TECHNICAL SPECIFICATION

Construction of 33/11 KV Primary Sub- Stations.
1 GENERAL

1.1 Scope of work

A. Supply

In the package materials have been classified as under

i. Owner’s supply materials (OSM)

33/11 KV Power Transformers, Station 33/0.4 KV Transformers , VCB, kiosk, CT, PT, CR panels, LA,33KV Isolator, 11KV AB Switch & HG Fuse, Battery with Charger, ABCD, SDB, Light Fittings, Control Cable, Structures, Hardware etc.

ii. Contractor’s scope

All other material except the items shown above such as cements, different type of aggregate, bricks, Heat shrink type end connector (for all level), earthing materials, Foundation Materials, all Civil works Materials and other consumable required to complete the job.

B. Construction of 33 / 11 KV Sub-Stations

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of the Sub Station</th>
<th>Location (Name of the division)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dhamdhada</td>
<td>JTED, Jajpur Town</td>
</tr>
<tr>
<td>2</td>
<td>Brahmabarada</td>
<td>KuED, Kuakhia</td>
</tr>
</tbody>
</table>

Prior to the commencement of the supply / work all relevant drawings, designs must be got approved from GM (P&EMS), NESCO

C. The scope of the proposal for the balance materials to be supplied by the bidder to complete the job shall be on the basis of a single Bidder”s responsibility, completely covering supply and erection of all the equipment specified under the accompanying Technical Specifications including other services. It will include the following

(i) Detailed investigation of substation and preparation of BOQ to be done by the bidder.

(ii) Complete manufacture, including shops testing & supply of materials from the approved vendor (materials which are to be supplied by the bidder)

(iii) Providing Engineering drawings related to foundation details, structural details of
Sub-station work, equipments data, operational manual, etc for the Owner’s approval;

(iv) Packing and transportation from the NESCO Store to the site.
(v) Receipt, storage, preservation and conservation of equipment at the site.
(vi) Pre-assembly, if any, erection testing and commissioning of all the equipments;
(vii) Reliability tests and performance and guarantee tests on completion of commissioning”
(viii) Loading, unloading and transportation as required,
(ix) Erection of installations of specified voltages,
(x) Testing, Commissioning of installations of the Sub-Station inclusive of all related Civil works.
(xi) Storing before erection
(xii) Getting the Sub- Stations inspected and certified by Electrical Inspection after completion of work.

Transportation of all above required materials from NESCO store to site and all other required materials (to be supplied by bidder) from supplier’s premises to work site, construction of new electrical/civil structures, safe custody of the items and return of unused NESCO supplied materials to the NESCO stores.

1.1.1 GENERAL CONDITIONS OF CONTRACT

Responsibility of the Contractor

The Contractor shall be responsible for the complete design and engineering, overall co-ordination with internal and external agencies, project management, loading, unloading, storage at site, inventory management including OSM materials at site during construction, installations as per Engineer. in charge's advice, handling, moving to final destination, obtaining statutory clearances for successful erection, testing and commissioning of the substation.

Specific exclusions:
The following items of work are specifically excluded from the Contractors scope of work unless otherwise specifically brought out.
1.2 SYSTEM DATA

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Description of Technical Parameter</th>
<th>Unit</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nominal system voltage</td>
<td>kV_{rms}</td>
<td>33kV</td>
</tr>
<tr>
<td>2</td>
<td>Maximum system voltage</td>
<td>kV_{rms}</td>
<td>36.4kV</td>
</tr>
<tr>
<td>3</td>
<td>Power frequency with stand</td>
<td>kV_{rms}</td>
<td>70kV</td>
</tr>
<tr>
<td></td>
<td>voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---------</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>4</td>
<td>Lightning impulse withstand voltage</td>
<td>KV ( p ) (for ( 1.2 / 50 \mu s ))</td>
<td>170kV( p ) 195kV( p )</td>
</tr>
<tr>
<td></td>
<td>a) Line to earth</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Across isolating gap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>One minute power frequency withstand value</td>
<td>Dry</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wet</td>
<td>80</td>
</tr>
<tr>
<td>6</td>
<td>System frequency</td>
<td>Hz</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>Variation in frequency</td>
<td>%</td>
<td>&lt;2.5</td>
</tr>
<tr>
<td>8</td>
<td>Continuous current rating</td>
<td>kA</td>
<td>800A</td>
</tr>
<tr>
<td>9</td>
<td>Symmetrical short circuit current</td>
<td>kA</td>
<td>25</td>
</tr>
<tr>
<td>10</td>
<td>Duration of short circuit fault current</td>
<td>Second</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>Dynamic short circuit current rating</td>
<td>kA</td>
<td>62.5kA</td>
</tr>
<tr>
<td>12</td>
<td>Air clearances</td>
<td>meters</td>
<td>0.480</td>
</tr>
<tr>
<td></td>
<td>Phase to ground</td>
<td>meters</td>
<td>0.530</td>
</tr>
<tr>
<td></td>
<td>Phase to phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Conductor spacing for AIS layouts</td>
<td>meters</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>Phase to ground</td>
<td>meters</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>Phase to phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Design ambient temperatures</td>
<td>°C</td>
<td>50</td>
</tr>
<tr>
<td>15</td>
<td>Pollution level as per IEC-815 and 71</td>
<td>III</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Creepage distance</td>
<td>mm</td>
<td>900</td>
</tr>
<tr>
<td>17</td>
<td>Maximum fault clearing time</td>
<td>ms</td>
<td>not exceeding 150ms</td>
</tr>
<tr>
<td>18</td>
<td>Safety clearances</td>
<td>metres</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Section clearance</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3) Ground clearances( between ground and bottom most part of energised object)</td>
<td>metres</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>4) Horizontal clearance between the fence and energised object</td>
<td>metres</td>
<td>As per I.E. Rules</td>
</tr>
<tr>
<td></td>
<td>5) Horizontal clearance between the road centre line and energised part of the nearby equipment</td>
<td>metres</td>
<td>As per I.E. Rules</td>
</tr>
<tr>
<td>19</td>
<td>Bay width</td>
<td>metres</td>
<td>5.5</td>
</tr>
<tr>
<td>20</td>
<td>Height of bus equipment interconnection from ground</td>
<td>metres</td>
<td>4</td>
</tr>
</tbody>
</table>
1.3 DATA
1.3.1 METEROLOGICAL

