

TECHNICAL SPECIFICATION
FOR
CIVIL WORKS

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Volume – I Technical Specification for Civil Work

1.0 GENERAL REQUIREMENT

- 1.1. This chapter includes the technical requirements for Establishment of **66/11 KV GIS Substation at Nawada, New Delhi** including associated design and preparation of all civil & structural drawings and execution of all associated civil works. This chapter deals mainly with technical specifications for the design, supervision and construction of complete civil works including structural and finishing works.
- 1.2. The specifications are intended for general description of work, quality and workmanship. The specifications are not however exhaustive to cover minute details and the work shall be executed according to relevant latest Indian Standards/IRC specifications/CPWD specifications. In the absence of the above, the work shall be executed according to the best prevailing practices in the trade, recommendations of relevant American or British Standards or to the instructions of Engineer. The IS standards/IRC specifications/CPWD specifications to be followed are mentioned in the technical specifications attached hereto. They shall be latest edition/version of the same issued 15 days prior to the date of opening of this tender. The Contractor is expected to get himself clarified on any doubts about the specifications etc. before bidding and the discussions recorded in writing with the Owner in respect of interpretation of any portion of this document.
- 1.3. The work shall be carried out according to the design / drawings to be developed by the Contractor and approved by the Owner based on Tender Drawings supplied to the Contractor by the Owner. For all buildings, structures, foundations etc. necessary layout and details shall be developed by the Contractor keeping in view the functional requirement of the Sub-Station facilities and providing enough space and access for operation, use and maintenance based on the input provided by the Owner. Certain minimum requirements are indicated in this specification for guidance purposes only. However, the Contractor shall quote according to the complete requirements.
- 1.4. The Contractor shall take all necessary precautions to protect all the existing equipments, structures, facilities & buildings etc. from damage. In case any damage occurs due to the activities of the Contractor on account of negligence, ignorance, accidental or any other reason whatsoever, the damage shall be made good by the Contractor at his own cost to the satisfaction of the Engineer. The Contractor shall also take all necessary safety measures, at his own cost, to avoid any harm / injury to his workers and staff from the equipment & facilities of the power station.
- 1.5. During the progress of work, the Engineer will exercise supervision of the work to ensure that the technical provisions of the contract are being followed and the work is being executed accurately and properly. However, such supervision shall in no way relieve the Contractor of the responsibility for executing the work in accordance with the specifications.
- 1.6. Before submitting the bid, the Contractor shall inspect and examine the site and its surroundings and shall satisfy himself as to the nature of the ground and subsoil, the availability of materials necessary for completion of the work, means of access to site and in general shall himself obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect his offer. No extra claim consequent on any misunderstanding or otherwise shall be allowed.
- 1.7. During execution, if any additional requirement arises for successful commissioning of grid ,then same shall be in scope of vendor by considering all safety and quality standards in all aspects

2.0 GEOTECHNICAL INVESTIGATION

The Owner will carry out Geo Technical Investigation and Topographical Survey for the entire Sub-Station plot including switchyard. The copy of the report will be given as an input to bidder for Civil

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Design & estimation work. In case of any further detailed study is required, same shall be in scope of bidder.

3.0 SITE PREPARATION

3.1. Scope

3.1.1. This clause covers the design and execution of the work for site preparation, such as clearing of the site, the supply and compaction of fill material, excavation and compaction of backfill for foundation, road construction, drainage, trenches and final topping by stone (broken hard stone). This work shall also include disposal of any non-essential/excess soil or malba.

3.2. General

3.2.1. The layout and levels of all structures, etc shall be made by the Contractor at his own cost from the general grids of the plot and benchmarks finalized / approved by the Owner. (The required filling up to formation level shall be in the scope of Vendor). The Contractor shall give all help in instruments, materials and personnel to the Owner for checking the detailed layout and shall be solely responsible for the correctness of the layout and levels.

3.2.2. The Contractor shall have to make good to all the damages to the boundary wall and gates during work execution.

3.2.3. Contractor shall develop a building layout and other layouts so that the trees inside the plot shall be avoided from cutting. In extreme conditions, if the tree cutting is unavoidable, necessary liaison for permission shall be on part of Contractor from respective Govt. Agency. Requisite formalities shall be carried out by Owner. Fee shall be borne by the Owner. Compensatory plantation shall be done (if required) by vendor; BRPL shall provide space for the same.

