		2.700	2	3.515	7.030
148	N1MQD220	L80x80x6-E250A	4329.00		7.300	2	31.602	63.204
149	N1MQD221	L75x75x6-E250A	248.00		6.800	2	1.686	3.372
150	N1MQD222	L70x70x5-E250A	2280.00		5.300	2	12.084	24.168
151	N1MQD222X	L70x70x5-E250A	2280.00		5.300	2	12.084	24.168
152	N1MQD223H	L75x75x6H-E350A	2378.00		6.800	2	16.170	32.340
153	N1MQD223XH	L75x75x6H-E350A	2378.00		6.800	2	16.170	32.340
154	N1MQD224H	L100x100x6H-E350A	3948.00		9.200	2	36.322	72.644
155	N1MQD225H	L90x90x6H-E350A	4633.00		8.200	2	37.991	75.982
156	N1MQD225XH	L90x90x6H-E350A	4633.00		8.200	2	37.991	75.982
157	N1MQD226	L45x45x4-E250A	1135.00		2.700	2	3.065	6.130
158	N1MQD226X	L45x45x4-E250A	1135.00		2.700	2	3.065	6.130
159	N1MQD227	L45x30x4-E250A	1319.00		2.200	4	2.902	11.608
160	N1MQD228	L45x45x4-E250A	1214.00		2.700	2	3.278	6.556

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/PQDBS//R-0

Date 27-08-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
161	N1MQD228X	L45x45x4-E250A	1214.00		2.700	2	3.278	6.556
162	N1MQD229	L65x65x4-E250A	3888.00		4.000	2	15.552	31.104
163	N1MQD230	6MM PLATE-E250A	155.00 X	215.00	47.100	4	1.570	6.280
164	N1MQD231	L45x30x4-E250A	1119.00		2.200	2	2.462	4.924
165	N1MQD232H	L75x75x6H-E350A	4034.00		6.800	2	27.431	54.862
166	N1MQD232XH	L75x75x6H-E350A	4034.00		6.800	2	27.431	54.862
167	N1MQD233	L45x30x4-E250A	1006.00		2.200	2	2.213	4.426
168	N1MQD233X	L45x30x4-E250A	1006.00		2.200	2	2.213	4.426
169	N1MQD234H	L55x55x4H-E350A	1727.00		3.300	4	5.699	22.796
170	N1MQD235	L45x30x4-E250A	1044.00		2.200	2	2.297	4.594
171	N1MQD235X	L45x30x4-E250A	1044.00		2.200	2	2.297	4.594
172	N1MQD236H	8MM PLATE H-E350A	150.00 X	202.00	62.800	4	1.903	7.612
173	N1MQD237H	L75x75x6H-E350A	3909.00		6.800	2	26.581	53.162
174	N1MQD237XH	L75x75x6H-E350A	3909.00		6.800	2	26.581	53.162
175	N1MQD238	L45x30x4-E250A	983.00		2.200	2	2.163	4.326
176	N1MQD238X	L45x30x4-E250A	983.00		2.200	2	2.163	4.326
177	N1MQD239	L45x30x4-E250A	1054.00		2.200	4	2.319	9.276
178	N1MQD240	L45x30x4-E250A	1047.00		2.200	2	2.303	4.606
179	N1MQD240X	L45x30x4-E250A	1047.00		2.200	2	2.303	4.606
180	N1MQD241H	L50x50x4H-E350A	3444.00		3.000	2	10.332	20.664
181	N1MQD242H	8MM PLATE H-E350A	150.00 X	321.00	62.800	4	3.024	12.096
182	N1MQD243H	L45x45x4H-E350A	1580.00		2.700	2	4.266	8.532
183	N1MQD244H	5MM PLATE H-E350A	110.00 X	180.00	39.250	2	0.777	1.554
184	N1MQD245H	5MM PLATE H-E350A	110.00 X	175.00	39.250	2	0.756	1.512
185	N1MQD246H	L45x45x4H-E350A	1594.00		2.700	2	4.304	8.608
186	N1MQD247H	5MM PLATE H-E350A	110.00 X	175.00	39.250	2	0.756	1.512
187	N1MQD248H	5MM PLATE H-E350A	110.00 X	180.00	39.250	2	0.777	1.554
188	N1MQD249H	L45x45x4H-E350A	1456.00		2.700	2	3.931	7.862
189	N1MQD250H	5MM PLATE H-E350A	110.00 X	175.00	39.250	2	0.756	1.512
190	N1MQD251H	5MM PLATE H-E350A	110.00 X	180.00	39.250	2	0.777	1.554
191	N1MQD252H	L45x45x4H-E350A	1470.00		2.700	2	3.969	7.938
192	N1MQD253H	5MM PLATE H-E350A	110.00 X	180.00	39.250	2	0.777	1.554

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/PQDBS//R-0

Date 27-08-2018

Sri No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
193	N1MQD254H	5MM PLATE H-E350A	110.00 X	175.00	39.250	2	0.756	1.512
194	N1MQD255H	L45x45x4H-E350A	1428.00		2.700	2	3.856	7.712
195	N1MQD256H	5MM PLATE H-E350A	110.00 X	175.00	39.250	2	0.756	1.512
196	N1MQD257H	5MM PLATE H-E350A	110.00 X	170.00	39.250	2	0.734	1.468
197	N1MQD258H	L45x45x4H-E350A	1442.00		2.700	2	3.893	7.786
198	N1MQD259H	5MM PLATE H-E350A	110.00 X	170.00	39.250	2	0.734	1.468
199	N1MQD260H	5MM PLATE H-E350A	110.00 X	175.00	39.250	2	0.756	1.512
200	N1MQD261	L45x30x4-E250A	1308.00		2.200	2	2.878	5.756
201	N1MQD262	5MM PLATE-E250A	110.00 X	170.00	39.250	2	0.734	1.468
202	N1MQD263	5MM PLATE-E250A	110.00 X	175.00	39.250	2	0.756	1.512
203	N1MQD264	L45x30x4-E250A	1322.00		2.200	2	2.908	5.816
204	N1MQD265	5MM PLATE-E250A	110.00 X	175.00	39.250	2	0.756	1.512
205	N1MQD266	5MM PLATE-E250A	110.00 X	170.00	39.250	2	0.734	1.468
206	N1MQD267	L45x30x4-E250A	1298.00		2.200	2	2.856	5.712
207	N1MQD268	5MM PLATE-E250A	110.00 X	170.00	39.250	2	0.734	1.468
208	N1MQD269	5MM PLATE-E250A	110.00 X	170.00	39.250	2	0.734	1.468
209	N1MQD270	L45x30x4-E250A	1305.00		2.200	2	2.871	5.742
210	N1MQD271	5MM PLATE-E250A	110.00 X	155.00	39.250	2	0.669	1.338
211	N1MQD272	5MM PLATE-E250A	110.00 X	170.00	39.250	2	0.734	1.468
212	N1MQD273	L45x30x4-E250A	1208.00		2.200	2	2.658	5.316
213	N1MQD274	5MM PLATE-E250A	110.00 X	170.00	39.250	2	0.734	1.468
214	N1MQD275	5MM PLATE-E250A	110.00 X	170.00	39.250	2	0.734	1.468
215	N1MQD276	L45x30x4-E250A	1217.00		2.200	2	2.677	5.354
216	N1MQD277	5MM PLATE-E250A	110.00 X	170.00	39.250	2	0.734	1.468
217	N1MQD278	5MM PLATE-E250A	110.00 X	155.00	39.250	2	0.669	1.338
218	N1MQD300SH	L110x110x8H-E350A	4050.00		13.400	2	54.270	108.540
219	N1MQD301H	L110x110x8H-E350A	4050.00		13.400	2	54.270	108.540
220	N1MQD302SH	L80x80x6H-E350A	5539.00		7.300	2	40.435	80.870
221	N1MQD303H	L80x80x6H-E350A	5539.00		7.300	2	40.435	80.870
222	N1MQD304SH	L60x60x5H-E350A	5542.00		4.500	2	24.939	49.878
223	N1MQD305H	L60x60x5H-E350A	5542.00		4.500	2	24.939	49.878
224	N1MQD306H	L100x100x6H-E350A	350.00		9.200	4	3.220	12.880

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/PQDBS//R-0 -

Date 27-08-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
225	N1MQD307H	6MM PLATE H-E350A	80.00 X	350.00	47.100	8	1.319	10.552
226	N1MQD308	4MM PLATE-E250A	80.00 X	170.00	31.400	8	0.427	3.416
227	N1MQD309H	L70x70x6H-E350A	356.00		6.300	4	2.243	8.972
228	N1MQD310H	6MM PLATE H-E350A	60.00 X	356.00	47.100	8	1.006	8.048
229	N1MQD310A	2MM PLATE-E250A	50.00 X	175.00	15.700	8	0.137	1.096
230	N1MQD311	L45x30x4-E250A	962.00		2.200	2	2.116	4.232
231	N1MQD312H	L70x70x6H-E350A	3633.00		6.300	2	22.888	45.776
232	N1MQD312XH	L70x70x6H-E350A	3633.00		6.300	2	22.888	45.776
233	N1MQD313	L45x30x4-E250A	726.00		2.200	4	1.597	6.388
234	N1MQD314	L45x30x4-E250A	887.00		2.200	2	1.951	3.902
235	N1MQD314X	L45x30x4-E250A	887.00		2.200	2	1.951	3.902
236	N1MQD315	5MM PLATE-E250A	90.00 X	140.00	39.250	2	0.495	.990
237	N1MQD316	5MM PLATE-E250A	130.00 X	140.00	39.250	2	0.714	1.428
238	N1MQD317H	L50x50x4H-E350A	1682.00		3.000	2	5.046	10.092
239	N1MQD317XH	L50x50x4H-E350A	1682.00		3.000	2	5.046	10.092
240	N1MQD318H	6MM PLATE H-E350A	160.00 X	498.00	47.100	2	3.753	7.506
241	N1MQD319	L45x30x4-E250A	953.00		2.200	2	2.097	4.194
242	N1MQD319X	L45x30x4-E250A	953.00		2.200	2	2.097	4.194
243	N1MQD320	L45x30x4-E250A	823.00		2.200	4	1.811	7.244
244	N1MQD321H	6MM PLATE H-E350A	140.00 X	179.00	47.100	4	1.180	4.720
245	N1MQD322H	L100x100x6H-E350A	3588.00		9.200	2	33.010	66.020
246	N1MQD322XH	L100x100x6H-E350A	3588.00		9.200	2	33.010	66.020
247	N1MQD323	L45x45x4-E250A	1370.00		2.700	4	3.699	14.796
248	N1MQD324	L70x70x5-E250A	2803.00		5.300	2	14.856	29.712
249	N1MQD325H	8MM PLATE H-E350A	140.00 X	250.00	62.800	4	2.198	8.792
250	N1MQD326	L45x30x4-E250A	967.00		2.200	2	2.127	4.254
251	N1MQD327H	L60x60x5H-E350A	3270.00		4.500	2	14.715	29.430
252	N1MQD327XH	L60x60x5H-E350A	3270.00		4.500	2	14.715	29.430
253	N1MQD328	5MM PLATE-E250A	162.00 X	207.00	39.250	2	1.316	2.632
254	N1MQD329	L45x30x4-E250A	784.00		2.200	2	1.725	3.450
255	N1MQD329X	L45x30x4-E250A	784.00		2.200	2	1.725	3.450
256	N1MQD330H	L50x50x4H-E350A	1447.00		3.000	2	4.341	8.682

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION

TRANSMISSION LINE DESIGN

MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.

PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Order Ref. -

Drg No. - -

BOM No. BOM/LE17D124/PQDBS//R-0

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
257	N1MQD330XH	L50x50x4H-E350A	1447.00		3.000	2	4.341	8.682
258	N1MQD331	L45x30x4-E250A	855.00		2.200	2	1.881	3.762
259	N1MQD331X	L45x30x4-E250A	855.00		2.200	2	1.881	3.762
260	N1MQD332H	8MM PLATE H-E350A	105.00 X	210.00	62.800	4	1.385	5.540
261	N1MQD333H	L75x75x6H-E350A	3233.00		6.800	2	21.984	43.968
262	N1MQD333XH	L75x75x6H-E350A	3233.00		6.800	2	21.984	43.968
263	N1MQD334	L45x30x4-E250A	1204.00		2.200	4	2.649	10.596
264	N1MQD335H	L65x65x4H-E350A	2352.00		4.000	2	9.408	18.816
265	N1MQD336H	8MM PLATE H-E350A	160.00 X	276.00	62.800	4	2.773	11.092
266	N1MQD337	6MM PLATE-E250A	50.00 X	95.00	47.100	4	0.224	.896
267	N1MQD338	L45x30x4-E250A	804.00		2.200	2	1.769	3.538
268	N1MQD339H	L50x50x4H-E350A	2638.00		3.000	2	7.914	15.828
269	N1MQD339XH	L50x50x4H-E350A	2638.00		3.000	2	7.914	15.828
270	N1MQD341H	L55x55x4H-E350A	2193.00		3.300	2	7.237	14.474
271	N1MQD342	L45x45x4-E250A	2200.00		2.700	4	5.940	23.760
272	N1MQD343	L45x45x4-E250A	1937.00		2.700	4	5.230	20.920
273	N1MQD344	L45x45x4-E250A	1645.00		2.700	4	4.442	17.768
274	N1MQD345	L45x30x4-E250A	1380.00		2.200	4	3.036	12.144
275	N1MQD346	L45x30x4-E250A	1163.00		2.200	4	2.559	10.236
276	N1MQD347	L45x30x4-E250A	458.00		2.200	4	1.008	4.032
277	N1MQD348H	8MM PLATE H-E350A	109.00 X	167.00	62.800	2	1.143	2.286
278	N1MQD349H	8MM PLATE H-E350A	156.00 X	393.00	62.800	1	3.850	3.850
279	N1MQD350	L45x30x4-E250A	1112.00		2.200	2	2.446	4.892
280	N1MQD351H	L65x65x5H-E350A	3675.00		4.900	2	18.008	36.016
281	N1MQD351XH	L65x65x5H-E350A	3675.00		4.900	2	18.008	36.016
282	N1MQD353	L45x30x4-E250A	911.00		2.200	2	2.004	4.008
283	N1MQD353X	L45x30x4-E250A	911.00		2.200	2	2.004	4.008
284	N1MQD356H	L55x55x4H-E350A	1528.00		3.300	2	5.042	10.084
285	N1MQD356XH	L55x55x4H-E350A	1528.00		3.300	2	5.042	10.084
286	N1MQD357	L45x30x4-E250A	944.00		2.200	2	2.077	4.154
287	N1MQD357X	L45x30x4-E250A	944.00		2.200	2	2.077	4.154
288	N1MQD358H	6MM PLATE H-E350A	140.00 X	157.00	47.100	4	1.035	4.140

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION

TRANSMISSION LINE DESIGN

MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.

PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Order Ref. -

Drg No. - -

BOM No. BOM/LE17D124/PQDBS//R-0

Date 27-08-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
289	N1MQD359H	L80x80x6H-E350A	3557.00		7.300	2	25.966	51.932
290	N1MQD359XH	L80x80x6H-E350A	3557.00		7.300	2	25.966	51.932
291	N1MQD361H	L50x50x4H-E350A	3003.00		3.000	2	9.009	18.018
292	N1MQD362	L45x30x4-E250A	1122.00		2.200	2	2.468	4.936
293	N1MQD363H	L65x65x4H-E350A	3313.00		4.000	2	13.252	26.504
294	N1MQD363XH	L65x65x4H-E350A	3313.00		4.000	2	13.252	26.504
295	N1MQD364	L45x30x4-E250A	808.00		2.200	2	1.778	3.556
296	N1MQD364X	L45x30x4-E250A	808.00		2.200	2	1.778	3.556
297	N1MQD365H	L50x50x4H-E350A	1309.00		3.000	2	3.927	7.854
298	N1MQD365XH	L50x50x4H-E350A	1309.00		3.000	2	3.927	7.854
299	N1MQD366	L45x30x4-E250A	848.00		2.200	2	1.866	3.732
300	N1MQD366X	L45x30x4-E250A	848.00		2.200	2	1.866	3.732
301	N1MQD367H	6MM PLATE H-E350A	105.00 X	200.00	47.100	4	0.989	3.956
302	N1MQD368H	L70x70x5H-E350A	3198.00		5.300	2	16.949	33.898
303	N1MQD368XH	L70x70x5H-E350A	3198.00		5.300	2	16.949	33.898
304	N1MQD369H	L50x50x4H-E350A	2563.00		3.000	2	7.689	15.378
305	N1MQD370H	6MM PLATE H-E350A	105.00 X	192.00	47.100	4	0.950	3.800
306	N1MQD372H	L50x50x4H-E350A	2680.00		3.000	2	8.040	16.080
307	N1MQD372XH	L50x50x4H-E350A	2680.00		3.000	2	8.040	16.080
308	N1MQD374H	6MM PLATE H-E350A	105.00 X	170.00	47.100	4	0.841	3.364
309	N1MQD375H	L55x55x4H-E350A	2193.00		3.300	2	7.237	14.474
310	N1MQD376H	8MM PLATE H-E350A	130.00 X	360.00	62.800	1	2.939	2.939
311	N1MQD377	L45x30x4-E250A	1127.00		2.200	2	2.479	4.958
312	N1MQD378	5MM PLATE-E250A	110.00 X	150.00	39.250	2	0.648	1.296
313	N1MQD379	5MM PLATE-E250A	110.00 X	160.00	39.250	2	0.691	1.382
314	N1MQD380	L45x30x4-E250A	1134.00		2.200	2	2.495	4.990
315	N1MQD381	5MM PLATE-E250A	110.00 X	150.00	39.250	2	0.648	1.296
316	N1MQD382	5MM PLATE-E250A	110.00 X	170.00	39.250	2	0.734	1.468
317	N1MQD383	L45x30x4-E250A	1066.00		2.200	2	2.345	4.690
318	N1MQD384	5MM PLATE-E250A	110.00 X	160.00	39.250	2	0.691	1.382
319	N1MQD385	5MM PLATE-E250A	110.00 X	150.00	39.250	2	0.648	1.296
320	N1MQD386	L45x30x4-E250A	1072.00		2.200	2	2.358	4.716

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/PQDBS//R-0

Date 27-08-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
321	N1MQD387	5MM PLATE-E250A	110.00 X	170.00	39.250	2	0.734	1.468
322	N1MQD388	5MM PLATE-E250A	110.00 X	150.00	39.250	2	0.648	1.296
323	N1MQD400LH	L75x75x6H-E350A	3065.00		6.800	2	20.842	41.684
324	N1MQD400RH	L75x75x6H-E350A	3065.00		6.800	2	20.842	41.684
325	N1MQD401LH	L60x60x4H-E350A	2936.00		3.700	2	10.863	21.726
326	N1MQD401RH	L60x60x4H-E350A	2936.00		3.700	2	10.863	21.726
327	N1MQD402H	6MM PLATE H-E350A	258.00 X	402.00	47.100	4	4.885	19.540
328	N1MQD403L	L45x45x4-E250A	1438.00		2.700	2	3.883	7.766
329	N1MQD403R	L45x45x4-E250A	1438.00		2.700	2	3.883	7.766
330	N1MQD404L	L45x30x4-E250A	603.00		2.200	2	1.327	2.654
331	N1MQD404R	L45x30x4-E250A	603.00		2.200	2	1.327	2.654
332	N1MQD404AH	6MM PLATE H-E350A	110.00 X	194.00	47.100	4	1.005	4.020
333	N1MQD405H	L50x50x4H-E350A	6325.00		3.000	1	18.975	18.975
334	N1MQD405XH	L50x50x4H-E350A	6325.00		3.000	1	18.975	18.975
335	N1MQD405AH	L50x50x4H-E350A	3198.00		3.000	2	9.594	19.188
336	N1MQD405AXH	L50x50x4H-E350A	3198.00		3.000	2	9.594	19.188
337	N1MQD406	L45x45x4-E250A	1231.00		2.700	2	3.324	6.648
338	N1MQD406A	L45x45x4-E250A	1231.00		2.700	2	3.324	6.648
339	N1MQD407	L45x45x4-E250A	1090.00		2.700	4	2.943	11.772
340	N1MQD408H	6MM PLATE H-E350A	125.00 X	207.00	47.100	2	1.219	2.438
341	N1MQD408AH	6MM PLATE H-E350A	163.00 X	265.00	47.100	2	2.034	4.068
342	N1MQD409H	8MM PLATE H-E350A	170.00 X	206.00	62.800	4	2.199	8.796
343	N1MQD410H	L55x55x5H-E350A	5161.00		4.100	2	21.160	42.320
344	N1MQD410XH	L55x55x5H-E350A	5161.00		4.100	2	21.160	42.320
345	N1MQD411	L45x45x4-E250A	1276.00		2.700	2	3.445	6.890
346	N1MQD411A	L45x45x4-E250A	1276.00		2.700	2	3.445	6.890
347	N1MQD412H	L45x45x4H-E350A	1411.00		2.700	2	3.810	7.620
348	N1MQD412AH	L45x45x4H-E350A	1411.00		2.700	2	3.810	7.620
349	N1MQD413H	L45x45x4H-E350A	1443.00		2.700	2	3.896	7.792
350	N1MQD413AH	L45x45x4H-E350A	1443.00		2.700	2	3.896	7.792
351	N1MQD414H	L70x70x5H-E350A	4755.00		5.300	2	25.202	50.404
352	N1MQD415H	16MM PLATE H-E350A	292.00 X	320.00	125.600	4	11.736	46.944

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX.: 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/PQDBS//R-0

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
353	N1MQD415ALH	L70x70x5H-E350A	225.00		5.300	2	1.193	2.386
354	N1MQD415ARH	L70x70x5H-E350A	225.00		5.300	2	1.193	2.386
355	N1MQD416H	L60x60x4H-E350A	3121.00		3.700	2	11.548	23.096
356	N1MQD416XH	L60x60x4H-E350A	3121.00		3.700	2	11.548	23.096
357	N1MQD417H	6MM PLATE H-E350A	130.00 X	210.00	47.100	2	1.286	2.572
358	N1MQD418H	6MM PLATE H-E350A	115.00 X	190.00	47.100	2	1.029	2.058
359	N1MQD419	6MM PLATE-E250A	100.00 X	120.00	47.100	4	0.565	2.260
360	N1MQD420	L70x70x5-E250A	5282.00		5.300	2	27.995	55.990
361	N1MQD420X	L70x70x5-E250A	5282.00		5.300	2	27.995	55.990
362	N1MQD421	L45x45x4-E250A	1405.00		2.700	2	3.794	7.588
363	N1MQD422	6MM PLATE-E250A	130.00 X	130.00	47.100	2	0.796	1.592
364	N1MQD423	6MM PLATE-E250A	100.00 X	130.00	47.100	4	0.612	2.448
365	N1MQD440LH	L70x70x6H-E350A	3035.00		6.300	2	19.121	38.242
366	N1MQD440RH	L70x70x6H-E350A	3035.00		6.300	2	19.121	38.242
367	N1MQD441LH	L55x55x4H-E350A	2956.00		3.300	2	9.755	19.510
368	N1MQD441RH	L55x55x4H-E350A	2956.00		3.300	2	9.755	19.510
369	N1MQD442H	6MM PLATE H-E350A	255.00 X	316.00	47.100	4	3.795	15.180
370	N1MQD443L	L45x45x4-E250A	1448.00		2.700	2	3.910	7.820
371	N1MQD443R	L45x45x4-E250A	1448.00		2.700	2	3.910	7.820
372	N1MQD444L	L45x30x4-E250A	605.00		2.200	2	1.331	2.662
373	N1MQD444R	L45x30x4-E250A	605.00		2.200	2	1.331	2.662
374	N1MQD445H	6MM PLATE H-E350A	110.00 X	194.00	47.100	4	1.005	4.020
375	N1MQD446H	L45x45x4H-E350A	5718.00		2.700	1	15.439	15.439
376	N1MQD446XH	L45x45x4H-E350A	5718.00		2.700	1	15.439	15.439
377	N1MQD447H	L45x45x4H-E350A	2880.00		2.700	2	7.776	15.552
378	N1MQD447XH	L45x45x4H-E350A	2880.00		2.700	2	7.776	15.552
379	N1MQD448H	6MM PLATE H-E350A	105.00 X	116.00	47.100	4	0.574	2.296
380	N1MQD449H	6MM PLATE H-E350A	105.00 X	186.00	47.100	2	0.920	1.840
381	N1MQD450H	6MM PLATE H-E350A	154.00 X	248.00	47.100	2	1.799	3.598
382	N1MQD451H	6MM PLATE H-E350A	150.00 X	202.00	47.100	4	1.427	5.708
383	N1MQD452	L60x60x5-E250A	4814.00		4.500	2	21.663	43.326
384	N1MQD452X	L60x60x5-E250A	4814.00		4.500	2	21.663	43.326

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/PQDBS//R-0

Date 27-08-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
385	N1MQD453	L45x45x4-E250A	1293.00		2.700	2	3.491	6.982
386	N1MQD453A	L45x45x4-E250A	1293.00		2.700	2	3.491	6.982
387	N1MQD454	L45x45x4-E250A	1363.00		2.700	2	3.680	7.360
388	N1MQD454A	L45x45x4-E250A	1363.00		2.700	2	3.680	7.360
389	N1MQD455	L45x45x4-E250A	1314.00		2.700	2	3.548	7.096
390	N1MQD455A	L45x45x4-E250A	1314.00		2.700	2	3.548	7.096
391	N1MQD456H	L70x70x5H-E350A	4319.00		5.300	2	22.891	45.782
392	N1MQD457H	16MM PLATE H-E350A	292.00 X	320.00	125.600	4	11.736	46.944
393	N1MQD457ALH	L70x70x5H-E350A	225.00		5.300	2	1.193	2.386
394	N1MQD457ARH	L70x70x5H-E350A	225.00		5.300	2	1.193	2.386
395	N1MQD458	6MM PLATE-E250A	130.00 X	130.00	47.100	2	0.796	1.592
396	N1MQD459H	L65x65x4H-E350A	4906.00		4.000	2	19.624	39.248
397	N1MQD459XH	L65x65x4H-E350A	4906.00		4.000	2	19.624	39.248
398	N1MQD459AH	6MM PLATE H-E350A	97.00 X	115.00	47.100	4	0.525	2.100
399	N1MQD459BH	6MM PLATE H-E350A	97.00 X	122.00	47.100	4	0.557	2.228
400	N1MQD460	L45x45x4-E250A	1436.00		2.700	2	3.877	7.754
401	N1MQD480LH	L70x70x5H-E350A	3056.00		5.300	2	16.197	32.394
402	N1MQD480RH	L70x70x5H-E350A	3056.00		5.300	2	16.197	32.394
403	N1MQD481LH	L55x55x4H-E350A	2899.00		3.300	2	9.567	19.134
404	N1MQD481RH	L55x55x4H-E350A	2899.00		3.300	2	9.567	19.134
405	N1MQD482H	6MM PLATE H-E350A	189.00 X	289.00	47.100	4	2.573	10.292
406	N1MQD483L	L45x45x4-E250A	1424.00		2.700	2	3.845	7.690
407	N1MQD483R	L45x45x4-E250A	1424.00		2.700	2	3.845	7.690
408	N1MQD484L	L45x30x4-E250A	516.00		2.200	2	1.135	2.270
409	N1MQD484R	L45x30x4-E250A	516.00		2.200	2	1.135	2.270
410	N1MQD484AH	6MM PLATE H-E350A	110.00 X	223.00	47.100	4	1.155	4.620
411	N1MQD485H	L60x60x4H-E350A	5109.00		3.700	1	18.903	18.903
412	N1MQD485XH	L60x60x4H-E350A	5109.00		3.700	1	18.903	18.903
413	N1MQD486H	6MM PLATE H-E350A	105.00 X	124.00	47.100	4	0.613	2.452
414	N1MQD487H	6MM PLATE H-E350A	140.00 X	174.00	47.100	4	1.147	4.588
415	N1MQD488	L70x70x5-E250A	4488.00		5.300	2	23.786	47.572
416	N1MQD488X	L70x70x5-E250A	4488.00		5.300	2	23.786	47.572

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/PQDBS//R-0

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
417	N1MQD489H	L45x45x4H-E350A	1899.00		2.700	2	5.127	10.254
418	N1MQD489AH	L45x45x4H-E350A	1899.00		2.700	2	5.127	10.254
419	N1MQD490H	L70x70x5H-E350A	3879.00		5.300	2	20.559	41.118
420	N1MQD490AH	16MM PLATE H-E350A	292.00 X	320.00	125.600	4	11.736	46.944
421	N1MQD490BLH	L70x70x5H-E350A	225.00		5.300	2	1.193	2.386
422	N1MQD490BRH	L70x70x5H-E350A	225.00		5.300	2	1.193	2.386
423	N1MQD491	L65x65x4-E250A	4520.00		4.000	2	18.080	36.160
424	N1MQD491X	L65x65x4-E250A	4520.00		4.000	2	18.080	36.160
425	N1MQD492	6MM PLATE-E250A	97.00 X	125.00	47.100	4	0.571	2.284
426	N1MQD493	6MM PLATE-E250A	97.00 X	125.00	47.100	4	0.571	2.284
427	N1MQD494H	L45x45x4H-E350A	1401.00		2.700	2	3.783	7.566
428	N1MQD495H	6MM PLATE H-E350A	130.00 X	130.00	47.100	2	0.796	1.592
429	N1MQD510LH	L70x70x6H-E350A	3055.00		6.300	2	19.247	38.494
430	N1MQD510RH	L70x70x6H-E350A	3055.00		6.300	2	19.247	38.494
431	N1MQD511LH	L55x55x4H-E350A	2921.00		3.300	2	9.639	19.278
432	N1MQD511RH	L55x55x4H-E350A	2921.00		3.300	2	9.639	19.278
433	N1MQD512H	6MM PLATE H-E350A	200.00 X	327.00	47.100	4	3.080	12.320
434	N1MQD513L	L45x45x4-E250A	1435.00		2.700	2	3.875	7.750
435	N1MQD513R	L45x45x4-E250A	1435.00		2.700	2	3.875	7.750
436	N1MQD514L	L45x30x4-E250A	520.00		2.200	2	1.144	2.288
437	N1MQD514R	L45x30x4-E250A	520.00		2.200	2	1.144	2.288
438	N1MQD515H	6MM PLATE H-E350A	110.00 X	223.00	47.100	4	1.155	4.620
439	N1MQD516H	L60x60x4H-E350A	4510.00		3.700	1	16.687	16.687
440	N1MQD516XH	L60x60x4H-E350A	4510.00		3.700	1	16.687	16.687
441	N1MQD517H	6MM PLATE H-E350A	110.00 X	127.00	47.100	4	0.658	2.632
442	N1MQD518H	6MM PLATE H-E350A	144.00 X	177.00	47.100	4	1.200	4.800
443	N1MQD519	L70x70x5-E250A	4147.00		5.300	2	21.979	43.958
444	N1MQD519X	L70x70x5-E250A	4147.00		5.300	2	21.979	43.958
445	N1MQD520H	L45x45x4H-E350A	1678.00		2.700	2	4.531	9.062
446	N1MQD520AH	L45x45x4H-E350A	1678.00		2.700	2	4.531	9.062
447	N1MQD521H	L70x70x5H-E350A	3434.00		5.300	2	18.200	36.400
448	N1MQD522H	16MM PLATE H-E350A	292.00 X	320.00	125.600	4	11.736	46.944

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/PQDBS//R-0

Date 27-08-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)								
449	N1MQD522ALH	L70x70x5H-E350A	225.00		5.300	2	1.193	2.386
450	N1MQD522ARH	L70x70x5H-E350A	225.00		5.300	2	1.193	2.386
451	N1MQD523H	L60x60x4H-E350A	4184.00		3.700	2	15.481	30.962
452	N1MQD523XH	L60x60x4H-E350A	4184.00		3.700	2	15.481	30.962
453	N1MQD524H	6MM PLATE H-E350A	97.00 X	120.00	47.100	4	0.548	2.192
454	N1MQD525H	6MM PLATE H-E350A	97.00 X	130.00	47.100	4	0.594	2.376
455	N1MQD540LH	L70x70x5H-E350A	3056.00		5.300	2	16.197	32.394
456	N1MQD540RH	L70x70x5H-E350A	3056.00		5.300	2	16.197	32.394
457	N1MQD541LH	L55x55x4H-E350A	2942.00		3.300	2	9.709	19.418
458	N1MQD541RH	L55x55x4H-E350A	2942.00		3.300	2	9.709	19.418
459	N1MQD542H	6MM PLATE H-E350A	200.00 X	297.00	47.100	4	2.798	11.192
460	N1MQD543L	L45x45x4-E250A	1445.00		2.700	2	3.902	7.804
461	N1MQD543R	L45x45x4-E250A	1445.00		2.700	2	3.902	7.804
462	N1MQD544L	L45x30x4-E250A	521.00		2.200	2	1.146	2.292
463	N1MQD544R	L45x30x4-E250A	521.00		2.200	2	1.146	2.292
464	N1MQD544AH	6MM PLATE H-E350A	110.00 X	224.00	47.100	4	1.161	4.644
465	N1MQD545H	L55x55x4H-E350A	3907.00		3.300	1	12.893	12.893
466	N1MQD545XH	L55x55x4H-E350A	3907.00		3.300	1	12.893	12.893
467	N1MQD546H	6MM PLATE H-E350A	154.00 X	163.00	47.100	4	1.182	4.728
468	N1MQD547	L65x65x5-E250A	3819.00		4.900	2	18.713	37.426
469	N1MQD547X	L65x65x5-E250A	3819.00		4.900	2	18.713	37.426
470	N1MQD548H	L45x45x4H-E350A	1467.00		2.700	2	3.961	7.922
471	N1MQD548AH	L45x45x4H-E350A	1467.00		2.700	2	3.961	7.922
472	N1MQD549H	L70x70x5H-E350A	2993.00		5.300	2	15.863	31.726
473	N1MQD550H	16MM PLATE H-E350A	301.00 X	320.00	125.600	4	12.098	48.392
474	N1MQD550ALH	L70x70x5H-E350A	225.00		5.300	2	1.193	2.386
475	N1MQD550ARH	L70x70x5H-E350A	225.00		5.300	2	1.193	2.386
476	N1MQD551H	L50x50x5H-E350A	3871.00		3.800	2	14.710	29.420
477	N1MQD551XH	L50x50x5H-E350A	3871.00		3.800	2	14.710	29.420
478	N1MQD552H	6MM PLATE H-E350A	97.00 X	115.00	47.100	4	0.525	2.100
479	N1MQD553H	6MM PLATE H-E350A	97.00 X	125.00	47.100	4	0.571	2.284
480	N1MQD570LH	L70x70x5H-E350A	3101.00		5.300	2	16.435	32.870

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/PQDBS//R-0

Date 27-08-2018

BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
481	N1MQD570RH	L70x70x5H-E350A	3101.00		5.300	2	16.435	32.870
482	N1MQD571LH	L55x55x4H-E350A	3171.00		3.300	2	10.464	20.928
483	N1MQD571RH	L55x55x4H-E350A	3171.00		3.300	2	10.464	20.928
484	N1MQD572H	6MM PLATE H-E350A	210.00 X	257.00	47.100	4	2.542	10.168
485	N1MQD573L	L45x45x4-E250A	1546.00		2.700	2	4.174	8.348
486	N1MQD573R	L45x45x4-E250A	1546.00		2.700	2	4.174	8.348
487	N1MQD574L	L45x30x4-E250A	748.00		2.200	2	1.646	3.292
488	N1MQD574R	L45x30x4-E250A	748.00		2.200	2	1.646	3.292
489	N1MQD574AH	6MM PLATE H-E350A	105.00 X	159.00	47.100	4	0.786	3.144
490	N1MQD575H	L50x50x4H-E350A	3280.00		3.000	1	9.840	9.840
491	N1MQD575XH	L50x50x4H-E350A	3280.00		3.000	1	9.840	9.840
492	N1MQD577	6MM PLATE-E250A	171.00 X	174.00	47.100	4	1.401	5.604
493	N1MQD578	L65x65x4-E250A	3517.00		4.000	2	14.068	28.136
494	N1MQD578X	L65x65x4-E250A	3517.00		4.000	2	14.068	28.136
495	N1MQD579	L45x45x4-E250A	1251.00		2.700	2	3.378	6.756
496	N1MQD579A	L45x45x4-E250A	1251.00		2.700	2	3.378	6.756
497	N1MQD580H	L70x70x5H-E350A	2553.00		5.300	2	13.531	27.062
498	N1MQD581H	16MM PLATE H-E350A	301.00 X	320.00	125.600	4	12.098	48.392
499	N1MQD581ALH	L70x70x5H-E350A	225.00		5.300	2	1.193	2.386
500	N1MQD581ARH	L70x70x5H-E350A	225.00		5.300	2	1.193	2.386
501	N1MQD582H	L45x45x4H-E350A	2985.00		2.700	1	8.060	8.060
502	N1MQD582XH	L45x45x4H-E350A	2985.00		2.700	1	8.060	8.060
503	N1MQD583H	L50x50x4H-E350A	3765.00		3.000	2	11.295	22.590
504	N1MQD583XH	L50x50x4H-E350A	3765.00		3.000	2	11.295	22.590
505	N1MQD584H	6MM PLATE H-E350A	97.00 X	130.00	47.100	4	0.594	2.376
506	N1MQD585H	6MM PLATE H-E350A	97.00 X	132.00	47.100	4	0.603	2.412

TOTAL WEIGHT : 13374.329

*** - Item welded with another item

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	27-08-2018
Drg No.	-	Page	1 of 2
BOM No.	BOM/LE17D124/PQDBS/P/R-0		

Srl No	Section Invloved	Section Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)		
1	L45x30x4-E250A	363.418
2	L100x100x7-E250A	213.744
3	L45x45x4-E250A	570.874
4	L50x50x4-E250A	58.032
5	L60x60x4-E250A	73.200
6	L60x60x5-E250A	86.652
7	L65x65x5-E250A	110.466
8	L65x65x4-E250A	230.000
9	L70x70x5-E250A	420.640
10	L75x75x6-E250A	236.298
11	L80x80x6-E250A	63.204
12	L90x90x6-E250A	159.048
13	L45x45x4H-E350A	264.870
14	L50x50x5H-E350A	58.840
15	L55x55x4H-E350A	347.790
16	L55x55x5H-E350A	84.640
17	L60x60x4H-E350A	333.024
18	L60x60x5H-E350A	158.616
19	L65x65x4H-E350A	150.320
20	L65x65x5H-E350A	72.032
21	L70x70x5H-E350A	530.300
22	L70x70x6H-E350A	262.716
23	L75x75x6H-E350A	452.032
24	L80x80x6H-E350A	339.072
25	L90x90x6H-E350A	791.124
26	L90x90x7H-E350A	504.920
27	L100x100x6H-E350A	302.132
28	L100x100x7H-E350A	346.532
29	L100x100x8H-E350A	345.672
30	L110x110x8H-E350A	486.688
31	L120x120x8H-E350A	22.344
32	L130x130x10H-E350A	37.192
33	L130x130x12H-E350A	379.384
34	L150x150x12H-E350A	184.332
35	L150x150x14H-E350A	504.000

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	27-08-2018
Drg No.	-	Page	2 of 2
BOM No.	BOM/LE17D124/PQDBS/P/R-0		

Srl No	Section Invloved	Section Weight
BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)		
36	L150x150x18H-E350A	641.600
37	L200x200x15H-E350A	1775.300
38	L50x50x4H-E350A	378.270
39	5MM PLATE H-E350A	44.280
40	6MM PLATE H-E350A	213.284
41	8MM PLATE H-E350A	166.635
42	10MM PLATE H-E350A	216.576
43	16MM PLATE H-E350A	284.560
44	2MM PLATE-E250A	3.072
45	3MM PLATE-E250A	4.336
46	4MM PLATE-E250A	9.072
47	5MM PLATE-E250A	56.584
48	6MM PLATE-E250A	25.240
49	8MM PLATE-E250A	11.372
	Total	13374.329

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project: LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref.: -
Drg No.: -
BOM No.: BOM/LE17D124/PQDBB/SQDBB/R-0

Date: 18-12-2018
Page: 1 of 1

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BOLTS & NUTS OF BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)							
1	SQDBB1	M16x35MM LONG(IS:12427)		0.119	1140	0.119	135.660
2	SQDBB2	M16x40MM LONG (IS:12427)		0.126	732	0.126	92.232
3	SQDBB3	M16x45MM LONG (IS:12427)		0.134	787	0.134	105.458
4	SQDBB4	M16x50MM LONG (IS:12427)		0.142	414	0.142	58.788
5	SQDBB5	M16x55MM LONG (IS:12427)		0.150	266	0.150	39.900
6	SQDBB6	M16x60MM LONG (IS:12427)		0.158	78	0.158	12.324
7	SQDBB7	M16x65MM LONG (IS:12427)		0.164	478	0.164	78.392
8	SQDBB8	M16x70MM LONG (IS:12427)		0.173	8	0.173	1.384
9	SQDBB9	M16x3.5mm SPR. WSR-IS3063		0.009	3903	0.009	35.127
10	SQDBB10	M16x175LG SB (50OD) 2N+1SP		0.423	160	0.423	67.680

TOTAL WEIGHT : **626.945**

*** - Item welded with another item

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	18-12-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/PQDBB/SQDBB/R-0		

Srl No	Section Invloved	Section Weight
	BOLTS & NUTS OF BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)	
1	M16x3.5mm SPR. WSR-IS3063	35.127
2	M16x175LG SB (50OD) 2N+1SP	67.680
3	M16x35MM LONG(IS:12427)	135.660
4	M16x40MM LONG (IS:12427)	92.232
5	M16x45MM LONG (IS:12427)	105.458
6	M16x50MM LONG (IS:12427)	58.788
7	M16x55MM LONG (IS:12427)	39.900
8	M16x60MM LONG (IS:12427)	12.324
9	M16x65MM LONG (IS:12427)	78.392
10	M16x70MM LONG (IS:12427)	1.384
	Total	626.945

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/PQDBB/SQDBW/R-0

Date 27-08-2018

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
PACK WASHERS OF BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)							
1	SQDBW1	M16x4MM ROUND P.WASHER IS2016		0.014	34	0.014	.476
2	SQDBW2	M16x5MM ROUND P.WASHER IS2016		0.018	36	0.018	.648
3	SQDBW3	M16x6MM ROUND P.WASHER IS2016		0.021	150	0.021	3.150
4	SQDBW4	M16x8MM ROUND P.WASHER IS2016		0.028	66	0.028	1.848
5	SQDBW5	M16x10MM ROUND P.WASHER IS2016		0.036	104	0.036	3.744

TOTAL WEIGHT : **9.866**

*** - Item welded with another item

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	27-08-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/PQDBB/SQDBW/R-0		

Srl No	Section Invloved	Section Weight
PACK WASHERS OF BASIC BODY FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)		
1	M16x4MM ROUND P.WASHER IS2016	.476
2	M16x5MM ROUND P.WASHER IS2016	.648
3	M16x6MM ROUND P.WASHER IS2016	3.150
4	M16x8MM ROUND P.WASHER IS2016	1.848
5	M16x10MM ROUND P.WASHER IS2016	3.744
	Total	9.866

L&T Construction
Power Transmission & Distribution

CLIENT: **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

PROJECT: TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

LOA No.: 073/74-201 Dated: 24.04.2017

DRG. No.: O17123-T-TL-4M-GA-0401

BOM No.: BOM/LE17D124/132kV/QD/001 | NO OF SHEETS: 4

CAT – I

☑ Approved / Released For Fabrication/Construction
☐ Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
☐ To be resubmitted for approval after incorporating the comments
☐ Not approved

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kv Transmission Line Project
Checked By: | Date: 2078/6/13
Approved By: | Date:

BILL OF MATERIAL
STUB & CLEATS FOR TOWER TYPE - "QD/DE" (132kV, WZ-4)

WEIGHT OF STRUCTURE	
HT MEMBERS: BOM/LE17D124/PQDSC/SQDSC/R-0	755.208
MS MEMBERS INCLUDING PACK WASHERS AND ACCESSORIES ETC.	-
WEIGHT OF BOLTS & NUTS,SPRING WASHERS: BOM/LE17D124/PQDSB/SQDSB/R-0	9.664
TOTAL WEIGHT OF STRUCTURE:	**764.872 Kgs**

पावरग्रिड
श्रेणियां
I. फैब्रीकेशन / निर्माण / हेतु अनुमोदित / जारी।
II. फैब्रीकेशन / निर्माण / हेतु अनुमोदित / जारी बशर्ते दी गई टिप्पणियां एवं आशोधनों को सम्मिलित किया जाए। कृपया आशोधित दस्तावेज अनुमोदनार्थ प्रस्तुत करें।
III. टिप्पणियों सम्मिलित कर पुनः अनुमोदनार्थ प्रस्तुत करें।
IV. सूचनार्थ एवं रिकार्ड हेतु।
V. अनुमोदित नहीं।
(हस्ताक्षर)
DE (पदनाम)
6/6/18 (तिथि)
पावर ग्रिड कॉरपोरेशन ऑफ इंडिया लि०
अभियांत्रिकी (टी० एल०) गुड़गाँव, हरियाणा

CAT 1 subject to type testing of tower

0	16.03.18	FIRST SUBMISSION FOR APPROVAL	PU	BSR	CSR
REV.	DATE	DESCRIPTION	CHKD.	REVED.	APPD.

PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY	DATE
ALEX	PU	BSR	CSR	16.03.18

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000   FAX : 044 - 22705494

BILL OF MATERIAL

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	16-03-2018
Drg No.	- -	Page	1 of 1
BOM No.	BOM/LE17D124/PQDSC/SQDSC/R-0		

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
STUB & CLEATS FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)							
1	N1MQD1H	L200x200x15H-E350A	3749.00	45.600	4	170.954	683.816
2	N1MQD2LH	L100x100x6H-E350A	205.00	9.200	8	1.886	15.088
3	N1MQD2RH	L100x100x6H-E350A	205.00	9.200	8	1.886	15.088
	N1MQD3H	L100x100x6H-E350A	280.00	9.200	16	2.576	41.216

TOTAL WEIGHT : **755.208**

*** - Item welded with another item

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	16-03-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/PQDSC/SQDSC/R-0		

Srl No	Section Invloved	Section Weight
STUB & CLEATS FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)		
1	L100x100x6H-E350A	71.392
2	L200x200x15H-E350A	683.816
	Total	755.208

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/PQDSB/SQDSB/R-0

Date 16-03-2018

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BOLTS & NUTS OF STUB & CLEATS FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)							
1	SQDSB1	M16x50MM LONG (IS:12427)		0.142	64	0.142	9.088
2	SQDSB2	M16x3.5mm SPR. WSR-IS3063		0.009	64	0.009	.576

TOTAL WEIGHT : **9.664**

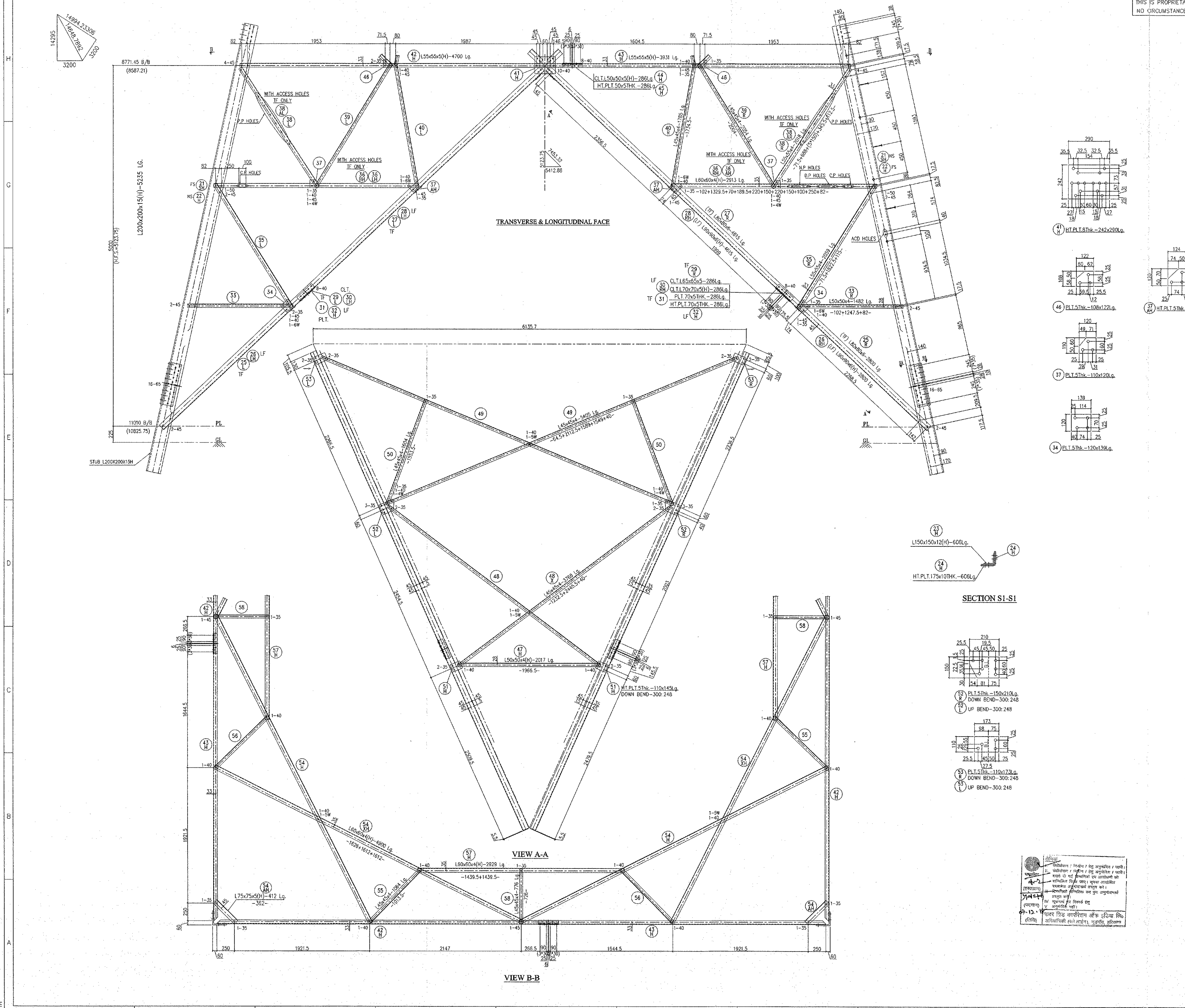
*** - Item welded with another item

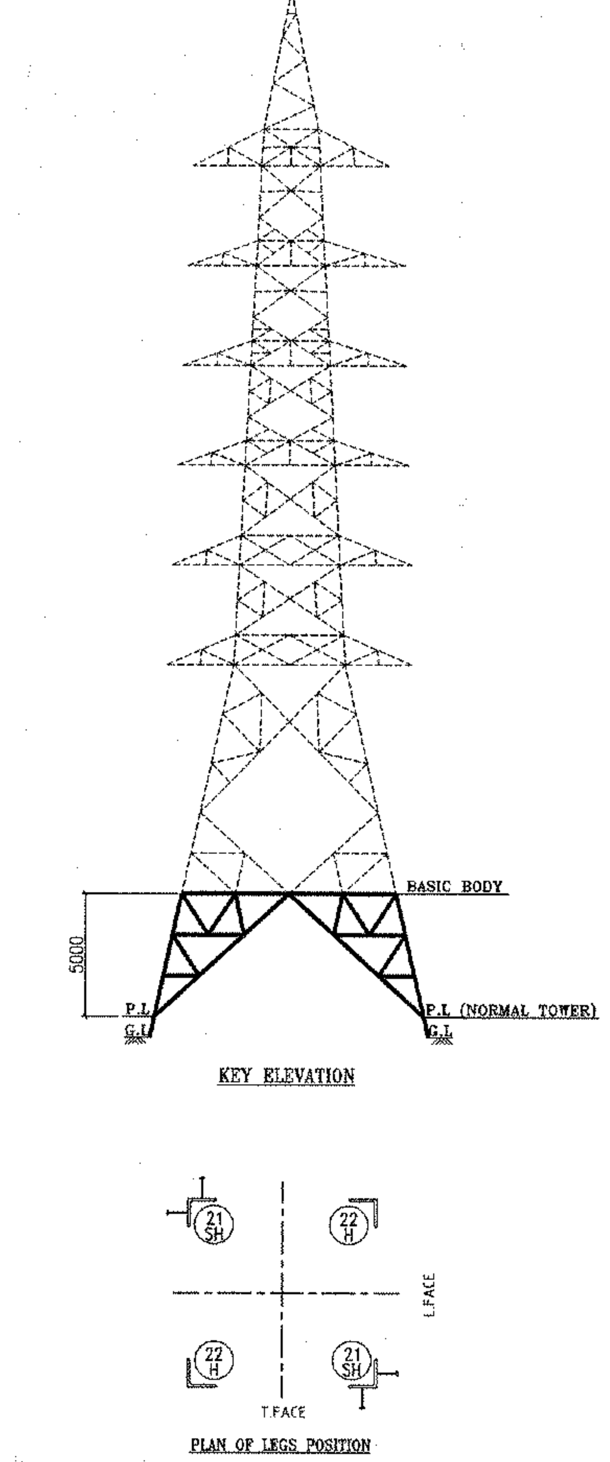
LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	16-03-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/PQDSB/SQDSB/R-0		

Srl No	Section Invloved	Section Weight
	BOLTS & NUTS OF STUB & CLEATS FOR TOWER TYPE-"QD/DE" (132kV, WZ-4)	
1	M16x3.5mm SPR. WSR-IS3063	.576
2	M16x50MM LONG (IS:12427)	9.088
	Total	9.664

THIS IS PROPRIETARY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH NEPAL ELECTRICITY AUTHORITY(NEA). UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM NEA IN WRITING.





REQUIREMENT OF BOLTS, NUTS & WASHERS			
SIZE	QTY.	GRADE	REMARKS
16ø x 35mm Lg.	164	5.6	BOLTS & NUTS
16ø x 40mm Lg.	212	5.6	BOLTS & NUTS
16ø x 45mm Lg.	116	5.6	BOLTS & NUTS
16ø x 50mm Lg.	8	5.6	BOLTS & NUTS
16ø x 65mm Lg.	128	5.6	BOLTS & NUTS
16ø x 3.5 THK	628	–	SPRING WASHERS
16ø x 4 THK	16	–	PACK WASHERS
16ø x 5 THK	12	–	PACK WASHERS
16ø x 6 THK	16	–	PACK WASHERS
16ø x 175LG	14	–	STEP BOLTS

NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. BOLT SYMBOLS 16ø = 17.5ø HOLES
   16ø = 17.5ø HOLES FOR STEP BOLTS
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH "N1MQD"
4. STRUCTURAL STEEL SHALL BE AS PER IS 2062–2011
   (i) MILD STEEL – GRADE E250 QUALITY A – UNLESS OTHERWISE SPECIFIED.
   (ii) "H" STANDS FOR HIGH TENSILE STEEL – GRADE E350 QUALITY A
5. BOLTS & NUTS SHALL CONFORM TO IS : 12427–2001 (R–2007) FOR DIMENSIONS AND IS : 1367 (PART 3)–2002 FOR MECHANICAL PROPERTIES
6. GALVANISING SHALL CONFORM TO IS:2629–1985 (R–2006) & IS:4759–1996 (R–2006)
7. SPRING WASHER SHALL BE CONFORM TO IS 3063–1994 (R–2004)
8. STEP BOLTS SHALL BE PROVIDED ON THE DIAGONALLY OPPOSITE LEGS.

CAT I

13/12/018

SUCCESSFULLY TESTED AT L&T-TLTRS-KANCHIPURAM ON 24th OF AUGUST 2018

PART NO. 21 TO 58

DATE	REV.NO.	DESCRIPTION	DESIGNED (STRUCTURAL)	CHECKED (STRUCTURAL)	DRAWN (DETAILING)	CHECKED (DETAILING)	APPROVED
27.08.18	1	SUBMISSION AFTER SUCCESSFUL TESTING	ANJ	RJR	ALEX	PU/BSR	CSR
16.03.18	0	FIRST SUBMISSION FOR APPROVAL BEFORE PROTO	ANJ	RJR	MR/BRK	SVR/BSR	CSR

REVISIONS

CLIENT: **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONSULTANT: **POWER GRID CORPORATION OF INDIA LTD**
पावरग्रिड

CONTRACTOR: **L&T Construction**
Power Transmission & Distribution

PROJECT:
TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

JOB No.: O17123-T-TL

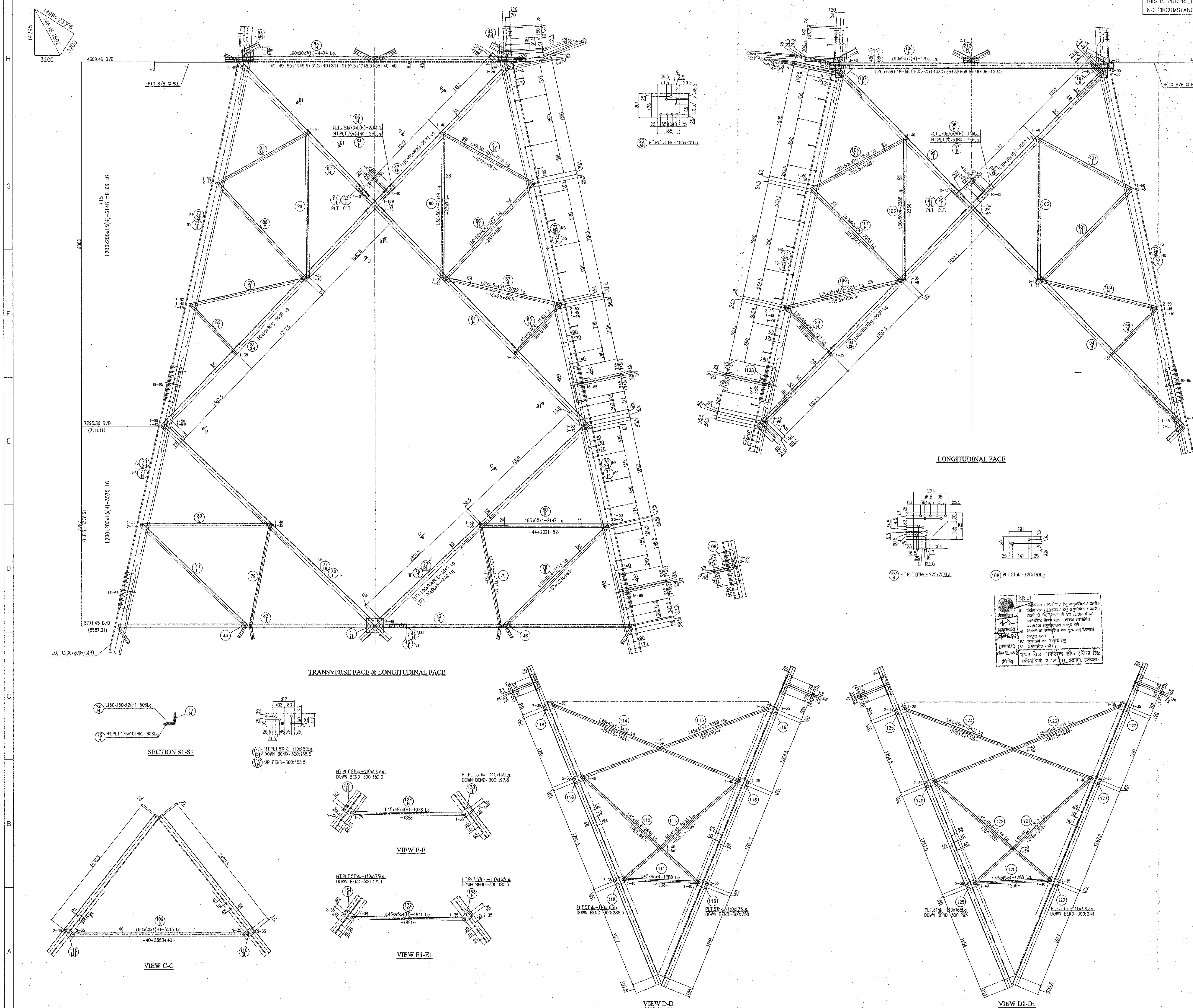
	NAME	DATE
DSGN	ANJ	20.01.18
DRWN	MR/BRK	19.02.18
CHKD	SVR/BSR	19.02.18
APPD	CSR	19.02.18

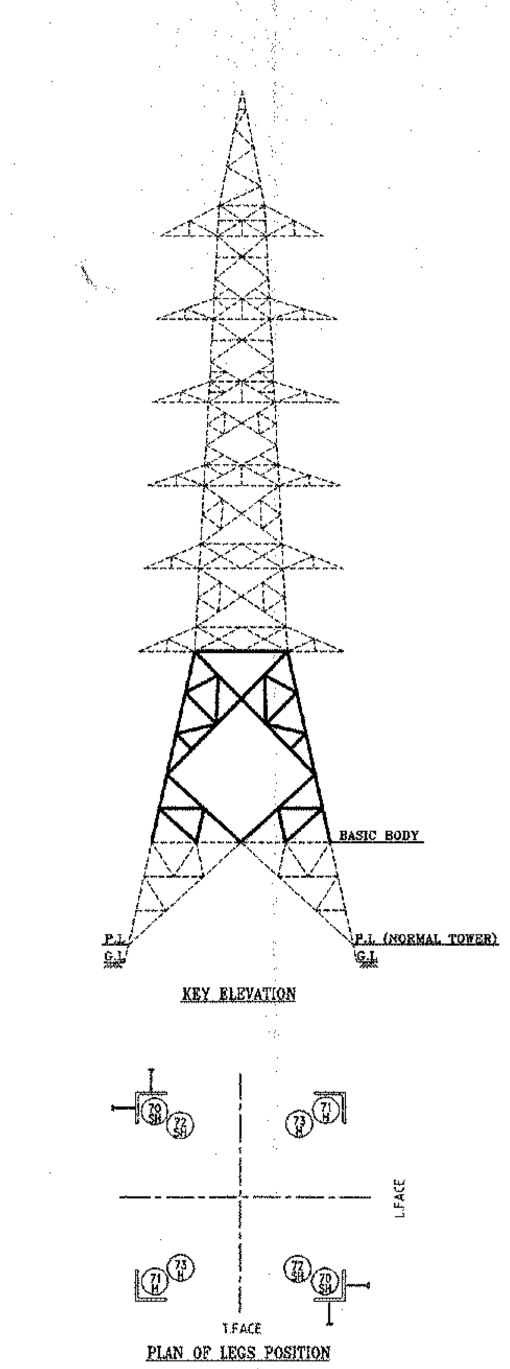
TITLE: G.A OF +0M BODY EXTN. FOR TOWER TYPE "QD (30°–60°)/DE(0°–15°)" (132kV M/C LINE, WZ–4)

SCALE 1 : 20

DRG No. 017123-T-TL-4M-GA-0403 SHEET 01 OF 01 SIZE A1 REV. 1

RELEASED FOR ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION





REQUIREMENT OF BOLTS, NUTS & WASHERS			
SIZE	QTY.	GRADE	REMARKS
16ø x 35mm Lg.	136	5.6	BOLTS & NUTS
16ø x 40mm Lg.	108	5.6	BOLTS & NUTS
16ø x 45mm Lg.	120	5.6	BOLTS & NUTS
16ø x 50mm Lg.	44	5.6	BOLTS & NUTS
16ø x 55mm Lg.	38	5.6	BOLTS & NUTS
16ø x 60mm Lg.	18	5.6	BOLTS & NUTS
16ø x 65mm Lg.	248	5.6	BOLTS & NUTS
16ø x 70mm Lg.	8	5.6	BOLTS & NUTS
16ø x 3.5 THK	720	-	SPRING WASHERS
16ø x 4 THK	8	-	PACK WASHERS
16ø x 5 THK	14	-	PACK WASHERS
16ø x 6 THK	4	-	PACK WASHERS
16ø x 8 THK	2	-	PACK WASHERS
16ø x 10 THK	8	-	PACK WASHERS
16ø x 175LG	44	-	STEP BOLTS

NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. BOLT SYMBOLS 16ø = 17.5ø HOLES
   16ø = 17.5ø HOLES FOR STEP BOLTS
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH "N1MQD"
4. STRUCTURAL STEEL SHALL BE AS PER IS 2062-2011
   (i) MILD STEEL - GRADE E250 QUALITY A - UNLESS OTHERWISE SPECIFIED.
   (ii) "H" STANDS FOR HIGH TENSILE STEEL - GRADE E350 QUALITY A
5. BOLTS & NUTS SHALL CONFORM TO IS : 12427-2001 (R-2007) FOR DIMENSIONS AND IS : 1367 (PART 3)-2002 FOR MECHANICAL PROPERTIES
6. GALVANISING SHALL CONFORM TO IS:2629-1985 (R-2006) & IS:4759-1996 (R-2006)
7. SPRING WASHER SHALL BE CONFORM TO IS 3063-1994 (R-2004)
8. STEP BOLTS SHALL BE PROVIDED ON THE DIAGONALLY OPPOSITE LEGS.

☑ Approved / Released For Fabrication/Construction
☐ Approved ... For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
☐ To be ... for approval after incorporating the ...
☐ For ... and record Cat I
☐ Not ...

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kV
Transmission Line Project
Checked By: Date: 13/12/2018
Recommended by: Date:
Approved By: Date:

SUCCESSFULLY TESTED AT L&T-TLTRS-KANCHIPURAM ON 24th OF AUGUST 2018

PART NO. 70 TO 134

PART NO. 86,89,92,99,102,105,117,119,126,128 NOT USED

DATE	REV.NO.	DESCRIPTION	DESIGNED (STRUCTURAL)	CHECKED (STRUCTURAL)	DRAWN (DETAILING)	CHECKED (DETAILING)	APPROVED
27.08.18	1	SUBMISSION AFTER SUCCESSFUL TESTING	ANJ	RJR	ALEX	PU/BSR	CSR
16.03.18	0	FIRST SUBMISSION FOR APPROVAL BEFORE PROTO	ANJ	RJR	MR/AAJ	SVR/BSR	CSR

REVISIONS

CLIENT: **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONSULTANT: **POWER GRID CORPORATION OF INDIA LTD**
पावरग्रिड

CONTRACTOR: **L&T Construction**
Power Transmission & Distribution

PROJECT:
TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

JOB No.: O17123-T-TL

	NAME	DATE
DSGN	ANJ	22.01.18
DRWN	MR/AAJ	13.02.18
CHKD	SVR/BSR	13.02.18
APPD	CSR	13.02.18

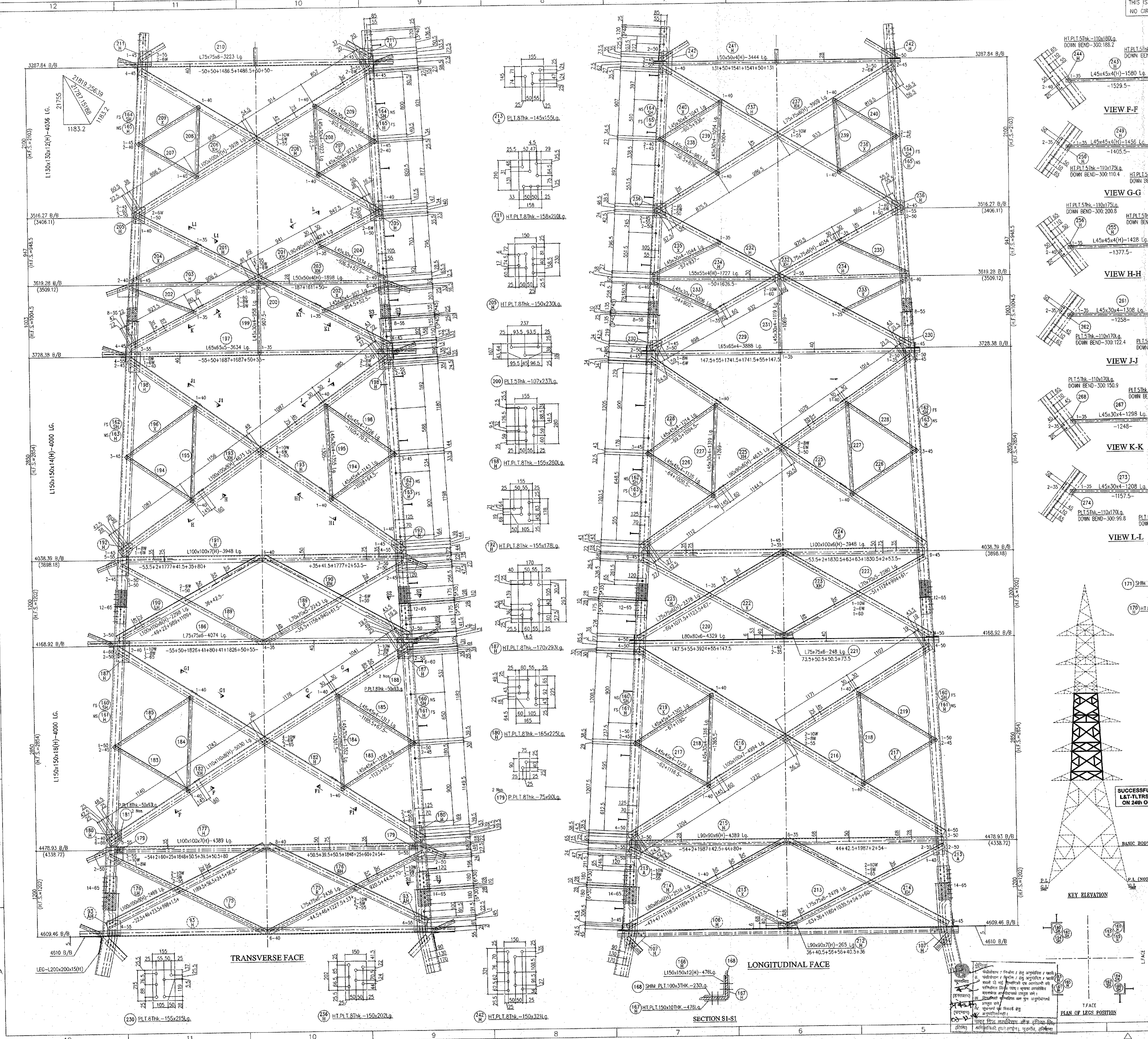
TITLE:
G.A OF BASIC BODY
FOR TOWER TYPE "QD (30°-60°)/DE (0°-15°)"
(132kV M/C LINE, WZ-4)

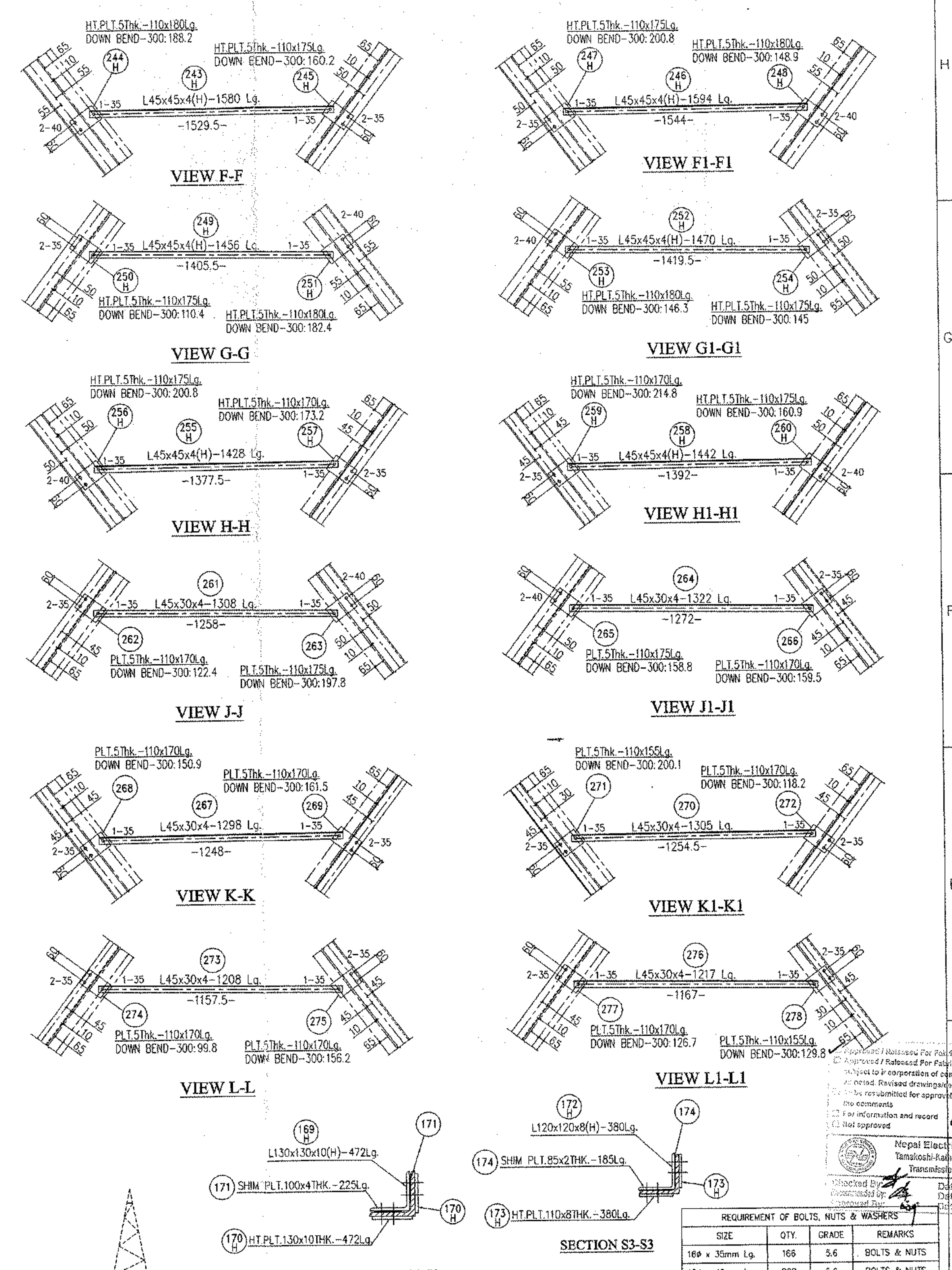
SCALE 1 : 30

DRG No. 017123-T-TL-4M-GA-0404
SHEET 01 OF 09
SIZE A1
REV. 1

RELEASED FOR ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

THIS IS PROPRIETARY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH NEPAL ELECTRICITY AUTHORITY(NEA). UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM NEA IN WRITING.





NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. BOLT SYMBOLS 16ø = 17.5ø HOLES
   16ø = 17.5ø HOLES FOR STEP BOLTS
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH "N1MQD"
4. STRUCTURAL STEEL SHALL BE AS PER IS 2062-2011
   (i) MILD STEEL – GRADE E250 QUALITY A – UNLESS OTHERWISE SPECIFIED.
   (ii) "H" STANDS FOR HIGH TENSILE STEEL – GRADE E350 QUALITY A
5. BOLTS & NUTS SHALL CONFORM TO IS : 12427-2001 (R-2007) FOR DIMENSIONS AND IS : 1367 (PART 3)-2002 FOR MECHANICAL PROPERTIES
6. GALVANISING SHALL CONFORM TO IS:2629-1985 (R-2006) & IS:4759-1996 (R-2006)
7. SPRING WASHER SHALL BE CONFORM TO IS 3063-1994 (R-2004)
8. STEP BOLTS SHALL BE PROVIDED ON THE DIAGONALLY OPPOSITE LEGS.

PART NO. 160 TO 278

PART NO. 178 NOT USED

REQUIREMENT OF BOLTS, NUTS & WASHERS

SIZE	QTY.	GRADE	REMARKS
16ø x 35mm Lg.	166	5.6	BOLTS & NUTS
16ø x 40mm Lg.	208	5.6	BOLTS & NUTS
16ø x 45mm Lg.	224	5.6	BOLTS & NUTS
16ø x 50mm Lg.	196	5.6	BOLTS & NUTS
16ø x 55mm Lg.	212	5.6	BOLTS & NUTS
16ø x 60mm Lg.	56	5.6	BOLTS & NUTS
16ø x 65mm Lg.	230	5.6	BOLTS & NUTS
16ø x 70mm Lg.	–	5.6	BOLTS & NUTS
16ø x 3.5 THK	1292	–	SPRING WASHERS
16ø x 5 THK	8	–	PACK WASHERS
16ø x 6 THK	80	–	PACK WASHERS
16ø x 8 THK	32	–	PACK WASHERS
16ø x 10 THK	56	–	PACK WASHERS
16ø x 175LG	50	–	STEP BOLTS

SUCCESSFULLY TESTED AT L&T-TLTRS-KANCHIPURAM ON 24th OF AUGUST 2018

DATE	REV.NO.	DESCRIPTION	STRUCTURAL DESIGNED	STRUCTURAL CHECKED	DETAILING DRAWN	DETAILING CHECKED	APPROVED
27.08.18	1	SUBMISSION AFTER SUCCESSFUL TESTING	ANJ	RJR	ALEX	PU/BSR	CSR
16.03.18	0	FIRST SUBMISSION FOR APPROVAL BEFORE PROTO	ANJ	RJR	MR/AAJ	SVR/BSR	CSR

REVISIONS

CLIENT: **NEPAL ELECTRICITY AUTHORITY** (An Undertaking of Government of Nepal)

CONSULTANT: **POWER GRID CORPORATION OF INDIA LTD**

CONTRACTOR: **L&T Construction** Power Transmission & Distribution

PROJECT: **TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE**

JOB No.: O17123-T-TL

	NAME	DATE
DSGN	ANJ	22.01.18
DRWN	MR/AAJ	13.02.18
CHKD	SVR/BSR	13.02.18
APPD	CSR	13.02.18

TITLE: G.A OF CAGE PART-1 FOR TOWER TYPE "QD (30°-60°)/DE (0°-15°)" (132kV M/C LINE, WZ-4)

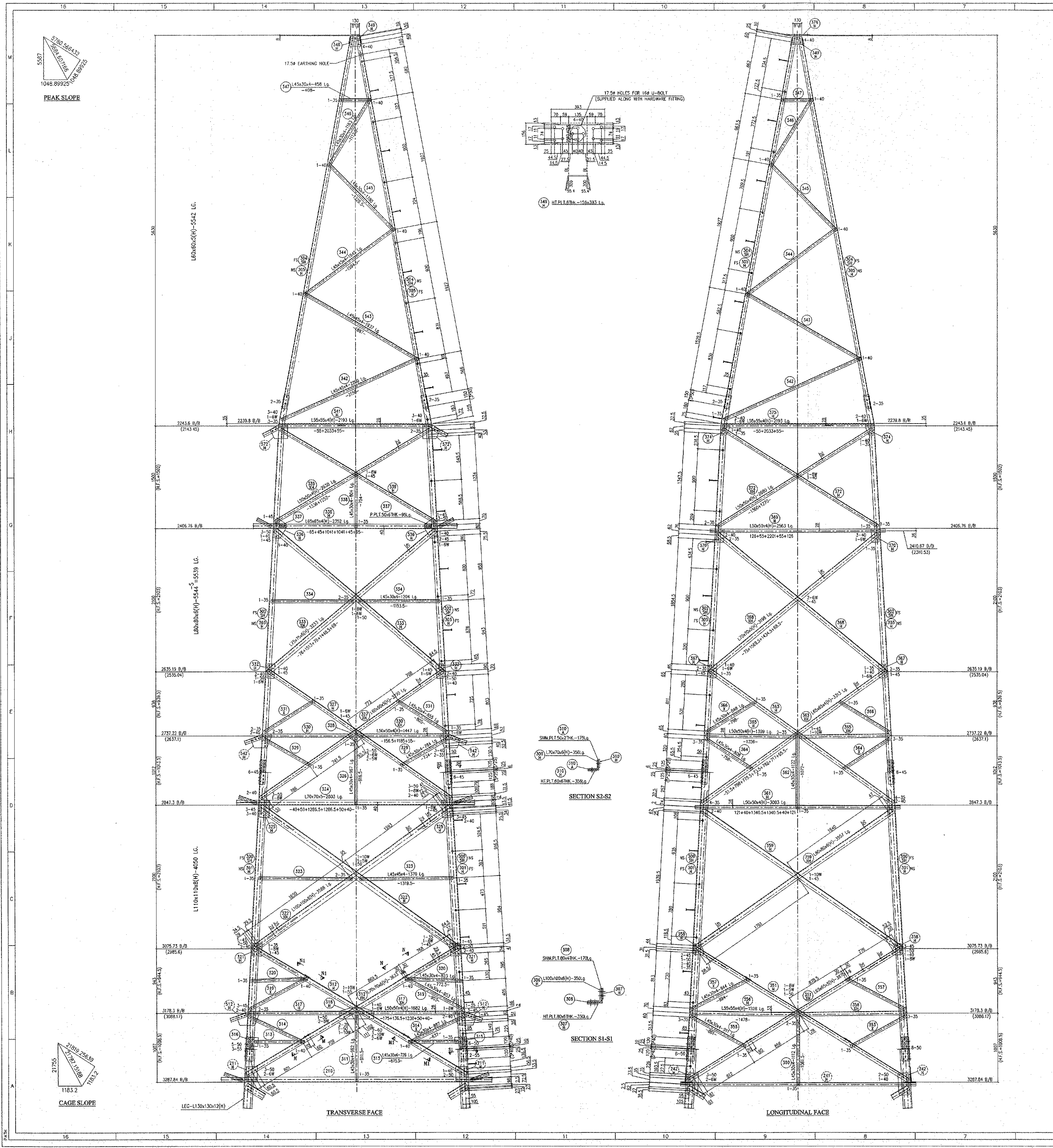
SCALE 1 : 25

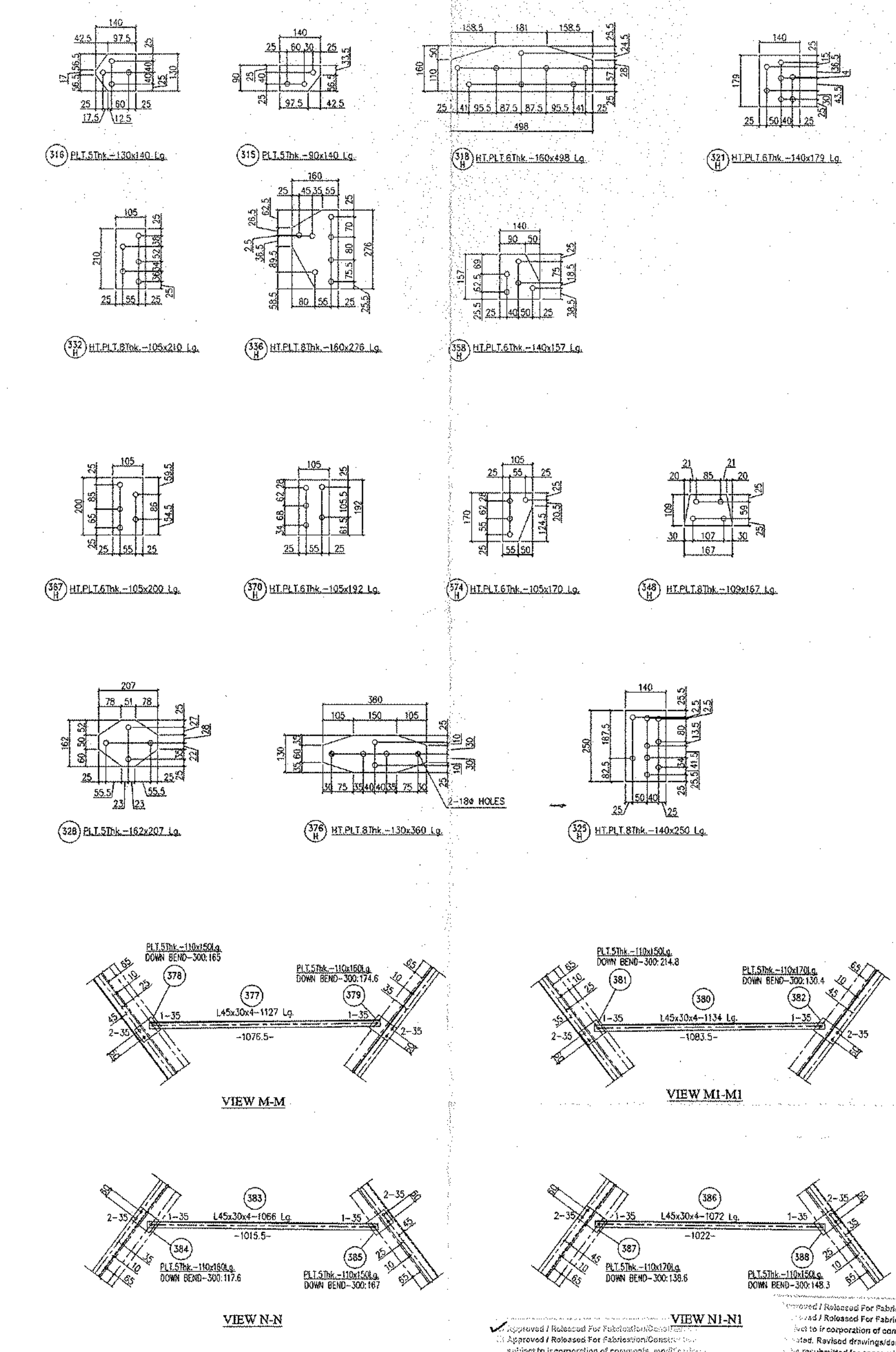
DRG No. 0 1 7 1 2 3 - T - TL - 4M - GA - 0 4 0 4 SHEET 02 OF 09 SIZE A1 REV. 1