<table>
<thead>
<tr>
<th>Description</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual mean of maximum monthly average temperature.</td>
<td>50</td>
</tr>
<tr>
<td>Annual mean of minimum monthly temperature in °C</td>
<td>5</td>
</tr>
<tr>
<td>Average rain fall in mm</td>
<td>1500</td>
</tr>
<tr>
<td>Average thunder storms days per year</td>
<td>77days</td>
</tr>
<tr>
<td>Design ambient temperature in °C</td>
<td>50</td>
</tr>
<tr>
<td>Maximum wind velocity in meter/sec.</td>
<td>50</td>
</tr>
<tr>
<td>Maximum relative humidity in %</td>
<td>100</td>
</tr>
<tr>
<td>Average relative humidity in %</td>
<td>85</td>
</tr>
<tr>
<td>Seismic co-efficient</td>
<td>0.06g Horizontal</td>
</tr>
<tr>
<td></td>
<td>0.01g Vertical</td>
</tr>
</tbody>
</table>

1.3.2 Sub station Philosophy

NESCO has adopted the philosophy of installing open terminal air insulated substations. The bus bars may be of either rigid type or flexible strain type depending upon the choice of the designer considering the overall suitability and economy of the substation to be installed.

a) Layout arrangement

The Contractor shall finalize the layout arrangements in case of new substations in line with this Specification with the approval of the Engg- In-charge which shall be meeting at least the basic minimum electrical clearances as specified in the schedules.

a) Location and site description

The Bidder shall make necessary visit to the substation sites and fully appraise himself before bidding. Deviations on account of inadequate data for substation works shall not be acceptable and the Bid shall not be considered for evaluation in such cases.
b) **Completeness and accuracy of information**

The Contractor shall note that the information provided above and in the relevant schedules may not be complete or fully accurate at the time of bidding. For his own interest the Contractor is advised to make site visits and fully satisfy himself regarding site conditions in all respects, and shall be fully responsible for the complete design and engineering of the substations.

1.4 **GUARANTEEDTECHNICAL PARTICULARS**

The Contract Works shall comply with the guaranteed technical particulars specified or quoted in the bid. All plant and apparatus supplied under this Contract shall be to the approval of the Engg In-charge.

**Use of electrical energy**

The Contractor shall arrange at his own cost and expense, any site supplies of electrical energy which he may require for supplying power for heavy erection plant, welding plant or other tools, lighting and testing purposes.

All wiring for such tackle and for lighting from the point of supply shall be provided by the Contractor and all such installations shall comply with all appropriate statutory regulations.

Wiring shall be of the best quality double insulated flexible cable, suitably fixed, protected and maintained. All necessary precautions shall be taken to ensure the safety of every person employed or working on the Site and this shall include routine inspection of all temporary installations and portable equipment.

The Engg In-charge or his authorised representative may require the disconnection or alteration of any parts which he may consider dangerous.

As soon as any part or the whole of the Contractor's installation is no longer required for the carrying out of the works, the Contractor shall disconnect and remove the same to the satisfaction of the Engg In-charge or his authorised representative.
1.5 **SUPERVISION AND CHECKING OF WORK ON SITE**

All work on site included in the contractor’s scope of works shall be supervised by sufficient number of qualified representatives of the Contractor. Before putting any plant or apparatus into operation the Contractor shall satisfy himself as to the correctness of all connections between the plant and apparatus supplied under this and other contracts. The Contractor shall advise the Engg In-charge in writing, giving the period of notice as specified in the General Conditions of Contract, when the plant or apparatus is ready for inspection or energisation.

1.6 **COMPLIANCE WITH REGULATIONS**

All apparatus and material supplied, and all work carried out shall comply in all respects with such of the requirements of all Regulations and Acts in force in the country and state in particular of the Employer as are applicable to the Contract Works and with any other applicable regulations to which the Employer is subjected to oblige.

The Contractor shall fully inform himself of the requirements of the local Laws, Regulations and rules in-force in the State of Odisha, especially with respect to local employment laws, licensing requirements, electrical safety rules and regulations, building regulations and planning procedures.

The Contractor shall be responsible for applying for all necessary licenses; including Electrical Contractors License, Workman’s Permits and Certificates of Competency for Supervisors, and local government approvals required for the contract works and for the payment of all necessary fees associated with such licenses and approvals. Additionally the Contractor shall also follow the adequate regulations on safety, environment, employees welfare etc. as stipulated under the relevant Clause of this section.

1.7 **MAINTENANCE AND CLEARING OF SITE**

The placing of materials and plant near the erection site prior to their being erected and installed shall be done in a neat, tidy and safe manner. The Contractor shall at his own expense keep the site area allocated to him and also the erection area of the Contract Works reasonably clean and shall remove all waste material as it accumulates and as directed by the Engg In-charge from time to time.
1.8  Insurance

1.8.1  General

In addition to the conditions covered under the Clause titled insurance in the Special Conditions of Contract, the following provisions will also apply to the portion of works to be done beyond the Suppliers own or his sub-Contractors manufacturing Works.

1.8.2  Workmen's Compensation Insurance

This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall also cover the Contractor against the claims for injury, disability, disease or death of his or his sub-contractor's employees, which for any reason are not covered under the Workman's Compensation Act, 1948. The liabilities shall not be less than;

a.  Workmen's Compensation  As per statutory provisions

b.  Employee's liability

As per statutory provisions According to the Govt. rules.

c.  Comprehensive General Liability Insurance

This insurance shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of members or public or damage to property of others, due to any act or omission on the part of the Contractor, its agents, its employees, its representatives and sub-contractors or from riots, strikes and civil commotion.

The hazards to be covered will pertain to all works and areas where the Contractor, its sub-contractors, agents and employees have to perform work pursuant to the Contracts.

The above are only an illustrative list of insurance covers normally required and it will be the responsibility of the Contractor to maintain all necessary insurance coverage to the extent both in time and amount to take care of all its liabilities either direct or indirect, in pursuance of the Contract.
1.9 **Work and Safety Regulations**

The Contractor shall ensure safety of all the workmen, plant and equipment belonging to him or to others, working at the Site. The Contractor shall also provide for all safety notices and safety equipment required by the relevant legislation and deemed necessary by the Engg In-charge.

All equipment used in construction and erection by Contractor shall meet Indian or International Standards and where such standards do not exist, the Contractor shall ensure these to be absolutely safe. All equipment shall be strictly operated and maintained by the Contractor in accordance with manufacturers operation manual and safety instructions and as per any existing Guidelines/Rules in this regard.

Periodical examinations and all tests for all lifting and hoisting equipment and tackle shall be carried out in accordance with the relevant provisions of Factories Act 1948, Indian Electricity (Supply) Act and associated Laws/Rules in force, from time to time. A register of such examinations and tests shall be properly maintained by the Contractor and will be promptly produced as and when desired by Engg In-charge (Divisional Engr.).
The Contractor shall provide suitable safety equipment of prescribed standard to all employees and workmen according to the need, as may be directed by the Engg In-charge who will also have the right to examine such safety equipment to determine it's suitability, reliability, acceptability and adaptability.