3.2.4. The Contractor shall develop the site area to meet the requirements of the intended purpose. The site preparation shall conform to the requirements of relevant sections of this specification or as per stipulations of standard specifications.

3.2.5. If fill material is required, the fill material shall be suitable for the above requirement. The fill shall be such a material and the site so designed as to prevent the erosion by wind and water of material from its final compacted position or the in-situ position of undisturbed soil.

3.2.6. Material unsuitable for filling works shall be removed and replaced by suitable fill material and to be approved by the Owner.

3.2.7. Backfill material around foundations or other works shall be suitable for the purpose for which it is used and shall be compacted to the density described under Compaction. Excavated material not suitable or not required for backfill shall be disposed off by the contractor in areas as directed by Owner upto a maximum lead of 5 km. Backfill material if found having mix of earth and fly ash should not be used for top 30 cm of formation level and should be supplemented with earth at the cost of contractor. The old / existing foundations if not required shall be dismantled by the contractor.

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3.3. Excavation and Backfill

- 3.3.1. Excavation and backfill for foundations shall be in accordance with the relevant code.
- 3.3.2. Whenever water level is met during the excavation, it shall be dewatered and water level shall be maintained below the bottom of the excavation level during excavation, concreting and backfilling. Nothing extra shall be payable by the owner on this account.
- 3.3.3. When embankments are to be constructed on slopes of 15% or greater, benches or steps with horizontal and vertical faces shall be cut in the original slope prior to placement of embankment material. Vertical face shall measure not more than 1 m in height.
- 3.3.4. Embankments adjacent to abutments, culverts, retaining walls and similar structures shall be constructed by compacting of the material in successive uniform horizontal layers not exceeding 15 cm in thickness (of loose material before compaction). Each layer shall be compacted as required by means of mechanical tampers approved by the Owner. Rocks larger than 10cm in any direction shall not be placed in embankment adjacent to structures.
- 3.3.5. Earth embankments of roadways and site areas adjacent to buildings shall be placed in successive uniform horizontal layers not exceeding 20 cm in thickness in loose stage measurement and compacted to the full width specified. The upper surface of the embankment shall be shaped so as to provide complete drainage of surface water at all times.

3.4. Compaction

- 3.4.1. The density to which fill materials shall be compacted shall be as per, relevant IS and as per direction of Owner. All compacted sand filling shall be confined as far as possible. Backfilled earth shall be compacted to minimum 95% of the Standard Proctor's density at OMC. The sub grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor's density at OMC. Cohesion less material sub grade shall be compacted to 70% relative density (minimum).
- 3.4.2. At all times unfinished construction shall have adequate drainage. Upon completion of the roads surface course, adjacent shoulders shall be given a final shaping, true alignment and grade.
- 3.4.3. Each layer of earth embankment when compacted shall be as close to optimum moisture content as practicable. Embankment material which does not contain sufficient moisture to obtain proper compaction shall be wetted. If the material contains any excess moisture, then it shall be allowed to dry before rolling. The rolling shall begin at the edges overlapping half the width of the roller each time and progress to the center of the road or towards the building as applicable. Rolling will also be required on rock fills. No compaction shall be carried out in rainy weather.

3.5. Requirement for fill material under foundation

- 3.5.1. The thickness of fill material under the foundations shall be such that the maximum pressure
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from the footing, transferred through the fill material and distributed onto the original undisturbed soil will not exceed the allowable soil bearing pressure of the original undisturbed soil. For expansive soils the fill materials and other protections etc. to be used under the foundation has to be approved by the Owner.

4.0 CODES AND STANDARDS

All standards, specifications, acts and code of practice shall be followed. In case of conflict between this specification and those (IS standard/ IRC specification/CPWD Specification, etc.) referred to herein, the former shall prevail.

5.0 SUBMISSIONS

The following documents shall be submitted by the Contractor for approval of the BRPL prior to commencement of fabrication and erection / construction.

This list is not exhaustive but indicative only. Final list of drawings shall be prepared by successful bidder during detailed engineering. Bidder shall submit the qualification details of his licensed Architect & structural engineer (Approved by any Govt organization for detailed engineering/Structural design/approved by Institution of Engineers (India)).