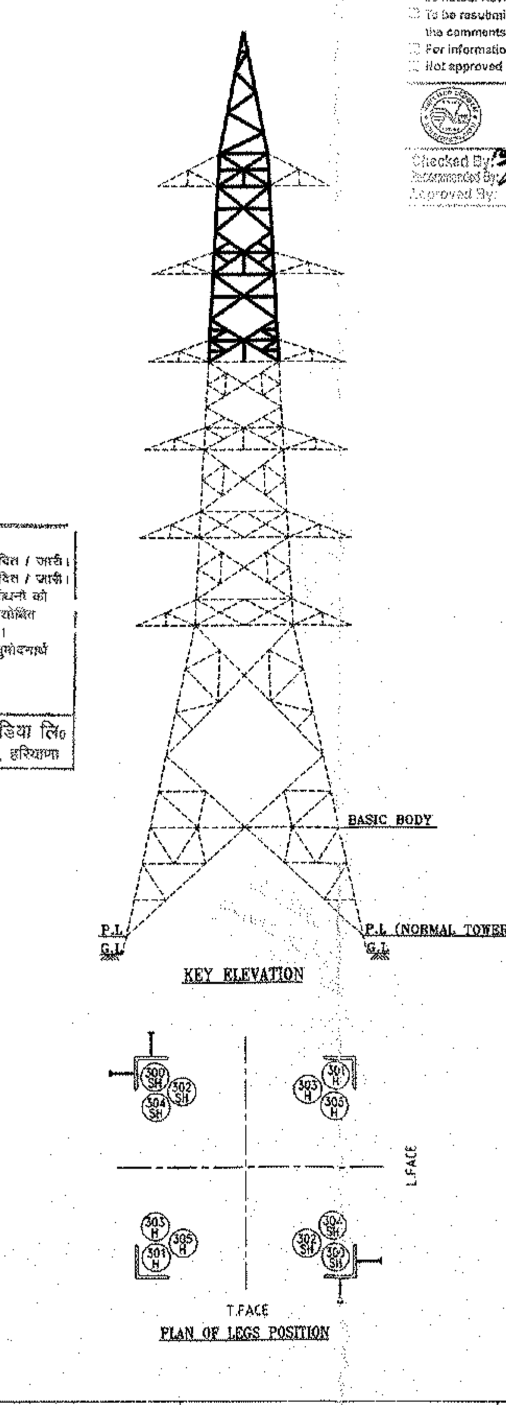
RELEASED FOR ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

No comments
For information and record
Not approved
Nepal Electricity Authority Tamakoshi-Kathmandu 220/400 kv Transmission Line Project
Checked By:
Recommended by:
Approved By:
Dated: 13/12/2018
CAT I

THIS IS PROPRIETARY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH NEPAL ELECTRICITY AUTHORITY(NEA). UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM NEA IN WRITING.







REQUIREMENT OF BOLTS, NUTS & WASHERS			
SIZE	QTY.	GRADE	REMARKS
16ø x 35mm Lg.	248	5.6	BOLTS & NUTS
16ø x 40mm Lg.	168	5.6	BOLTS & NUTS
16ø x 45mm Lg.	122	5.6	BOLTS & NUTS
16ø x 50mm Lg.	124	5.6	BOLTS & NUTS
16ø x 55mm Lg.	16	5.6	BOLTS & NUTS
16ø x 60mm Lg.	4	5.6	BOLTS & NUTS
16ø x 3.5 THK	682	–	SPRING WASHERS
16ø x 5 THK	8	–	PACK WASHERS
16ø x 6 THK	48	–	PACK WASHERS
16ø x 8 THK	26	–	PACK WASHERS
16ø x 10 THK	14	–	PACK WASHERS
16ø x 175LG	66	–	STEP BOLTS

Approved / Released For Fabrication/Construction
Approved / Released For Fabrication/Construction subject to incorporation of comments, modifications noted. Revised drawings/designs required to be resubmitted for approval after incorporating the comments
For information and record
Not approved

CAT I

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kV Transmission Line Project
Checked By: Date: 13/12/018
Recommended By: Date:
Approved By: Date:

NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. BOLT SYMBOLS 16ø = 17.5ø HOLES
   16ø = 17.5ø HOLES FOR STEP BOLTS
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH "N1MQD"
4. STRUCTURAL STEEL SHALL BE AS PER IS 2062-2011
   (i) MILD STEEL – GRADE E250 QUALITY A – UNLESS OTHERWISE SPECIFIED.
   (ii) "H" STANDS FOR HIGH TENSILE STEEL – GRADE E350 QUALITY A
5. BOLTS & NUTS SHALL CONFORM TO IS : 12427-2001 (R-2007) FOR DIMENSIONS AND IS : 1367 (PART 3)-2002 FOR MECHANICAL PROPERTIES
6. GALVANISING SHALL CONFORM TO IS:2629-1985 (R-2006) & IS:4759-1996 (R-2006)
7. SPRING WASHER SHALL BE CONFORM TO IS 3063-1994 (R-2004)
8. STEP BOLTS SHALL BE PROVIDED ON THE DIAGONALLY OPPOSITE LEGS.

SUCCESSFULLY TESTED AT L&T-TLTRS-KANCHIPURAM ON 24th OF AUGUST 2018

PART NO. 300 TO 388

PART NO. 340,352,354,355,360,371,373 NOT USED

DATE	REV.NO.	DESCRIPTION	DESIGNED (STRUCTURAL)	CHECKED (STRUCTURAL)	DRAWN (DETAILING)	CHECKED (DETAILING)	APPROVED
27.08.18	1	SUBMISSION AFTER SUCCESSFUL TESTING	ANJ	RJR	ALEX	PU/BSR	CSR
16.03.18	0	FIRST SUBMISSION FOR APPROVAL BEFORE PROTO	ANJ	RJR	MR/AAJ	SVR/BSR	CSR

REVISIONS

CLIENT: **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONSULTANT: **POWER GRID CORPORATION OF INDIA LTD**

CONTRACTOR: **L&T Construction**
Power Transmission & Distribution

PROJECT:
TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

JOB No.: O17123-T-TL

	NAME	DATE
DSGN	ANJ	22.01.18
DRWN	MR/AAJ	13.02.18
CHKD	SVR/BSR	13.02.18
APPD	CSR	13.02.18

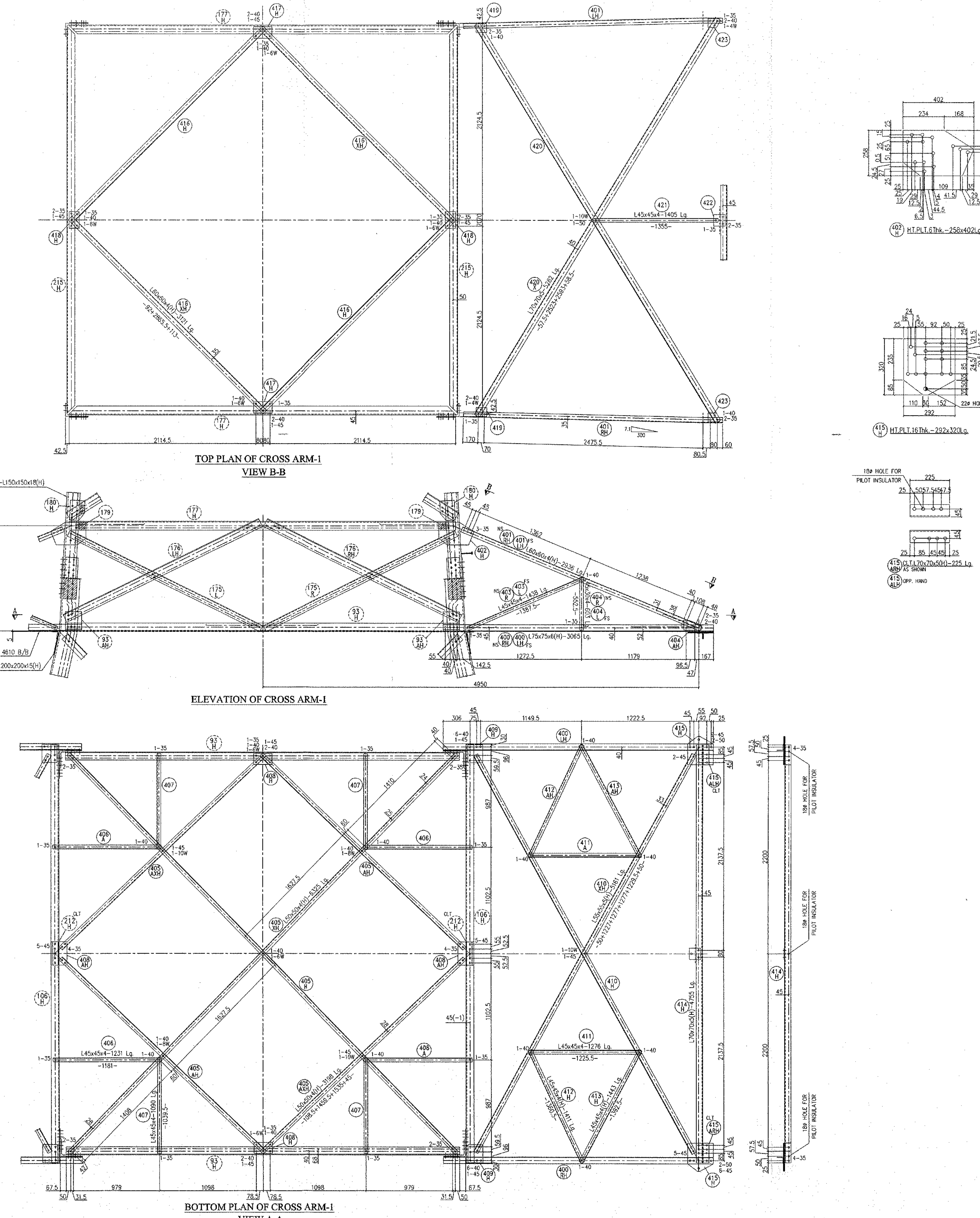
TITLE: G.A OF CAGE PART-2 & PEAK FOR TOWER TYPE "QD (30°-60°)/DE (0°-15°)" (132kV M/C LINE, WZ-4)

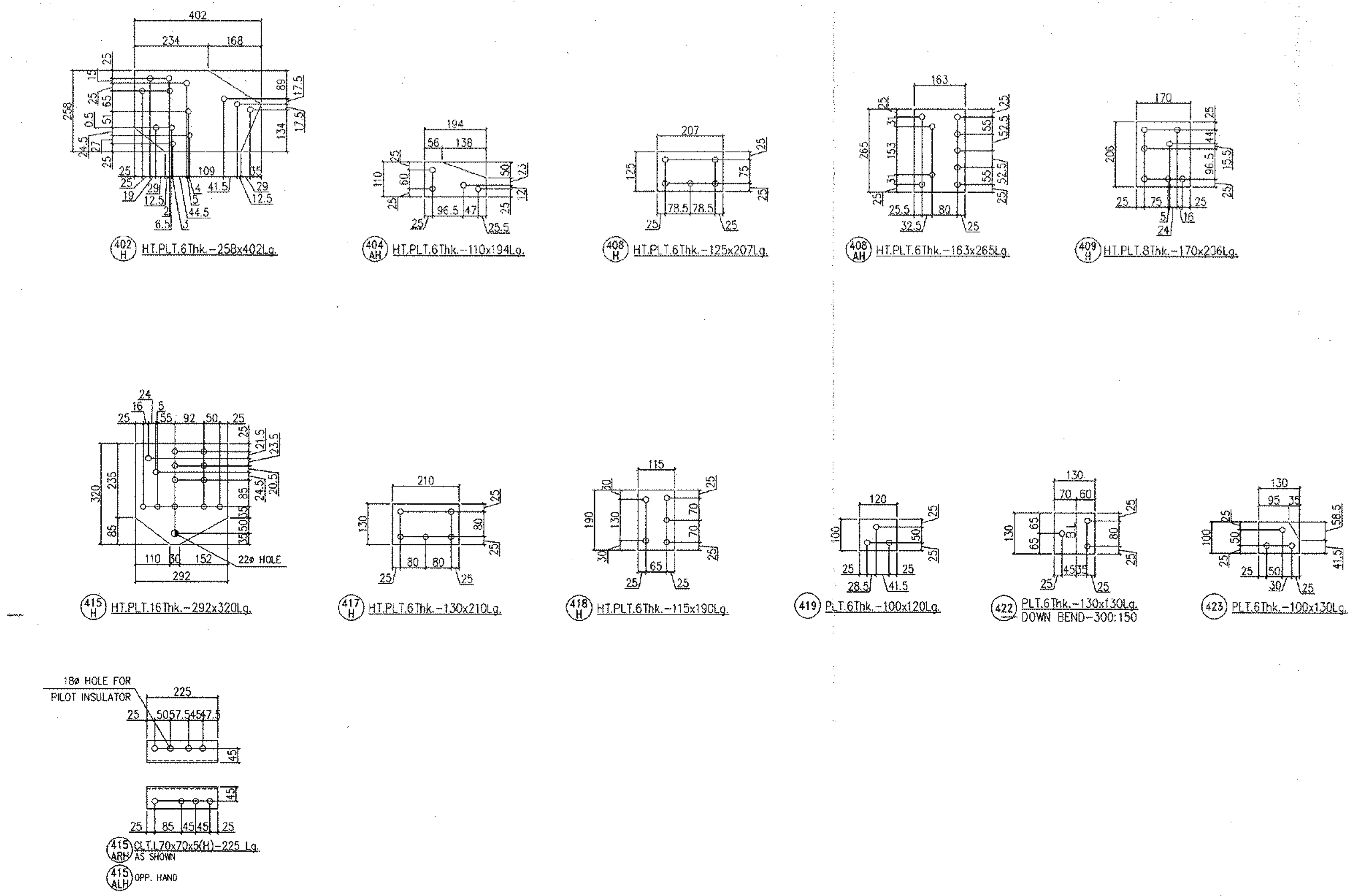
SCALE 1 : 20

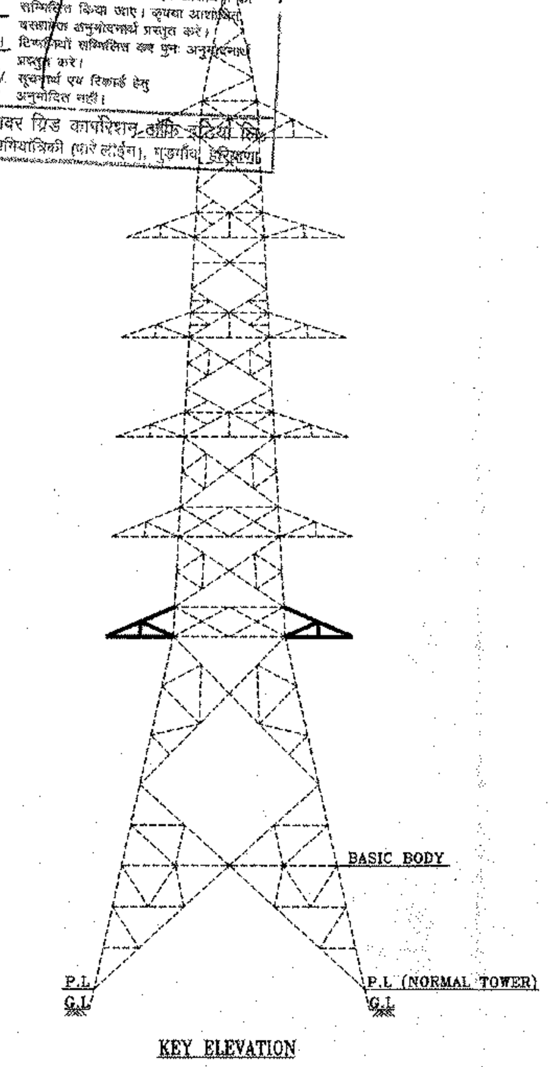
DRG No. O17123-T-TL-4M-GA-0404 SHEET 03 OF 09 SIZE A0 REV. 1

RELEASED FOR: ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

THIS IS PROPRIETARY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH NEPAL ELECTRICITY AUTHORITY(NEA). UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM NEA IN WRITING.







REQUIREMENT OF BOLTS, NUTS & WASHERS			
SIZE	QTY.	GRADE	REMARKS
16ø x 35mm Lg.	96	5.6	BOLTS & NUTS
16ø x 40mm Lg.	81	5.6	BOLTS & NUTS
16ø x 45mm Lg.	68	5.6	BOLTS & NUTS
16ø x 50mm Lg.	10	5.6	BOLTS & NUTS
16ø x 3.5 THK	255	-	SPRING WASHERS
16ø x 4 THK	4	-	PACK WASHERS
16ø x 6 THK	7	-	PACK WASHERS
16ø x 8 THK	2	-	PACK WASHERS
16ø x 10 THK	6	-	PACK WASHERS

NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. BOLT SYMBOLS 16ø = 17.5ø HOLES
   16ø = 17.5ø HOLES FOR STEP BOLTS
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH "N1MOD"
4. STRUCTURAL STEEL SHALL BE AS PER IS 2062-2011
   (i) MILD STEEL - GRADE E250 QUALITY A - UNLESS OTHERWISE SPECIFIED.
   (ii) "H" STANDS FOR HIGH TENSILE STEEL - GRADE E350 QUALITY A
5. BOLTS & NUTS SHALL CONFORM TO IS : 12427-2001 (R-2007) FOR DIMENSIONS AND IS : 1367 (PART 3)-2002 FOR MECHANICAL PROPERTIES
6. GALVANISING SHALL CONFORM TO IS:2629-1985 (R-2006) & IS:4759-1996 (R-2006)
7. SPRING WASHER SHALL BE CONFORM TO IS 3063-1994 (R-2004)
8. STEP BOLTS SHALL BE PROVIDED ON THE DIAGONALLY OPPOSITE LEGS.

☑ Approved / Released For Fabrication/Construction
☐ Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
☐ To be resubmitted for approval after incorporating the comments
☐ For information and record CAT I
☐ Not approved

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kV
Transmission Line Project
Checked By: Date:
Recommended By: Date:
Approved By: Date:

SUCCESSFULLY TESTED AT L&T-TLTRS-KANCHIPURAM ON 24th OF AUGUST 2018

PART NO. 400 TO 423

DATE	REV.NO.	DESCRIPTION	DESIGNED (STRUCTURAL)	CHECKED (STRUCTURAL)	DRAWN (DETAILING)	CHECKED (DETAILING)	APPROVED
27.08.18	1	SUBMISSION AFTER SUCCESSFUL TESTING	ANJ	RJR	ALEX	PU/BSR	CSR
16.03.18	0	FIRST SUBMISSION FOR APPROVAL BEFORE PROTO	ANJ	RJR	MR/GER	SVR/BSR	CSR

REVISIONS

CLIENT:
NEPAL ELECTRICITY AUTHORITY
(An Undertaking of Government of Nepal)

CONSULTANT:
POWER GRID CORPORATION OF INDIA LTD

CONTRACTOR:
L&T Construction
Power Transmission & Distribution

PROJECT:
TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

JOB No.: O17123-T-TL

	NAME	DATE
DSGN	ANJ	22.01.18
DRWN	MR/GER	17.02.18
CHKD	SVR/BSR	17.02.18
APPD	CSR	17.02.18

TITLE: G.A OF CROSS ARM-1 FOR TOWER TYPE "QD (30°-60°)/DE (0°-15°)" (132kV M/C LINE, WZ-4)

SCALE 1 : 25

DRG No. O17123-T-TL-4M-GA-0404 SHEET 04 OF 09

SIZE A1 REV. 1

RELEASED FOR ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

TOWER DESIGN DD TYPE

THIS IS PROPRIETORY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH POWERGRID. UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM POWERGRID IN WRITING

☑ Approved / Released For Fabrication/Construction
☐ Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
☐ To be resubmitted for approval after incorporating the comments
☐ For information and record CAT I
☐ Not approved

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kv Transmission Line Project

Checked By: Date: 4/7/018
Recommended By: Date: 2/07/018
Approved By: Date:

श्रेणियां CAT 1
I. फेब्रीकेशन / निर्माण हेतु अनुमोदित।
II. फेब्रीकेशन / निर्माण हेतु अनुमोदित। बशर्ते दी गई टिप्पणियों एवं आशोधनों को सम्मिलित किया जाए। कृपया आशोधित दस्तावेज अनुमोदनार्थ प्रस्तुत करें।
III. टिप्पणियों को सम्मिलित कर पुनः अनुमोदनार्थ प्रस्तुत करें।
IV. सूचनार्थ एवं रिकार्ड हेतु।
V. अनुमोदित नहीं।

पावरग्रिड
(हस्ताक्षर)
(प्रबंधक / व अभियंता)
26/6/18
(तिथि)

पावर ग्रिड कारपोरेशन ऑफ इंडिया लि० अभियांत्रिकी (पार.लाईन) गुरुग्राम, (हरियाणा)
This document is recommended for approval for construction of 400KV /132kV D/C TAMAKOSHI - BARHABISE - KATHMANDU in NEPAL

DATE	REV.	DESCRIPTION	DESIGNED	CHECKED	APPROVED
06.01.2018	0	First submission for Approval	KMR	RJR	CSR

REVISIONS

CLIENT : NEPAL ELECTRICITY AUTHORITY (An Undertaking of Government of Nepal)

CONSULTANT : पावरग्रिड POWERGRID CORPORATION OF INDIA LTD

CONTRACTOR : L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT : TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)

JOB No. O17123-T-TL

TOTAL NO. OF PAGES 19

TITLE :

FOUNDATION DESIGN & DRAWING OF TOWER TYPE
DD/DE +0M BE
WET SOIL (DEPTH=3M)
(132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)

	NAME	DATE
DSGN	KMR	06.01.2018
CHKD	RJR	06.01.2018
APPD	CSR	06.01.2018

DOC. No O 1 7 1 2 3 - T - T L - 4 D - D C - 2 0 0 1 B

CODE IS | REV. 0

RELEASED FOR ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No**		**Date**
		O17123-T-TL-4D-DC-2001B		06.01.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE	**DESIGNED**	**CHECKED**	**Sheet**
		KMR	RJR	1 OF 17

Design Summary For Different Load Cases:

S.No.	Extension	LC	K-bar	L-bar	M-bar	N-bar	Chimney Interaction Ratio		FOS				SHEAR CHECK
							Compression	Tension	Uplift	Bearing	Sliding	Overturning	
1	+0m B.E	99	**GOVERNS**							1.702			SAFE
2	+0m B.E	108		**GOVERNS**	**GOVERNS**	**GOVERNS**			1.01				SAFE
3	+0m B.E	107					**0.779**					1.07	SAFE
4	+0m B.E	100						**0.948**			1.48		SAFE

Note: In addition to the governing load cases mentioned above, the foundation has been checked for reactions pertaining to all the load cases as mentioned in the reaction document.

		Document No		Date
PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	O17123-T-TL-4D-DC-2001B		06.01.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE WET SOIL (DEPTH=3M) (132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)	DESIGNED	CHECKED	Sheet
		KMR	RJR	2 of 19

Input Parameters for Foundation Design :-

Sl.No	Description	Variable	Unit	Value
1	1st Slope of Tower Leg	Φ	Deg	8.558
2	Depth of lower Layer	Dl	m	1.350
3	Depth of Upper Layer (maximum)	Du	m	1.500
4	Depth of Upper Layer (minimum)	Du	m	3.000
5	Unit Weight of Soil in Lower layer	W_l	Kg/m^3	940
6	Unit Weight of Soil in Upper layer	W_U	Kg/m^3	1440
7	Angle of Repose in Lower Layer	α	Deg	15
8	Angle of Repose in Upper Layer	β	Deg	25
9	Limit Bearing Capacity of Soil	Lbcs	Kg/m^2	13675
10	Factor of Safety applied on foundation loads	Fos	--	1.100
11	Total Depth of Foundation Below G.L (Including Pcc Pad)	D	m	3.000
12	Plinth Height in mm	Dp	m	0.225
13	Unit Weight of Concrete in Lower Layer	Wcl	Kg/m^3	1400
14	Unit Weight of Concrete in Upper Layer	Wcu	Kg/m^3	2400
15	Characteristic Strength of Concrete	Fck	N/mm^2	20
16	Characteristic Strength of Steel	Fy	N/mm^2	500
17	Cover To Chimney Reinforcement	Ccc	mm	50
18	Cover To Footing Slab Reinforcement	Ccs	mm	50
19	Slope of Tower Leg	Φ	Deg	12.014

Assumed Dimensions of Foundation Refer Figure- I				
1	Footing Width at the Bottom of Slab - I	B	m	3.780
2	Footing Width At Bottom of Slab - II	B'	m	3.780
3	Footing Width At Top of Slab - II	B1	m	3.480
4	Width of Footing At Bottom of Slab - III	B2	m	2.020
5	Width of Footing At Bottom of Slab - IV	B3	m	1.450
6	Width of Chimney	Bc	m	0.480
7	Depth of PCC Pad	Dpad	m	0.050
8	Depth of Slab -I Fom top of PCC Pad	D1	m	0.100
9	Depth of Slab -II from top of Slab-I	D2	m	0.150
10	Depth of Slab -III from top of Slab-II	D3	m	0.100
11	Depth of Slab -IV from top of Slab-III	D4	m	0.200
12	Height of Chimney Upto G.L From Top of Slab - IV	Dc	m	2.400

Ultimate Foundation Loads in kg - Refer Doc. No. O17123-T-TL-4D-DC-2000

		DD+0M B E	
		Supp No. 2	Supp No. 4
		LC-99	LC-108
Sr. No	Type of Load	CASE-1	CASE-2
1	Compression	88566	-
2	Uplift	-	82789
3	Side Thrust (Transverse)	5619	5048
4	Side Thrust (Longitudinal)	1724	1197

(Over Load Factor 1.1 included)

	L&T CONSTRUCTION POWER TRANSMISSION AND DISTRIBUTION IC			
PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No		Date
		O17123-T-TL-4D-DC-2001B		06 01 2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE WET SOIL (DEPTH=3M) (132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)	DESIGNED	CHECKED	Sheet
		KMR	RJR	3 of 19

(1) CHECK FOR UPLIFT (REFER FIGURE - 2)

Sr. No.	Description	Expression	Value
(a)	Horizontal Offset of cone in Lower Layer	X = 1.35*Tan(15)	0.3617
(b)	Horizontal Offset of cone in Upper Layer	Y = 1.5 * Tan(25)	0.6995
(c)	Gross volume of soil in Lower Layer in M^3	{(3 78)^2 *1 35+(2*3 78*1 35*0.3617)+(PI/ 3 *1 35*(0.3617)^2)}	23.166
(d)	Volume of Concrete in Lower Layer in M^3	((3 78^2+3.48^2+3 78*3 48)*0.15/3)+(2.02^2*0 1)+(1.45^2*0 2)+(0 48^2*0.9)	3.014
(e)	Net Volume Lower Layer in M^3	(23 166-3.014)	20 152
(f)	A1 = B*B + 4B*H1*tanϕ1+ π H1²*tan²ϕ1	(3 78^2 + 4 x 3.78 x 1 35 x tan(15)+3.142x1.35^2xtan(15)^2	20 1690
	A2 = B*B+4B* (H1*tanϕ1+ H2*tanϕ2) + π((H1*tanϕ1+ H2*tanϕ2)²	(3.78^2 + 4 x 3.78 x (0 3617+0.6995)+3 142x(0.3617+0 6995)^2)	33.872
(g)	Gross Volume of Soil in Upper Layer in M^3 (As per CBIP manual No 10), V = (A1+A2+ sqrt(A1A2))*H_2/3	(20.169 + 33.872 + sqrt (20 169 x 33.872)) x 1 5/3	40.089
(h)	Volume of Concrete in Upper Layer in M^3	(0 48^2*1 5)	0.346
(i)	Net Volume of Soil in Upper Layer in M^3	(40.089-0 346)	39.744
(j)	Weight of Soil Resisting Uplift in Kg	(20.152*940) + (39.744 * 1440)	76174
(k)	Weight of Concrete in Kg	(3 014*1400)+(0.3456*2400)+(0 1*3.78^2*1400)+(0 48^2*0.225*2400)	7173
(l)	Total Resistance against Uplift in Kg	(76174 24 + 7173.216)	83347
	Factor of Safety against Uplift	83347.46 / 82789	**1.01**
		Since F.O.S is > 1.00 , Foundation is Safe against Uplift	

(2) --- CHECK FOR DOWNTHRUST

(A) Bearing Pressure Due to Downthrust in Kg/m^2

Sr. No.	Description	Expression	Value
(a)	Downthrust acting perpendicular to footing (Y1)	(88566 * (COS(12.014)))	86626
(b)	Over Load due to Concrete (Kg)	(0.48^2 x 0.225x2400)+(0 48^2x1 5x(2400-1440))+[(0 48^2x0.9)+(2.02^2x0.1)+(3 78^2x0.1)+ (1.45^2x0 2)+ (3.78^2+3 48^2+3 78x3 48)x0 15/3]x(2400-1440)+3 78^2*0 05x(2400-1440))	5407
(c)	Total Downthrust acting normal to footing in Kg	(86626 12+5406 74)	92033
(d)	Bearing Pressure Due to Downthrust (Kg/m^2) (P/A)	(92032 86 / 3 78^2)	6441
(e)	Depth of Slab below chimney in M	(0.1+0 15+0 1+0.2)	0.550
(f)	Moment Due to Eccentricity (MX & MZ)	(86626 12 * Tan (8 558) *0 55)	7170
(g)	Bearing Pressure Due to Eccentricity in Kg/m^2 (Pe/Z)	(7170 / (3 78^3 / 6)	797
(h)	Bearing Pressure Due to Eccentricity in Kg/m^2 (Pe/Z)	(7170 / (3.78^3 / 6) + (7170 / (3.78^3 / 6))	1593
(i)	Total Bearing Pressure in Kg/m^2	(6441 + 1593 03)	8034
(j)	**Factor of Safety against Downthrust**	(13675 / 8034 03)	**1.702**
		Since F.O.S is > 1.00 , Foundation is Safe Against Downthrust	

L&T CONSTRUCTION POWER TRANSMISSION AND DISTRIBUTION IC			
PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No O17123-T-TL-4D-DC-2001B	Date 06 01 2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE WET SOIL (DEPTH=3M) (132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)	DESIGNED: KMR CHECKED: RJR	Sheet 4 of 19

Sr. No.	Description	Expression		Value
	(B) Bearing Pressure Due to Transverse Side Thrust in Kg/m^2			
(a)	Coefficient of Passive Earth Pressure in upper layer (Kp_1)	(1+ Sin (25)) / (1- Sin (25))		2.464
	Coefficient of Passive Earth Pressure in lower layer (Kp_2)	(1+ Sin (15)) / (1- Sin (15))		1.698
(b)	Depth of Chimey above Slab-IV	Dc = 2.4		2.400
(c)	To find the depth of effective earth pressure He(=H_1+H_2), equating the passive pressure of soil to the side thrust			
		$1/2*Kp_1W_uH_1^2B_c+Kp_2W_uH_1H_2B_c+1/2*Kp_2W_LH_2^2B_c$=S.T		
	Solving this equation for H_2 with			
	A=	$1/2*Kp_2W_LB_C$	=0.5*1.698*940*0.48	383.069
	B=	$Kp_2W_uH_1B_c$	=1.698*1440*(1.5-0.5)*0.48	1173.658
	C=	$1/2*Kp_1W_uH_1^2B_c$-S.T	=0.5*2.464*1440*(1.5-0.5)^2*0.48-5619	-4767.44
	H_2=	(-B+sqrt(B^2-4AC))/2A		2.314
	Depth of Effective earth pressure Zone (He) in M	=(H2+H1)	=2.314+(1.5-0.5)	3.314
(d)	Since Effective Pressure Zone (He) >(2.4- 0.5)Therefore Soil Pressure will only be mobilised in (2.4 - 0.5) m Depth			
(e)	Resisting Soil Force in upper layer Kg (R1) =	0.5*2.464*1440*(1.5-0.5)^2*0.48		851.558
	Resisting Soil Force in lower layer Kg (R2) =	1.698*1440*(1.5-0.5)*(2.4-1.5)*0.48		1056
	Resisting Soil Force in lower layer Kg (R3) =	0.5*1.698*940*(2.4-1.5)^2*0.48		310
	Total Resisting Soil Force in Kg (R) =	851.5584+1056.29184+310.285728		2218.136
(f)	C G of Resultant force in m	(851.5584*((1.5-0.5)/3+(2.4-1.5))+1056.29184*((2.4-1.5)*0.5)+310.285728*((2.4-1.5)/3))/(851.5584+1056.29184+310.285728)		0.730
(g)	Moment @ Base Due to Side Thrust (Kg-m)	5619*(3-0.05+0.225)-2218.14*(0.73+0.55)		15001
(h)	Bearing Pressure due to SideThrust in Kg/m^2	(15001.11/ (3.78^3/ 6))		1666.476
	(C) Bearing Pressure Due to Longitudinal Side Thrust in Kg/m^2			
(a)	To find the depth of effective earth pressure He(=H_1+H_2), equating the passive pressure of soil to the side thrust			
		$1/2*Kp_1W_uH_1^2B_c+Kp_2W_uH_1H_2B_c+1/2*Kp_2W_LH_2^2B_C$=S.T		
	Solving this equation for H_2 with			
	A=	$1/2*Kp_2W_LB_C$	=0.5*1.698*940*0.48	383.069
	B=	$Kp_2W_uH_1B_c$	=1.698*1440*(1.5-0.5)*0.48	1173.658
	C=	$1/2*Kp_1W_uH_1^2B_c$-S.T	=0.5*2.464*1440*(1.5-0.5)^2*0.48-1724	-872.442
	H_2=	(-B+sqrt(B^2-4AC))/2A		0.618
	Depth of Effective earth pressure Zone (He) in M	=(H2+H1)	=0.618+(1.5-0.5)	1.618
(b)	Since Effective Pressure Zone (He) is Less than (2.4- 0.5) , Therefore Soil Pressure will only be mobilised in 1.618 m Depth			

	L&T CONSTRUCTION **POWER TRANSMISSION AND DISTRIBUTION IC**

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No**		**Date**
		017123-T-TL-4D-DC-2001B		06.01.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE WET SOIL (DEPTH=3M) (132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)	**DESIGNED**	**CHECKED**	**Sheet**
		KMR	RJR	5 of 19

	Resisting Soil Force in upper layer Kg (R1) =	0.5*2.464*1440*(1.5-0.5)^2*0.48	852
	Resisting Soil Force in lower layer Kg (R2) =	1.698*1440*(1.5-0.5)*(1.618-1)*0.48	725
	Resisting Soil Force in lower layer Kg (R3) =	0.5*1.698*940*(1.618-1)^2*0.48	146
	Total Resisting Soil Force in Kg (R) =	851.5584+725.3203968+146.3031683712	1723
(c)	C.G of Resultant force in m	(851.5584*((1.5-0.5)/3+(1.618-(1.5-0.5)))+725.3203968*((1.618-(1.5-0.5))*0.5)+146.3031683712*((1.618-(1.5-0.5))/3))/(851.5584+725.3203968+146.3031683712)	0.618
(d)	Moment @ Base Due to Side Thrust (Kg-m)	1724*(3-0.05+0.225)-1723.18*(0.618+(2.4-0.5-1.618)+0.55)	2975
(e)	Bearing Pressure due to SideThrust in Kg/m²	(2975.09/ (3.78^3/ 6))	330.503
	(D) Total Bearing Pressure		
(f)	Total Bearing Pressure due to Downthrust & Side Thrust in K	Pmax = (8034 + 1666 + 331)	10031
		Pmin = (6441 - 1593 - 1666 - 331)	2851
(g)	**Factor of Safety against Bearing** **(Limit bearing pressure is increased by 25% as per IS code.)**	(13675*1.25 / 10031.01) **Since F.O.S in bearing is >1.00, Foundation is Safe In Bearing**	**1.70**

(3) STRUCTURAL DESIGN OF FOUNDATION

Sr. No.	Description	Expression	Value
A)	**Design Base Slab Reinforcement** *(Refer Fig-5 for base pressure distribution)*		
(a)	Design bearing pressure (Kg/m2)	= {(P/A+(0.5*Pe/Z)) + Max. of (Bearing pressure due to S.T.(T),S.T.(L) }	
(b)	Maximum , Pmax in Kg/m²	= (6441 + 796.517 + 1666.48)	8904
(c)	Minimum , Pmin in Kg/m²	= (6441 - 796.517 -1666.48)	3978
(d)	Maximum pressure Pmax in N/mm2	8903.993*9.81/1000000	0.087348
(e)	Minimum pressure Pmin in N/mm2	3978.007*9.81/1000000	0.039024
(f)	Total Depth of At Section X-X in 'm'	(0.1 + 0.15 +0.1+0.2)	0.550
(g)	Effective Depth of Slab (Dactual) at Section X-X in mm	(550 - (10 + 10 / 2 + 50))	485
(h)	Total Depth of At Section Y-Y in M	(0.1 + 0.15+ 0.1)	0.350
(i)	Effective Depth of Slab (Dactual) in mm	(350 - (10 + 10 / 2 + 50))	285
(j)	Total Depth of At Section Z-Z in M	(0.1 + 0.15)	0.250
(k)	Effective Depth of Slab (Dactual) in mm	(250 - (10 + 10 / 2 + 50))	185
(l)	Distance from the edge of the footing to Section X-X in 'm'	(3.78-0.48)/2	1.65

L&T CONSTRUCTION POWER TRANSMISSION AND DISTRIBUTION IC				
PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No OH7123-T-TL-4D-DC-2001B		Date 06 01 2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE WET SOIL (DEPTH=3M) (132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)	DESIGNED KMR	CHECKED RJR	Sheet 6 of 19