In case any accident occurs during the construction, erection or other associated activities undertaken by the Contractor, thereby causing any minor or major or fatal injury to his employees due to any reason whatsoever, it shall be the responsibility of the Contractor to promptly inform the same to the Engg In-charge and also to all the authorities envisaged under the applicable laws.

The Engg In-charge (Divisional Engr.) shall have the right at his sole discretion to stop the work, if in his opinion the work is being carried out in such a way as may cause accidents or endanger the safety of the persons and/or equipment. In such cases, the Contractor shall be informed in writing about the nature of hazards and possible injury/accident and he shall remove shortcomings immediately.

The Contractor shall follow and comply with all Safety Rules, relevant provisions of applicable laws pertaining to the safety of workmen, employees, plant and equipment as may be prescribed from time to time without any demur, protest or contest or reservation. In case of any conflict between statutory requirement and Safety Rules referred above, the most stringent clause shall be applicable.

1.10 Drawings

Within 7 days of contract commencement the Contractor shall submit, for approval by the Project Manager, a schedule of the drawings to be produced detailing which are to be submitted for "Approval" and which are to be submitted "For Information Only". The schedule shall also provide a programme of drawing submission, for approval by the Project Manager, that ensures that all drawings and calculations are submitted within the period specified above.

All detail drawings submitted for approval shall be to scale not less than 1:20.

Lettering sizes and thickness of lettering and lines shall be selected so that if reduced by two stages to one quarter of their size, the alphanumeric characters and lines are still perfectly legible so as to enable them to be microfilmed.

For presentation of design drawings and circuit documents IEC Publication 617 or equivalent standards for graphical symbols are to be followed.
1.11 General Requirements

1.11.1 Construction Management

1.11.1.1 General

Time is the essence of the Contract and the Contractor shall be responsible for performance of his Works in accordance with the specified construction schedule. If at any time the Contractor is falling behind the schedule, he shall take necessary action to make good for such delays by increasing his work force or by working overtime to accelerate the progress of the work and to comply with schedule and shall communicate such actions in writing to the Engg. Incharge (Divisional Engr.), providing evidence that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

12.0 ERECTION WORK

12.1 CIVIL WORKS

Civil works includes the following items.

The scope shall generally cover sub- station structures, including gantries and equipment support structures and their foundations, cable trenches along with covers, switchyard dressing and levelling, site clearance, soil investigation, drains, fencing, gravel filling and, transformer foundations, . Any other items, not specifically mentioned here but required for the commissioning of substation shall be deemed to be included in the scope of this Specification. All civil works shall also satisfy the General Technical Clauses specified in other sections of this specification and as detailed below.

Excavation, dewatering, carriage of excavated earth, plain cement concrete (PCC), casting of reinforced cement concrete (RCC) foundations, super-structures for sub- station structures, equipment supports, their control cubicles, bus post supports, lighting poles and panels, brick and stone masonry, cable trenches, pipe trenches with necessary pre cast RCC removable covers, with lifting facility(In every 5 th slab) and sump pits, cable supports and their embedment in cable trenches with backfilling complete as per drawings approved by NESCO, shall be carried out by the contractor. The cable trenches inside the control room shall be provided with GI chequered plate with angle stiffeners at the bottom for mechanical strength and painting there of as per the standard practice.

The Contractor shall furnish all designs, (unless otherwise specified) drawings, labour, tools, equipment, materials, temporary works, constructional plant and machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for
complete performance of the Works in accordance with approved drawings, specifications and as per direction of the Engg In-charge (Divisional Engr.).

The work shall be carried out according to the design/drawings to be developed by the Contractor, and approved by the GM (Project) or supplied to the bidder by the Engg In-charge (Divisional Engr.). For all buildings, structures, foundations etc. necessary layout, levels and details shall be developed by the Contractor keeping in view the functional requirement of the plant and facilities and providing enough space and access for operation, use and maintenance based on the input provided by the Engg In-charge (Divisional Engr.). Certain minimum requirements are indicated in this specification for guidance purposes only. However, the Bidder shall quote according to the complete requirements.
12.2 TRANSFORMER FOUNDATION, RAIL TRACK

12.2.1 General

All the transformer foundations should be designed for 5 MVA power transformers & shall be of RCC, M15 (1:2:4 mix) grade (as per the indicative drawing enclosed). The rails shall be first quality 52 kg/m medium manganese steel as per Indian Railway specification T- 12-64.

The station transformer (Owner supply materials) has to be column mounted with provision of LA, HG Fuse, AB Switch etc. has to be done by the contractor.

12.3 CABLE TRENCHES

12.3.1 General

The cable trenches should be primarily of Brick masonry `supported with RCC pillars 250*250mm at an interval of 2500mm over 75 mm RCC base. In each pillar, 2 nos of MS flats of 50*6*200mm shall be suitably embedded to hold 2nos of cable racks. The cable trench wall inside the control room will be of 100mm thick RCC only. The top of the cable trench should be RCC to hold the RCC covers (as per the approved drawing, enclosed). For main power cables separate cable trench should be made.

Cable trenches and pre-cast removable RCC covers (with lifting arrangement) shall be constructed using RCC of M15 grade.

The cable trenches shall be designed for the following loads.

Dead load of 155 kg/ m length of cable support plus 75 kg on one tier at the end.

Cable trench covers shall be designed for (i) self weight of top slab plus concentrated load of 200 kg at centre of span on each panel and a surcharge load of 2 tonnes per sq. metre.
Cable trench crossings of roads should be designed accordingly and to be submitted to EE/DE for approval. Trenches shall be drained. Necessary sumps be constructed and sump pumps shall be supplied. Cable trenches shall not be used as storm water drains.

The top of trenches shall be kept at least 300 mm above the finished ground level (FGL). The FGL means the finish level of the soil but not the top of metalling surface. The top of cable trench shall be such that the surface rain water does not enter the trench.

All metal parts inside the trench shall be connected to the earthing system.

Cables from trench to equipments shall run in hard conduit pipes (GI pipe and necessary G.I bends and sockets)

A suitable clear gap shall be maintained between trench walls and foundations.

A clear (vertical) space of at least 200 mm shall be available for each tier in cable trench. From trench bed to lowest tier, a minimum clearance of 100 mm shall be available for all tier trench. The spacing between stands (cable tray supports) shall be 2000mm. No sharp bending of cable trench is permissible, it should be done as per 15D principle.

The trench bed shall have a slope of 1/500 along the run and 1/250 perpendicular to the run.