- i. Design calculation, general arrangement drawings, foundation drawing & detailed erection / construction drawings including R/F drawings for Sub-Station Control Room Building.
- ii. Foundation design and drawing of Cable Pot Head.
- iii. Foundation design & drawing of all equipment foundations.
- iv. Structural steel fabrication drawings for Cable Pot & equipment support structure.
- v. Site preparation, filling up to formation level, removal of trees, if any and site cleanliness
- vi. Foundation design & drawing of Power Transformer
- vii. Design & drawing of transformer grating, firewall & burnt oil tank
- viii. Foundation design & drawing for lighting pole.
- ix. Foundation design & drawing of Capacitor bank (roof/yard as decided during engineering), Auxiliary Transformer and design of fencing for both.
- x. Complete fencing along with gate for the Sub-Station yard
- xi. Details of Indoor and Outdoor Cable Trenches with cable tray supports and trench covers
- xii. Design & drawing of Rainwater Harvesting System, sewerage system including septic tank, water supply arrangement, landscaping, etc.
- xiii. Design & drawing of roads and complete drainage system (with final connection to Rain Water Harvesting recharge pit) within Sub-Station including crossings.
- xiv. Design & drawing Security room.
- xv. Design & drawing NIFPS system & underground water tank.

6.0 SUB-STATION CONTROL ROOM BUILDINGS GENERAL REQUIREMENTS

6.1. General

- 6.1.1. The scope includes the design, engineering and construction including anti-termite treatment, plinth protection, DPC of buildings including sanitary, water supply, electrification, fire fighting system, etc. The building shall be of RCC framed structure of minimum concrete grade M25. The Sub-Station Building shall include rooms as specified below:
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- S. No. Facility
- I. Control and 11KV Room
 - II. Switchgear Room/ GIS Room
 - III. Cellar
 - IV. Battery Room/ Charger Room, Maintenance room and office rooms
 - V. Pantry
 - VI. Toilet (Male & Female separately)
 - VII. Staircase (for approach till topmost roof slab) including separate staircase for Fire-escape.
 - VIII. Steel staircase with all safety features for approach till mummy slab
- 6.1.2. Minimum floor area requirements have been given in tender drawings, which may be increased at the time of detailed engineering to suit project requirements.
- 6.1.3. An open space of 1200 mm minimum shall be provided on the periphery of the rows of panel and equipment generally in order to allow easy operator movement and access as well as maintenance.
- 6.1.4. The building shall be aesthetically designed keeping in view the surrounding landscape; proper architecture shall be used to design the exterior look and finish. The architectural drawing shall be submitted for Owner's approval.
- 6.1.5. Future extension of one floor shall be considered at the time of design. Any other possibility of annex building shall be taken care of while finalizing the layout of the control room building.
- 6.1.6. Control Room cum Administrative building shall be constructed as per the approved drawings by Owner. CPWD specification shall be followed in all the building works. The clear height of building shall be minimum 4.50 m (from Finish floor level to bottom of roof beam of First floor & Second Floor). The height of GIS hall shall be as per requirement of GIS equipment & EOT.
- 6.1.7. Cable cellar shall be provided in the building. The clear height of cable caller shall be minimum 3.00 m (from floor level to bottom of roof beam of Ground floor).
- 6.1.8. Plinth level of sub-station building shall be 750mm above the existing slab/ road.
- 6.1.9. The structure will be RCC Framed above ground & with RCC Retaining wall and Framed structure below the proposed road level/Existing Nallah Road level in the complete plot area including roof slab of desired loading Minimum 60 Ton capacity .This floor is also act as celler floor in substation area .Provision of drainage and sump pit from cellar slab bottom raft to be provided. Construction of Approach Roads, drainage and both side Ramps as per approved drawing including development of Balance area beside Approach roads in total Grid Boundary towards Nallah side shall be provided.
- 6.1.10. The Contractor shall have to provide adequate sump pumps Automatic not less than 03 nos. to evacuate the water to the water harvesting pit with stand by arrangement.
- 6.1.11. The Contractor shall have to provide arrangement of proper ventilation in the sub-station building.
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- 6.1.12. Providing & fixing rebar of required length and dia with HILTI RE500 chemical suitable epoxy resin where ever required in RCC members i/c power drilling, cleaning of holes then rebars should be inserted in holes that should be filled with epoxy to ensure the bond as per manufacturer recommendations complete as per site requirement and direction of engineer - in - charge.
- 6.1.13. Use Rebar Coupler of Dextra make for lapping of reinforcements.
- 6.1.14. The Contractor shall have to take special care related to water proofing/ seepage matters and make good to all the damages to the structure during work execution.