(m)	Distance from the edge of the footing to Section Y-Y in 'm'	(3 78-1 45)/2		1.165
(n)	Distance from the edge of the footing to Section Z-Z in 'm'	(3 78-2 02)/2		0.880
(o)	Pressure at a distanced=485mmfrom section X-X	(8904-3978)/3 78*(3 78-1 65+0.485)+3978		7386
(p)	Pressure at a distanced=285mmfrom section Y-Y	(8904-3978)/3 78*(3 78-1 165+0.285)+3978		7757
(q)	Pressure at a distanced=185mmfrom section Z-Z	(8904-3978)/3.78*(3 78-0.88+0 185)+3978		7998
(r)	The pressure at section X-X (Pxx in Kg/m^2)	(8904-3978)/3 78*(3 78-1 65)+3978		6754
(s)	The pressure at section Y-Y (Pyy in Kg/m^2)	(8904-3978)/3.78*(3.78-1.165)+3978		7386
(t)	The pressure at section Z-Z (Pyy in Kg/m^2)	(8904-3978)/3.78*(3 78-0.88)+3978		7757
(u)	Bending Moment at face of chimney at Section X-X in kg-m per m width	6754*(3 78-0.48)^2/8+(8904-6754)*1 65/2*2/3*1.65		11145
(v)	Bending Moment at face of chimney at Section X-X in N-mm per m width	(11144.893*9.81*1000)		1 0933E+08
	No and Diameter of Bars to be used in Base Slab	No of Bars required for base slab	Diameter of Bar in mm	Area of Bars (Ast) in mm^2
	MKD "K"	32	10	2513.27
	Value of Xumax /d to be used in slab design	Fy = 500 (Xumax / d) = 0 46 & For Fy = 415 (Xumax/d) = 0.48		
	Effective Depth Required for slab (Dreqd) in mm	Sqrt (1.093E+08/ (0 36 * 20 * 0 46*(1-(0 42*0 46)) * 1 * 1000)		202
	Breadth at section -XX in M = 1.45	**Since (dreqd) < than (dactual), Slab depth is O.K**		
	Moment of Resistance at Section - XX Mrx in N-mm	[Mrx =0 87 *500 * Ast *485 * [1-(Ast *500 / 20 * 1000*485]		
	Total Reinforcement Ast required in mm2	= 10 875 Ast^2 - 210975 Ast + 1 093E+08 = 0		
	where Ast = Reinforcement Reqd for moment Mrx /m width Ast required for total width	Solving the above Quadratic equation for Ast We Get Ast = =533 13*3.78		533 13 2015 23
	Minimum steel area required , mm2	0.12/100 x 3780 x 550		2494.80
(c)	Bending Moment about Section Y-Y per m width	7386*(1.165)^2/2+(8904-7386)*1 165/2*2/3*1.165)*9.81*1000		5.6E+07
	Effective Depth Required for slab (Dreqd) in mm	Sqrt (5 591E+07/ (0 36 * 20 * 0 46*(1-(0 42*0 46)) * 1 * 1000)		145
	Breadth at section -YY in M = 2.02	**Since (dreqd) < than (dactual), Slab depth is O.K**		
(d)	Moment of Resistance at Section - YY Mry in N-mm	(Mry =0 87 *500 * Ast *285 * [1-(Ast *500 / 20 * 1000*285]		
	where Ast = Reinforcement Reqd for moment Mry/m width Ast required for total width	Solving the above Quadratic equation for Ast We Get Ast = =470 6*3.78		471 1778 87
(f)	Minimum steel area required , mm2	0 12/100 x 3780 x 350		1587 60
(g)	Bending Moment about Section Z-Z per m width	7757*(0 88)^2/2+(8904-7757)*0 88/2*2/3*0 88)*9 81*1000		3 2E+07
	Effective Depth Required for slab (Dreqd) in mm	Sqrt (3 237E+07/ (0 36 * 20 * 0 46*(1-(0 42*0 46)) * 1 * 1000)		110
	Breadth at section -ZZ in M = 3.78	**Since (dreqd) < than (dactual), Slab depth is O.K**		
(h)	Moment of Resistance at Section - ZZ Mry in N-mm	(Mry =0 87 *500 * Ast *185 * [1-(Ast *500 / 20 * 1000*185]		
	where Ast = Reinforcement Reqd for moment Mry Ast required for total width	Solving the above Quadratic equation for Ast We Get Ast = =427 08*3 78		427 1614 36
(i)	Minimum steel area required , mm2	0 12/100 x 3780 x 250		1134 00
	Maximum of the above area of steel is provided as Slab Reinforcement	(Ast = Maximum of (533 13 , 2494.8 , 470 6, 1587 6 , 427 08, 1134))		2494 80
	Total No of bars required for slab	(2494 8 / (Pi / 4 * 10 ^ 2)) (No of bars required = 31 765		32
		(Let us Provide 32 Nos of 10mm diameter rod as slab reinforcement)		
	Hence the speacing between rod is (mm)	**119**		**O.K.**

L&T CONSTRUCTION	
POWER TRANSMISSION AND DISTRIBUTION IC	

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No		Date
		O17123-T-TL-4D-DC-2001B		06.01.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE WET SOIL (DEPTH=3M) (132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)	DESIGNED	CHECKED	Sheet
		KMR	RJR	7 of 19

B)	**Check for One Way Shear At Section - XX : - (Refer Fig -3)**		
(a)	Shear At Section - XX/m in N	(0.5*(8904+7386)*(((3.78-0.48)/2)-0.485))*9.81	93085
(b)	Effective Area of Cross Section per m run in mm^2	485*1000	485000
(c)	Nominal Shear Stress Tv in N/mm^2 /m	(93085.16 / 485000)	0.192
(d)	Total Effective Area of Cross Section in mm^2	((1450*200)+(2020*100)+0.5*(3480+3780)*150+3780*(100-50-5))	1206600
(e)	Percentage Slab reinforcement (p)	p = (100 * 2513.27 / 1206600)	0.208
(f)	Permissible Shear Stress Tc in N/mm^2	(Refer clause no 4.10 of Sp-16- 1980 Design Aids for IS 456	
(g)	Permissible Shear Stress Tc in N/mm^2	[0.85 x { Sqrt (0.8 x Fck) }x{{sqrt(1+5Ct)}-1}]/(6xCt)	
(h)	Where Coefficient Ct is given by	Ct = (0.8 x 20 / (6.89 x 0.208)	11.164
(i)	Permissible Shear Stress Tc in N/mm^2	(((0.85* ((0.8 * 20) ^0.5*(((1+5 * 11.164)^0.5-1)) / (6 * 11.164)))	0.332
		(Since Tc > than Tv Shear Reinforcement is not required	
C)	**Check for One Way Shear At Section - YY : - (Refer Fig -3)**		
(a)	Shear At Section - YY/m N	(0.5*(8904+7757)*(((3.78-1.45)/2)-0.285))*9.81	71916
(b)	Effective Area of Cross Section per m run in mm^2	285*1000	285000
(c)	Nominal Shear Stress Tv in N/mm^2 /m	(71916 / 285000)	0.252
(d)	Total Effective Area of Cross Section in mm^2	((2020*100)+0.5*(3480+3780)*150+3780*(100-50-5))	916600
(e)	Percentage Slab reinforcement (p)	p = 100 * 2513.27 / 916600	0.274
(f)	Where Coefficient Ct is given by	Ct = (0.8 x 20 / (6.89 x 0.274)	8.475
(g)	Permissible Shear Stress Tc in N/mm^2	(((0.85* ((0.8 * 20) ^0.5*(((1+5 * 8.475)^0.5-1)) / (6 *8.475)))	0.374
		(Since Tc > than Tv Shear Reinforcement is not required	
D)	**Check for One Way Shear At Section - ZZ : - (Refer Fig -3)**		
(a)	Shear At Section - ZZ/m N	(0.5*(8904+7998)*(((3.78-2.02)/2)-0.185))*9.81	57619
(b)	Effective Area of Cross Section per m run in mm^2	185*1000	185000
(c)	Nominal Shear Stress Tv in N/mm^2 /m	(57619 / 185000)	0.311
(d)	Total Effective Area of Cross Section in mm^2	(0.5*(3480+3780)*150+3780*(100-50-5))	714600
(e)	Percentage Slab reinforcement (p)	p = 100 * 2513.27/ 714600	0.352
(f)	Where Coefficient Ct is given by	Ct = (0.8 x 20 / (6.89 x 0.352)	6.597
(g)	Permissible Shear Stress Tc in N/mm^2	(((0.85* ((0.8 * 20) ^0.5*(((1+5 * 6.597)^0.5-1)) / (6 *6.597)))	0.415
		(Since Tc > than Tv Shear Reinforcement is not required	
E)	**Check for Two Way Shear At Section - XX : - (Due to Downthrust) (Refer Fig -3)**		
(a)	Pressure at Section XX in N/mm2	8903.993*9.81/1000000	0.08735
(b)	Shear At Section - XX in N	((0.087*[3780^2-(480+485)^2])	1166725
(c)	Effective Area of Cross Section in mm^2	(480 + 485)*4 *485	1872100
(d)	Nominal Shear Stress Tv in N/mm^2	(1166725 / 1872100)	0.623
	Allowable Shear Stress (Tcmax) in N/mm^2	(As per Clause 31.6.3.1 of IS 456 - 2000)	
	Tcmax = Ks * Tc	Where (Ks = 0.5 + B[1]) Not > than 1 , Tc = 0.25 *Sqrt(Fck)	
(e)	Allowable Shear Stress in concrete (Tcmax) in N/mm^2	Min of (0.5 + (1.45 / 1.45) ,1) * (0.25 * SQRT (20))	1.118
		(Since Tcmax > than Tv Shear Reinforcement is not required)	

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No** O17123-T-TL-4D-DC-2001B		**Date** 06 01 2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE WET SOIL (DEPTH=3M) (132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)	**DESIGNED** KMR	**CHECKED** RJR	**Sheet** 8 of 19

Sr. No.	Description	Expression	Value
F)	**Check for Two Way Shear At Section - YY : - (Due to Downthrust) (Refer Fig -3)**		
(a)	Pressure at Section YY in N/mm2	8903.993*9.81/1000000	0.08735
(b)	Shear At Section - YY in N	((0.087*[3780^2-(1450+285)^2])	985128
(c)	Effective Area of Cross Section in mm^2	(1450 + 285)*4 *285	1977900
(d)	Nominal Shear Stress Tv in N/mm^2	(985128 / 1977900)	0.498
(e)	Allowable Shear Stress in concrete (Tcmax) in N/mm^2	Min of (0.5 + (2.02 / 2.02) ,1) * (0.25 * SQRT (20))	1.118
		(Since Tcmax > than Tv Shear Reinforcement is not required)	
G)	**Check for Two Way Shear At Section - ZZ : - (Due to Downthrust) (Refer Fig -3)**		
(a)	Pressure at Section ZZ in N/mm2	8903.993*9.81/1000000	0.08735
(b)	Shear At Section - ZZ in N	((0.087*[3780^2-(2020+185)^2])	823377
(c)	Effective Area of Cross Section in mm^2	(2020 + 185)*4 *185	1631700
(d)	Nominal Shear Stress Tv in N/mm^2	(823377 / 1631700)	0.505
(e)	Allowable Shear Stress in concrete (Tcmax) in N/mm^2	Min of (0.5 + (3.48 / 3.48) ,1) * (0.25 * SQRT (20))	1.118
		(Since Tcmax > than Tv Shear Reinforcement is not required)	
H)	**Design of Slab for Uplift Reinforcement at Section - ZZ : -**		
(a)	Bearing Pressure due to Uplift in Kg/m^2	(82789) / (3.78^2 - 0.48^2))	5889
(a)	Bending Moment/m width @ - ZZ (Mux) in N-mm	(5889.102 * (3.78 - 2.02)^2 / 8 * 3.78) * 9.81* 1000)	8.456E+07
(b)	Moment of Resistance at Section - ZZ Muy in N-mm	(Muy =0.87 *500*Astuy *185 * [1-(Astuy *500 / 20 * 3780*185)]	
(c)	Astuy = Reinforcement for Uplift @ - ZZ /M-width	Solving the above Quadratic equation for Astuy We Get Astuy =	1094.03
	Minimum steel area required . mm2	0.12/100 x 3780 x 250	1134
(d)	No and Diameter of Bars to be used in Base Slab	Diameter of Bar in mm	No of Bars required for Uplift force @ ZZ
	At Section - ZZ for Uplift Reinforcement	10	(1134 / (Pi /4 *10^2)) = 15.000
	(Let us Provide 15 Nos of 10mm diameter rod as Uplift Reinforcement at Section - ZZ MKD. 'L')		
	Hence the spcacing between rod is (mm)	**263**	**O.K.**

I) Design of Slab for Uplift Reinforcement at Section - YY : -

It may be noted that reinforcement provided at section Z-Z for uplift falls in tension zone and thus would also contribute in moment capacity of section at section Y-Y. This is because under uplift, compression occurs at the face of the base slab having more width (more area of compression flange) and section behaves as a highly under reinforced section. From the equilibrium of internal and external forces on the slab section and using stress and strains of concrete and steel as per IS:456, the following equation (Moment of resistance) can be obtained

$Xu/d_1 = (p_3/100)x(d_2/d_1)x(fs/0.36f_{ck}) + (p_4/100)x(0.87f_y/0.36f_{ck})$

where:- p_3 = (100 A_{s3} / Bd_2) and p_4 = (100 A_{s4}/ B_{d1}); fs= Design yield stress of steel at d_2 from MCE calculated for strain in steel at that level(arrived through interpolation from strain diagram)

A_{s3} = Area of reinforcement at the top of bottom-most step, A_{s4} = Area of reinforcement at the top of the topmost step

Moment of resistance of slab section at the face of the chimney:

$M_u = [0.87f_y * (p_3/100) * (d_2/d_1) * (d_2/d_1 - 0.416\ Xu/d_1) + (0.87f_y) * (p_4/100) * \{1-0.416Xu/d_1\}] * Bd_1^2$

Substituting the value of Xu/d1 in the above equation, we get the second order degree equation which can be resolve as follows:-

A = 0.416* $(0.87*f_y)$^2/$(0.36*f_{ck})$

B = 0.416*$((0.87*f_y)/(0.36*f_{ck}))$ * $((fs*(p_3/100)*(d_2/d_1))$ + $((0.416*fs*(p_3/100)*(d_2/d_1))*((0.87*f_y)/(0.36*f_{ck}))$ - $0.87*f_y$

C= $(M_{ux}/B*d_1*d_1)$ - $(fs*(p_3/100)*(d_2/d_1)$^2) + $(0.416*(p_3/100)*(d_2/d_1))$ * $((fs)/(0.36*f_{ck}))*((fs*(p_3/100)*(d_2/d_1))$

(a)	Bearing Pressure due to Uplift in Kg/m^2	(82789) / [3.78^2 - 0.48^2)]	5889
(b)	Bending Moment @ - YY (Mux) in N-mm	(5889.102 * (3.78 - 1.45)^2 / 8 * 2.02) * 9.81 * 1000)	7.9194E+07
(c)	Strain in reinforcement at d_2 from Bottom of slab-I (By linear interpolation from Strain Diagram)		1.4820E-03
(d)	Design yield stress of reinforcement at d_2 from Bottom of slab-I (fs in N/mm2) [Refer Fig.3 of SP-16]		296.39
	A = 0.416* $(0.87*f_y)$^2/$(0.36*f_{ck})$	A=((0.416*(0.87*500)^2/(0.36*20))	10933
	B = 0.416*$((0.87*f_y)/(0.36*f_{ck}))$ *$((fs*(p_3/100)*(d_2/d_1))$	B=0.416*((0.87*500)/(0.36*20))*((296.39*0.0017*(185/285))	
	+ $((0.416*fs*(p_3/100)*(d_2/d_1))*((0.87*f_y)/(0.36*f_{ck}))$	+((0.416*296.39*0.0017*(185/285))*((0.87*500)/(0.36*20))	-418.707
	- $0.87*f_y$	-0.87*500	
	C= $(M_{ux}/B*d_1*d_1)$ - $(fs*(p_3/100)*(d_2/d_1)$^2)	C=(79193822.949/2020*285*285)-(296.39*0.0017*(185/285)^2))	
	+ $(0.416*(p_3/100)*(d_2/d_1))$ * $((fs)/(0.36*f_{ck}))$	+(0.416*0.0017*(185/285))*((296.39)/(0.36*20))	0.27834
	*$((fs*(p_3/100)*(d_2/d_1))$	*((296.39*0.0017*(185/285))	
	Therefore by resolving the above equation, we get,		
	ps4/100	ps4/100 = (-b - SQRT(b^2-4ac))/2*a	
		ps4/100=418.707-SQRT(175315.958-4*10933*0.278))/(2*10933))	0.000677
		Therfore, ps4 =	0.07
	Therefore reinforcement Ast4 in mm2	Ast4=((0.068*2020*285)/100)	389.59

(e)	No and Diameter of Bars to be used in Base Slab	Diameter of Bar in mm	No of Bars required for Uplift force @ YY	
	At Section - YY for Uplift Reinforcement	10	(389.593 / (Pi /4 *10^2)) =	8.000
	(Let us Provide 8 Nos of 10mm diameter rod as Uplift Reinforcement at Section - YY, MKD 'M')			
	Hence the spacing between rod is (mm)	274		**O.K.**

	L&T CONSTRUCTION **POWER TRANSMISSION AND DISTRIBUTION IC**

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No**		**Date**
		017123-T-TL-4D-DC-2001B		06 01 2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE WET SOIL (DEPTH=3M) (132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)	**DESIGNED**	**CHECKED**	**Sheet**
		KMR	RJR	10 of 19

J)	**Design of Slab for Uplift Reinforcement at Section - XX : -**		
	It may be noted that reinforcement provided at section Y-Y for uplift falls in tension zone and thus would also contribute in moment capacity of section at section X-X.		
(a)	Bearing Pressure due to Uplift in Kg/m^2	(82789) / { 3 78 ^2 - 0 48^2)}	5889
(b)	Bending Moment @ - XX (Mux) in N-mm	(5889.102 * (3 78 - 0.48)^2 / 8 * 1.45) * 9 81* 1000)	1 140E+08
(c)	Strain in reinforcement at d_2 from Bottom of slab-I (By linear interpolation from Strain Diagram)		1.0100E-03
(d)	Design yield stress of reinforcement at d_2 from Bottom of slab-I (fs in N/mm2) [Refer Fig 3 of SP-16]		202 00
	A = 0.416* (0 87*f_y)^2/(0.36*f_{ck})	A=((0 416*(0 87*500)^2/(0 36*20))	10933
	B = 0 416*((0 87*f_y)/(0.36*f_{ck})) *((fs*(p_3/100)*(d_2/d_1))	B=0.416*((0.87*500)/(0.36*20))*((201 998*0 0011*(285/485))	
	+ ((0 416*fs*(p_3/100)*(d_2/d_1))*((0 87*f_y)/(0.36*f_{ck}))	+((0 416*201.998*0 0011*(285/485))*((0.87*500)/(0.36*20))	-428.488
	- 0 87*f_y	-0,87*500	
	C= (M_{ux}/B*d_1*d_1) - (fs*(p_3/100)*(d_2/d_1)^2)	C=(114031274 617/(1450*485*485)-(201.998*0 0011*(285/485)^2))	
	+ (0.416*(p_3/100)*(d_2/d_1)) * ((fs)/(0 36*f_{ck}))	+(0.416*0 0011*(285/485))*((201.998)/(0 36*20))	0.25917
	((fs(p_3/100)*(d_2/d_1))	*((201 998*0 0011*(285/485))	
	Therefore by resolving the above equation, we get,		
	ps5/100	ps5/100 = (-b - SQRT(b^2-4ac))/2*a	
		ps5/100=428 488-SQRT(183601 972-4*10933*0 2591)/(2*10933))	0 000614
		Therfore, ps5 =	0 061
	Therefore reinforcement Ast5 in mm2	Ast5=((0.061*1450*485)/100)	432 14
	Minimum steel area required , mm2	0 12/100 x 1450 x 550	957

(e)	No and Diameter of Bars to be used in Base Slab	Diameter of Bar in mm	No of Bars required for Uplift force @ XX	
	At Section - XX for Uplift Reinforcement	10	(957 / (Pi /4 *10^2)) =	13 000
	(Let us Provide 13 Nos of 10mm diameter rod as Uplift Reinforcement at Section - XX. MKD 'N')			
	Hence the spcacing between rod is (mm)	**113**		**O.K.**

	L&T CONSTRUCTION **POWER TRANSMISSION AND DISTRIBUTION IC**

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No**		**Date**
		O17123-T-TL-4D-DC-2001B		06.01.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE WET SOIL (DEPTH=3M) (132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)	**DESIGNED**	**CHECKED**	**Sheet**
		KMR	RJR	11 of 19

(4) CHECK FOR SLIDING (Refer Figure - 4)

Sr. No.	Description	Expression	Value
(a)	Coefficient of Passive Earth Pressure in Lower layer	(1+ Sin (15)) / (1- Sin (15))	1.698
(b)	Coefficient of Passive Earth Pressure in Upper layer	(1+ Sin (25)) / (1- Sin (25))	2.464
(c)	Facial Area in upper layer of Chimney in m^2	A1 = (0.48 * (1.5 -0.5))	0.480
(d)	Facial Area in lower layer of Chimney in m^2	A1 = (0.48 * (2.4 - 1.5))	0.432
(e)	Facial Area in Portion of Slab- IV in m^2	A2 = (0.2 * 1.45)	0.290
(f)	Facial Area in Portion of Slab- III in m^2	A3 = (0.1 * 2.02)	0.202
(g)	Facial Area in Portion of Slab- II in m^2	A4 = (0.15 * (3.78 + 3.48) / 2)	0.545
(h)	Facial Area in Portion of Slab- I in m^2	A5 = (0.1 * 3.78)	0.378
(i)	Earth Pressures in Upper Layer in Kg /m^2	(P1u = (2.464 * 1440 * (1.5-0.5)))	3548
(j)	Earth Pressures in Lower Layer 1 in Kg /m^2	(P11 = (1.698 * 1440 * (1.5-0.5)))	2445
(k)	Earth Pressures in Lower Layer 2 in Kg /m^2	(P2 = (2445.12 + (1.698 * 940 *(1.35 - 0.15 - 0.1 - 0.2))	3882
(l)	Earth Pressures in Lower Layer 3 in Kg /m^2	(P3 = (3881.628 + (1.698 * 940 * 0.2))	4201
(m)	Earth Pressures in Lower Layer 4 in Kg /m^2	(P4 = (4200.852 + (1.698 * 940 * 0.1))	4360
(n)	Earth Pressures in Lower Layer 5 in Kg /m^2	(P5 = (4360.464 + (1.698 * 940 * 0.15))	4600
(o)	Earth Pressures in Lower Layer 6 in Kg /m^2	(P6 = (4599.882 + (1.698 * 940 * 0.1))	4759
(p)	Lateral Force in Lower Layer -1 in Kg	(F1 = 0.48 / 2 * (3548.16))	852
(q)	Lateral Force in Lower Layer -2 in Kg	(F2 = 0.432 / 2 * (2445.12+3881.628))	1367
(r)	Lateral Force in Lower Layer -3 in Kg	(F3 = 0.29 / 2 * (3881.628+4200.852))	1172
(s)	Lateral Force in Lower Layer -4 in Kg	(F4 = 0.202 / 2 * (4200.852+4360.464))	865
(t)	Lateral Force in Lower Layer -5 in Kg	(F5 = 0.5445 / 2 * (4360.464+4599.882))	2439
(u)	Lateral Force in Lower Layer -5 in Kg	(F5 = 0.378 / 2 * (4599.882+4759.494))	1769
		Total Lateral Force in Kg	**8463**
	Factor of Safety Against Sliding : -		
		(8463.165 / 5619)	**1.51**
		Since F.O.S >1.00 foundation is Safe against sliding	

(5) CHECK FOR OVERTURNING

Sr. No.	Description	Expression	Value
(a)	Maximum Transverse Side Thrust in Kg	(5619)	5619
(b)	Maximum Longidutinal Side Thrust in Kg	(1724)	1724
(c)	Resultant Side Thrust (R) in Kg	(Sqrt (5619^2 + 1724^2))	5878
(d)	Total Overturning Moment in Kg-m	(82789 * Cos (12.014) * (3.78 / 2 - 3.78 / 6) + 5877.528 * (3 + 0.225 - 0.05) - 7173.216 * (3.78 / 2 - 3.78 / 6)	111652
(e)	Total Resisting Moment in Kg-m	(0.5 * 76174.24 * 5 / 6 * 3.78)	119974
(f)	Factor of Safety Against Overturning	(119974.428 / 111652.223)	**1.08**
		Since F.O.S >1.00 foundation is Safe against Overturning	

	L&T CONSTRUCTION POWER TRANSMISSION AND DISTRIBUTION IC			
PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No: OI7123-T-TL-4D-DC-2001B		Date: 06.01.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE WET SOIL (DEPTH=3M) (132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)	DESIGNED: KMR	CHECKED: RJR	Sheet: 12 of 19

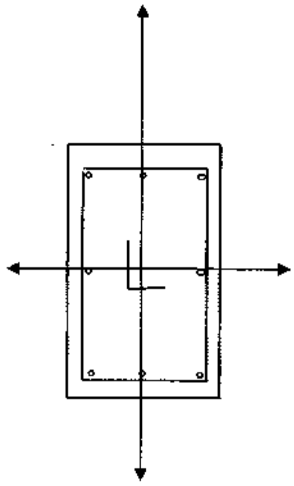
3.0 DESIGN OF CHIMNEY (Chimney Design with Stub contribution)

3.1 Loading:Compression with biaxial bending

Puc= (88566+0.48^2*(0.225+2.4)*2400)*9.81/1000
= **883.07 KN**

Mux= (5619)*(2.4+0.225)-2218.136*(2.4-0.5)/3)*9.81/1000
= **130.91 KN-m**

Muy= (1724)*(2.4+0.225)-1723.182*(2.4-0.5)/3)*9.81/1000
= **33.69 KN-m**



Material Property:

fy= 500 N/mm^2
fys= 250 N/mm^2
fck= 20 N/mm^2

Geometric Property:

D= 480 mm
Clear cover 50 mm
Dia of reinf 20 mm and 20 mm
No. of reinf= 4 nos. and 4 nos.
d' = 60 mm

TRIAL-I Say Neutral Axis at a distance from MCE = Xu = **249.849** mm
MCE: Most Compressed Edge of concrete

Location	Distance from MCE	Strain	Stress (f_{si}-f_{ci})	Area	Force	Distance from NA	Distance from CG	Moment
	mm		N/mm^2	mm^2	KN	mm	mm	KN-m
MCE	0.0	0.00350	-	-	-	249.849	240	-
R1	60.0	0.00266	386.64	942.48	364.40	189.849	180	65.59
R2	240.0	0.00014	7.59	628.32	4.77	9.849033	0	0.00
Stub	240.0	0.00014	7.59	2988.00	22.69	9.849033	0	0.00
R3	420.0	0.00238	394.99	942.48	-372.27	-170.151	-180	67.01
		Total		**5501.27**	**19.59**			**132.60**

Concrete force incompression, F = 0.36*fck*xu*d
Concrete force incompression,F = **863.48 KN**
Total axial Capacity = Concrete force in compression + Summation of all internal forces induced by the rebar & the stub
Total axial capacity = 863.48 + 19.59 = **883.07 KN** ≥ **883.07 KN**

Moment due to compression force in concrete = F*(C.G - 0.416Xu)
= 117.488 kN-m

Total Moment capacity = Moment due to compression force in concrete + Moment due to rebar & the stub
Total Moment capacity = 250.09 kN-m

Puz= 3526.816329 Pu/Puz= 0.25039

Interaction formula = **0.610** **OK**

3.2 **Loading:Tension with biaxial bending**

Put= 82789*9.81/1000

= **812 KN**

Mux= **116.21 KN-m**

Muy= **20.12 KN-m**

Material Property:

fy= 500 N/mm2

fys= 250 N/mm2

fck= 20 N/mm2

Geometric Property:

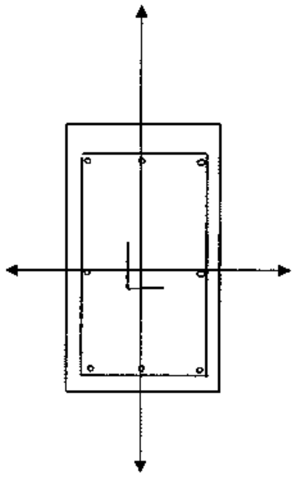
D= 480 mm

clear cover 50 mm

Dia of reinf 20 mm and 20 mm

No. of reinf= 4 nos. and 4 nos.

d' = 60 mm



TRIAL-I Say Neutral Axis at a distance from MCE = Xu = **91.078** mm

MCE: Most Compressed Edge of concrete

Location	Distance from MCE	Strain	Stress $(f_{si}-f_{ci})$	Area	Force	Distance from NA	Distance from CG	Moment
	mm		N/mm2	mm2	KN	mm	mm	KN-m
MCE	0	0.00350	-	-	-	91.07751	240	-
R1	60	0.00119	218.85	942.48	206.27	31.07751	180	37.13
R2	240	0.00572	435.00	628.32	-273.32	-148.922	0	0.00
Stub	240	0.00572	217.50	2988.00	-649.89	-148.922	0	0.00
R3	420	0.01264	435.00	942.48	-409.98	-328.922	-180	73.80
		Total		**5501.27**	**-1126.92**			**110.92**

Concrete force incompression, F = 0.36*fck*xu*d

Concrete force incompression,F = **314.76** KN

Total axial Capacity = Concrete force in compression + Summation of all internal forces induced by the rebar & the stub

Total axial capacity = 314.76 + -1126.92 = **812.16** KN ≥ **812.16** KN

Moment due to tension force in concrete = F*(C.G - 0.416Xu)

= 63.6167 kN-m

Total Moment capacity = Moment due to compression force in concrete + Moment due to rebar & the stub

Total Moment capacity = 174.54 kN-m

Pu/Puz= 1

Interaction formula = **0.781** OK

Design of Lateral ties

Minimum Diameter of Lateral Ties in mm =1/4 of largest dia. of Longitudinal bar = 0.25*20

= 5 mm

Hence provide lateral ties of dia = 6 mm

As per Clause 26.5.3.2 of IS 456 - 2000 Pitch of lateral Ties shall be least of the following

(i) Least lateral dimension of compression member = 0.48*1000 = 480 mm

(ii) 16 times smallest diameter of longitudinal bars = 16*20 = 320 mm

(iii) 300mm = 300 = 300 mm

So, provide the lateral ties at a distance of 300 mm c/c

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No**		**Date**
		O17123-T-TL-4D-DC-2001B		06.01.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE WET SOIL (DEPTH=3M) (132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)	**DESIGNED**	**CHECKED**	**Sheet**
		KMR	RJR	14 of 19

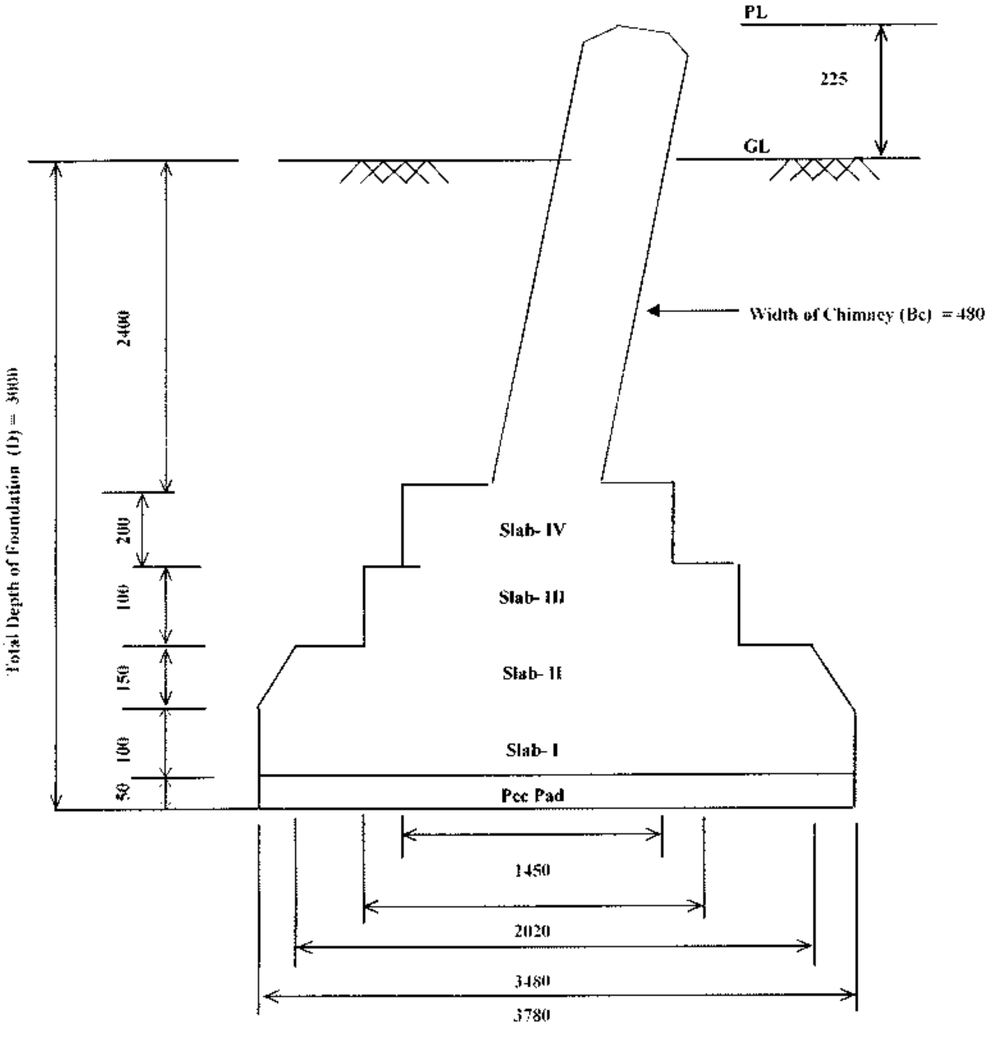


FIGURE - 1

Note :

All Dimensions are in Millimeters

L&T CONSTRUCTION

POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	**Document No**		**Date**
		O17123-T-TL-4D-DC-2001B		06.01.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE WET SOIL (DEPTH=3M) (132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)	**DESIGNED**	**CHECKED**	**Sheet**
		KMR	RJR	15 of 19

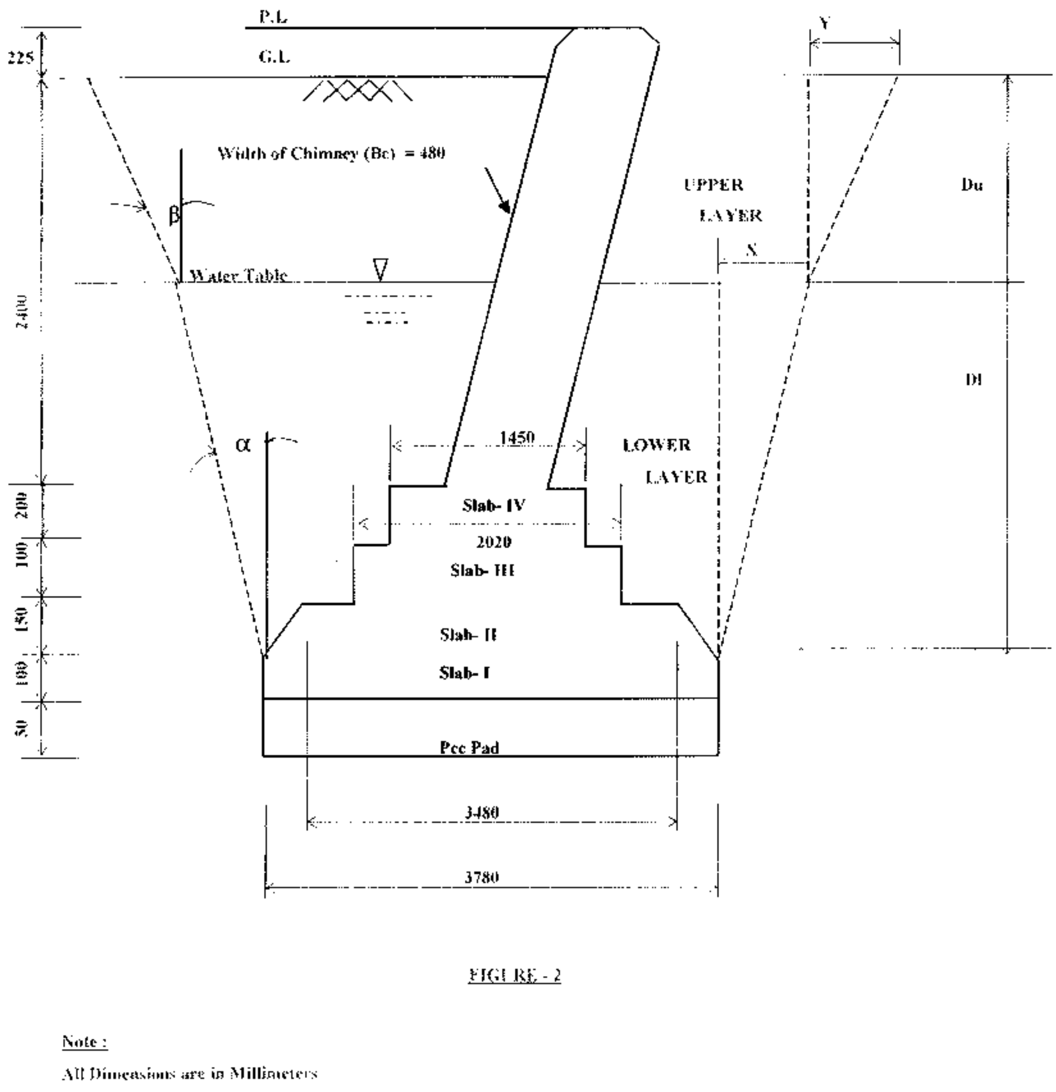


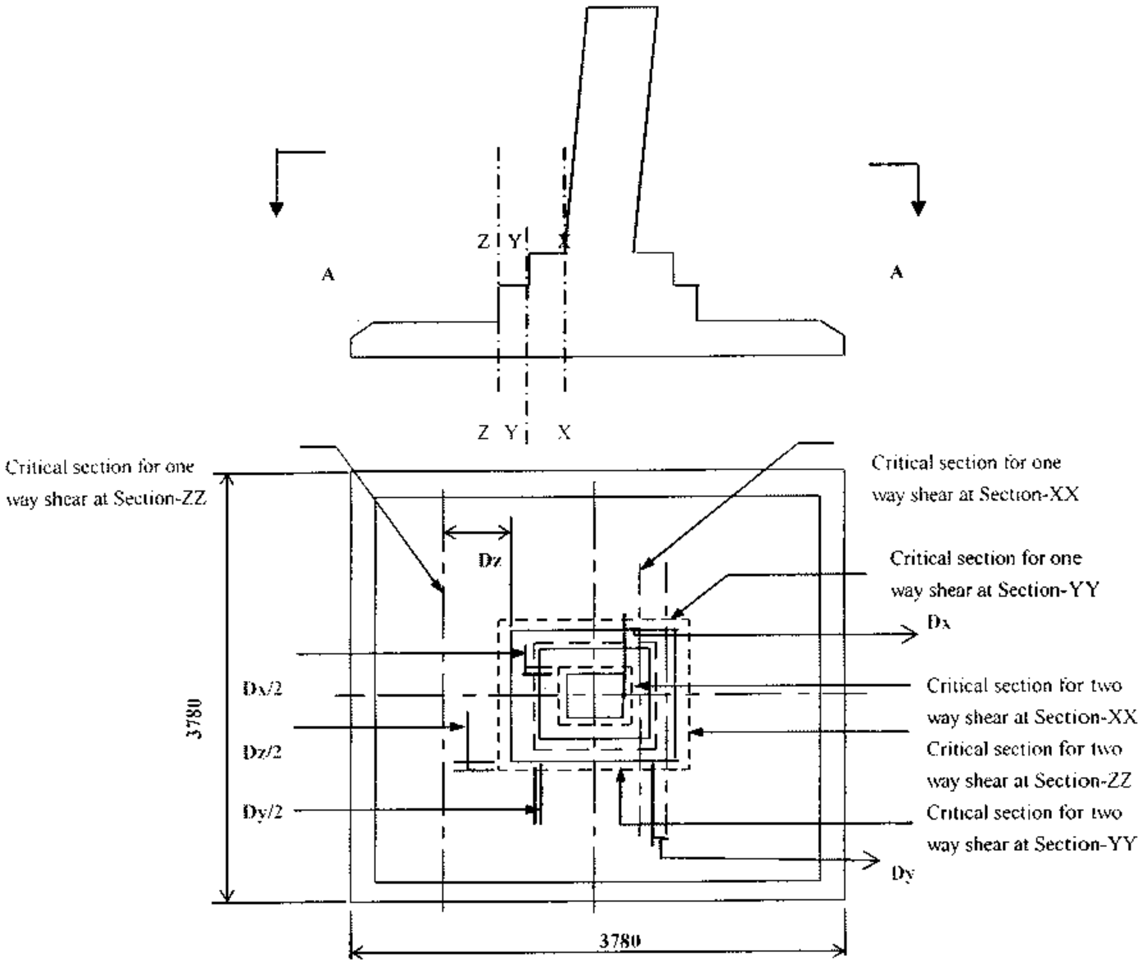
FIGURE - 2

Note :