Cable tray supports (all galvanised structures) shall be designed and constructed to be a single complete fabrication or assembly such that every layer of the horizontal cable tray supports are fixed, either bolted or welded, to a vertical steel support that is embedded in the concrete wall of the cable trough. It shall not be permitted to embed a horizontal support beam directly into the wall of the trough in order to use the concrete wall as a means of load bearing.

Concrete troughs shall be provided with concrete covers of suitable load bearing strength. Where the cable troughs are run across or within 3 m of substation roads, the trough covers shall be capable of bearing an accidental wheel load of 20 kN. The drawings showing the details of fixing of cable racks in concrete cable trench walls, fixing of cable tray, no. of layers to be provided has to be provided by the contractor and to be get approved by the GM o/o CPIO.
NB :- All the relevant drawings related to construction of Sub-station should submitted within 7 days from the detail work order to the concern Engineer in charge positively.

The thickness of the RCC wall of the trench shall be 100mm and thickness of the raft shall be 75mm. All the frames for fixing of cable trays shall be of hot dip galvanized. A running earth strip has to run all through the cable trench for proper earthing of the cable trays and stand (frame). The size of the earth strip is of 50X6mm G.I flats. Welding the G.I flats to the frame to be carried out. Earthing strips to be welded with the running earth mat at 10mtrs interval.

The bidder also to supply and fix G.I perforated cable trays (of thickness 2mm) of appropriate size before laying of cables on the cable tray stand.

The covers of the slab are also of RCC with ratio mixing1:2:4. The thickness of the slab shall be 50 mm (MS Rods to be used 8mm), The MS rods to be used shall be placed at 100 mm centre to centre both way and properly bided. The cover slab shall have provision of lifting hooks at two points for easy lifting of the slabs. Slabs having lifting hooks shall be placed at every 10th slabs, it should remain inside the top of concrete surface of the slab.

The covers for the cable trench inside the control room shall be provided with GI chequered plate with MS angle stiffeners at the bottom for proper mechanical strength.

Once the trench covers have been made they are to be stored and not laid until all trench cabling, is finished. Any covers laid before this time which become damaged shall be replaced at the Contractor's expense.

Trench covers and bridging beams for covers, except where heavy duty, shall be light enough for two men to lift.

12.3.2 Buried cables

Cables are to be laid in neat lines and at suitable levels. Their depth below ground level will depend upon the voltage associated with the cables but in all cases the excavation must provide a clear trench. Sand filling below, around and above the cables will always be required and protection covers or tiles /bricks will be placed in position over the sand filling before final backfilling to the ground level. The line of the cable trenches shall be marked with suitable posts as required by relevant section of this Specification.
12.04 FOUNDATION DESIGN

12.04.1 General

All foundations shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS 456 and minimum grade of concrete shall be M15 corresponding to 1:2:4 nominal mix ratio with 12-20 mm coarse aggregate. Higher grades of concrete than specified above may be used at the discretion of the Bidder without any financial implication to the owner.

Limit state method of design shall be adopted unless stated otherwise in the Specification.

For design and construction of steel-concrete composite beams IS: 11384 shall be followed.

For detailing of reinforcement IS 2502 shall be followed. Cold twisted deformed bars (Fe= 415 N/sq mm) conforming to IS 1786 shall be used as reinforcement. However, in specific areas, mild steel (Grade1) conforming to IS 432 can also be used. Two layers of reinforcement (on inner and outer face) shall be provided for wall and slab sections having thickness of 150 mm and above. Clear cover to reinforcement towards the earth face shall be minimum 40 mm.

The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and/or equipment and/or superstructure, and other conditions which produce the maximum stresses in the foundation or the foundation component, and as per the relevant IS Codes of foundation design. The design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.

All foundations shall rest below virgin ground level and the minimum depth of foundation below the virgin ground level (minimum one meter below the virgin ground level) shall be maintained.

Design shall consider any sub-soil water pressure that may be encountered.

Necessary protection to the foundation work, if required, shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental or harmful to the concrete foundations.

RCC columns shall be provided with rigid connection at the base.

All building sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factors of safety for these cases shall be as stated in relevant IS Codes or as stipulated elsewhere in the Specifications.

Earth pressure for all underground structures shall be calculated using coefficient of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable).

The following conditions shall be considered for the design of water tanks, pump houses, channels, sumps, trenches and other underground concrete structures such as basements etc.
Full water pressure from inside and no earth pressure, ground water pressure and surcharge pressure from outside (applicable only to structures which are liable to be filled with water or any other liquid).

Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

The Twin pole and equipment foundations shall be checked for a factor of safety of 2.2 for normal condition and 1.65 for short circuit condition against sliding, overturning and pullout. The same factor shall be used as partial safety factor over loads in limit state design also.

All underground concrete structures such as basements, water retaining structures etc. shall have plasticizer cum water proofing cement additive conforming to IS 9103. In addition, the limit on permeability as given in IS 2645 shall also be met. The concrete surface of these structures in contact with earth shall also be provided with two coats of bituminous painting for water /damp proofing.

In case of water leakage in the above structures, leakage repair shall be achieved by the injection method.

12.04.2 Other Foundations

All foundations shall be designed in accordance with the provisions of the relevant parts of latest revisions of IS 2911 and IS 456.

Type of foundation system i.e. isolated footing, raft or piling shall be decided based on the load intensity and soil strata.

Twin Pole foundations shall be designed for an additional factor of safety of 1.1 for normal/ broken wire conditions and for short circuit condition.

Circuit breaker foundations shall be designed for impact loading and shall be strictly in accordance with the Manufacturer's recommendations.

Switchyard foundation plinths and building plinths shall be minimum 300 mm and 500 mm above finished ground level respectively or as per minimum required safety electrical clearance stipulated in IE Rule.

12.04.3 Cement

The cement to be used shall be the best quality of its type and must not be more than 3 months old in stock.

All cement shall be sampled and tested in accordance with Indian Standards.

The Portland cement used in concrete shall confirm to IS 269.
Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the Indian Standards based on the findings of the detailed soil investigation to be carried out by the contractor.

High Alumina cement shall NOT be used.

12.04.4 Aggregate

Coarse and fine aggregate shall conform to the requirements of IS 383-1970.

Sampling and testing of aggregates shall be in accordance with the relevant Indian Standard.

Fine and coarse aggregates shall be obtained from the same source and the Contractor shall ensure that material from the source is known to have a good service record over a long period of time.

Aggregate shall be hard and dense and free from earth, clay, loam and soft, clayey, shaley or decomposed stone, organic matter and other impurities.

12.04.5 Storage of aggregates

Coarse and fine aggregates shall be stored on site in bins or on clean, dry, hard surfaces, and be kept free from all sources of contamination. Aggregates of different gradings shall be stored separately, and no new aggregate shall be mixed with existing stocks until tested, and approved by the Engg In-charge (Divisional Engr.).