6.2. Design

- a) The Building shall be designed on Green Building Concept duly certified by (IGBC Green Service Building rating certification/Svagriha Certification). The design of control room building shall be such decided that's minimum one floor can be added in future.

Following parameters shall be followed: -

- To the requirements of the National Building Code of India and the standards quoted therein. The contractor shall also arrange approval of building from any local authorities such as MCD or fire officer if required so. The official fees shall be born by BRPL.
 - For the specified climatic & loading conditions.
 - The building shall have framed super structure.
 - To adequately suit the requirements of the equipment and apparatus contained in the buildings and in all respects to be compatible with the intended use and occupancy.
 - With a functional and economical space arrangement.
 - To be aesthetically pleasing. Different structures shall show a uniformity and consistency in architectural design.
 - To allow for easy access to equipment and maintenance of the equipment.
 - With wherever required, fire retarding materials for walls, ceilings and doors which would prevent supporting or spreading of fire.
 - With materials preventing dust accumulation.
- b) Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns.
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- c) Individual members of the buildings frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion etc.
- d) Permissible stresses for different load combinations shall be taken as per relevant IS Codes.
- e) The building lighting shall be designed in accordance with the requirements of relevant section.
- f) The building auxiliary services like exhaust and ventilation systems, fire protection and detection systems and all other miscellaneous services shall be designed in accordance with the requirements specified in relevant section or elsewhere in the Specification for the project.
- g) Two nos. of emergency exits shall be provided in the building.

6.3. Design Loads

Building structures shall be designed for the most critical combinations of dead loads, super- imposed loads, equipment loads, crane load, wind loads, seismic loads, and temperature loads Dead loads shall include the weight of structures complete with finishes, fixtures and partitions and should be taken as per IS:875. Super-imposed loads in different areas shall include live loads, minor equipment loads, cable trays, small pipe racks & hangers and erection, operation and maintenance loads. Equipment loads shall constitute, if applicable, all load of equipments to be supported on the building frame The wind loads shall be computed as per IS 875, Seismic Coefficient method shall be used for the seismic analysis as per IS 1893 with importance factor 1.5.

For crane loads an impact factor of 25% and lateral crane surge of 10% (of lifted weight + trolley weight) shall be considered in the analysis of frame according to provisions of IS : 875 (latest revision). The longitudinal crane surge shall be 5% of the static wheel load. For temperature loading, the total temperature variation shall be considered as 2/3 of the average maximum annual variation in temperature. The average maximum annual variation in temperature for the purpose shall be taken as the difference between the mean of the daily minimum temperature during the coldest month of the year and mean of daily maximum temperature during the hottest month of the year. The structure shall be designed to withstand stresses due to 50% of the total temperature variation. Wind and Seismic forces shall not be considered to act simultaneously.

Floors/slabs shall be designed to carry loads imposed by equipment. Floors shall be designed for live loads as per relevant IS codes. Cable and piping loads shall also be considered additionally for floors where these loads are expected.

In addition, beams shall be designed for any incidental point loads to be applied at any point along the beams, the floor loads shall be subject to Owner’s approval.

For consideration of loads on structures IS: 875, the following minimum superimposed live loads shall however be considered for the design.

RCC-Floor	5 KN/M2	for offices,
GIS & all Equipments Room Floor	15 KN/M2 (min)	actual requirements if higher than 15KN/M2 based on equipment weight and

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Layout plan

Stairs
& balconies 5 KN/M2

Chequered plate floor 4 KN/M2

Any additional load coming in the structure shall be calculated as per IS: 875.

6.4. Submission

The following information shall be submitted for review and approval to the Owner:

- a) Design criteria shall comprise the codes and standards used. Applicable climatic data including wind loads, earthquake factors, maximum and minimum temperatures applicable to the building locations, assumptions of dead and live loads, including equipment loads, impact factors, safety factors and other relevant information.
- b) Structural design calculations and drawing (including construction/fabrication) for all reinforced concrete and structural steel structures.
- c) Fully, dimensioned concept plan including floor plans, cross sections, longitudinal sections, elevations and perspective view of each building. These drawings shall be drawn at a scale not smaller than 1 : 50 and shall identify the major building components.
- d) Fully dimensioned drawings showing details and sections drawn to scales of sufficient size to clearly show sizes and configuration of the building components and the relationship between them.
- e) Product information of building components and materials, including walls partitions flooring ceiling, roofing, door and windows and building finishes.
- f) A detailed schedule of building finishes including color schemes.
- g) A door & window schedule showing door types and locations, door lock sets and latch sets and other door hardware.
- h) Copy of all tests/ studies/ investigation carried out by bidder as per scope.