All Dimensions are in Millimeters

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No O17123-T-TL-4D-DC-2001B		Date 06.01.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE WET SOIL (DEPTH=3M) (132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)	DESIGNED KMR	CHECKED RJR	Sheet 16 of 19

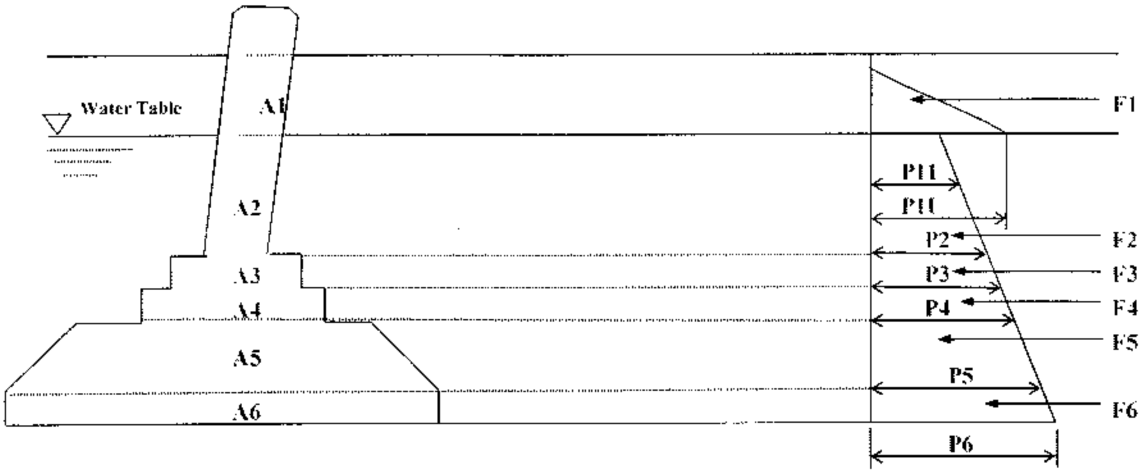


SECTION A-A

FIGURE - 3

Note :

All Dimensions are in Millimeters



EARTH PRESSURE DISTRIBUTION

FIGURE - 4

L&T CONSTRUCTION
POWER TRANSMISSION AND DISTRIBUTION IC

PROJECT	TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)	Document No O17123-T-TL-4D-DC-2001B		Date 06.01.2018
TITLE	FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE WET SOIL (DEPTH=3M) (132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)	DESIGNED KMR	CHECKED RJR	Sheet 18 of 19

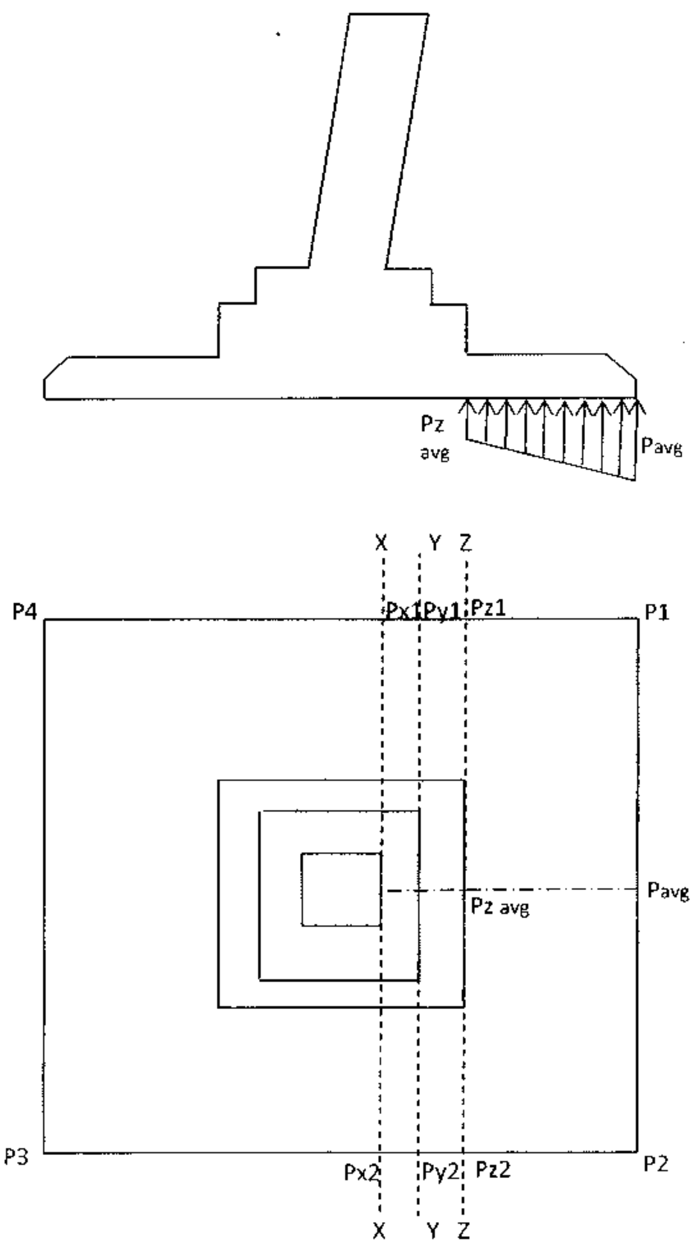
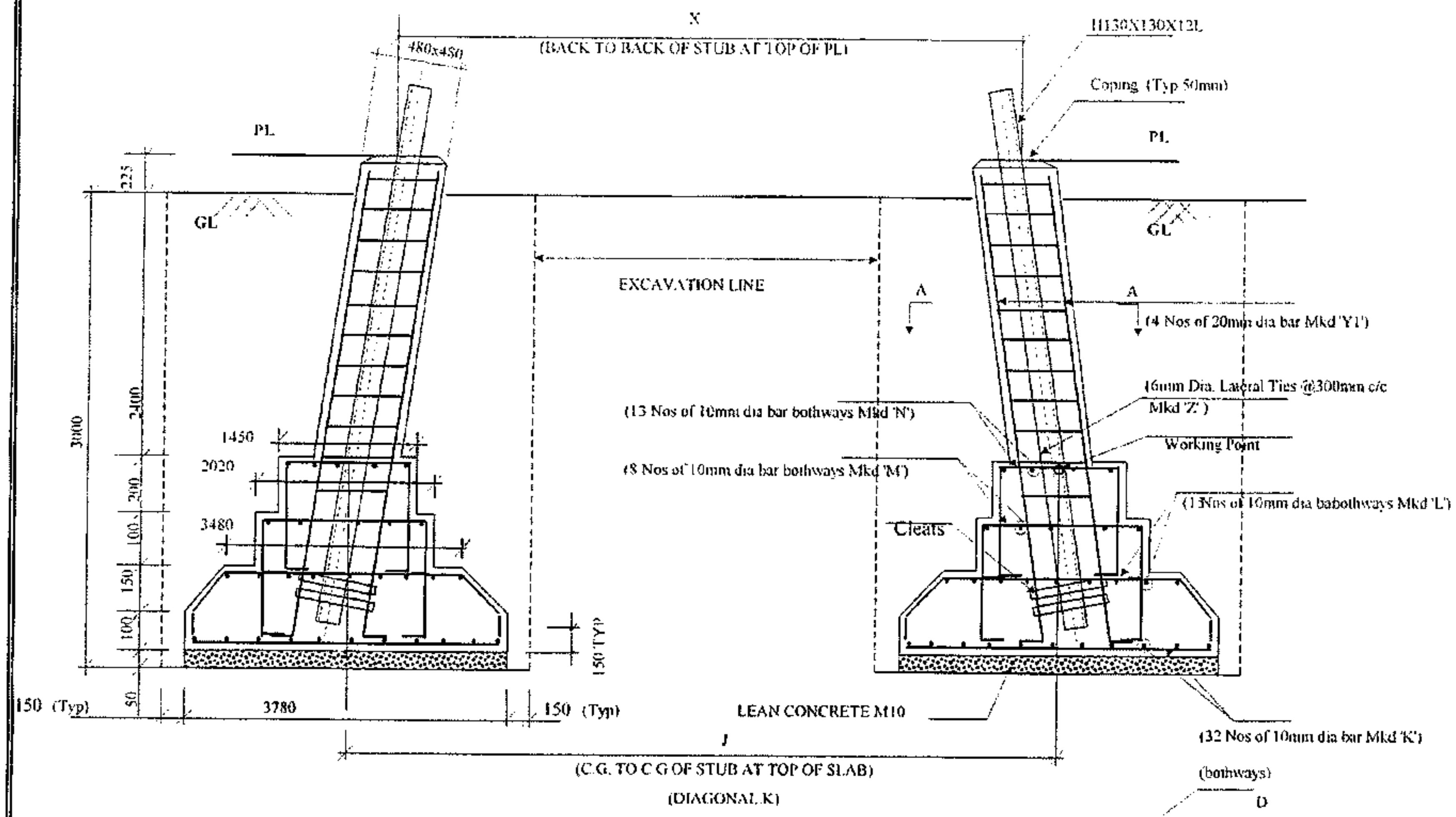
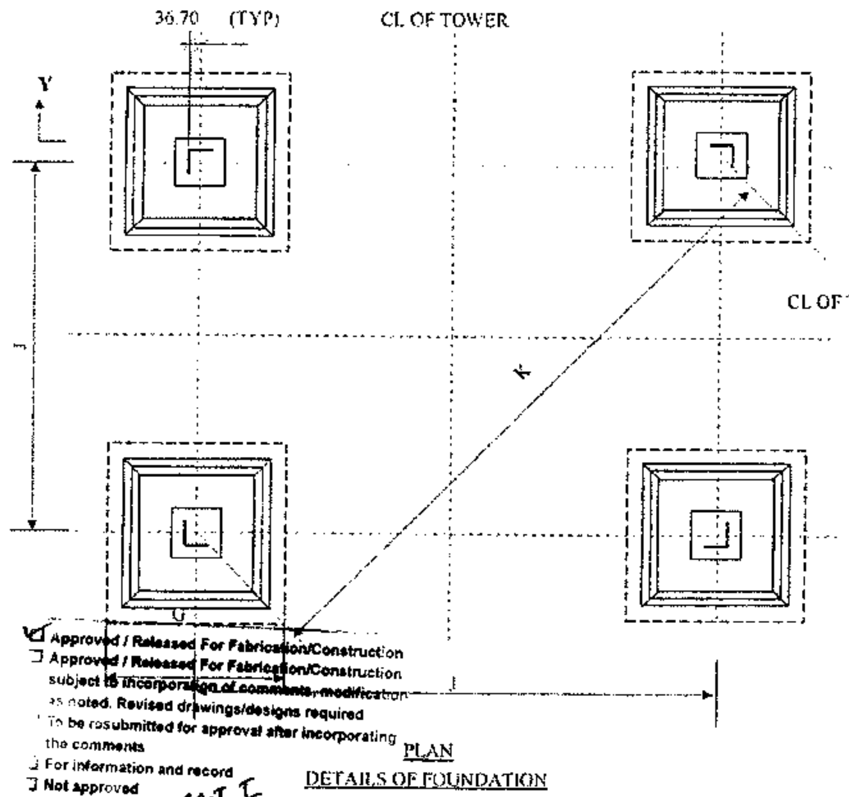
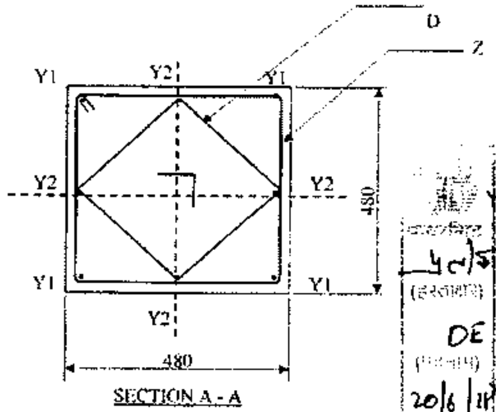


FIGURE - 5







SOIL TYPE	Basic Body/ Leg Extn	FOUNDATION					EXCAVATION		Reinforcement Per Tower in kg
		X (Back to Back) in mm	J in mm (C/C)	K in mm	Volume of Concrete Per Tower in M^3		Width in mm	Volume per Tower in M^3	
					M20	M10			
WET SOIL	DD+0	7364	8081	11428	19.36	2.86	4080	199.76	1387

BAR BENDING SCHEDULE

Mkd No	SKETCH	Dia in MM	Length in MM	Nos/ Leg	Unit Wt in Kg	Wt/ Leg Kg	Total Wt/Tower Kg
K	3680	10	3680	64	0.617	145.3	581.2
L	141 25 3380 141 25	10	3712	30	0.617	68.7	274.8
M	225 100 1920 100 225	10	2570	16	0.617	25.4	101.6
Y1	300 3035	20	3335	4	2.466	32.9	131.6
Y2	300 3035	20	3335	4	2.466	32.9	131.6
Z	380 380	6	1670	11	0.222	4.1	16.4
D	269	6	1225	11	0.222	3.0	12.0
N	295 100 1350 100 295	10	2140	26	0.617	34.3	137.2
			Total weight of steel required in Kg =				1387

CAT 1

4c/5

DE

20/6/18

LEG SLOPE:	0.15049

THIS FOUNDATION HAS BEEN DESIGNED FOR THE FOLLOWING PARAMETERS:

TYPE OF SOIL: WET SOIL (3m Depth)

UNIT WEIGHT: 1440/940 kg/m3

LIMIT BEARING CAPACITY: 13675 kg/m2

ANGLE OF REPOSE: 25/15 Deg

WATER TABLE: From 3m Upto 1.5m from GL

NOTES

1. ALL DIMENSIONS ARE IN MM UNLESS OTHER WISE SPECIFIED
2. CONCRETE GRADE IS M 20 UNLESS OTHERWISE SPECIFIED.
3. CONCRETE COVER IS 50mm UNLESS OTHERWISE STATED.
4. MIX PROPERTIES CONFIRMING TO IS 456-2000.
5. STEEL USED IS Fe500 CONFORMING TO IS 1786-2008
6. DURING PLACEMENT OF REINFORCEMENT BARS,THE BAR SPACING HAS TO READJUSTED TO PROVIDE PROPER CLEARANCE FOR CLEATS.
7. FOR FOUNDATION DESIGN REFER DOC: O17123-T-TL-4D-DC-2001B
8. SST DRAWINGS SHALL BE REFFERED FOR THE VALUES OF X (INDICATED IN THE TABLE) FOR CONSTRUCTION PURPOSE.
9. FOR SPLICING, LAP LENGTH TO BE PROVIDED IS 57d, d= DIA OF LARGER BAR.

☑ Approved / Released For Fabrication/Construction
☐ Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required to be resubmitted for approval after incorporating the comments
☐ For information and record
☐ Not approved

CAT I

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kV Transmission Line Project

Checked By: Date: 4/7/018
Recommended By: Date:
Approved By: Date: 4/7/018

CLIENT : NEPAL ELECTRICITY AUTHORITY (An Undertaking of Government of Nepal)

CONSULTANT : POWERGRID CORPORATION OF INDIA LTD

CONTRACTOR : L&T CONSTRUCTION *POWER TRANSMISSION AND DISTRIBUTION IC*

	SIGN	DATE
DSND	KMR	06.01.2018
DRWN	KMR	06.01.2018
CHKD	RJR	06.01.2018
APPD	CSR	06.01.2018
SCALE		NTS

PROJECT : TAMAKOSHI to KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220KV AND 132 KV BARHABISE - KATHMANDU TRANSMISSION LINE (TKTL)

TITLE: FOUNDATION DESIGN & DRAWING OF TOWER TYPE DD/DE +0M BE WET SOIL (DEPTH=3M) (132kV D/C SINGLE ACSR BEAR) (WIND ZONE - 4)

Document No	REV
O17123-T-TL-4D-DC-2001B	
PAGE 19 OF 19	0

Rev No	DATE	DESCRIPTION	PREP	CHKD	APPD
0	06.01.2018	FIRST SUBMISSION FOR APPROVAL	KMR	RJR	CSR

L&T Construction
Power Transmission & Distribution

CLIENT : **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

ONSULTANT पावरग्रिड **POWER GRID CORPORATION OF INDIA LTD**

PROJECT : **TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE**

LOA No. : **073/74-201 Dated: 24.04.2017**

CAT-I

DRG. No. : O17123-T-TL-4D-GA-0401A

BOM No. : BOM/LE17D124/132kV/DD/001A

NO OF SHEETS: 2

पावरग्रिड
(हस्ताक्षर)
(अभियंता / व.अभियंता)
26/07/19
(तिथि)

श्रेणियां
I. फेब्रीकेशन / निर्माण हेतु अनुमोदित।
II. फेब्रीकेशन / निर्माण हेतु अनुमोदित। बताई दी गई टिप्पणियों एवं आशोधनों को सम्मिलित किया जाए। कृपया आशोधित दस्तावेज अनुमोदनार्थ प्रस्तुत करें।
III. टिप्पणियों को सम्मिलित कर पुनः अनुमोदनार्थ प्रस्तुत करें।
IV. सूचनार्थ एवं रिकार्ड हेतु।
V. अनुमोदित नहीं।

पावर ग्रिड कारपोरेशन ऑफ इंडिया लि० अभियांत्रिकी (पारे.लाईन) गुरुग्राम, (हरियाणा)
This document is recommended for approval for construction of 400kV/132kV D/C TAMAKOSHI - BARHABISE - KATHMANDU in NEPAL

BILL OF MATERIAL

3M STUB EXTENDER FOR TOWER TYPE - "DD/DE" (132kV, WZ-4) (-4.5M TO +9M EXTN.) ONE CORNER ONLY

WEIGHT OF STRUCTURE	
HT MEMBERS: BOM/LE17D124/P3DRC	82.846
MS MEMBERS INCLUDING PACK WASHERS AND ACCESSORIES ETC.	-
WEIGHT OF BOLTS & NUTS,SPRING WASHERS: BOM/LE17D124/P3DRB	2.544
TOTAL WEIGHT OF STRUCTURE:	85.39 Kgs

THIS STUB EXTENDER SHALL COMPLETE WITH EXISTING STANDARD STUB OF DD TYPE TOWER FOR 3M DEPTH FOUNDATION

0	17.07.19	FIRST SUBMISSION FOR APPROVAL	PU	BSR	CSR
REV.	DATE	DESCRIPTION	CHKD.	REVED.	APPD.

PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY	DATE
ALEX	PU	BSR	CSR	17.07.19

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 17-Jul-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/P3DRC

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
	BOM OF 3M STUB EXTENDER FOR TOWER TYPE-"DD/DE" (132KV WZ-4) ONE CORNER							
1	N1SDD3E1H	L130X130X12H-E350A	3057.00	23.500	1	71.840	71.840	
2	N1SDD3E2H	L120X120X8H-E350A	386.00	14.700	1	5.674	5.674	
3	N1SDD3E3H	8MM PLATE H-E350A	110.00 X 386.00	62.800	2	2.666	5.332	
				Total Weight :			**82.846**	

Associated Parts

Part Code	Type of Association	Associated with	Total Weight

No Association Part

Raw Material Involved	Standard Material	Total Weight (In Kg)
BOM OF 3M STUB EXTENDER FOR TOWER TYPE-"DD/DE" (132KV WZ-4) ONE CORNER		
8MM PLATE H-E350A	HT	5.332
L120X120X8H-E350A	HT	5.674
L130X130X12H-E350A	HT	71.840
Total		82.846
HT		**82.846**

** -- Item Welded with another item
*** -- Item Assembled with another item

LARSEN & TOUBRO LIMITED, CONSTRUCTION.,
979,Mount-Poonamallee Road,Manapakkam,
Tamilnadu-600089,PHONE :044-22526000,FAX :044-22526059

Date: 17-Jul-2019

BILL OF MATERIAL

Order No : LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Bom No : BOM/LE17D124/P3DRB

Order Ref: REF/LE17D124

Sl.No	Part Code	Raw Material	Length Size (In MM)	Unit Wt (In KG)	Req Qty	Per piece wt	Total Wt	Per Piece Ass.Wt
	BOLTS & NUTS OF 3M STUB EXTENDER FOR TOWER TYPE-"DD/DE" (132KV WZ-4) ONE CORNER							
1	P3DRB1	M16x55MM LONG (IS:12427)		0.150	16	0.150	2.400	
2	P3DRB2	M16x3.5MM SPRING WASHER IS3063		0.009	16	0.009	0.144	
				Total Weight :			**2.544**	

Associated Parts

Part Code	Type of Association	Associated with	Total Weight

No Association Part

Raw Material Involved	Standard Material	Total Weight (In Kg)
BOLTS & NUTS OF 3M STUB EXTENDER FOR TOWER TYPE-"DD/DE" (132KV WZ-4) ONE CORNER		
M16x3.5MM SPRING WASHER IS3063		0.144
M16x55MM LONG (IS:12427)		2.400
	Total	2.544

** -- Item Welded with another item
*** -- Item Assembled with another item

L&T Construction
Power Transmission & Distribution

CLIENT : **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONSULTANT : पावरग्रिड **POWER GRID CORPORATION OF INDIA LTD**

PROJECT : **TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE**

LOA No. : **073/74-201 Dated: 24.04.2017**

DRG. No. : O17123-T-TL-4D-GA-0403

BOM No. : BOM/LE17D124/132kV/DD/003

NO OF SHEETS: 12

☑ Approved / Released For Fabrication/Construction
☐ Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
☐ To be resubmitted for approval after incorporating the comments
☐ For information and record CAT I
☐ Not approved
Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kv Transmission Line Project
Checked By: Date: 5/9/018
Recommended By: Date:
Approved By: Date:

पावरग्रिड
श्रेणियाँ
I. फेब्रीकेशन / निर्माण हेतु अनुमोदित।
II. फेब्रीकेशन / निर्माण हेतु अनुमोदित। बशर्ते दी गई टिप्पणियों एवं संशोधनों को सम्मिलित किया जाए। कृपया संशोधित दस्तावेज अनुमोदन हेतु प्रस्तुत करें।
III. टिप्पणियों को सम्मिलित कर पुनः अनुमोदनार्थ प्रस्तुत करें।
IV. सूचनार्थ एवं रिकार्ड हेतु।
V. अनुमोदित नहीं।
(हस्ताक्षर)
AGBE
(अभियंता / इं.अभियंता)
07/8/18
(तिथि)
पावर ग्रिड कारपोरेशन ऑफ इंडिया लि०
अभियांत्रिकी (परामर्श) गुड़गांव (हरियाणा)
This document is recommended for approval for construction of 400kV /132kV D/C TAMAKOSHI - BARHABISE - KATHMANDU in NEPAL

BILL OF MATERIAL
+0M LEG EXTN. FOR TOWER TYPE - "DD/DE" (132kV, WZ-4)
(ONE CORNER ONLY)

WEIGHT OF +0M LEG EXTN. (ONE CORNER) (WITH STEP BOLT)		WEIGHT OF +0M LEG EXTN. (ONE CORNER) (WITH OUT STEP BOLT)	
HT MEMBERS: BOM/LE17D124/P1D0S/S1D0S/R-0 = 117.500 BOM/LE17D124/P1D0E/S1D0H/R-0 = 22.832	140.332	HT MEMBERS: BOM/LE17D124/P1D0R/S1D0R/R-0 = 117.500 BOM/LE17D124/P1D0E/S1D0H/R-0 = 22.832	140.332
MS MEMBERS INCLUDING PACK WASHERS AND ACCESSORIES ECT. BOM/LE17D124/P1D0E/S1D0M/R-0 = 180.602 BOM/LE17D124/P1D0B/S1D0W/R-0 = 0.036	180.638	MS MEMBERS INCLUDING PACK WASHERS AND ACCESSORIES ECT. BOM/LE17D124/P1D0E/S1D0M/R-0 = 180.602 BOM/LE17D124/P1D0B/S1D0W/R-0 = 0.036	180.638
WEIGHT OF BOLTS & NUTS,SPRING WASHERS BOM/LE17D124/P1D0B/S1D0B/R-0	9.834	WEIGHT OF BOLTS & NUTS,SPRING WASHERS BOM/LE17D124/P1D0B/S1D0B/R-0	9.834
WEIGHT OF STEP BOLTS BOM/LE17D124/P0S1D/S0S1D/R-0	2.961	WEIGHT OF STEP BOLTS	-
TOTAL WEIGHT OF STRUCTURE:	333.765 Kgs	TOTAL WEIGHT OF STRUCTURE:	330.804 Kgs

SUCCESSFULLY TESTED AT CPRI - BENGALURU
ON 11th OF JULY 2018

REV.	DATE	DESCRIPTION	CHKD.	REVED.	APPD.
0	12.07.18	SUBMISSION FOR APPROVAL AFTER SUCCESSFUL TESTING	PU	BSR	CSR

PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY	DATE
ALEX	PU	BSR	CSR	12.07.18

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX :979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/P1D0S/S1D0S/R-0

Date 12-07-2018

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
+0M LEG EXTN. (WITH STEP BOLT) FOR TOWER TYPE-"DD/DE" (132kV, WZ-4) ONE CORNER							
1	N1SDD21SH	L130x130x12H-E350A	5000.00	23.500	1	117.500	117.500

TOTAL WEIGHT : **117.500**

*** - Item welded with another item

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	12-07-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/P1D0S/S1D0S/R-0		

Srl No	Section Invloved	Section Weight
	+0M LEG EXTN. (WITH STEP BOLT) FOR TOWER TYPE-"DD/DE" (132kV, WZ-4) ONE CORNER	
1	L130x130x12H-E350A	117.500
	Total	117.500

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/P1D0R/S1D0R/R-0

Date 12-07-2018

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
+0M LEG EXTN. (WITHOUT STEP BOLT) FOR TOWER TYPE-"DD/DE" (132kV, WZ-4) ONE CORNER							
1	N1SDD22H	L130x130x12H-E350A	5000.00	23.500	1	117.500	117.500

TOTAL WEIGHT : **117.500**

*** - Item welded with another item

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	12-07-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/P1D0R/S1D0R/R-0		

Srl No	Section Invloved	Section Weight
	+0M LEG EXTN. (WITHOUT STEP BOLT) FOR TOWER TYPE-"DD/DE" (132kV, WZ-4) ONE CORNER	
1	L130x130x12H-E350A	117.500
	Total	117.500

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION

TRANSMISSION LINE DESIGN

MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.

PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/P1D0E//R-0

Date 12-07-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
+0M LEG EXTN.(COMMON ITEMS) FOR T.T-"DD/DE"(132kV)ONE CORNER								
1	N1SDD23H	L120x120x8H-E350A	386.00		14.700	1	5.674	5.674
2	N1SDD24H	8MM PLATE H-E350A	110.00 X	386.00	62.800	2	2.666	5.332
3	N1SDD25L	L90x90x6-E250A	6132.00		8.200	1	50.282	50.282
4	N1SDD25R	L90x90x6-E250A	6132.00		8.200	1	50.282	50.282
5	N1SDD26L	L45x30x4-E250A	1011.00		2.200	1	2.224	2.224
6	N1SDD26R	L45x30x4-E250A	1011.00		2.200	1	2.224	2.224
7	N1SDD27L	L45x45x4-E250A	1856.00		2.700	1	5.011	5.011
8	N1SDD27R	L45x45x4-E250A	1856.00		2.700	1	5.011	5.011
9	N1SDD28LH	L50x50x4H-E350A	1971.00		3.000	1	5.913	5.913
10	N1SDD28RH	L50x50x4H-E350A	1971.00		3.000	1	5.913	5.913
11	N1SDD29L	L50x50x4-E250A	2361.00		3.000	1	7.083	7.083
12	N1SDD29R	L50x50x4-E250A	2361.00		3.000	1	7.083	7.083
13	N1SDD30	L45x45x4-E250A	1725.00		2.700	2	4.658	9.316
14	N1SDD31	L45x30x4-E250A	1312.00		2.200	1	2.886	2.886
15	N1SDD32	L45x45x4-E250A	2791.00		2.700	1	7.536	7.536
16	N1SDD32X	L45x45x4-E250A	2791.00		2.700	1	7.536	7.536
17	N1SDD33	L45x45x4-E250A	3705.00		2.700	2	10.004	20.008
18	N1SDD34	5MM PLATE-E250A	110.00 X	150.00	39.250	4	0.648	2.592
19	N1SDD35L	5MM PLATE-E250A	110.00 X	177.00	39.250	1	0.764	.764
20	N1SDD35R	5MM PLATE-E250A	110.00 X	177.00	39.250	1	0.764	.764

TOTAL WEIGHT : **203.434**

*** - Item welded with another item

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION.
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX.: 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	12-07-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/P1D0E/P/R-0		

Srl No	Section Invloved	Section Weight
	+0M LEG EXTN.(COMMON ITEMS) FOR T.T-"DD/DE"(132kV)ONE CORNER	
1	L45x30x4-E250A	7.334
2	L45x45x4-E250A	54.418
3	L50x50x4-E250A	14.166
4	L90x90x6-E250A	100.564
5	L120x120x8H-E350A	5.674
6	L50x50x4H-E350A	11.826
7	8MM PLATE H-E350A	5.332
8	5MM PLATE-E250A	4.120
	Total	203.434

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	12-07-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/P1D0B/S1D0B/R-0		

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BOLTS & NUTS OF +0M LEG EXTN. FOR TOWER TYPE-"DD/DE" (132kV) ONE CORNER							
1	S1D0B1	M16x35MM LONG(IS:12427)		0.119	16	0.119	1.904
2	S1D0B2	M16x40MM LONG (IS:12427)		0.126	30	0.126	3.780
3	S1D0B3	M16x45MM LONG (IS:12427)		0.134	2	0.134	.268
4	S1D0B4	M16x50MM LONG (IS:12427)		0.142	6	0.142	.852
5	S1D0B5	M16x55MM LONG (IS:12427)		0.150	16	0.150	2.400
6	S1D0B6	M16x3.5mm SPR. WSR-IS3063		0.009	70	0.009	.630
						TOTAL WEIGHT :	9.834

*** - Item welded with another item

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION

TRANSMISSION LINE DESIGN

MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.

PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	12-07-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/P1D0B/S1D0B/R-0		

Srl No	Section Invloved	Section Weight
	BOLTS & NUTS OF +0M LEG EXTN. FOR TOWER TYPE-"DD/DE" (132kV) ONE CORNER	
1	M16x3.5mm SPR. WSR-IS3063	.630
2	M16x35MM LONG(IS:12427)	1.904
3	M16x40MM LONG (IS:12427)	3.780
4	M16x45MM LONG (IS:12427)	.268
5	M16x50MM LONG (IS:12427)	.852
6	M16x55MM LONG (IS:12427)	2.400
	Total	9.834

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/P1D0B/S1D0W/R-0

Date 12-07-2018

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
PACK WASHERS OF +0M LEG EXTN. FOR TOWER TYPE-"DD/DE" (132kV) ONE CORNER							
1	S1D0W1	M16x5MM ROUND P.WASHER IS2016		0.018	2	0.018	.036

TOTAL WEIGHT : **.036**

*** - Item welded with another item

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	12-07-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/P1D0B/S1D0W/R-0		

Srl No	Section Invioved	Section Weight
	PACK WASHERS OF +0M LEG EXTN. FOR TOWER TYPE-"DD/DE" (132kV) ONE CORNER	
1	M16x5MM ROUND P.WASHER IS2016	.036
	Total	.036

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	12-07-2018
Drg No.	- -	Page	1 of 1
BOM No.	BOM/LE17D124/P0S1D/S0S1D/R-0		

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
STEP BOLTS OF +0M LEG EXTN. FOR TOWER TYPE-"DD/DE" (132kV) ONE CORNER							
1	S0S1D1	M16x175LG SB (50 OD) 2N+1SP		0.423	7	0.423	2.961

TOTAL WEIGHT : **2.961**

*** - Item welded with another item

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	12-07-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/P0S1D/S0S1D/R-0		

Srl No	Section Invloved	Section Weight
	STEP BOLTS OF +0M LEG EXTN. FOR TOWER TYPE-"DD/DE" (132kV) ONE CORNER	
1	M16x175LG SB (50 OD) 2N+1SP	2.961
	Total	2.961

L&T Construction
Power Transmission & Distribution

CLIENT: **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONSULTANT: पावरग्रिड **POWER GRID CORPORATION OF INDIA LTD**

PROJECT: **TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE**

LOA No.: **073/74-201 Dated: 24.04.2017**

DRG. No.: **O17123-T-TL-4D-GA-0404 (SHEET 1 To 5)**

BOM No.: **BOM/LE17D124/132kV/DD/004**

NO OF SHEETS: 16

श्रेणियां
I. निरीक्षण / निर्माण हेतु अनुमोदित।
II. ... / निर्माण हेतु अनुमोदित। ... एवं आशोधनों को ... आशोधित ... प्रस्तुत करें।
III. ... पुनः ... प्रस्तुत करें।
IV. सूचनार्थ एवं रिकार्ड हेतु।
V. अनुमोदित नहीं।
(हस्ताक्षर) ACPE
(अभियंता / उ. अभियंता)
05/8/18
(तिथि)
पावर ग्रिड कारपोरेशन ऑफ इंडिया लि० ... गुरुग्राम, (हरियाणा)
This document is recommended for approval for construction of 400kV /132kV D/C TAMAKOSHI - BARHABISE - KATHMANDU in NEPAL

✓ Approved / Released For Fabrication/Construction
☐ Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
☐ To be resubmitted for approval after incorporating the comments
☐ For information and record
☐ Not approved
CAT I
Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kv Transmission Line Project
Checked By: Date: 5/5/018
Recommended By: Date:
Approved By: Date:

BILL OF MATERIAL

BASIC BODY FOR TOWER TYPE - "DD/DE" (132kV, WZ-4)

WEIGHT OF STRUCTURE	
HT MEMBERS: BOM/LE17D124/P1DBS/S1DBH/R-0	2431.250
MS MEMBERS INCLUDING PACK WASHERS AND ACCESSORIES ETC. BOM/LE17D124/P1DBS/S1DBM/R-0 = 2428.809 BOM/LE17D124/P1DBB/S1DBW/R-0 = 3.967	2432.776
WEIGHT OF BOLTS & NUTS,SPRING WASHERS: BOM/LE17D124/P1DBB/S1DBB/R-0	261.608
TOTAL WEIGHT OF STRUCTURE:	**5125.634 Kgs**

SUCCESSFULLY TESTED AT CPRI - BENGALURU
ON 11th OF JULY 2018

REV.	DATE	DESCRIPTION	CHKD.	REVED.	APPD.
0	12.07.18	SUBMISSION FOR APPROVAL AFTER SUCCESSFUL TESTING	PU	BSR	CSR

PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY	DATE
ALEX	PU	BSR	CSR	12.07.18

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/P1DBS//R-0

Date 12-07-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)								
1	N1SDD50	L65x65x5-E250A	5812.00		4.900	4	28.479	113.916
2	N1SDD51H	8MM PLATE H-E350A	190.00 X	320.00	62.800	4	3.818	15.272
3	N1SDD52H	L50x50x4H-E350A	3275.00		3.000	4	9.825	39.300
4	N1SDD52XH	L50x50x4H-E350A	3275.00		3.000	4	9.825	39.300
5	N1SDD52A	L65x65x5-E250A	439.00		4.900	4	2.151	8.604
6	N1SDD60SH	L130x130x10H-E350A	5500.00		19.700	2	108.350	216.700
7	N1SDD61H	L130x130x10H-E350A	5500.00		19.700	2	108.350	216.700
8	N1SDD62SH	L110x110x10H-E350A	3985.00		16.600	2	66.151	132.302
9	N1SDD63H	L110x110x10H-E350A	3985.00		16.600	2	66.151	132.302
10	N1SDD64H	L100x100x8H-E350A	386.00		12.100	4	4.671	18.684
11	N1SDD65H	8MM PLATE H-E350A	90.00 X	386.00	62.800	8	2.182	17.456
12	N1SDD66	2MM PLATE-E250A	80.00 X	185.00	15.700	8	0.232	1.856
13	N1SDD67H	L100x100x8H-E350A	376.00		12.100	4	4.550	18.200
14	N1SDD68H	8MM PLATE H-E350A	90.00 X	376.00	62.800	8	2.125	17.000
15	N1SDD69	L90x90x6-E250A	4600.00		8.200	2	37.720	75.440
16	N1SDD69X	L90x90x6-E250A	4600.00		8.200	2	37.720	75.440
17	N1SDD70	L80x80x6-E250A	4600.00		7.300	2	33.580	67.160
18	N1SDD70X	L80x80x6-E250A	4600.00		7.300	2	33.580	67.160
19	N1SDD71	L90x90x6-E250A	2818.00		8.200	2	23.108	46.216
20	N1SDD71X	L90x90x6-E250A	2818.00		8.200	2	23.108	46.216
21	N1SDD72	L80x80x6-E250A	2818.00		7.300	2	20.571	41.142
22	N1SDD72X	L80x80x6-E250A	2818.00		7.300	2	20.571	41.142
23	N1SDD73	L70x70x5-E250A	286.00		5.300	8	1.516	12.128
24	N1SDD74	5MM PLATE-E250A	60.00 X	286.00	39.250	16	0.674	10.784
25	N1SDD75	L45x30x4-E250A	1301.00		2.200	8	2.862	22.896
26	N1SDD76	L45x30x4-E250A	1588.00		2.200	4	3.494	13.976
27	N1SDD76X	L45x30x4-E250A	1588.00		2.200	4	3.494	13.976
28	N1SDD77	L60x60x4-E250A	2772.00		3.700	8	10.256	82.048
29	N1SDD78	L45x45x4-E250A	2200.00		2.700	4	5.940	23.760
30	N1SDD78X	L45x45x4-E250A	2200.00		2.700	4	5.940	23.760
31	N1SDD79	L45x30x4-E250A	1267.00		2.200	8	2.787	22.296
32	N1SDD80H	8MM PLATE H-E350A	145.00 X	229.00	62.800	4	2.085	8.340

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/P1DBS//R-0

Date 12-07-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)								
33	N1SDD81H	L90x90x7H-E350A	5294.00		9.600	2	50.822	101.644
34	N1SDD81XH	L90x90x7H-E350A	5294.00		9.600	2	50.822	101.644
35	N1SDD82	L45x30x4-E250A	917.00		2.200	2	2.017	4.034
36	N1SDD82X	L45x30x4-E250A	917.00		2.200	2	2.017	4.034
37	N1SDD83	L45x30x4-E250A	1674.00		2.200	2	3.683	7.366
38	N1SDD83X	L45x30x4-E250A	1674.00		2.200	2	3.683	7.366
39	N1SDD84	L45x45x4-E250A	1969.00		2.700	4	5.316	21.264
40	N1SDD85	L45x30x4-E250A	1077.00		2.200	2	2.369	4.738
41	N1SDD85X	L45x30x4-E250A	1077.00		2.200	2	2.369	4.738
42	N1SDD86	L70x70x6-E250A	3017.00		6.300	2	19.007	38.014
43	N1SDD86AH	8MM PLATE H-E350A	140.00 X	207.00	62.800	4	1.820	7.280
44	N1SDD87	8MM PLATE-E250A	145.00 X	227.00	62.800	4	2.067	8.268
45	N1SDD88	L80x80x6-E250A	5250.00		7.300	2	38.325	76.650
46	N1SDD88X	L80x80x6-E250A	5250.00		7.300	2	38.325	76.650
47	N1SDD89	L45x30x4-E250A	920.00		2.200	2	2.024	4.048
48	N1SDD89X	L45x30x4-E250A	920.00		2.200	2	2.024	4.048
49	N1SDD90	L45x30x4-E250A	1631.00		2.200	2	3.588	7.176
50	N1SDD90X	L45x30x4-E250A	1631.00		2.200	2	3.588	7.176
51	N1SDD91	L45x45x4-E250A	1915.00		2.700	4	5.171	20.684
52	N1SDD92	L45x30x4-E250A	1097.00		2.200	2	2.413	4.826
53	N1SDD92X	L45x30x4-E250A	1097.00		2.200	2	2.413	4.826
54	N1SDD93	L70x70x5-E250A	3165.00		5.300	1	16.775	16.775
55	N1SDD93A	L70x70x5-E250A	3207.00		5.300	1	16.997	16.997
56	N1SDD94H	L45x45x4H-E350A	1821.00		2.700	4	4.917	19.668
57	N1SDD95	L45x45x4-E250A	2989.00		2.700	4	8.070	32.280
58	N1SDD96	L45x45x4-E250A	2946.00		2.700	4	7.954	31.816
59	N1SDD97H	5MM PLATE H-E350A	110.00 X	170.00	39.250	8	0.734	5.872
60	N1SDD98	5MM PLATE-E250A	110.00 X	170.00	39.250	8	0.734	5.872
61	N1SDD99	L45x45x4-E250A	1687.00		2.700	4	4.555	18.220
62	N1SDD100	5MM PLATE-E250A	110.00 X	170.00	39.250	8	0.734	5.872
63	N1SDD102	L45x45x4-E250A	1330.00		2.700	2	3.591	7.182
64	N1SDD102A	L45x45x4-E250A	1337.00		2.700	2	3.610	7.220

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION

TRANSMISSION LINE DESIGN

MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.

PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/P1DBS//R-0

Date 12-07-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)								
65	N1SDD103	L45x30x4-E250A	2069.00		2.200	2	4.552	9.104
66	N1SDD103A	L45x30x4-E250A	2044.00		2.200	2	4.497	8.994
67	N1SDD104	L45x30x4-E250A	2005.00		2.200	2	4.411	8.822
68	N1SDD104A	L45x30x4-E250A	2043.00		2.200	2	4.495	8.990
69	N1SDD105	5MM PLATE-E250A	110.00 X	170.00	39.250	4	0.734	2.936
70	N1SDD105A	5MM PLATE-E250A	110.00 X	170.00	39.250	4	0.734	2.936
71	N1SDD106	5MM PLATE-E250A	110.00 X	165.00	39.250	4	0.712	2.848
72	N1SDD106A	5MM PLATE-E250A	110.00 X	165.00	39.250	4	0.712	2.848
73	N1SDD130SH	L100x100x8H-E350A	4100.00		12.100	2	49.610	99.220
74	N1SDD131H	L100x100x8H-E350A	4100.00		12.100	2	49.610	99.220
75	N1SDD132SH	L75x75x6H-E350A	4175.00		6.800	2	28.390	56.780
76	N1SDD133H	L75x75x6H-E350A	4175.00		6.800	2	28.390	56.780
77	N1SDD134SH	L60x60x5H-E350A	6337.00		4.500	2	28.517	57.034
78	N1SDD135H	L60x60x5H-E350A	6337.00		4.500	2	28.517	57.034
79	N1SDD136H	L80x80x6H-E350A	356.00		7.300	4	2.599	10.396
80	N1SDD137H	6MM PLATE H-E350A	75.00 X	356.00	47.100	8	1.258	10.064
81	N1SDD138	2MM PLATE-E250A	50.00 X	175.00	15.700	8	0.137	1.096
82	N1SDD139	L45x30x4-E250A	992.00		2.200	2	2.182	4.364
83	N1SDD140	L90x90x6-E250A	3469.00		8.200	2	28.446	56.892
84	N1SDD140X	L90x90x6-E250A	3469.00		8.200	2	28.446	56.892
85	N1SDD141H	6MM PLATE H-E350A	107.00 X	216.00	47.100	2	1.089	2.178
86	N1SDD142H	L45x45x4H-E350A	1553.00		2.700	2	4.193	8.386
87	N1SDD142XH	L45x45x4H-E350A	1553.00		2.700	2	4.193	8.386
88	N1SDD143	8MM PLATE-E250A	155.00 X	304.00	62.800	4	2.959	11.836
89	N1SDD144	L90x90x6-E250A	3360.00		8.200	2	27.552	55.104
90	N1SDD144X	L90x90x6-E250A	3360.00		8.200	2	27.552	55.104
91	N1SDD145	L45x30x4-E250A	1297.00		2.200	4	2.853	11.412
92	N1SDD146	L65x65x5-E250A	2562.00		4.900	2	12.554	25.108
93	N1SDD147H	6MM PLATE H-E350A	120.00 X	214.00	47.100	4	1.210	4.840
94	N1SDD148	L45x30x4-E250A	1004.00		2.200	2	2.209	4.418
95	N1SDD149H	L70x70x5H-E350A	3117.00		5.300	2	16.520	33.040
96	N1SDD149XH	L70x70x5H-E350A	3117.00		5.300	2	16.520	33.040

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION

TRANSMISSION LINE DESIGN

MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.

PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Order Ref. -

Drg No. - -

BOM No. BOM/LE17D124/P1DBS//R-0

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)								
97	N1SDD150H	6MM PLATE H-E350A	107.00 X	166.00	47.100	2	0.837	1.674
98	N1SDD151H	L45x45x4H-E350A	1317.00		2.700	2	3.556	7.112
99	N1SDD151XH	L45x45x4H-E350A	1317.00		2.700	2	3.556	7.112
100	N1SDD152H	6MM PLATE H-E350A	110.00 X	215.00	47.100	4	1.114	4.456
101	N1SDD153H	L70x70x5H-E350A	3037.00		5.300	2	16.096	32.192
102	N1SDD153XH	L70x70x5H-E350A	3037.00		5.300	2	16.096	32.192
103	N1SDD154	L45x30x4-E250A	1102.00		2.200	4	2.424	9.696
104	N1SDD155H	6MM PLATE H-E350A	110.00 X	199.00	47.100	4	1.031	4.124
105	N1SDD156H	L60x60x4H-E350A	2140.00		3.700	2	7.918	15.836
106	N1SDD157	L45x30x4-E250A	650.00		2.200	2	1.430	2.860
107	N1SDD158	L50x50x4-E250A	2333.00		3.000	2	6.999	13.998
108	N1SDD158X	L50x50x4-E250A	2333.00		3.000	2	6.999	13.998
109	N1SDD159H	L50x50x4H-E350A	2013.00		3.000	2	6.039	12.078
110	N1SDD160	L45x30x4-E250A	2179.00		2.200	2	4.794	9.588
111	N1SDD160X	L45x30x4-E250A	2179.00		2.200	2	4.794	9.588
112	N1SDD161	L45x30x4-E250A	1856.00		2.200	2	4.083	8.166
113	N1SDD161X	L45x30x4-E250A	1856.00		2.200	2	4.083	8.166
114	N1SDD162	L45x30x4-E250A	1568.00		2.200	2	3.450	6.900
115	N1SDD162X	L45x30x4-E250A	1568.00		2.200	2	3.450	6.900
116	N1SDD163	L45x30x4-E250A	584.00		2.200	2	1.285	2.570
117	N1SDD164H	8MM PLATE H-E350A	109.00 X	166.00	62.800	2	1.136	2.272
118	N1SDD165H	8MM PLATE H-E350A	155.00 X	393.00	62.800	1	3.825	3.825
119	N1SDD166H	8MM PLATE H-E350A	130.00 X	360.00	62.800	1	2.939	2.939
120	N1SDD167	L45x30x4-E250A	1159.00		2.200	2	2.550	5.100
121	N1SDD168H	L75x75x6H-E350A	3512.00		6.800	2	23.882	47.764
122	N1SDD168XH	L75x75x6H-E350A	3512.00		6.800	2	23.882	47.764
123	N1SDD169	L50x50x4-E250A	1296.00		3.000	1	3.888	3.888
124	N1SDD169A	L50x50x4-E250A	1296.00		3.000	1	3.888	3.888
125	N1SDD169B	L50x50x4-E250A	1296.00		3.000	1	3.888	3.888
126	N1SDD169C	L50x50x4-E250A	1296.00		3.000	1	3.888	3.888
127	N1SDD170	6MM PLATE-E250A	109.00 X	478.00	47.100	2	2.454	4.908
128	N1SDD171	5MM PLATE-E250A	101.00 X	120.00	39.250	4	0.476	1.904

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/P1DBS//R-0

Date 12-07-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)								
129	N1SDD172H	8MM PLATE H-E350A	151.00 X	245.00	62.800	4	2.323	9.292
130	N1SDD173	L75x75x6-E250A	3320.00		6.800	2	22.576	45.152
131	N1SDD173X	L75x75x6-E250A	3320.00		6.800	2	22.576	45.152
132	N1SDD174	L65x65x4-E250A	2722.00		4.000	1	10.888	10.888
133	N1SDD174A	L65x65x4-E250A	2772.00		4.000	1	11.088	11.088
134	N1SDD175	8MM PLATE-E250A	154.00 X	225.00	62.800	4	2.176	8.704
135	N1SDD176	L65x65x5-E250A	3163.00		4.900	2	15.499	30.998
136	N1SDD176X	L65x65x5-E250A	3163.00		4.900	2	15.499	30.998
137	N1SDD177	L45x45x4-E250A	1122.00		2.700	1	3.029	3.029
138	N1SDD177A	L45x45x4-E250A	1122.00		2.700	1	3.029	3.029
139	N1SDD177B	L45x45x4-E250A	1122.00		2.700	1	3.029	3.029
140	N1SDD177C	L45x45x4-E250A	1122.00		2.700	1	3.029	3.029
141	N1SDD178	6MM PLATE-E250A	82.00 X	323.00	47.100	2	1.247	2.494
142	N1SDD179	6MM PLATE-E250A	110.00 X	200.00	47.100	4	1.036	4.144
143	N1SDD180	L65x65x5-E250A	2994.00		4.900	2	14.671	29.342
144	N1SDD180X	L65x65x5-E250A	2994.00		4.900	2	14.671	29.342
145	N1SDD181	6MM PLATE-E250A	110.00 X	125.00	47.100	4	0.648	2.592
146	N1SDD182H	L60x60x4H-E350A	2285.00		3.700	1	8.455	8.455
147	N1SDD182AH	L60x60x4H-E350A	2306.00		3.700	1	8.532	8.532
148	N1SDD183	L45x45x4-E250A	2359.00		2.700	2	6.369	12.738
149	N1SDD183X	L45x45x4-E250A	2359.00		2.700	2	6.369	12.738
150	N1SDD184H	L60x60x4H-E350A	2013.00		3.700	1	7.448	7.448
151	N1SDD184AH	L60x60x4H-E350A	2013.00		3.700	1	7.448	7.448
152	N1SDD185	L45x30x4-E250A	2167.00		2.200	2	4.767	9.534
153	N1SDD185X	L45x30x4-E250A	2167.00		2.200	2	4.767	9.534
154	N1SDD186	L45x30x4-E250A	1846.00		2.200	2	4.061	8.122
155	N1SDD186X	L45x30x4-E250A	1846.00		2.200	2	4.061	8.122
156	N1SDD187	L45x30x4-E250A	1560.00		2.200	2	3.432	6.864
157	N1SDD187X	L45x30x4-E250A	1560.00		2.200	2	3.432	6.864
158	N1SDD188	L45x30x4-E250A	569.00		2.200	2	1.252	2.504
159	N1SDD210L	L65x65x5-E250A	3224.00		4.900	1	15.798	15.798
160	N1SDD210R	L65x65x5-E250A	3224.00		4.900	1	15.798	15.798

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/P1DBS//R-0

Date 12-07-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)								
161	N1SDD211LH	L55x55x4H-E350A	3134.00		3.300	1	10.342	10.342
162	N1SDD211RH	L55x55x4H-E350A	3134.00		3.300	1	10.342	10.342
163	N1SDD212LH	6MM PLATE H-E350A	177.00 X	282.00	47.100	1	2.351	2.351
164	N1SDD212RH	6MM PLATE H-E350A	177.00 X	282.00	47.100	1	2.351	2.351
165	N1SDD213L	L45x30x4-E250A	1497.00		2.200	1	3.293	3.293
166	N1SDD213R	L45x30x4-E250A	1497.00		2.200	1	3.293	3.293
167	N1SDD214L	L45x30x4-E250A	563.00		2.200	1	1.239	1.239
168	N1SDD214R	L45x30x4-E250A	563.00		2.200	1	1.239	1.239
169	N1SDD215H	6MM PLATE H-E350A	100.00 X	182.00	47.100	1	0.857	.857
170	N1SDD216LH	L70x70x5H-E350A	2932.00		5.300	1	15.540	15.540
171	N1SDD216RH	L70x70x5H-E350A	2932.00		5.300	1	15.540	15.540
172	N1SDD217L	L55x55x4-E250A	2887.00		3.300	1	9.527	9.527
173	N1SDD217R	L55x55x4-E250A	2887.00		3.300	1	9.527	9.527
174	N1SDD218	6MM PLATE-E250A	177.00 X	283.00	47.100	2	2.359	4.718
175	N1SDD219L	L45x30x4-E250A	1439.00		2.200	1	3.166	3.166
176	N1SDD219R	L45x30x4-E250A	1439.00		2.200	1	3.166	3.166
177	N1SDD220	L45x30x4-E250A	520.00		2.200	2	1.144	2.288
178	N1SDD221	5MM PLATE-E250A	105.00 X	203.00	39.250	2	0.837	1.674
179	N1SDD222H	L65x65x4H-E350A	4206.00		4.000	1	16.824	16.824
180	N1SDD222XH	L65x65x4H-E350A	4206.00		4.000	1	16.824	16.824
181	N1SDD223	6MM PLATE-E250A	105.00 X	134.00	47.100	2	0.663	1.326
182	N1SDD224H	L45x45x4H-E350A	1442.00		2.700	1	3.893	3.893
183	N1SDD224AH	L45x45x4H-E350A	1442.00		2.700	1	3.893	3.893
184	N1SDD225H	L45x45x4H-E350A	1677.00		2.700	1	4.528	4.528
185	N1SDD226H	L75x75x6H-E350A	669.00		6.800	1	4.549	4.549
186	N1SDD226AH	20MM PLATE H-E350A	230.00 X	370.00	157.000	1	13.361	13.361
187	N1SDD227	6MM PLATE-E250A	150.00 X	163.00	47.100	2	1.152	2.304
188	N1SDD228	L65x65x4-E250A	3948.00		4.000	1	15.792	15.792
189	N1SDD228X	L65x65x4-E250A	3948.00		4.000	1	15.792	15.792
190	N1SDD229H	L45x45x4H-E350A	1572.00		2.700	1	4.244	4.244
191	N1SDD229AH	L45x45x4H-E350A	1572.00		2.700	1	4.244	4.244
192	N1SDD230	L45x45x4-E250A	1365.00		2.700	1	3.686	3.686

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/P1DBS//R-0

Date 12-07-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)								
193	N1SDD231H	L75x75x5H-E350A	3207.00		5.700	1	18.280	18.280
194	N1SDD232H	20MM PLATE H-E350A	220.00 X	289.00	157.000	2	9.982	19.964
195	N1SDD233	L45x30x4-E250A	1338.00		2.200	1	2.944	2.944
196	N1SDD233A	L45x30x4-E250A	1338.00		2.200	1	2.944	2.944
197	N1SDD234H	L45x45x4H-E350A	1642.00		2.700	1	4.433	4.433
198	N1SDD235	L45x45x4-E250A	275.00		2.700	1	0.743	.743
199	N1SDD236	6MM PLATE-E250A	110.00 X	127.00	47.100	2	0.658	1.316
200	N1SDD237	L55x55x4-E250A	4012.00		3.300	1	13.240	13.240
201	N1SDD237X	L55x55x4-E250A	4012.00		3.300	1	13.240	13.240
202	N1SDD238H	L45x45x4H-E350A	1471.00		2.700	1	3.972	3.972
203	N1SDD238AH	L45x45x4H-E350A	1471.00		2.700	1	3.972	3.972
204	N1SDD239	5MM PLATE-E250A	97.00 X	112.00	39.250	2	0.426	.852
205	N1SDD240	5MM PLATE-E250A	97.00 X	117.00	39.250	2	0.445	.890
206	N1SDD260LH	L60x60x5H-E350A	2999.00		4.500	1	13.496	13.496
207	N1SDD260RH	L60x60x5H-E350A	2999.00		4.500	1	13.496	13.496
208	N1SDD261LH	L55x55x4H-E350A	2929.00		3.300	1	9.666	9.666
209	N1SDD261RH	L55x55x4H-E350A	2929.00		3.300	1	9.666	9.666
210	N1SDD262LH	6MM PLATE H-E350A	177.00 X	257.00	47.100	1	2.143	2.143
211	N1SDD262RH	6MM PLATE H-E350A	177.00 X	257.00	47.100	1	2.143	2.143
212	N1SDD263L	L45x30x4-E250A	1401.00		2.200	1	3.082	3.082
213	N1SDD263R	L45x30x4-E250A	1401.00		2.200	1	3.082	3.082
214	N1SDD264L	L45x30x4-E250A	570.00		2.200	1	1.254	1.254
215	N1SDD264R	L45x30x4-E250A	570.00		2.200	1	1.254	1.254
216	N1SDD265H	6MM PLATE H-E350A	100.00 X	174.00	47.100	1	0.820	.820
217	N1SDD266LH	L65x65x5H-E350A	2739.00		4.900	1	13.421	13.421
218	N1SDD266RH	L65x65x5H-E350A	2739.00		4.900	1	13.421	13.421
219	N1SDD267LH	L55x55x4H-E350A	2730.00		3.300	1	9.009	9.009
220	N1SDD267RH	L55x55x4H-E350A	2730.00		3.300	1	9.009	9.009
221	N1SDD268H	6MM PLATE H-E350A	177.00 X	257.00	47.100	2	2.143	4.286
222	N1SDD269L	L45x30x4-E250A	1355.00		2.200	1	2.981	2.981
223	N1SDD269R	L45x30x4-E250A	1355.00		2.200	1	2.981	2.981
224	N1SDD270	L45x30x4-E250A	524.00		2.200	2	1.153	2.306

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION

TRANSMISSION LINE DESIGN

MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.

PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Order Ref. -

Drg No. - -

BOM No. BOM/LE17D124/P1DBS//R-0

Date 12-07-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)								
225	N1SDD271H	5MM PLATE H-E350A	105.00 X	191.00	39.250	2	0.787	1.574
226	N1SDD272H	L55x55x4H-E350A	3580.00		3.300	1	11.814	11.814
227	N1SDD272XH	L55x55x4H-E350A	3580.00		3.300	1	11.814	11.814
228	N1SDD273	6MM PLATE-E250A	100.00 X	149.00	47.100	2	0.702	1.404
229	N1SDD274	L45x45x4-E250A	1349.00		2.700	1	3.642	3.642
230	N1SDD274A	L45x45x4-E250A	1349.00		2.700	1	3.642	3.642
231	N1SDD275	L45x45x4-E250A	1397.00		2.700	1	3.772	3.772
232	N1SDD276H	L75x75x6H-E350A	617.00		6.800	1	4.196	4.196
233	N1SDD277H	20MM PLATE H-E350A	230.00 X	370.00	157.000	1	13.361	13.361
234	N1SDD278	6MM PLATE-E250A	147.00 X	170.00	47.100	2	1.177	2.354
235	N1SDD279	L65x65x4-E250A	3499.00		4.000	1	13.996	13.996
236	N1SDD279X	L65x65x4-E250A	3499.00		4.000	1	13.996	13.996
237	N1SDD280	L45x45x4-E250A	1356.00		2.700	1	3.661	3.661
238	N1SDD280A	L45x45x4-E250A	1356.00		2.700	1	3.661	3.661
239	N1SDD281	L45x45x4-E250A	1270.00		2.700	1	3.429	3.429
240	N1SDD282H	L75x75x5H-E350A	2772.00		5.700	1	15.800	15.800
241	N1SDD283H	20MM PLATE H-E350A	220.00 X	292.00	157.000	2	10.086	20.172
242	N1SDD285	L45x30x4-E250A	1279.00		2.200	1	2.814	2.814
243	N1SDD285A	L45x30x4-E250A	1279.00		2.200	1	2.814	2.814
244	N1SDD286	L45x45x4-E250A	1408.00		2.700	1	3.802	3.802
245	N1SDD287	L45x45x4-E250A	262.00		2.700	1	0.707	.707
246	N1SDD288	6MM PLATE-E250A	110.00 X	127.00	47.100	2	0.658	1.316
247	N1SDD289H	L50x50x4H-E350A	3581.00		3.000	1	10.743	10.743
248	N1SDD289XH	L50x50x4H-E350A	3581.00		3.000	1	10.743	10.743
249	N1SDD290	L45x45x4-E250A	1256.00		2.700	1	3.391	3.391
250	N1SDD290A	L45x45x4-E250A	1256.00		2.700	1	3.391	3.391
251	N1SDD291H	5MM PLATE H-E350A	97.00 X	115.00	39.250	2	0.438	.876
252	N1SDD292H	5MM PLATE H-E350A	97.00 X	118.00	39.250	2	0.449	.898
253	N1SDD310LH	L60x60x5H-E350A	2888.00		4.500	1	12.996	12.996
254	N1SDD310RH	L60x60x5H-E350A	2888.00		4.500	1	12.996	12.996
255	N1SDD311LH	L55x55x4H-E350A	2916.00		3.300	1	9.623	9.623
256	N1SDD311RH	L55x55x4H-E350A	2916.00		3.300	1	9.623	9.623

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION

TRANSMISSION LINE DESIGN

MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.

PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV

Order Ref. -

Drg No. - -

BOM No. BOM/LE17D124/P1DBS//R-0

Date 12-07-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)								
257	N1SDD312LH	6MM PLATE H-E350A	199.00 X	243.00	47.100	1	2.278	2.278
258	N1SDD312RH	6MM PLATE H-E350A	199.00 X	243.00	47.100	1	2.278	2.278
259	N1SDD313L	L45x30x4-E250A	1398.00		2.200	1	3.076	3.076
260	N1SDD313R	L45x30x4-E250A	1398.00		2.200	1	3.076	3.076
261	N1SDD314L	L45x30x4-E250A	647.00		2.200	1	1.423	1.423
262	N1SDD314R	L45x30x4-E250A	647.00		2.200	1	1.423	1.423
263	N1SDD315H	6MM PLATE H-E350A	100.00 X	158.00	47.100	1	0.744	.744
264	N1SDD316LH	L60x60x5H-E350A	2740.00		4.500	1	12.330	12.330
265	N1SDD316RH	L60x60x5H-E350A	2740.00		4.500	1	12.330	12.330
266	N1SDD317L	L55x55x4-E250A	2818.00		3.300	1	9.299	9.299
267	N1SDD317R	L55x55x4-E250A	2818.00		3.300	1	9.299	9.299
268	N1SDD318	6MM PLATE-E250A	199.00 X	243.00	47.100	2	2.278	4.556
269	N1SDD319L	L45x30x4-E250A	1396.00		2.200	1	3.071	3.071
270	N1SDD319R	L45x30x4-E250A	1396.00		2.200	1	3.071	3.071
271	N1SDD320	L45x30x4-E250A	598.00		2.200	2	1.316	2.632
272	N1SDD321	5MM PLATE-E250A	100.00 X	162.00	39.250	2	0.636	1.272
273	N1SDD322H	L45x45x4H-E350A	2972.00		2.700	1	8.024	8.024
274	N1SDD322XH	L45x45x4H-E350A	2972.00		2.700	1	8.024	8.024
275	N1SDD323	6MM PLATE-E250A	100.00 X	143.00	47.100	2	0.674	1.348
276	N1SDD324	L45x45x4-E250A	1323.00		2.700	1	3.572	3.572
277	N1SDD324A	L45x45x4-E250A	1323.00		2.700	1	3.572	3.572
278	N1SDD325	L45x45x4-E250A	1176.00		2.700	1	3.175	3.175
279	N1SDD326H	L75x75x6H-E350A	524.00		6.800	1	3.563	3.563
280	N1SDD327H	20MM PLATE H-E350A	230.00 X	370.00	157.000	1	13.361	13.361
281	N1SDD328	6MM PLATE-E250A	155.00 X	160.00	47.100	2	1.168	2.336
282	N1SDD329	L60x60x4-E250A	3193.00		3.700	1	11.814	11.814
283	N1SDD329X	L60x60x4-E250A	3193.00		3.700	1	11.814	11.814
284	N1SDD330	L45x45x4-E250A	1134.00		2.700	1	3.062	3.062
285	N1SDD330A	L45x45x4-E250A	1134.00		2.700	1	3.062	3.062
286	N1SDD331	L45x45x4-E250A	1289.00		2.700	1	3.480	3.480
287	N1SDD332H	L75x75x5H-E350A	2306.00		5.700	1	13.144	13.144
288	N1SDD333H	20MM PLATE H-E350A	225.00 X	290.00	157.000	2	10.244	20.488

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/P1DBS//R-0

Date 12-07-2018

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)								
289	N1SDD335	L45x45x4-E250A	2536.00		2.700	1	6.847	6.847
290	N1SDD335X	L45x45x4-E250A	2536.00		2.700	1	6.847	6.847
291	N1SDD336	6MM PLATE-E250A	101.00 X	107.00	47.100	4	0.509	2.036
292	N1SDD337	L45x45x4-E250A	1366.00		2.700	1	3.688	3.688
293	N1SDD337A	L45x45x4-E250A	1366.00		2.700	1	3.688	3.688
294	N1SDD338	L45x45x4-E250A	1173.00		2.700	1	3.167	3.167
295	N1SDD339	L45x45x4-E250A	240.00		2.700	1	0.648	.648
296	N1SDD340	6MM PLATE-E250A	110.00 X	130.00	47.100	1	0.674	.674
297	N1SDD341	L45x45x4-E250A	3356.00		2.700	1	9.061	9.061
298	N1SDD341X	L45x45x4-E250A	3356.00		2.700	1	9.061	9.061
299	N1SDD342	L45x45x4-E250A	1035.00		2.700	1	2.795	2.795
300	N1SDD342A	L45x45x4-E250A	1035.00		2.700	1	2.795	2.795
301	N1SDD343	5MM PLATE-E250A	97.00 X	124.00	39.250	2	0.472	.944
302	N1SDD344	5MM PLATE-E250A	97.00 X	120.00	39.250	2	0.457	.914

TOTAL WEIGHT : **4860.059**

*** - Item welded with another item

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/P1DBS/P/R-0

Date 12-07-2018

Srl No	Section Invloved	Section Weight
BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)		
1	L45x30x4-E250A	378.614
2	L45x45x4-E250A	329.825
3	L50x50x4-E250A	43.548
4	L55x55x4-E250A	64.132
5	L60x60x4-E250A	105.676
6	L65x65x5-E250A	299.904
7	L65x65x4-E250A	81.552
8	L70x70x5-E250A	45.900
9	L70x70x6-E250A	38.014
10	L75x75x6-E250A	90.304
11	L80x80x6-E250A	369.904
12	L90x90x6-E250A	467.304
13	L45x45x4H-E350A	99.891
14	L55x55x4H-E350A	100.908
15	L60x60x4H-E350A	47.719
16	L60x60x5H-E350A	191.712
17	L65x65x4H-E350A	33.648
18	L65x65x5H-E350A	26.842
19	L70x70x5H-E350A	161.544
20	L75x75x5H-E350A	47.224
21	L75x75x6H-E350A	221.396
22	L80x80x6H-E350A	10.396
23	L90x90x7H-E350A	203.288
24	L100x100x8H-E350A	235.324
25	L110x110x10H-E350A	264.604
26	L130x130x10H-E350A	433.400
27	L50x50x4H-E350A	112.164
28	5MM PLATE H-E350A	9.220
29	6MM PLATE H-E350A	47.587
30	8MM PLATE H-E350A	83.676
31	20MM PLATE H-E350A	100.707
32	2MM PLATE-E250A	2.952
33	5MM PLATE-E250A	42.546
34	6MM PLATE-E250A	39.826
35	8MM PLATE-E250A	28.808

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX ; 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	12-07-2018
Drg No.	-	Page	2 of 2
BOM No.	BOM/LE17D124/P1DBS/P/R-0		

Srl No	Section Invloved	Section Weight
	BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)	
	Total	4860.059

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/P1DBB/S1DBB/R-0

Date 12-07-2018

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BOLTS & NUTS OF BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV)							
1	S1DBB1	M16x35MM LONG(IS:12427)		0.119	526	0.119	62.594
2	S1DBB2	M16x40MM LONG (IS:12427)		0.126	562	0.126	70.812
3	S1DBB3	M16x45MM LONG (IS:12427)		0.134	125	0.134	16.750
4	S1DBB4	M16x50MM LONG (IS:12427)		0.142	243	0.142	34.506
5	S1DBB5	M16x55MM LONG (IS:12427)		0.150	110	0.150	16.500
6	S1DBB6	M16x60MM LONG (IS:12427)		0.158	4	0.158	.632
7	S1DBB7	M16x3.5mm SPR. WSR-IS3063		0.009	1570	0.009	14.130
8	S1DBB8	M16x175LG SB (50 OD) 2N+1SP		0.423	108	0.423	45.684

TOTAL WEIGHT : **261.608**

*** - Item welded with another item

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION

TRANSMISSION LINE DESIGN

MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.

PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	12-07-2018
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/P1DBB/S1DBB/R-0		

Srl No	Section Invloved	Section Weight
	BOLTS & NUTS OF BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV)	
1	M16x3.5mm SPR. WSR-IS3063	14.130
2	M16x35MM LONG(IS:12427)	62.594
3	M16x40MM LONG (IS:12427)	70.812
4	M16x45MM LONG (IS:12427)	16.750
5	M16x50MM LONG (IS:12427)	34.506
6	M16x55MM LONG (IS:12427)	16.500
7	M16x60MM LONG (IS:12427)	.632
8	M16x175LG SB (50 OD) 2N+1SP	45.684
	Total	261.608

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/P1DBB/S1DBW/R-0

Date 12-07-2018
Page 1 of 1

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
PACK WASHERS OF BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV)							
1	S1DBW1	M16x4MM ROUND P.WASHER IS2016		0.014	17	0.014	.238
2	S1DBW2	M16x5MM ROUND P.WASHER IS2016		0.018	47	0.018	.846
3	S1DBW3	M16x6MM ROUND P.WASHER IS2016		0.021	34	0.021	.714
4	S1DBW4	M16x8MM ROUND P.WASHER IS2016		0.028	41	0.028	1.148
5	S1DBW5	M16x10MM ROUND P.WASHER IS2016		0.036	20	0.036	.720
6	S1DBW6	M16x12MM ROUND P.WASHER IS2016		0.043	7	0.043	.301

TOTAL WEIGHT : **3.967**

*** - Item welded with another item

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/P1DBB/S1DBW/R-0

Date 12-07-2018

Srl No	Section Invloved	Section Weight
	PACK WASHERS OF BASIC BODY FOR TOWER TYPE-"DD/DE" (132kV)	
1	M16x4MM ROUND P.WASHER IS2016	.238
2	M16x5MM ROUND P.WASHER IS2016	.846
3	M16x6MM ROUND P.WASHER IS2016	.714
4	M16x8MM ROUND P.WASHER IS2016	1.148
5	M16x10MM ROUND P.WASHER IS2016	.720
6	M16x12MM ROUND P.WASHER IS2016	.301
	Total	3.967

L&T Construction

Power Transmission & Distribution

CLIENT: **NEPAL ELECTRICITY AUTHORITY**

(An Undertaking of Government of Nepal)

PROJECT: TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

LOA No.: 073/74-201 Dated: 24.04.2017

DRG. No.: O17123-T-TL-4D-GA-0401

BOM No.: BOM/LE17D124/132kV/DD/001

NO OF SHEETS: 4

BILL OF MATERIAL

STUB & CLEATS FOR TOWER TYPE - "DD/DE" (132kV, WZ-4)

(-4.5M TO +9M EXTN.)

CAT I subject to type testing of tower

WEIGHT OF STRUCTURE	
HT MEMBERS: BOM/LE17D124/P1DSC/S1DSC/R-0	400.500
MS MEMBERS INCLUDING PACK WASHERS AND ACCESSORIES ETC.	-
WEIGHT OF BOLTS & NUTS,SPRING WASHERS: BOM/LE17D124/P1DSB/S1DSB/R-0	9.408
TOTAL WEIGHT OF STRUCTURE:	409.908 Kgs

Approved / Released For Fabrication/Construction
Approved / ... Construction subject to incorporation ... modification as noted. Revised ... required
To be resubmitted for approval after incorporating the comments
For information and record
Not approved

Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kv Transmission Line Project
Checked / Recommended / Approved by ... Date: 29/6/018 Date: 29/6/18 Date:

श्रेणियाँ
I. केंद्रीकरण / निर्माण हेतु अनुमोदित।
II. केंद्रीकरण / निर्माण हेतु अनुमोदित बशर्ते की गई टिप्पणियाँ एवं आशोधन को सम्मिलित किया जाए। कृपया आशोधित दस्तावेज अनुमोदनार्थ प्रस्तुत करें।
III. टिप्पणियों को सम्मिलित कर पुनः अनुमोदनार्थ प्रस्तुत करें।
IV. सूचनार्थ एवं रिकार्ड हेतु।
V. अनुमोदित नहीं।
पावरग्रिड
(हस्ताक्षर)
(तिथि) 15/6/18
पावर ग्रिड कारपोरेशन ऑफ इंडिया लि० अभियांत्रिकी (पारे.लाईन) गुरुग्राम, (हरियाणा)
This document is recommended for approval for construction of 400kV/132kV D/C TAMAKOSHI - BARHABISE - KATHMANDU in NEPAL

CAT 1 subject to type testing of tower

REV.	DATE	DESCRIPTION	CHKD.	REVED.	APPD.
0	22.12.17	FIRST SUBMISSION FOR APPROVAL	PU	BSR	CSR

PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY	DATE
ALEX	PU	BSR	CSR	22.12.17

LARSEN & TOUBRO LIMITED

ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. - -
BOM No. BOM/LE17D124/P1DSC/S1DSC/R-0

Date 22-12-2017

Srl No	Erection Mark	Section	Length Size(In MM)		Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
STUB & CLEATS FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)								
1	N1SDD1H	L130x130x12H-E350A	3683.00		23.500	4	86.551	346.204
2	N1SDD2LH	L65x65x6H-E350A	180.00		5.800	8	1.044	8.352
3	N1SDD2RH	L65x65x6H-E350A	180.00		5.800	8	1.044	8.352
4	N1SDD3H	L65x65x6H-E350A	250.00		5.800	16	1.450	23.200
5	N1SDD4H	6MM PLATE H-E350A	95.00 X	402.00	47.100	8	1.799	14.392

TOTAL WEIGHT : 400.500

*** - Item welded with another item

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	22-12-2017
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/P1DSC/S1DSC/R-0		

Srl No	Section Invloved	Section Weight
STUB & CLEATS FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)		
1	L65x65x6H-E350A	39.904
2	L130x130x12H-E350A	346.204
3	6MM PLATE H-E350A	14.392
	Total	400.500

LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, PO BOX : 979 CHENNAI - 600 089. INDIA.
PHONE : 044 - 22704000 FAX : 044 - 22705494

BILL OF MATERIAL

Project LE17D124 - Intra-Pith-Kathmandu 400/220 KV
Order Ref. -
Drg No. -
BOM No. BOM/LE17D124/P1DSB/S1DSB/R-0

Date 22-12-2017

Srl No	Erection Mark	Section	Length Size(In MM)	Unit Wt. In Kgs	Reqd. Qty.	Unit/Ass. Weight	Total Weight
BOLTS & NUTS OF STUB & CLEATS FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)							
1	S1DSB1	M16x45MM LONG (IS:12427)		0.134	32	0.134	4.288
2	S1DSB2	M16x50MM LONG (IS:12427)		0.142	32	0.142	4.544
3	S1DSB3	M16x3.5mm SPR. WSR-IS3063		0.009	64	0.009	.576

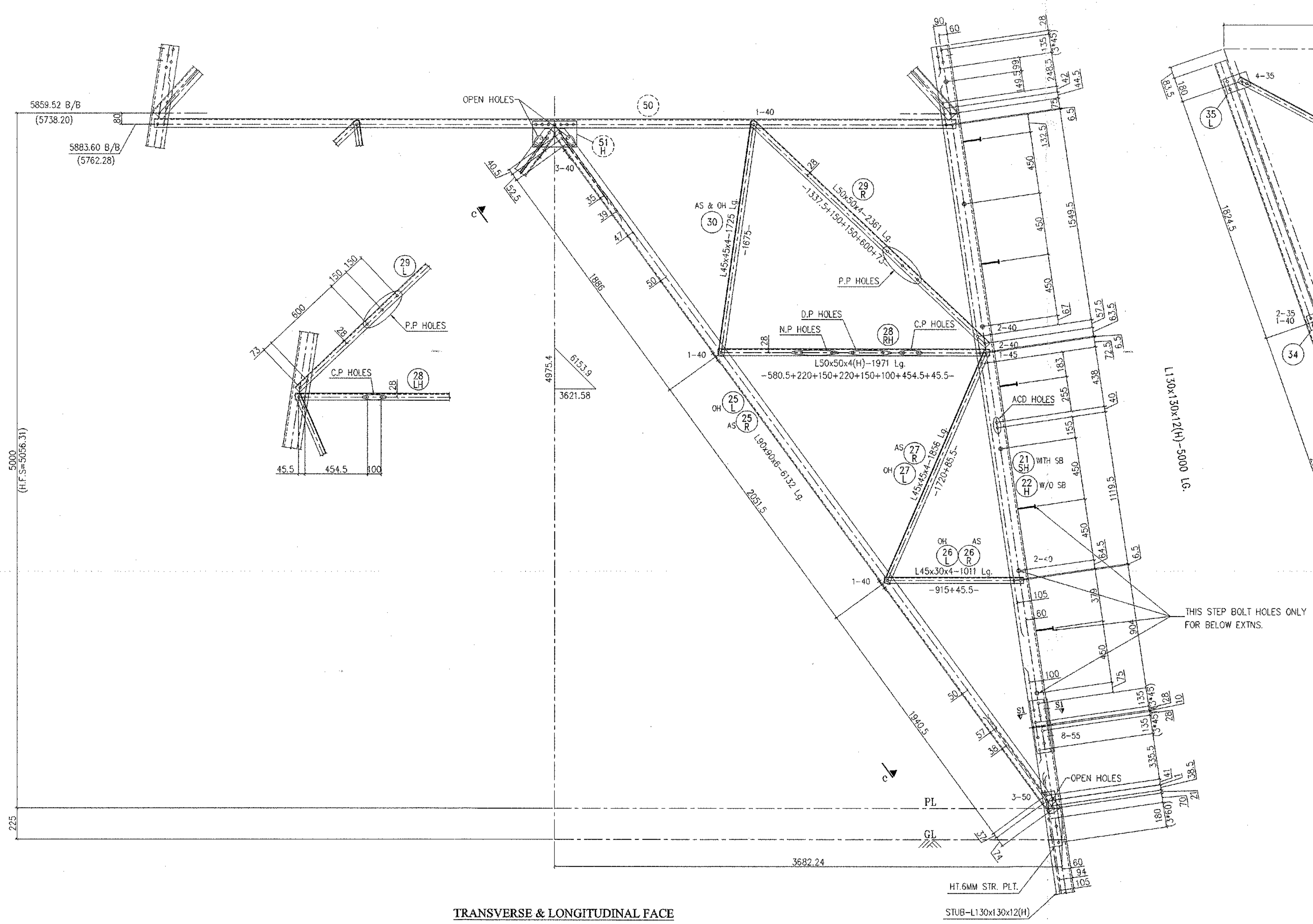
TOTAL WEIGHT : **9.408**

*** - Item welded with another item

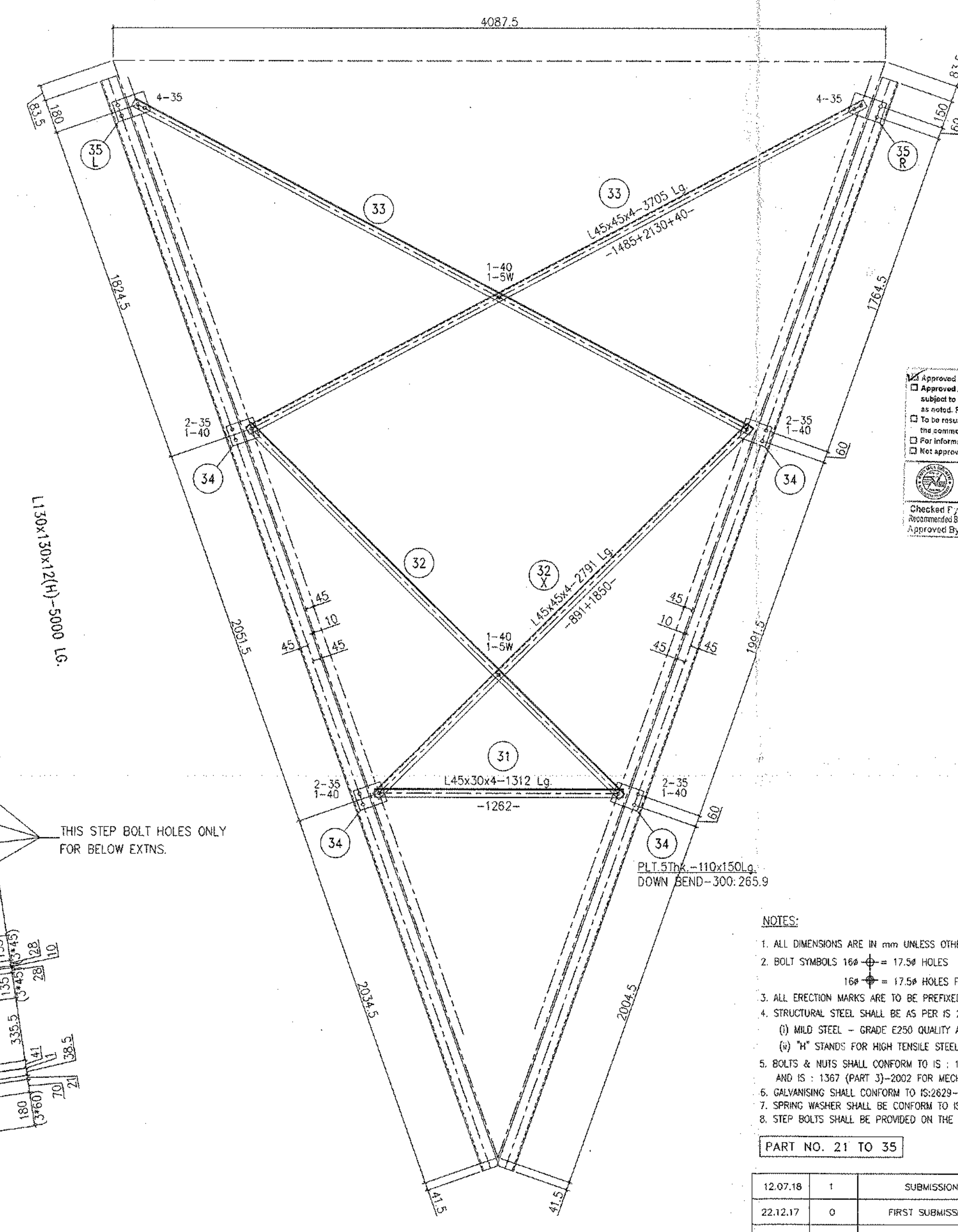
LARSEN & TOUBRO LIMITED
ECC CONSTRUCTION DIVISION
TRANSMISSION LINE DESIGN
MOUNT POONAMALLE ROAD, P.O BOX : 979 CHENNAI - 600 089, INDIA.
PHONE : 044 - 22492747 (20 LINES) FAX : 044 - 22494172