12.04.6 Water

Water used for mixing concrete and mortar shall be clean, fresh water obtained from an approved source and free from harmful chemicals, oils, organic matter and other impurities. Normally potable water may be considered satisfactorily for mixing and curing concrete and masonry work.

12.04.7 Steel bar reinforcement

Reinforcement shall comply with the appropriate Indian Standards.

All bar reinforcement shall be hot rolled steel except where the use of cold worked steel is specified on the drawings or otherwise approved.

The bars shall be round and free from corrosion, cracks, surface flaws, laminations, rough, jagged and imperfect edges and other defects.

The bar reinforcement shall be new, clean and of the lengths and diameters described on the Drawings and Schedules. Bars shall be transported and stored so that they remain clean, straight, undamaged and free from corrosion, rust or scale. Bars of different diameters shall be separately bundled.
12.04.8  Welding of reinforcement

Spot or tack welding for positioning bars in heavily reinforced areas will only be allowed with the express permission of the Engg In-charge (Divisional Engr.). Extension of lengths of reinforcement by welding will not be permitted.

Welding will be approved only in low stress members, and lap welding will not be approved in any circumstances.

12.04.9 Fixing of reinforcement

Before fixing in the works bars shall be seen to be free from pitting, mud, oil, paint, loose rust or scale or other adherents harmful to the bond or strength of the reinforcement. Bars shall be fixed rigidly and accurately in position in accordance with the working drawings, unless otherwise approved by the Engg In-charge (Divisional Engr.). Reinforcement at all intersections shall be securely tied together with 1.5 mm soft annealed tying wire the ends of which shall be cut and bent inwards. Cover to the reinforcement shall be in accordance permissible standard and sufficient spacers and chairs of precast concrete of approved design shall be provided to maintain the specified cover and position. No insertion of bars in previously placed concrete shall be permitted. Projecting bars shall be adequately protected from displacement. The fixing of reinforcement in the works shall be approved by the Engg In-charge (Divisional Engr.) before concrete is placed. Measurement will be based on the calculated weights of steel actually used in tonnes corrected to second place of decimal.

Concrete cover to reinforcement

For durability the minimum concrete cover to any reinforcing bar shall be as follows:

Concrete above ground.

- Internal faces of slabs: 25 mm
- Internal faces of beams and walls: 30 mm
- Exposed faces of slabs, beams and walls: 50 mm
- All faces of columns: 50 mm

Concrete below ground (including piles).

- Faces in contact with soil including blinding concrete: 75 mm
- All other faces (i.e. internal faces of basement wall): 50 mm

Only concrete or steel spacers shall be used to achieve the required minimum thickness of concrete cover to reinforcement. Concrete spacers shall have non metallic ties. Timber blocks for wedging the steel off the formwork will not be allowed.
12.04.10 Formwork

Formwork shall be constructed from timber, metal, lined as necessary for special finishes and designed with the quality and strength required to ensure rigidity throughout placing, ramming, vibration and setting of the concrete, without detrimental effect.

Formwork shall be erected true to line, level and shapes required using a minimum of approved internal ties. Faces in contact with the concrete shall be true and free from defect, jointed to prevent loss of water or fines, in panels or units which permit easy handling. Ties or spaces remaining embedded shall have the minimum cover specified for reinforcement. Forms for exposed concrete beams, girder casings and columns shall provide for a twenty five millimetre chamfer on external corners.

Wedges and clamps shall be kept tight during vibration operations. Before commencement or resumption of concreting, the interior of forms shall be cleaned and free of sawdust, shavings, dust, mud or other debris and openings shall be formed to facilitate this cleaning and inspection. The inside of the forms shall be treated with a coating of an approved substance to prevent adhesion. Care shall be taken to prevent this substance being in contact with the reinforcement.

12.13 Grades of concrete

Concrete shall be either ordinary or controlled and in grades designated M10, M15, M20 and M25 as specified in IS: 456 (latest edition). In addition, nominal mixes of 1:3: 6 and 1: 4: 8 of nominal size 40 mm maximum, or as indicated on drawings, or any other mix without any strength requirements as per mix design shall be used where specified.

Ordinary concrete

Ordinary concrete shall be used for all plain cement concrete work and where shown on drawings or allowed by the Engg In-charge (Divisional Engr.). Ordinary concrete shall not require preparation of trial mixes.

In proportioning concrete, the minimum quantity of cement shall be as specified in of this clause and the amount to be used shall be determined by actual weight. The quantities of fine and coarse aggregate may be determined by volume, but preferably by weight.

The water cement ratio shall not be more than those specified in IS 456.

<table>
<thead>
<tr>
<th>Grade of Concrete</th>
<th>Minimum cement content per c.m. of finished concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 10</td>
<td>236 kg</td>
</tr>
<tr>
<td>M 15</td>
<td>310 kg</td>
</tr>
</tbody>
</table>
As a guide to perform the mix design properly, the relationship between water cement ratio, aggregate to cement ratio, workability and strength of concrete will be as per relevant IS.

The cement /total aggregate ratio is not to be increased beyond 1: 9.0 without specific permission of the Engg In-charge (Divisional Engr.). It should be noted that such high aggregate/cement ratios will be required for concretes of very low slump and high water cement ratios which may be required to be used in mass concrete work only.

The actual cement aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used, and from trial mixes.

**12.14 Strength requirements**

The mix proportions for all grades of concrete shall be designed to produce the grade of concrete having the required workability and a characteristic strength not less than the value given below:

<table>
<thead>
<tr>
<th>Grade Designation</th>
<th>Characteristic Compressive Strength at 28 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 10</td>
<td>10 N / sq. mm</td>
</tr>
<tr>
<td>M 15</td>
<td>15 N / sq. mm</td>
</tr>
<tr>
<td>M 20</td>
<td>20 N / sq. mm</td>
</tr>
</tbody>
</table>

The strength of concrete given above is the 28 days characteristic compressive strength of 15 cm cube.

The placing of concrete shall be a continuous operation with no interruption in excess of 30 minutes between the placing of continuous portions of concrete. When fresh concrete is required to be placed on previously placed and hardened concrete, special care should be taken to clean the surface of all foreign matter. For securing a good bond and water tight joint, the receiving surface should be made rough and a rich mortar placed on it unless it has been poured just before. The mortar layer should be about 15 mm thick with cement and sand proportion as that of the mix in use, and have the same water-cement ratio as the concrete to be placed.