Project	LE17D124 - Intra-Pith-Kathmandu 400/220 KV		
Order Ref.	-	Date	22-12-2017
Drg No.	-	Page	1 of 1
BOM No.	BOM/LE17D124/P1DSB/S1DSB/R-0		

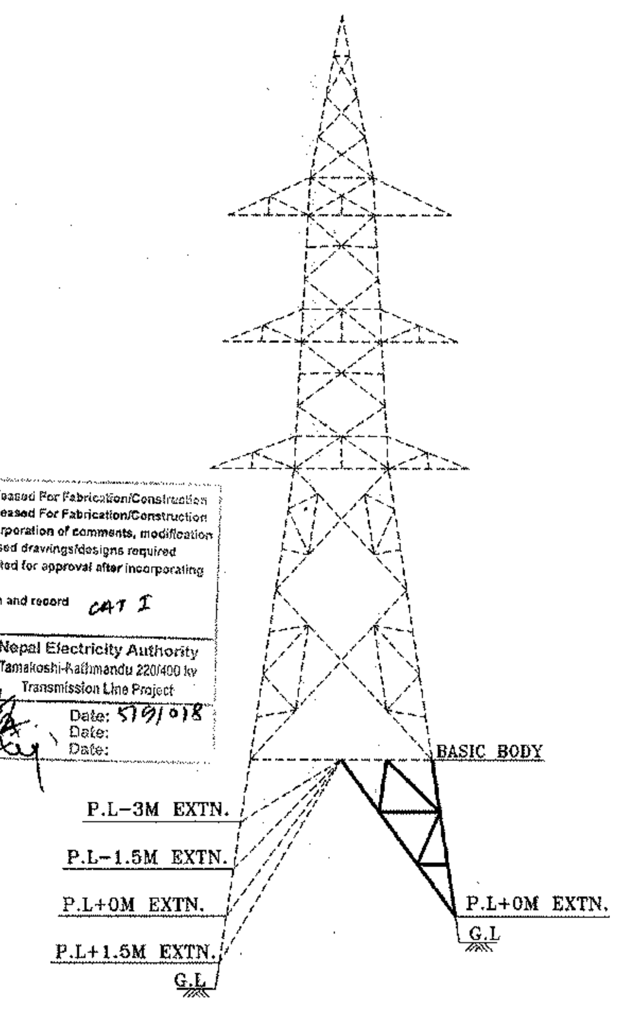
Srl No	Section Invloved	Section Weight
	BOLTS & NUTS OF STUB & CLEATS FOR TOWER TYPE-"DD/DE" (132kV, WZ-4)	
1	M16x3.5mm SPR. WSR-IS3063	.576
2	M16x45MM LONG (IS:12427)	4.288
3	M16x50MM LONG (IS:12427)	4.544
	Total	9.408



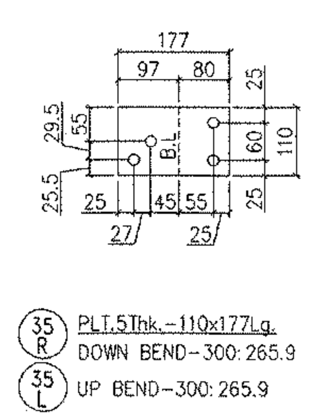
TRANSVERSE & LONGITUDINAL FACE

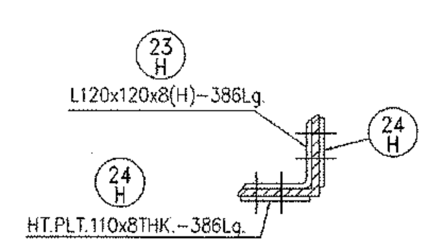


VIEW C-C



KEY ELEVATION





SECTION S1-S1

REQUIREMENT OF BOLTS, NUTS & WASHERS (ONE CORNER ONLY)			
SIZE	QTY.	GRADE	REMARKS
16ø x 35mm Lg.	16	5.6	BOLTS & NUTS
16ø x 40mm Lg.	30	5.6	BOLTS & NUTS
16ø x 45mm Lg.	2	5.6	BOLTS & NUTS
16ø x 50mm Lg.	6	5.6	BOLTS & NUTS
16ø x 55mm Lg.	16	5.6	BOLTS & NUTS
16ø x 3.5 THK	70	–	SPRING WASHERS
16ø x 5 THK	2	–	PACK WASHERS
16ø x 6 THK	–	–	PACK WASHERS
16ø x 175LG	7	–	STEP BOLTS

NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. BOLT SYMBOLS 16ø = 17.5ø HOLES
   16ø = 17.5ø HOLES FOR STEP BOLTS
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH "N1SDD"
4. STRUCTURAL STEEL SHALL BE AS PER IS 2062-2011
   (i) MILD STEEL – GRADE E250 QUALITY A – UNLESS OTHERWISE SPECIFIED.
   (ii) "H" STANDS FOR HIGH TENSILE STEEL – GRADE E350 QUALITY A
5. BOLTS & NUTS SHALL CONFORM TO IS : 12427-2001 (R-2007) FOR DIMENSIONS AND IS : 1367 (PART 3)-2002 FOR MECHANICAL PROPERTIES
6. GALVANISING SHALL CONFORM TO IS:2629-1985 (R-2006) & IS:4759-1996 (R-2006)
7. SPRING WASHER SHALL BE CONFORM TO IS 3063-1994 (R-2004)
8. STEP BOLTS SHALL BE PROVIDED ON THE DIAGONALLY OPPOSITE LEGS.

PART NO. 21 TO 35

SUCCESSFULLY TESTED AT CPRI - BENGALURU ON 11th OF JULY 2018

DATE	REV.NO.	DESCRIPTION	DESIGNED	CHECKED	DRAWN	CHECKED	APPROVED
12.07.18	1	SUBMISSION AFTER SUCCESSFUL TESTING	KMR	RJR	ALEX	PU/BSR	CSR
22.12.17	0	FIRST SUBMISSION FOR APPROVAL BEFORE PROTO	KMR	RJR	KLN/AAJ	SVR/BSR	CSR
			STRUCTURAL		DETAILING		

REVISIONS

CLIENT:

NEPAL ELECTRICITY AUTHORITY
(An Undertaking of Government of Nepal)

CONSULTANT:

POWER GRID CORPORATION OF INDIA LTD

CONTRACTOR:

L&T Construction
Power Transmission & Distribution

PROJECT:

TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

JOB No.: O17123-T-TL

TITLE: G.A OF +0M LEG/BODY EXTN. FOR TOWER TYPE "DD (30°-60°)"/DE(0°-15°) (132kV D/C LINE, WZ-4)

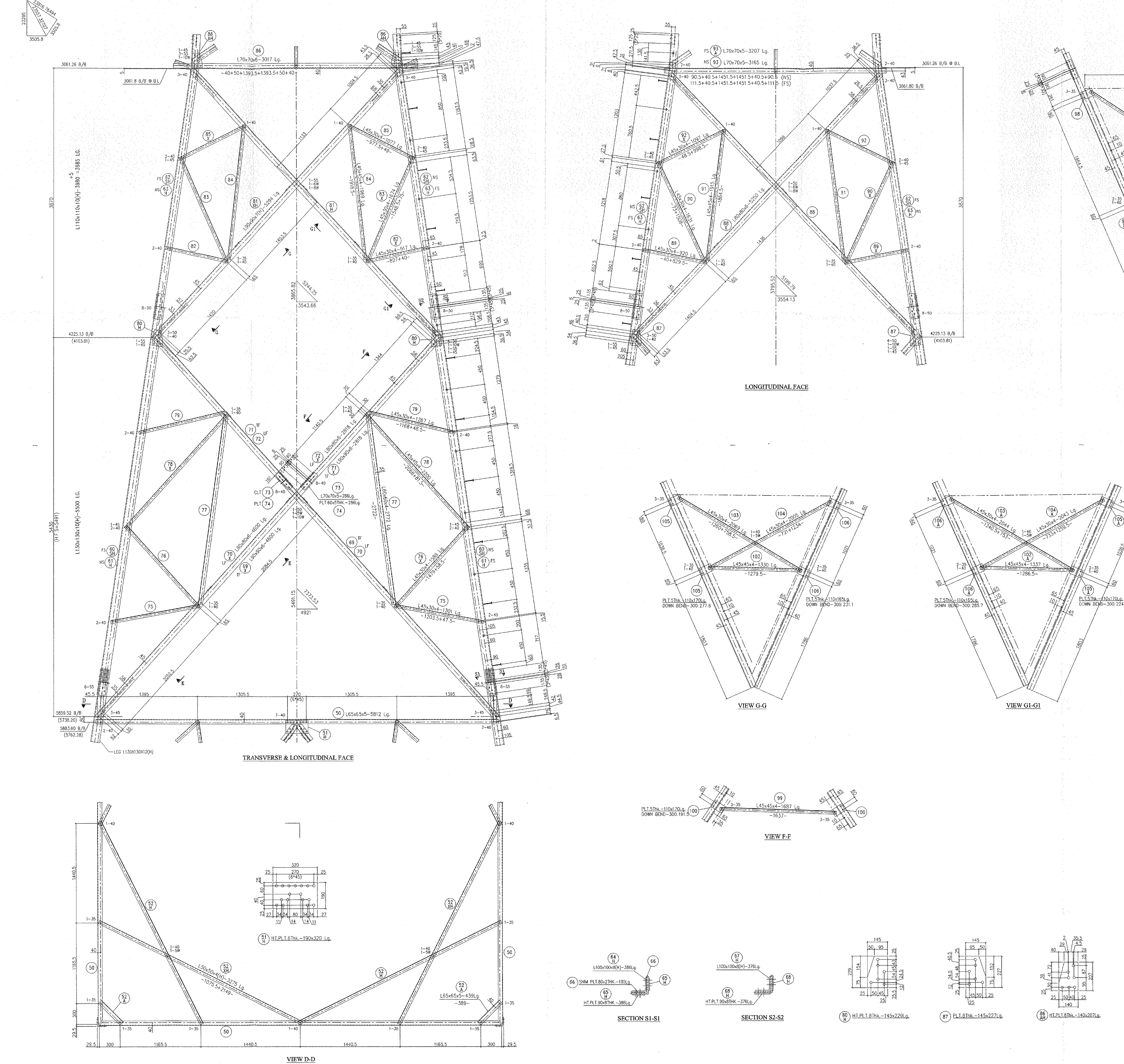
SCALE 1 : 20

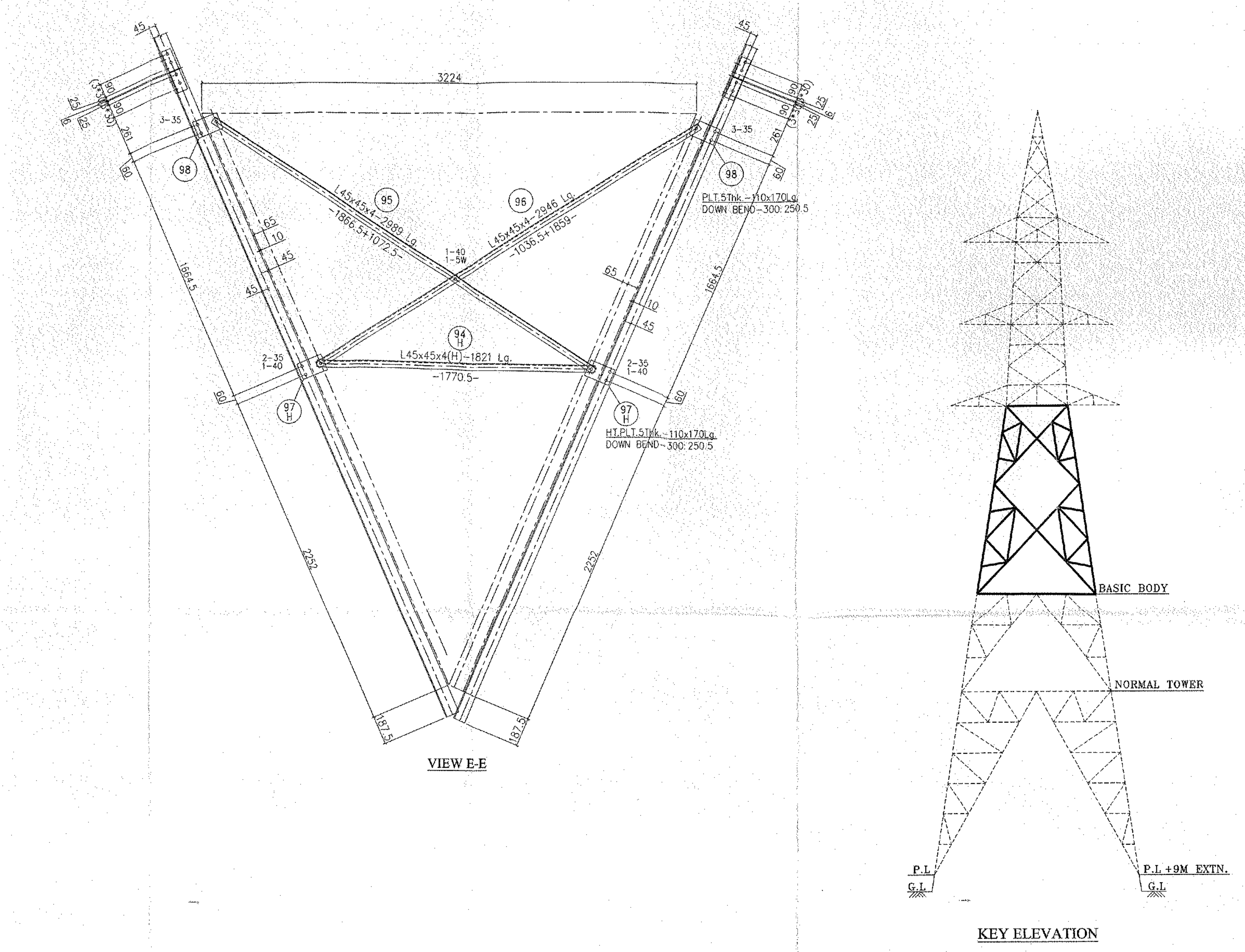
	NAME	DATE
DSGN	KMR	03.11.17
DRWN	KLN/AAJ	07.11.17
CHKD	SVR/BSR	07.11.17
APPD	CSR	07.11.17

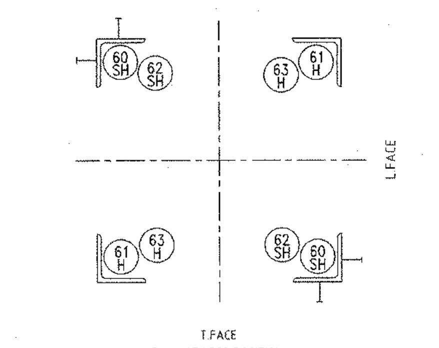
DRG No. 0 1 7 1 2 3 - T - T L - 4 D - G A - 0 4 0 3 | SHEET 01 OF 01 | SIZE A1 | REV. 1

RELEASED FOR ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

THIS IS PROPRIETARY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH NEPAL ELECTRICITY AUTHORITY(NEA). UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM NEA IN WRITING.







REQUIREMENT OF BOLTS, NUTS & WASHERS			
SIZE	QTY.	GRADE	REMARKS
16ø x 35mm Lg.	144	5.6	BOLTS & NUTS
16ø x 40mm Lg.	288	5.6	BOLTS & NUTS
16ø x 45mm Lg.	52	5.6	BOLTS & NUTS
16ø x 50mm Lg.	98	5.6	BOLTS & NUTS
16ø x 55mm Lg.	86	5.6	BOLTS & NUTS
16ø x 60mm Lg.	–	5.6	BOLTS & NUTS
16ø x 3.5 THK	668	–	SPRING WASHERS
16ø x 4 THK	–	–	PACK WASHERS
16ø x 5 THK	16	–	PACK WASHERS
16ø x 6 THK	4	–	PACK WASHERS
16ø x 8 THK	4	–	PACK WASHERS
16ø x 10 THK	12	–	PACK WASHERS
16ø x 12 THK	–	–	PACK WASHERS
16ø x 175LG	42	–	STEP BOLTS

NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. BOLT SYMBOLS 16ø = 17.5ø HOLES
   16ø = 17.5ø HOLES FOR STEP BOLTS
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH "N1SDD"
4. STRUCTURAL STEEL SHALL BE AS PER IS 2062-2011
   (i) MILD STEEL – GRADE E250 QUALITY A – UNLESS OTHERWISE SPECIFIED.
   (ii) "H" STANDS FOR HIGH TENSILE STEEL – GRADE E350 QUALITY A
5. BOLTS & NUTS SHALL CONFORM TO IS : 12427-2001 (R-2007) FOR DIMENSIONS AND IS : 1367 (PART 3)-2002 FOR MECHANICAL PROPERTIES
6. GALVANISING SHALL CONFORM TO IS:2629-1985 (R-2006) & IS:4759-1996 (R-2006)
7. SPRING WASHER SHALL BE CONFORM TO IS 3063-1994 (R-2004)
8. STEP BOLTS SHALL BE PROVIDED ON THE DIAGONALLY OPPOSITE LEGS.

PART Nos. 50,51,52 & 60 TO 106

PART No. 101 NOT USED

Approved / Released For Fabrication/Construction
Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
To be resubmitted for approval after incorporating the comments
For information and record CAT I
Not approved
Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kV Transmission Line Project
Checked By: Date: 5/9/018
Recommended By: Date:
Approved By: Date:

SUCCESSFULLY TESTED AT CPRI- BENGALURU ON 11th OF JULY 2018

DATE	REV.NO.	DESCRIPTION	DESIGNED (STRUCTURAL)	CHECKED (STRUCTURAL)	DRAWN (DETAILING)	CHECKED (DETAILING)	APPROVED
12.07.18	1	SUBMISSION AFTER SUCCESSFUL TESTING				PU/BSR	CSR
22.12.17	0	FIRST SUBMISSION FOR APPROVAL BEFORE PROTO	KMR	RJR	KLN/AAJ	SVR/BSR	CSR

REVISIONS

CLIENT: **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONSULTANT: **POWER GRID CORPORATION OF INDIA LTD**

CONTRACTOR: ***L&T Construction***
Power Transmission & Distribution

PROJECT:
TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

JOB No.: O17123-T-TL

	NAME	DATE
DSGN	KMR	03.11.17
DRWN	KLN/AAJ	07.11.17
CHKD	SVR/BSR	07.11.17
APPD	CSR	07.11.17

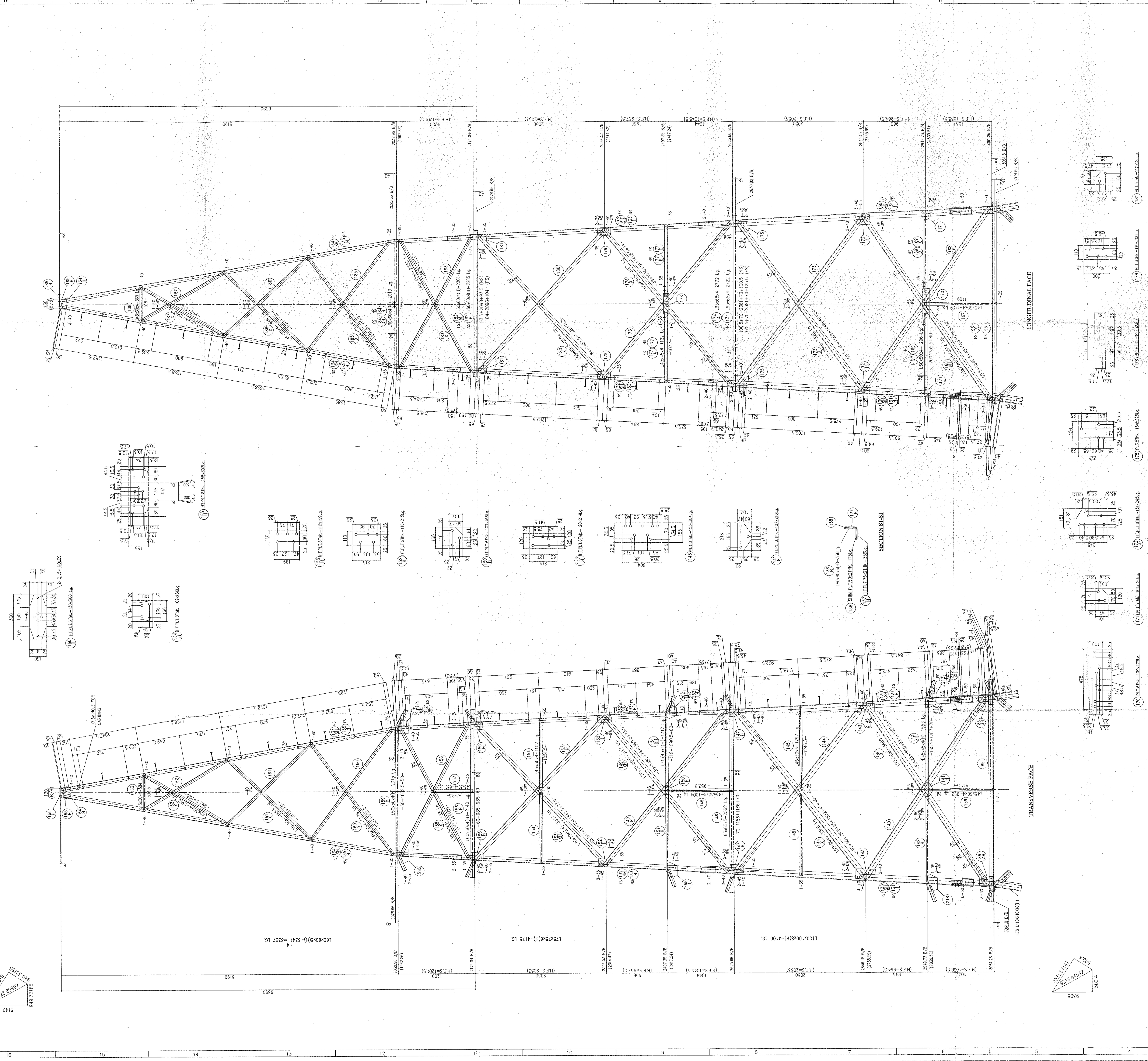
TITLE:
G.A OF BASIC BODY
FOR TOWER TYPE-"DD (30°-60°)"/DE(0°-15°)
(132kV D/C LINE, WZ-4)

SCALE 1 : 20

DRG No. O17123-T-TL-4D-GA-0404 SHEET 01 OF 05

SIZE A0 REV. 1

RELEASED FOR ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

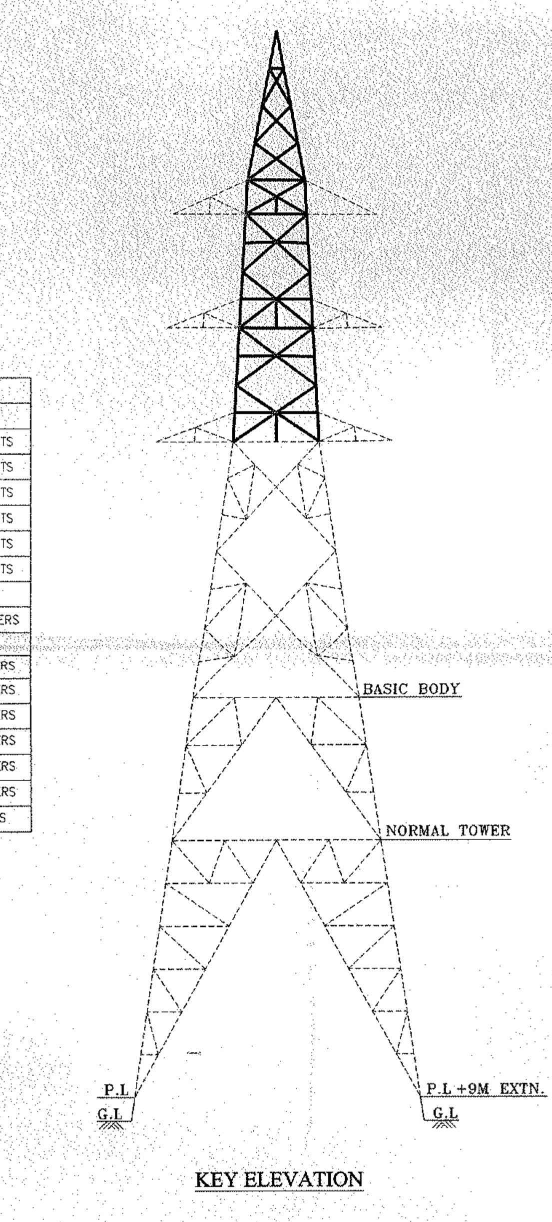


LONGITUDINAL FACE

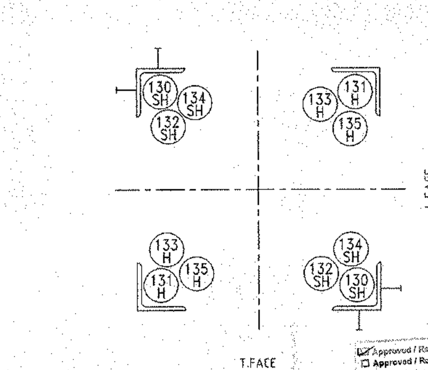
TRANSVERSE FACE

SECTION S1-S1

REQUIREMENT OF BOLTS, NUTS & WASHERS			
SIZE	QTY.	GRADE	REMARKS
16ø x 35mm Lg.	164	5.6	BOLTS & NUTS
16ø x 40mm Lg.	218	5.6	BOLTS & NUTS
16ø x 45mm Lg.	70	5.6	BOLTS & NUTS
16ø x 50mm Lg.	70	5.6	BOLTS & NUTS
16ø x 55mm Lg.	18	5.6	BOLTS & NUTS
16ø x 60mm Lg.	4	5.6	BOLTS & NUTS
16ø x 3.5 THK	544	–	SPRING WASHERS
16ø x 4 THK	10	–	PACK WASHERS
16ø x 5 THK	24	–	PACK WASHERS
16ø x 6 THK	28	–	PACK WASHERS
16ø x 8 THK	34	–	PACK WASHERS
16ø x 10 THK	8	–	PACK WASHERS
16ø x 12 THK	4	–	PACK WASHERS
16ø x 175LG	66	–	STEP BOLTS



KEY ELEVATION



T.FACE

PLAN OF LEGS POSITION

NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. BOLT SYMBOLS 16ø = 17.5ø HOLES
   16ø = 17.5ø HOLES FOR STEP BOLTS
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH "N1SDD"
4. STRUCTURAL STEEL SHALL BE AS PER IS 2062–2011
   (i) MILD STEEL – GRADE E250 QUALITY A – UNLESS OTHERWISE SPECIFIED.
   (ii) "H" STANDS FOR HIGH TENSILE STEEL – GRADE E350 QUALITY A
5. BOLTS & NUTS SHALL CONFORM TO IS : 12427–2001 (R–2007) FOR DIMENSIONS AND IS : 1367 (PART 3)–2002 FOR MECHANICAL PROPERTIES
6. GALVANISING SHALL CONFORM TO IS:2629–1985 (R–2006) & IS:4759–1996 (R–2006)
7. SPRING WASHER SHALL BE CONFORM TO IS 3063–1994 (R–2004)
8. STEP BOLTS SHALL BE PROVIDED ON THE DIAGONALLY OPPOSITE LEGS.

☑ Approved / Released For Fabrication/Construction
☐ Approved / Released For Fabrication/Construction subject to incorporation of comments, modification as noted. Revised drawings/designs required
☐ To be resubmitted for approval after incorporating the comments
☐ For information and record CAT I
☐ Not approved
Nepal Electricity Authority
Tamakoshi-Kathmandu 220/400 kV Transmission Line Project
Checked By: Date: 5/9/018
Recommended By: Date:
Approved By: Date:

SUCCESSFULLY TESTED AT CPRI - BENGALURU ON 11th OF JULY 2018

PART NO. 130 TO 188

12.07.18	1	SUBMISSION AFTER SUCCESSFUL TESTING		ALEX	PU/BSR	CSR
22.12.17	0	FIRST SUBMISSION FOR APPROVAL BEFORE PROTO	KMR	RJR	KLN/AAJ	SVR/BSR	CSR
DATE	REV.NO.	DESCRIPTION	DESIGNED (STRUCTURAL)	CHECKED (STRUCTURAL)	DRAWN (DETAILING)	CHECKED (DETAILING)	APPROVED

REVISIONS

CLIENT: **NEPAL ELECTRICITY AUTHORITY**
(An Undertaking of Government of Nepal)

CONSULTANT: **POWER GRID CORPORATION OF INDIA LTD**

CONTRACTOR: **L&T Construction**
Power Transmission & Distribution

PROJECT:
TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE

JOB No.: O17123-T-TL

	NAME	DATE
DSGN	KMR	03.11.17
DRWN	KLN/AAJ	07.11.17
CHKD	SVR/BSR	07.11.17
APPD	CSR	07.11.17

TITLE:
G.A OF CAGE PART
FOR TOWER TYPE–"DD (30°–60°)"/DE(0°–15°)
(132kV D/C LINE, WZ–4)

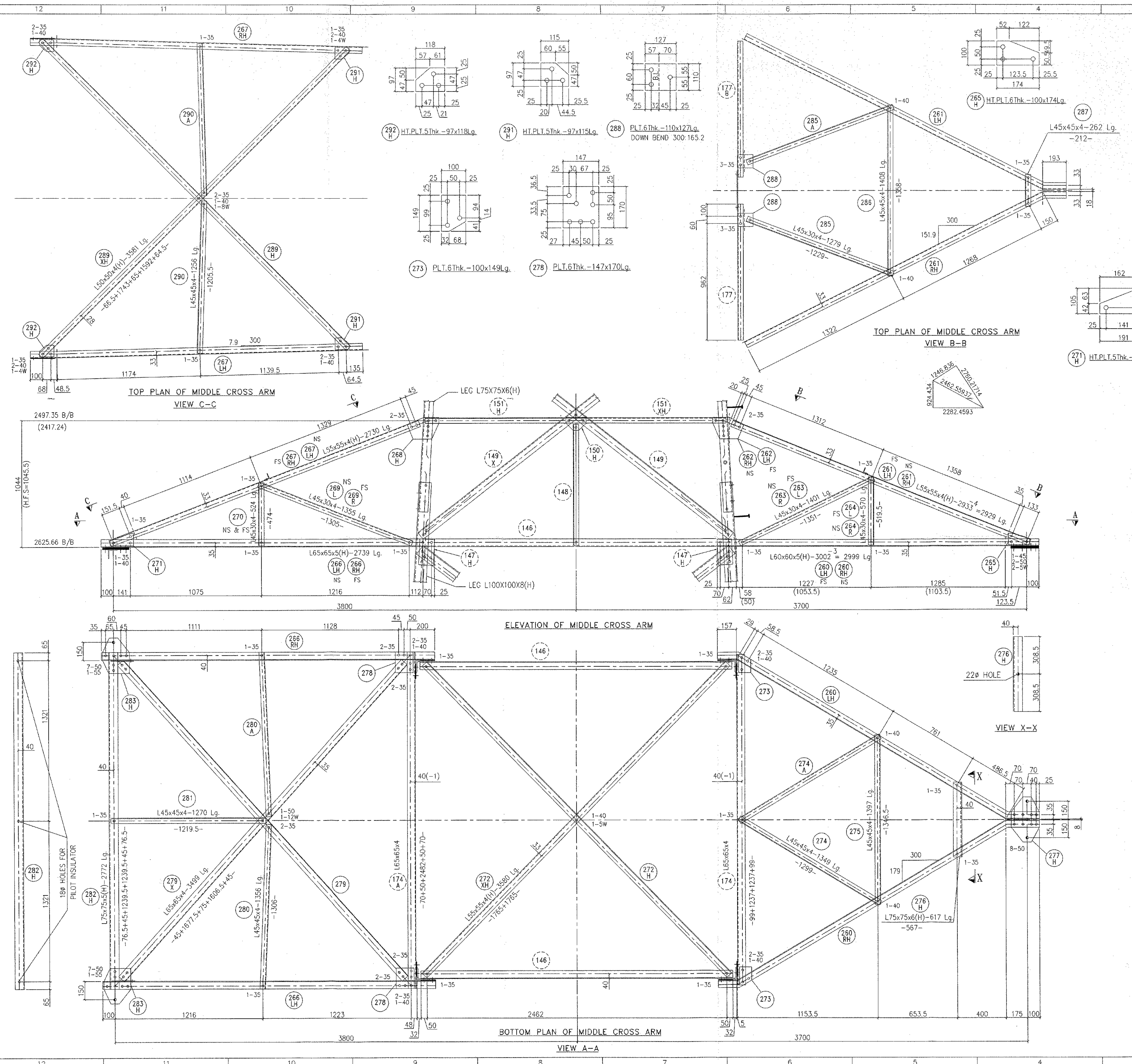
SCALE 1 : 20

DRG No. O 1 7 1 2 3 - T - T L - 4 D - G A - 0 4 0 4
SHEET 02 OF 05

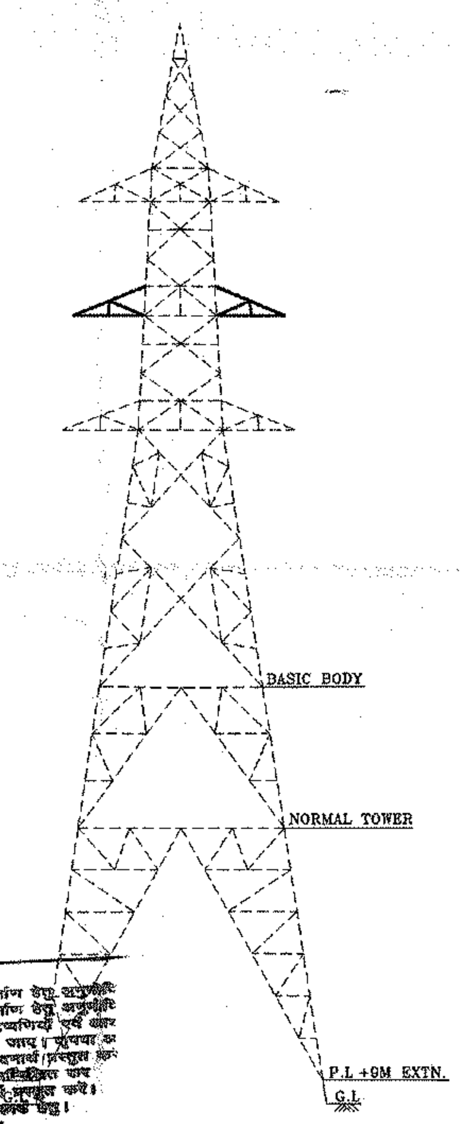
SIZE A0 REV. 1

RELEASED FOR ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

THIS IS PROPRIETARY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH NEPAL ELECTRICITY AUTHORITY(NEA). UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM NEA IN WRITING.



REQUIREMENT OF BOLTS, NUTS & WASHERS			
SIZE	QTY.	GRADE	REMARKS
16ø x 35mm Lg.	70	5.6	BOLTS & NUTS
16ø x 40mm Lg.	18	5.6	BOLTS & NUTS
16ø x 45mm Lg.	1	5.6	BOLTS & NUTS
16ø x 50mm Lg.	25	5.6	BOLTS & NUTS
16ø x 55mm Lg.	2	5.6	BOLTS & NUTS
16ø x 3.5 THK	116	–	SPRING WASHERS
16ø x 4 THK	2	–	PACK WASHERS
16ø x 5 THK	3	–	PACK WASHERS
16ø x 6 THK	–	–	PACK WASHERS
16ø x 8 THK	1	–	PACK WASHERS
16ø x 12 THK	1	–	PACK WASHERS



NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. BOLT SYMBOLS 16ø = 17.5ø HOLES
   16ø = 17.5ø HOLES FOR STEP BOLTS
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH "N1SDD"
4. STRUCTURAL STEEL SHALL BE AS PER IS 2062–2011
   (i) MILD STEEL – GRADE E250 QUALITY A – UNLESS OTHERWISE SPECIFIED.
   (ii) "H" STANDS FOR HIGH TENSILE STEEL – GRADE E350 QUALITY A
5. BOLTS & NUTS SHALL CONFORM TO IS : 12427–2001 (R–2007) FOR DIMENSIONS AND IS : 1367 (PART 3)–2002 FOR MECHANICAL PROPERTIES
6. GALVANISING SHALL CONFORM TO IS:2629–1985 (R–2006) & IS:4759–1996 (R–2006)
7. SPRING WASHER SHALL BE CONFORM TO IS 3063–1994 (R–2004)
8. STEP BOLTS SHALL BE PROVIDED ON THE DIAGONALLY OPPOSITE LEGS.