After the concrete has been placed it shall be thoroughly compacted by approved mechanical vibration to a maximum subsidence without segregation and thoroughly worked around reinforcement or other embedded fixtures into the correct form and shape. Vibrators must be operated by experienced men and over vibration shall not be permitted. Care should be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or disturbed during
placing of concrete. No concrete shall be placed in open while it rains. If there is any sign of washing of cement and sand, the concrete shall be entirely removed immediately. Slabs, beams and similar structure shall be poured in one operation normally. In special circumstances with the approval of Engg In-charge (Divisional Engr.) these can be poured in horizontal layers not exceeding 50 cm. in depth. When poured in layers, it must be ensured that the under layer is not hardened. Bleeding of under layer if any shall be effectively removed.

12.15 Compaction of Concrete

Compaction is necessary for production of good concrete. After the concrete has been placed it shall be thoroughly compacted by approved mechanical vibrator to a maximum subsidence without segregation and thoroughly worked around reinforcement or other embedded fixtures into the correct form and shape. Vibrators must be operated by experienced men. Care should be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or disturbed during the vibration of the concrete. The Contractors shall provide standby vibrators. Vibration is commonly used method of compaction of concrete, the use of mechanical vibrators complying with IS 2505, IS 2506, IS 2514 and IS 4656 for compacting concrete is recommended.

For all practical purposes, the vibration can be considered to be sufficient when the air bubbles cease to appear and sufficient mortar appears to close the surface and facilitate easy finishing operations. The period of vibration required for a mix depends upon the workability of the mix.

12.16 Curing of Concrete

In order to achieve proper and complete strength of the concrete, the loss of water from evaporation should be prevented. Eighty to eighty five per cent of the strength is attained in the first 28 days and hence this 28-day strength is considered to be the criterion for the design and is called characteristic strength. The concrete after setting for 24 hours shall be cured by keeping the concrete wet continuously for a period of 10 days after laying.

The curing increases compressive strength, improves durability, impermeability and abrasion resistance. Failure to carry out satisfactory curing can lead to cracking in the concrete. This in turn can lead to salt attack of the reinforcement and consequential failure of the structure. If cracks occur in a structure which are severe enough to affect the structure, the Contractor shall cut out and replace the defective concrete at his own cost. The Contractor's attention is, therefore, drawn to this particular aspect of proper and adequate curing.

12.17 Removal of formwork

Formwork shall be kept in position fully supported, until the concrete has hardened and gained sufficient strength to carry itself and any loads likely to be imposed upon it. Stripping must be effected in such a manner and at such a time that no shock or other injury is caused to the concrete.
The responsibility for safe removal rests with the Contractor but the Engg In-charge (Divisional Engr.) may delay the time of striking if he deems it necessary.

Minimum periods, in the absence of agreement to the contrary, between completion of concreting and removal of forms are given below but due regard must be paid to the method of curing and prevailing conditions during this period.

Removal of forms are to be done as under

i) Sides of foundations, columns, beams and wall 2days

ii) Under side of slabs up to 4.5 m span 7days

iii) Under side of slabs above to 4.5 m span

and underside of beams and arches up to 6m span 14days

iv) Under side of beams and arches above 6m and up to 9m span 21days

12.18 WATER SUPPLY

The Contractor shall be overall responsible for supply of water within switchyard / control room for fire fighting, drinking purposes and other miscellaneous purposes. Water shall be made available at a single point by the Employer. The scope is also inclusive of supply and erection of all over head tanks, pipes, fittings etc. required for the water supply to be taken from the terminal point to the respective required areas. A scheme shall be prepared by the contractor indicating the layout and details of water supply which shall subject to the approval of the Engg In-charge (Divisional Engr.) before actual start of work. Any extra bore holes required shall be within the scope of the contractor.

There shall be pump houses for the bore wells and approach road to the pump houses shall be provided.

The Contractor shall have overall responsibility to provide a suitable arrangement for permanent supply for and retention of water within switchyard building and to the yard for watering to the earth pits, drinking purposes. The submersible pump shall be 1.5HP and all control as per standard has to be provided.

12.19 EARTHING :

Earth Grid should not be more than TWO meters square. This should be done by using 75x10 mm GI flats. Earth risers should be 50x6 mm GI flats. All equipments & metal parts of the Sub-Station should be connected with main earth grid by using 50x6 GI flats at two different places. The main earth grid should be laid not less than 600 mm below the finished ground level. The lap
welding should not less than 100 mm. The welding of joints should be done after removal of Zinc by using Blow lamps. Welding should be done in all four sides and should be double layer continuous. Before taking up the second layer welding the deposited flux should be removed. During welding the two flats should be tightened properly by using _C_ clamps. Immediately after welding two layers of anti-corrosive paints should be painted over the welded portion along with two coats of Black bituminous paints. Before back filling of earth trenches the welded portion should be covered by wrapping with bituminous tape properly and also jointing portion should be covered with PCC (1:2:4) mix. The backfilling of earth pits and trenches should be done with powered loam soil mixed with Bentonate powder (10:1) mix.

All equipments, steel structures etc should be connected with Main earth mat at two rows separately. All LAs, PTs, Columns having spikes should individually connected with individual Pipe electrodes and again should be connected with main earth grid at two separate places. The Neutral of Power Transformer should be connected with two separate pipe electrodes and again connected with main earth electrodes at two separate places. The separation distance between each pipe electrodes should not be less than 2 mts. The back filling of pipe electrodes should be done in layer of Charcoal, Salt & loam soil mixed with Bentonate power.

There should be a closely spaced earth grid (1.5 mts square having .5 mts spacing) below the mechanism boxes of each Isolators & AB switches. In Sub-station the diameter of pipe electrode should not be less than 50 mm. The Flange(50x6) mm GI flat should be welded in all sides with Pipe electrode. In each face of Flange there should be two nos 17.5 mm hole to accommodate 16 mm GI Bolt nut with 1 no spring washer.

Each handles of Isolators/AB switches etc should be connected with earth grid by using flexible Tinned Copper earth bonds. In each earth switches TWO nos flexible earth bonds should be provided. Each earth pits having pipe electrodes should be provided 250 mm Brick wall chambers with RCC cover Slab.
12.20 Laying and installing of cables

12.20.1 General

For cable laying the following shall apply:

a) Switchyard area In concrete cable troughs (cable trench having cable racks with cable trays)
b) Control Room On cable racks consisting of slotted type and ladder type cable trays
c) Buildings Conduits

Directly buried cables shall be used wherever necessary with the approval of Engg. Incharge (Divisional Engr.).

12.20.2 Laying of cable

Cables shall be laid in concrete troughs provided under this contract or drawn into pipes or ducts or on cable racks or directly buried as may be required by the Engg. Incharge (Divisional Engr.). Concrete troughs shall be designed so that the cables are supported on cable support systems and the supports shall be arranged so as to allow the segregation of power, control (including CT and VT circuits) and communications cables onto different layers of cable supports. All cable supports shall be earthed in accordance with IS 3043. The minimum vertical separation between layers of cable tray shall be not less than 300 mm.
The cable support system shall be designed and constructed to carry the required cables without undue crowding of the supports and without overloading the supports. The maximum number of layers of cable that shall be permitted on a single cable support shall be three. The width of the cable supports shall be selected to ensure that the supports are not crowded, the cable supports are not overloaded and that sufficient space is provided in the cable trough to allow for personnel access during and after cable installation. The width of cable supports should not exceed 750 mm.

Cables shall be laid direct in the ground only at the discretion of the Engg. Incharge (Divisional Engr.). All cables laid direct in the ground outside buildings shall be laid in a trench and protected by reinforced concrete slabs or cable tiles.

For auxiliary cables the top of the slab or tile shall be at a depth not less than 300 mm below the surface of the ground and there shall be a layer of fine well packed riddled earth 75 mm thick in between the cable and the bottom of the trench and between the top of the cable and the underside of the slab.

The Contractor shall be responsible for the proper laying of all cables in the ground. Where cables in the same trench are laid over each other, they shall be separated by not less than 75 mm of riddled earth. The riddled earth used for this purpose shall have been passed through a screen having a 12 mm square mesh.

Where cables pass under roadways they shall be laid in pipes at a depth not less than 800 mm below the surface.

The Contractor shall be responsible for the excavation of trenches which shall include all pumping and baling required and the provision of all necessary labour, plant, tools, water, additional soil, fuel or motor power for such purposes.

Cables in trenches will be inspected by the Engg. Incharge (Divisional Engr.) before the trenches are backfilled.

The running of communications and power cables along the same route shall be avoided as far as possible. Where this is not possible they shall be segregated, the one group from the other. Power and communication cables shall be laid in separate tiers. For other than directly buried cables the order of laying of various cables shall be as follows:

a) Power cables on top tiers.

b) Control/ instrumentation and other service cables in bottom tiers.

12.20.3 Cable tags and markers
Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

The tag shall be of aluminum with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS 280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

Location of cables laid directly in the ground shall be clearly indicated with cable marker made of galvanised iron plate.

Location of buried cable joints shall be indicated with a cable marker having an additional inscription "Cable joint".

Cable markers shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings.

Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct, conduit entry and at every twenty meters (20 m) in cable tray/trench runs. Cable tags shall be provided inside switchgear, motor control centres, control and relay panels etc. and wherever required for cable identification when a number of cables enter together through a gland plate.

The price of cable tags and markers shall be included in the installation rates for cables/conduits quoted by the Bidder.

12.20.4 Cable supports and cable tray mounting arrangements in control room

The control room will normally be provided with embedded steel inserts on concrete floors/walls for the purpose of cabling in the control room. The supports shall be secured by welding to these inserts or available building steel structures. However, in cases where no such embedded steel inserts are available, the same shall have to secure to the supports on walls or floors by suitable anchoring.

12.20.5 Cable support structure in switchyard cable trenches

The contractor shall fabricate and install cable support structures in cable trenches. These supports shall be provided at 750 mm spacing along the run of cable trenches.

Cable supports and cable racks shall be fabricated from standard structural steel members, channels, angles and flats of required size. The fabrication, welding and erection of these structures shall conform to the relevant clauses of this Specification, in addition to the specification given herein.
12.20.6 Termination of cables and wires

Where cables leave the apparatus in an upward direction the cable boxes shall be provided with a barrier joint to prevent leakage of cable oil or compound into the apparatus. Where cable cores are liable to contact with oil or oil vapour the insulation shall be unaffected by oil.

PVC sheathed cables shall be terminated by compression glands complying with BS 6121 (or equivalent).

Auxiliary PVC insulated cables shall be terminated with compression type glands, clamps or armour clamps complete with all the necessary fittings.

Colours shall be marked on the cable box, cable tail ends and single core cables at all connecting points and/or any positions the Engg. Incharge (Divisional Engr.) may determine. Cable boxes shall be provided with suitable labels indicating the purpose of the supply where such supply is not obvious or where the Engg. Incharge (Divisional Engr.) may determine.

All cables shall be identified and shall have phase colours marked at their termination.

All incoming and outgoing connections shall be terminated at a terminal block. Direct termination into auxiliary switches will not be accepted.

**BREAKER FOUNDATION DESIGN**
**BREAKER ROD DETAILS**

**ROD BINDING SCHEDULE**

**REQUIREMENT OF RODS**

<table>
<thead>
<tr>
<th>SIZE</th>
<th>VCB</th>
<th>Total Mtr</th>
<th>Kg./Mtr</th>
<th>TOTAL in Kg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. 10 tor</td>
<td>2<em>8</em>1.8</td>
<td>28.8</td>
<td>0.630</td>
<td>18.144</td>
</tr>
<tr>
<td>B. 10 tor</td>
<td>2<em>13</em>1.1</td>
<td>28.6</td>
<td>0.630</td>
<td>18.018</td>
</tr>
<tr>
<td>C. 12 tor</td>
<td>2<em>10</em>1.8</td>
<td>36</td>
<td>0.888</td>
<td>31.968</td>
</tr>
<tr>
<td>D. 6 tor</td>
<td>2<em>7</em>1.38</td>
<td>19.32</td>
<td>0.222</td>
<td>4.289</td>
</tr>
</tbody>
</table>

**EXCAVATION:**

- 2.15*1.4*1.2 = 3.612 Cum. 12.481
- PCC:1:4:8 2.15*1.4*0.075 = 0.226 Cum. 0.462
- RCC:1:2:4 1.2*1.915*0.2 = 0.4596 Cum.
- 2*(1.0*0.5*1.4) = 1.4 Cum. 1.8596 Cum. 2.421
Foundation for 11 KV KIOSK

EXCAVATION:  

\[ 2.5 \times 1.2 \times 1.0 = 3 \text{ cum.} \]

PCC: 1:4:8  

\[ 2.5 \times 1.2 \times 0.075 = 0.225 \text{ cum.} \]
\[ (5.0 + 1.5) \times 1.3 \times \]

Brick  

0.25  

= 2.11 \text{ cum.}

Sand  

2 \times 0.7 \times 1.3  

= 1.82 \text{ cum.}

RCC  

i)  

2.5 \times 1.2 \times 0.15  

= 0.45 \text{ cum.}

ii)  

(0.2 \times 0.2 \times 1.3) \times 4  

= 0.21 \text{ cum.}

Rod  

10 tor  

= 60 \text{ Kg.}
**Single Isolator Foundation Design**

![Diagram of a single isolator foundation design with dimensions and calculations]