SUCCESSFULLY TESTED AT CPRI - BENGALURU ON 11th OF JULY 2018

PART Nos. 260 TO 292

PART No. 284 NOT USED

DATE	REV.NO.	DESCRIPTION	DESIGNED (STRUCTURAL)	CHECKED (STRUCTURAL)	DRAWN (DETAILING)	CHECKED (DETAILING)	APPROVED
12.07.18	1	SUBMISSION AFTER SUCCESSFUL TESTING	KMR	RJR	ALEX	PU/BSR	CSR
22.12.17	0	FIRST SUBMISSION FOR APPROVAL BEFORE PROTO	KMR	RJR	KLN/AAJ	SVR/BSR	CSR

REVISIONS

CLIENT: **NEPAL ELECTRICITY AUTHORITY** (An Undertaking of Government of Nepal)

CONSULTANT: **POWER GRID CORPORATION OF INDIA LTD**

CONTRACTOR: **L&T Construction** Power Transmission & Distribution

PROJECT: **TAMAKOSHI – KATHMANDU 220/400 KV TRANSMISSION LINE PROJECT - 400/220 KV AND 132 KV BARHABISE – KATHMANDU TRANSMISSION LINE**

JOB No.: O17123-T-TL

	NAME	DATE
DSGN	KMR	03.11.17
DRWN	KLN/AAJ	07.11.17
CHKD	SVR/BSR	07.11.17
APPD	CSR	07.11.17

TITLE: G.A OF MIDDLE CROSS ARM FOR TOWER TYPE–"DD (30°–60°)"/DE(0°–15°) (132kV D/C LINE, WZ–4)

SCALE 1 : 15

DRG No. 0 1 7 1 2 3 - T - T L - 4 D - G A - 0 4 0 4 SHEET 04 OF 05 SIZE A1 REV. 1

RELEASED FOR ☐ PRELIMINARY ☐ TENDER ☐ INFORMATION ☑ APPROVAL ☐ CONSTRUCTION

☑ Approved / Released For Fabrication/Construction
☐ Approved / Released For Fabrication/Construction subject to incorporation of comments, modifications as noted. Revised drawings/designs required
☐ For information and record
☐ Not approved

Nepal Electricity Authority Tamakoshi-Kathmandu 220/400 kV Transmission Line Project
Checked By: Date:
Recommended By: Date:
Approved By: Date: 7/7/2018

VOLUME – II-A OF III
CHAPTER - 15
TENDER DRAWINGS

Turnkey Bidding Document

Kohalpur Nepalgunj 132 kV TLP

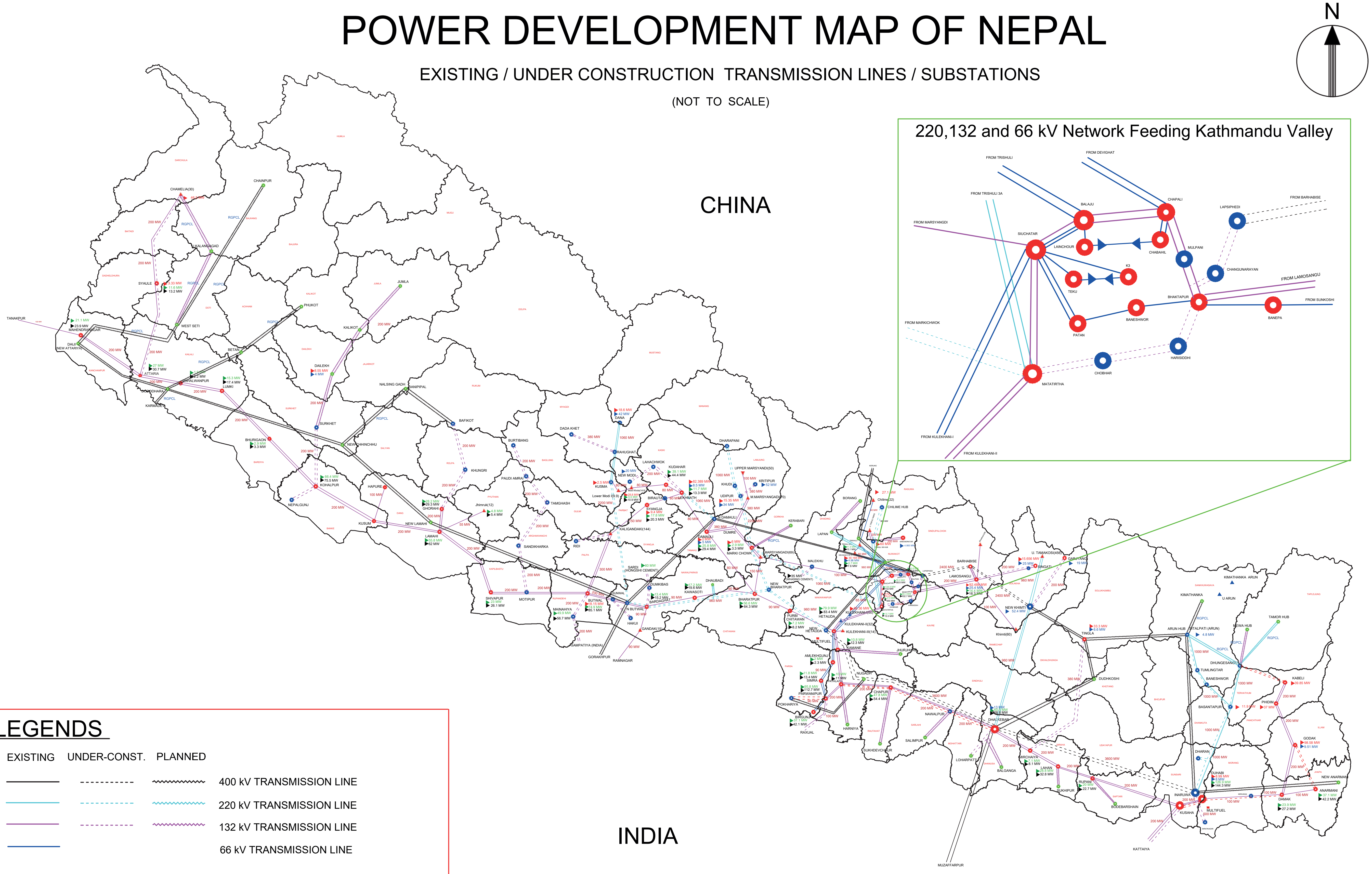
LIST OF TENDER DRAWINGS

Sl. No.	Drawing Number	Drawing Description
1.	DWG001	Power Map of Nepal
2.	DWG002	Location Map of Kohalpur Nepalgunj 132 kV Transmission Line Project
3.	DWG003-1, 3-2, 3-3, 3-4, 3-5	Route Alignment of 132kV Transmission Line from Kohalpur to Nepalgunj on Topographic Map
5.	DWG007-1	Tower and Line Identification Plates
6.	DWG007-2	Anti Climbing Devices for Tower
7.	DWG008	Tower Grounding
8.	DWG009	Tower Counterpoise Connection
9.	DWG010	Sample Visual Chart
10.	DWG011	Tower Outline Configuration
11.	DWG012	Conceptual Foundation Drawing

POWER DEVELOPMENT MAP OF NEPAL

EXISTING / UNDER CONSTRUCTION TRANSMISSION LINES / SUBSTATIONS

(NOT TO SCALE)



LEGENDS

EXISTING | UNDER-CONST. | PLANNED

400 kV TRANSMISSION LINE

220 kV TRANSMISSION LINE

132 kV TRANSMISSION LINE

66 kV TRANSMISSION LINE

GRID SUB-STATION

EXISTING | UP TO ASAR 2079

POWER PLANTS

LOAD

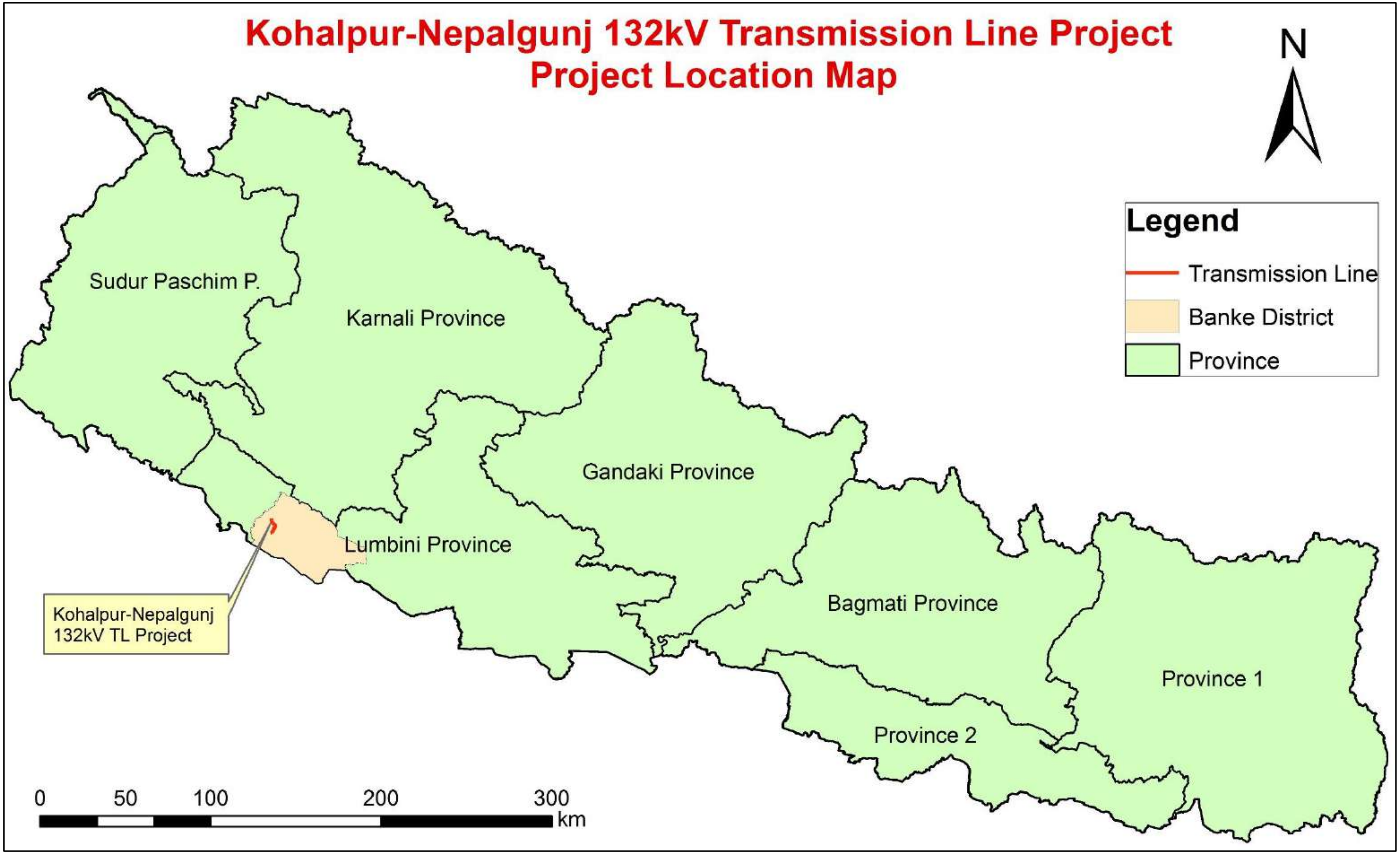
Proposed For Reinforcement

NEPAL ELECTRICITY AUTHORITY

TRANSMISSION DIRECTORATE

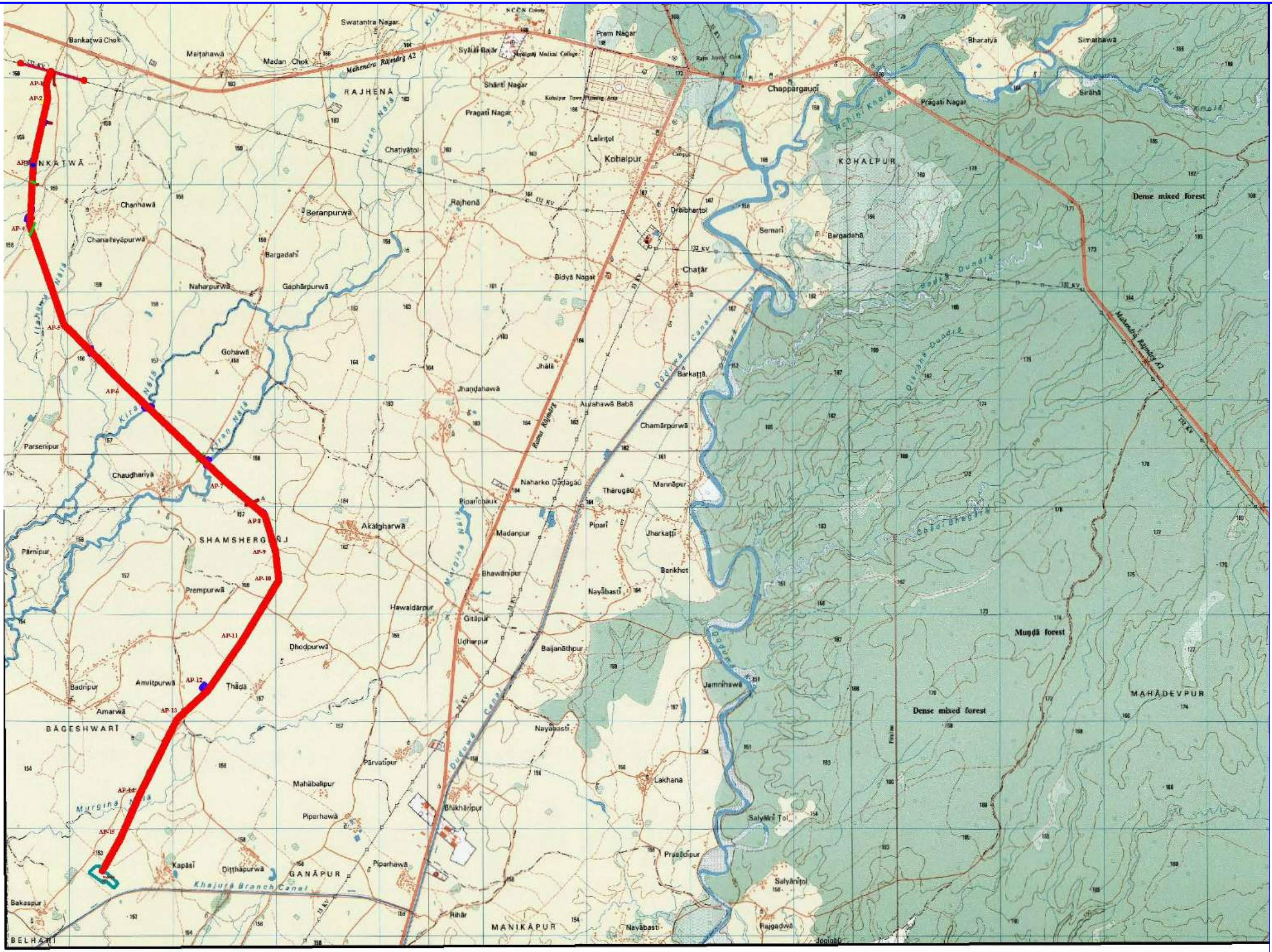
GRID DEVELOPMENT DEPARTMENT

(Revised Date: July 2021)



DWG002: Project Location Map

Source: GIS Analysis and Department of Survey



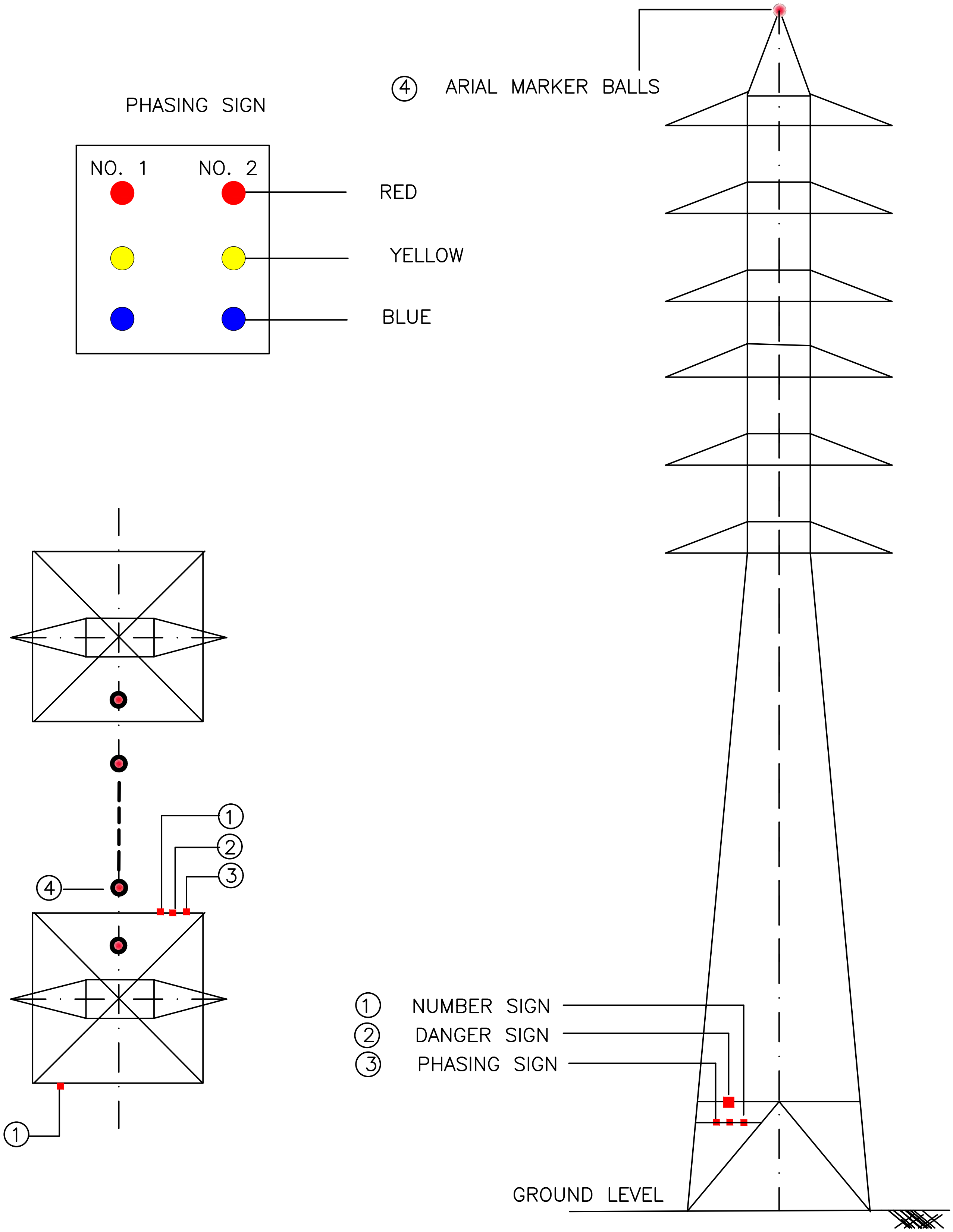
LEGEND

- Highway with Bridge
- Feeder Road with Bridge
- District Road with Bridge
- Other Road with Bridge
- Cart Track with Bridge
- Main Foot Trail with Bridge
- Minor Foot Trail with Bridge
- Road under construction
- Ropeway line
- Built-up area
- Building or house
- Factory, Chimney
- School, Post office
- Hospital, Health post
- Cemetery
- Temple or Stupa, Mane
- Mosque, Church
- Orchard, Nursery
- Trees:Scattered, Prominent, Row
- Tea or coffee plantation
- Forest
- Bush, Grass, Bamboo
- Swamp
- Lake, pond or water tank
- Streams
- River
- Canal, Ditch
- Dam,Sluice gate,Weir
- Water tank or pond, Well
- Sand and Gravel area
- Aqueduct
- Ferry, Ford, Twin service
- Water tap, well, Water tower
- Spring, Ooze away place
- Triangulationpoint, Bench mark
- Mountain pass, Spot height ·4312
- Fence or wall
- Index contour
- Intermediate contour
- Supplementary contour
- Embankment
- Cutting
- Depression: Big
- Depression: Small
- Soil cliff: Large, Small
- Rocks: Large, Small
- Cliff: rock, ice
- Quarry, gravel or clay pit
- International boundary
- District boundary
- VDC/Municipality boundary
- VDC Name — BASANTAPUR
- Radiotransmission tower
- Angle point — AP 1

SHEET INDEX

N

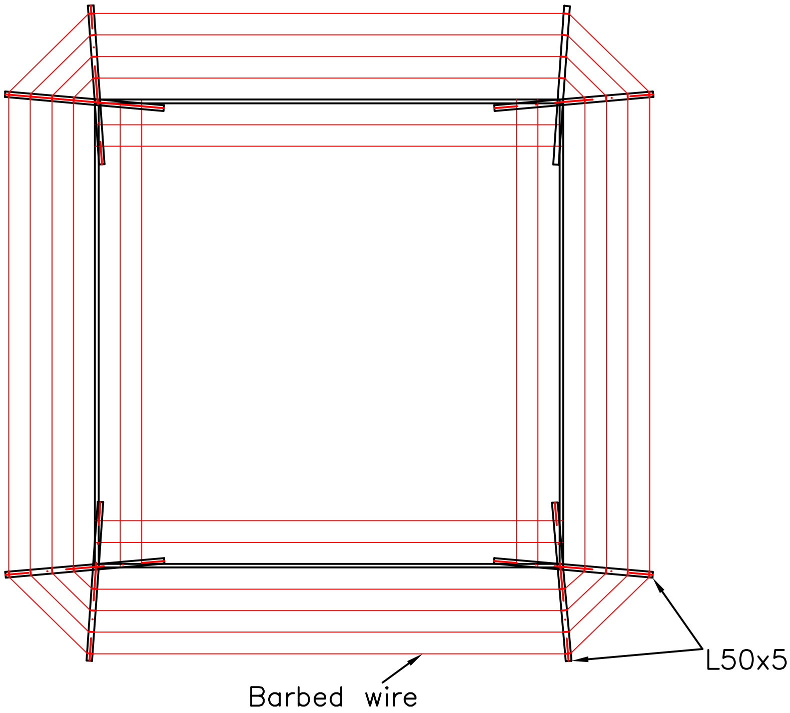
Submitted To:	Prepared By:		Title		Sheet. No.
NEPAL ELECTRICITY AUTHORITY GRID DEVELOPMENT DEPARTMENT KOHALPUR NEPALGUNJ 132 kV TRANSMISSION LINE	NEPAL ELECTRICITY AUTHORITY ENGINEERING SERVICES DIRECTORATE PROJECT DEVELOPMENT DEPARTMENT DURBARMARG, KATHMANDU	KOHALPUR NEPALGUNJ 132 kV TRANSMISSION LINE SURVEY	ROUTE ALIGNMENT PLAN	0 250 500 750 1000 1250m Scale 1:25,000	DWG003



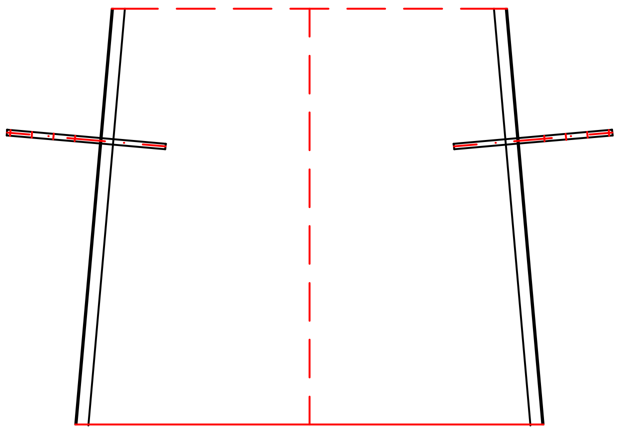
FOR TENDER PURPOSE ONLY

NEPAL ELECTRICITY AUTHORITY
(A Government Of Nepal Undertaking)

PROJECT :	KOHALPUR NEPALGUNJ 132kV TRANSMISSION LINE PROJECT
DRAWING TITLE :	TOWER AND LINE IDENTIFICATION PLATES
DRAWING NO. :	DWG007_1
SCALE :	NTS



PLAN

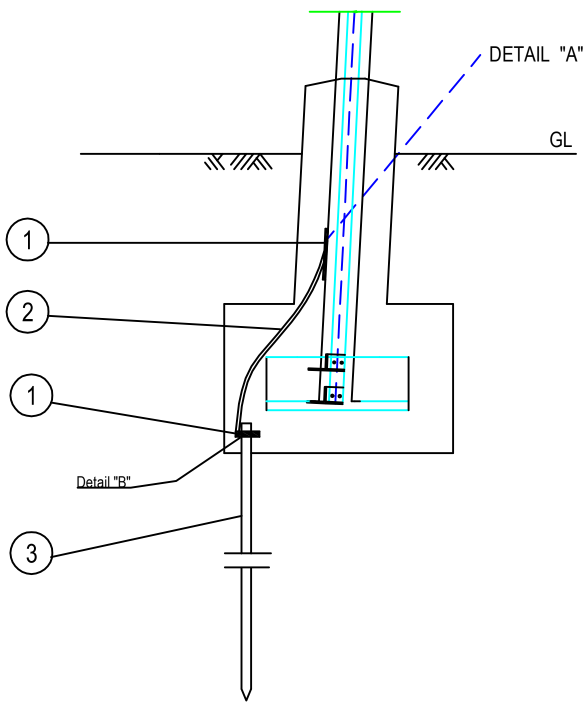


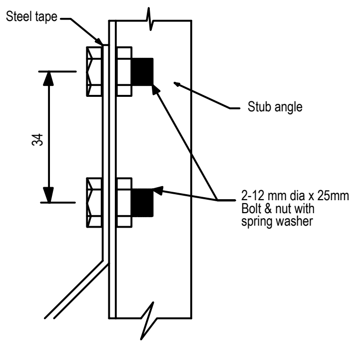
ELEVATION

FOR TENDER PURPOSE ONLY

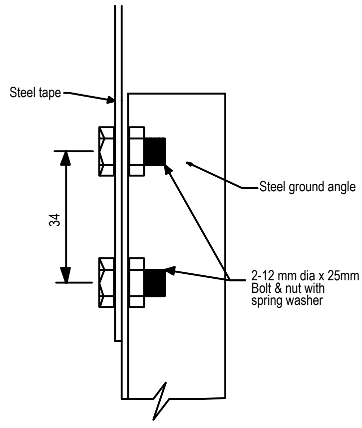
NEPAL ELECTRICITY AUTHORITY
(A Government Of Nepal Undertaking)

PROJECT :	KOHALPUR NEPALGUNJ 132kV TRANSMISSION LINE PROJECT
DRAWING TITLE :	ANTI CLIMBING DEVICES FOR TOWER
DRAWING NO. :	DWG007_2
SCALE :	NTS

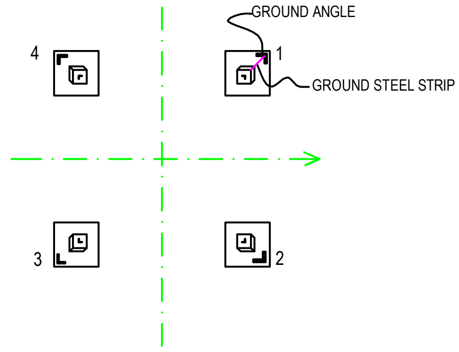




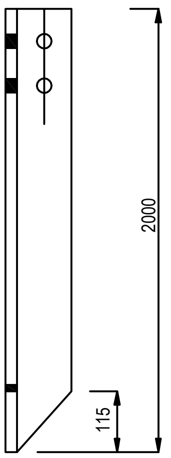
DETAIL "A"



DETAIL "B"



GROUND ANGLE CONNECTION



GROUND ANGLE

GROUNG ELECTRODE SET

Legend	Description	Ref. Dwg.
1	2-12 mm dia x 25 mm galv.steel bolt & nut	
	with spring washer.	
2	Galv. steel tape 25mm x 3 mm thickness.	
3	Galv. steel angle, 50x50x5 - 4	
	1,000 mm long.	

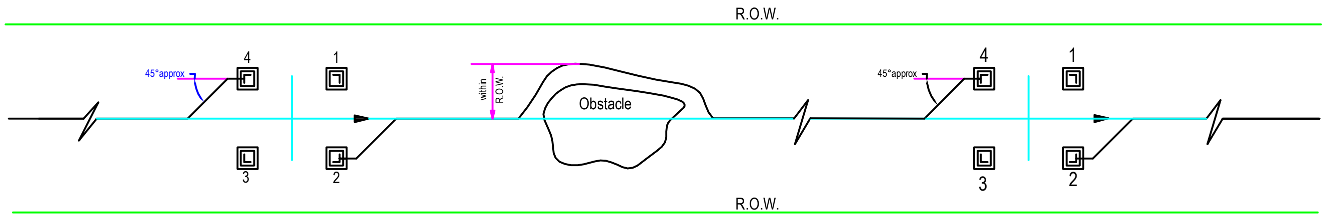
NOTE :

1. Dimensions are in millimeters except otherwise specified.
2. All grounding material shall have galvanizing weight of not less than specified in ASTM A 123+30%.

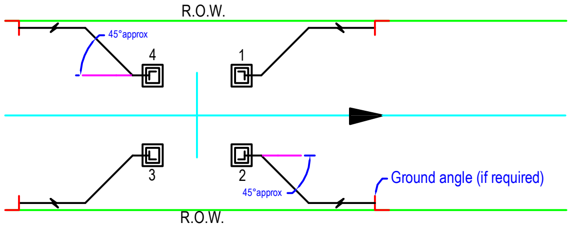
FOR TENDER PURPOSE ONLY

NEPAL ELECTRICITY AUTHORITY
(A Government Of Nepal Undertaking)

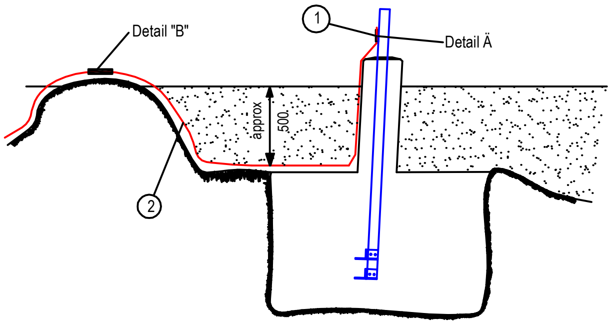
PROJECT :	KOHALPUR NEPALGUNJ 132kV TRANSMISSION LINE PROJECT
DRAWING TITLE :	TOWER GROUNDING
DRAWING NO. :	DWG008
SCALE :	NTS



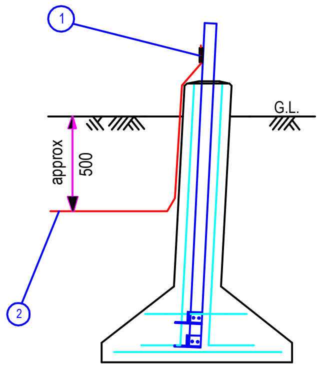
ONE WIRE CONTINUOUS COUNTERPOISE CONNECTION



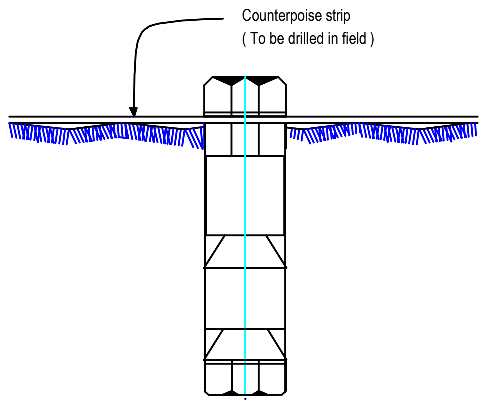
RADIAL COUNTERPOISE CONNECTION



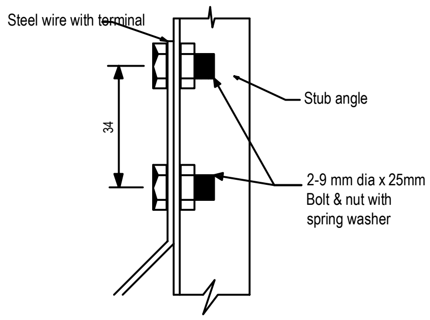
GROUND CONNECTION FOR PAD TYPE FOUNDATION



GROUND CONNECTION
FOR PAD TYPE FOUNDATION



DETAIL "B"
COUNTERPOISE ROCK
ANCHOR



DETAIL "A"

COUNTERPOISE SET

Legend	DESCRIPTION	Ref. Dwg.
1	2-12 mm dia x 25mm galv.steel bolt & nut with	
	spring washer.	
2	Galv. steel wire, 7 x 3.048 mm dia.	
	a. Radial counterpoise ; 50 meter long.	

NOTE :

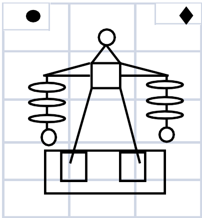
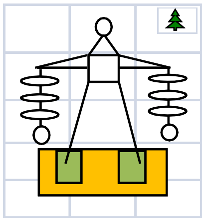
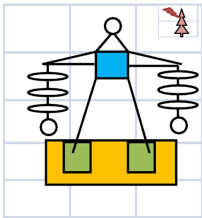
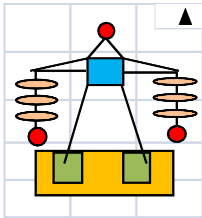
1. Dimensions are in millimeters except otherwise specified.
2. All grounding material shall have galvanizing weight of not less than specified in ASTM A 123+30%.

FOR TENDER PURPOSE ONLY

NEPAL ELECTRICITY AUTHORITY
(A Government Of Nepal Undertaking)

PROJECT :	KOHALPUR NEPALGUNJ 132kV TRANSMISSION LINE PROJECT
DRAWING TITLE :	TOWER COUNTERPOISE CONNECTION
DRAWING NO. :	DWG009
SCALE :	NTS

SAMPLE VISUAL CHART

				
LOCATION NUMBER	--	--	--	--
TOWER TYPE	--	--	--	--
WORK PROGRESS	NO WORK	FOUNDATION COMPLETED	TOWER ERECTION COMPLETED	STRINGING OF EARTHWIRE & CONDUCTOR COMPLETED

LEGEND:

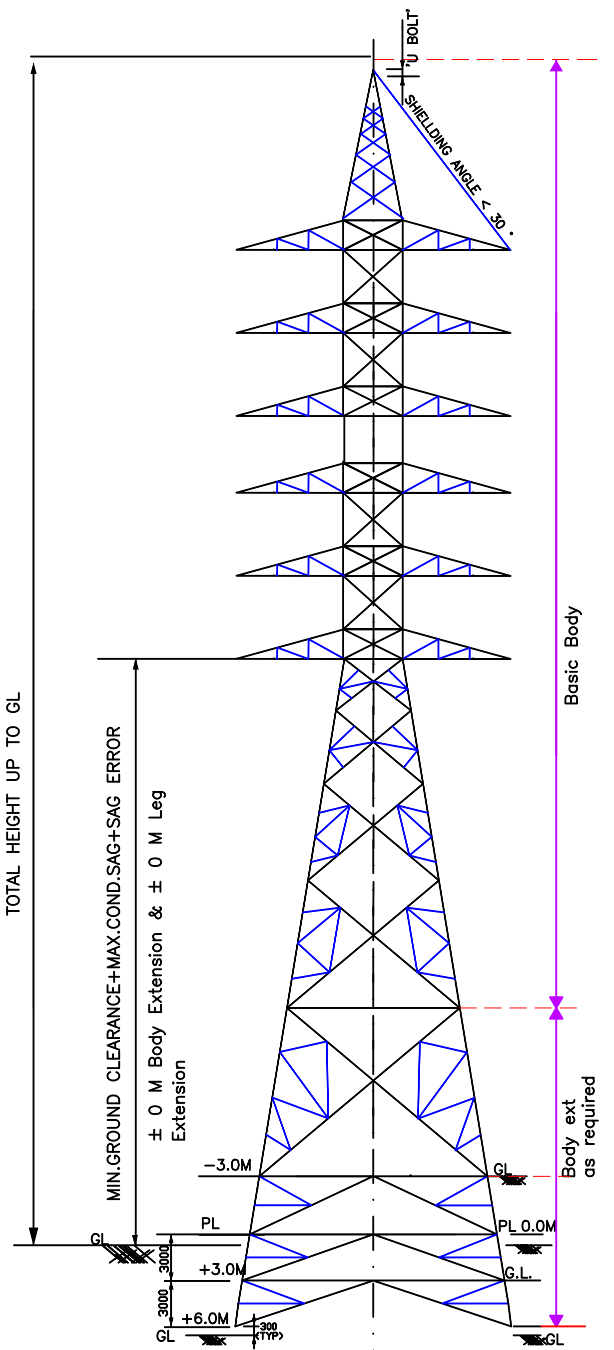
●	RIVER CROSSING
▲	POWER LINE CROSSING
◆	ROAD CROSSING
	FOREST
	TREE TO BE CLEARED

FOR TENDER PURPOSE ONLY

NEPAL ELECTRICITY AUTHORITY
(A Government Of Nepal Undertaking)

PROJECT :	KOHALPUR NEPALGUNJ 132kV TRANSMISSION LINE PROJECT
DRAWING TITLE :	SAMPLE VISUAL CHART FOR 132kV TRANSMISSION LINE PROJECT
DRAWING NO. :	DWG010
SCALE :	NTS

TOWER OUTLINE CONFIGURATION

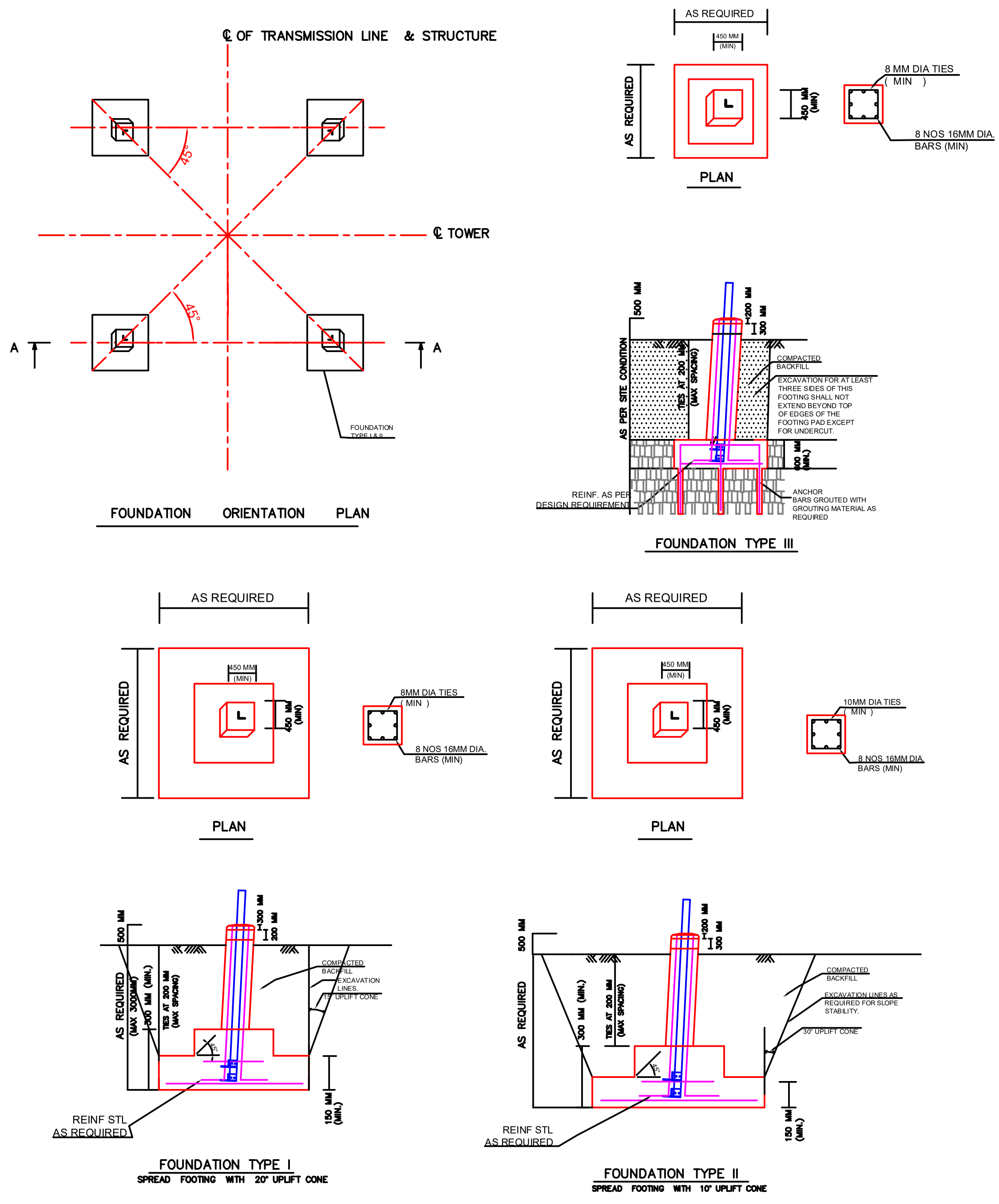


TENSION TOWER

FOR TENDER PURPOSE ONLY

NEPAL ELECTRICITY AUTHORITY
(A Government Of Nepal Undertaking)

PROJECT :	KOHALPUR NEPALGUNJ 132kV TRANSMISSION LINE PROJECT
DRAWING TITLE :	DEVICES FOR TOWER
DRAWING NO. :	DWG007_2
SCALE :	NTS



NOTES

GENERAL NOTES:

1. FOUNDATIONS OUTLINES AND DETAILES ILLUSTRATED ON THIS DRAWING ARE CONCEPTUAL ONLY AND ARE NOT RESTRICTED BEYOND THE GENERAL OUTLINE CONFIGURATION AND FOUNDATION DIMENSIONING.
2. FINAL FOUNDATION DESIGN SHALL BE BASED ON THE RESULT OF DETAIL SOIL TEST.
3. FINAL FOUNDATION SELECTION SHALL BE MADE AFTER COMPLETION OF EXCAVATION.
4. THE VALUES OF SOIL BEARING CAPACITY GIVEN IN THE FOUNDATION APPLICATION SCHEDULES ARE ONLY REFERENCE VALUES AND DETAIL DESIGN SHALL BE BASED ON THE RESULT OF DETAIL SOIL TEST CARRIED OUT BY THE CONTRACTOR.
5. FOR ADDITIONAL FOUNDATION REQUIREMENTS, SEE SPECIFICATION.

CONCRETE NOTES:

1. CONCRETE SHALL HAVE A 28 DAY MINIMUM COMPRESSIVE STRENGTH OF 210 KG/SQ CM.
2. ALL REINFORCING BARS SHALL BE TORSTEEL BAR CONFORMING TO Fe – 415 AS PER IS 1786.
3. REINFORCING STEEL SHALL BE DETAILED AND FABRICATED AS PER IS 456 & SP16 IN ACCORDANCE WITH – MANUAL OF STANDARD PRACTICE OF THE CONCRETE REINFORCING STEEL INSTITUTE.
4. MINIMUM COVER FOR REINFORCING STEEL SHALL BE
   a. CONCRETE CAST AGAINST EARTH 50 mm.
   b. ALL OTHER CONCRETE 50 mm.
5. CONCRETE FOUNDATIONS SHALL HAVE THE FOLLOWING MINIMUM STEEL.
   a. FOUNDATION PIERS – 0.008% GROSS AREA
   b. FOUNDATION FOOTINGS – 0.012% AVERAGE GROSS AREA
6. ALL EXPOSED CONCRETE SHALL HAVE TOOLED EDGES.

FOR TENDER PURPOSE ONLY

NEPAL ELECTRICITY AUTHORITY
(A Government Of Nepal Undertaking)

PROJECT :	KOHALPUR NEPALGUNJ 132kV TRANSMISSION LINE PROJECT
DRAWING TITLE :	CONCEPTUAL FOUNDATION DRAWING
DRAWING NO. :	DWG012
SCALE :	NTS