**CIVIL WORKS**

Ex.-2.1 x 0.9 x 1.250 x 2 = 4.725

**LIST OF FOUNDATION BOLTS**

- 2.5 mm x 700 mm foundation bolts-8 Nos.
- PCC (1 : 4 : 8)-2.1 x 0.9 x 0.075 x 2 = 0.283
  - 2.730 Kg x 8 =21.840 Kg
- RCC- (a) 1.9 x 0.7 x 0.250 x 2 = 0.665
  - Plate 75 x 12….8 Nos. = 4.240 Kg.
- (b) 1.25 x 0.7 x 1.25 x 2 =2.188
  - Nut Bolt washers 26.080 Kg.
  - Total =2.853 Total Wt. of members 268.813 Kg
  - Total =308.525 Kg.
CONTROL CABLE TRENCH

8 tor 150 mm C / C

2250 mm

250 mm

G.I. Flat

50 mm RCC1 2 4

RCC(1:2:4) 75 mm

PCC(1:4:8) 75 mm

150 mm C / C
11 Kv Cable Trench

Abstract for Cable Trench

For 10 Mtrs.

<table>
<thead>
<tr>
<th></th>
<th>For 10 mtr</th>
<th>For 1 Mtr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Excavation</td>
<td>0.870<em>2.0</em>10</td>
</tr>
<tr>
<td>2</td>
<td>PCC</td>
<td>0.075<em>2.0</em>10</td>
</tr>
<tr>
<td>3</td>
<td>RCC (1:2:4)</td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Base</td>
<td>1.8<em>0.1</em>10</td>
</tr>
<tr>
<td>b</td>
<td>Pillar</td>
<td>4*(0.25<em>1.02</em>0.25)</td>
</tr>
<tr>
<td>c</td>
<td>Over Brick work (top)</td>
<td>0.25<em>0.075</em>10</td>
</tr>
<tr>
<td>d</td>
<td>Over Brick work (top) on Pillar side</td>
<td>0.25<em>0.075</em>9</td>
</tr>
<tr>
<td>4</td>
<td>Brick Masonary (1:5)</td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>No pillar side</td>
<td>0.25<em>0.94</em>10</td>
</tr>
<tr>
<td>b</td>
<td>Pillar side</td>
<td>0.25<em>0.94</em>9</td>
</tr>
<tr>
<td>5</td>
<td>Plastering (1:6)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inside</td>
<td>2<em>10</em>1.02</td>
</tr>
<tr>
<td></td>
<td>Outside</td>
<td>2<em>10</em>0.5</td>
</tr>
<tr>
<td>6</td>
<td>G.I. Flat 50 x 6</td>
<td>0.2<em>2</em>4</td>
</tr>
</tbody>
</table>

Abstract of ROD

Wt. 10% Extra
ROAD INSIDE SUB STATION

12 ton 19.68 mtr 17.57 kg 19 Kg.
8 ton 245 mtr 95.55 kg. 105 Kg.
6 ton 29.2 mtr 6.424 kg. 7 Kg.

131 Kg. 13.1 Kg.

Per Mtr

1 Excavation : 0.550mx1.0mx3.5m = 1.925 cum
2 Boulder Packing : 0.5mx 1.0mx3.5m = 1.750 cum
3 W.Base course : i) 0.075 m x 1.0m x 3.5m = 0.2625
                 : ii) 0.075 m x 1.0m x 3.5m = 0.2625 0.525 cum
4 PCC(1:2:4) : 0.1m x 1.0m x 3.5m = 0.35 cum
5 Brick work : i) 0.25 m x 0.25m x 1.0m = 0.0625
               ii) 0.30 m x 0.25/2 m x 1.0m = 0.0375 0.1 cum
FOUNDATION DETAIL FOR POWER TRANSFORMER

1. EXCAVATION: 3m x 3 x 1.1 m = 9.9 Cum.
   in Hard Soil

2. Stone Grating by using RRHG Boulder of 250 mm size maximum
   3m x 3 m x 0.5m = 4.5 Cum.

3. PCC: 1:4:8
   3m x 3 m x 0.075m = 0.675 Cum. (Above RRGH)

4. RCC: 1:2:4
   i) 3m x 3 m x 0.2m = 1.8 Cum.
ii) \[ 2 \times (2.7 \times 0.6 \times 0.925 \text{ m}) = 2.997 \text{ Cum.} \]

Length x width x height

iii) Wall \[ 0.075 \times [(2.8 + 2.8 + 2.8) + (3 \times (0.1 + 0.1 + 0.6)) \times 0.625] \text{ m} \times 0.625 \text{ m} = 0.4688 \text{ Cum.} \]

Thickness side1 x side2 x side3

Total RCC (i + ii + iii) \[ 5.26 \text{ Cum.} \]

ROD

a) 12 tor \[ 2.9 \times 20 \times 4 \times 2 = 232 \times 0.888 = 206.016 \text{ Kg.} \]

b) 10 tor \[ 0.9 \times 70 \times 2 = 63 \times 0.617 = 38.871 \text{ Kg.} \]

c) 10 tor \[ 1.28 \times 5 \times 2 = 6.4 \times 0.617 = 3.9488 \text{ Kg.} \]

d) 8 tor \[ 10 \times 6 \times 2 = 60 \times 0.395 = 23.7 \text{ Kg.} \]

Beam

a) 16 tor \[ 2 \times (26 \times 2 + 10) \times 1.775 = 220.1 \times 1.58 = 347.758 \text{ Kg.} \]

b) 8 tor \[ 2 \times (8 \times 6.4) \times 2 = 102.4 \times 0.395 = 40.448 \text{ Kg.} \]

STEEL:

500 x 500 x 10 mm G.I. Base Plate- 6 No.

65 x 65 x 6 mm MS Angle - 2 No. x 2.7 m = 5.4 mtr.

70 lb Rail Pole- 2 No. x 2.7 = 5.4 mtr.
Foundations for T1........... T5 Columns

1. Excavation: 2.15m x 2.15 m x 1.825 m = 8.436 cum
2. PCC (1:4:8): 2.15m x 2.15 m x 0.075 m = 0.3467 cum
3. RCC (1:2:4): (2 m x 2 m x 0.25 m) + (0.8 m x 0.8 m x 2.15 m) = 2.376 cum
4. Base Plate: 620 x 620 12 mm GI- 36 Kg. welded to column.
5. Foundation Bolts- GI: 32 mm x 1400 mm = 8.834 kg
6. ROD 12 Tor: 2.4 m x 12 No. = 28.8 m x 0.888 kg. = 25.57 Kg. 91.76
   12 Tor: 2.0 m x 44 No. = 88 m x 0.63 = 55.44 Kg. 90 kg.
   2.42 m x 20 no. = 48.4m x 0.222 kg. = 10.74 Kg.