Approval of the above information shall be obtained before ordering materials or starting fabrication or construction as applicable.

6.5. Flooring

Flooring in various rooms of control room building shall be as per detailed schedules given in Table –
1. Pantry countertop shall be of granite stone of required specification as per direction of Engineer-In-Charge.

2. Providing and fixing Raised Access Flooring .The Access raised floor shall be heavy grade UNIFLOOR FS800H with point load of 3.6KN/over 25mm sq.and UDL of 15 KN /M2 panels manufactured from steel with lightweight cementitious core in the size 600x600x35mm.The bottom of
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the panel shall be embossed in hemispherical shape to give strength and flexural rigidity on the exposed surface for lifetime protection and shall be zinc whisker free. The panel has to be placed on the pedestal base plate 100x100x8mm x 25mm solid road 450mm/600MM height 75x75x4mm mm top plate made from all steel zinc plated construction. Pedestal assembly shall provide for easy adjustment of leveling and accurately align panels to ensure lateral restraint. Pedestal head shall be designed to avoid rattle or squeaks. The steel base plate of the pedestal shall be fixed on to the sub-floor with epoxy pedestal adhesive and /or mechanical fixing. An all-steel rectangular stringer system having pre punched holes at both ends to ensure correct alignment with pedestal heads be applied for maximum stability. The panel shall be finished with high abrasion anti-static HPL in size 600x600x0.9mm with beading on all sides to provide protection of edges as per Drawings and as per Manufacturers recommendations. Providing Heavy Duty Double Suction Panel Lifter is included in item. Grommets for Easy Cable Access shall be provided as per design wherever required.
600 mm Finished Floor Height (FFH)

6.6. Walls

Control room building shall be of framed superstructure. All walls shall be non-load bearing walls. Minimum thickness of walls shall be 340mm upto DPC level in cement mortar 1:4 (1 Cement: 4 Coarse sand) and 230mm above DPC level in cement mortar 1: 4 (1 Cement: 4 coarse sand). Parapet walls shall be 230 mm thick and 1100mm high from top of roof treatment.

6.7. Plastering

All internal and external walls shall have minimum 12mm/ 15mm thick 1:4 (1 Cement: 4 coarse Sand) cement sand plaster. The ceiling shall have 6mm thick 1:3 cement sand plaster.

6.8. Finishing

All external surfaces (S/stn building, boundary wall and other structures) shall have Texture finish of Make UTTPPL (Ultratech Texture Paints Pvt. LTD) as per below detail:

- Building area: GRANITE ATELOI SA – 36-50% LIGHT
- Beam/ column: GRANITE ATELIO SA - PINK

6.9. False Ceiling

Providing and fixing false ceiling at all height including providing and fixing of frame work made of special sections, power pressed from M.S. sheets and galvanized with zinc coating of 120 gms/sqm (both side inclusive) as per IS : 277 and consisting of angle cleats of size 50mm length x 50 mm wide x 3.0 mm thick with flanges of at 1200 mm centre to centre, one flange fixed to the steel truss members and other flange of cleat fixed to the angle hangers of 50x50x3 mm of required length with nuts & bolts of required size and other end of angle hanger fixed with intermediate G.I. channels 45x15x0.9 mm running at the spacing of 1200 mm centre to centre, to which the ceiling section 0.5 mm thick bottom wedge of 80 mm with tapered flanges of 26 mm each having lips of 10.5 mm, at 450 mm centre to centre, shall be fixed in a direction perpendicular to G.I. intermediate channel with connecting clips made out of 2.64 mm dia x 230 mm long G.I. wire at every junction, including fixing perimeter channels 0.5 mm thick 27 mm high having flanges of 20 mm and 30 mm long, the perimeter of ceiling fixed to wall/partition with the help of rawl plugs at 450 mm centre, with 25mm long dry wall screws @ 230 mm interval, including fixing of gypsum board to ceiling section and perimeter channel

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with the help of dry wall screws of size 3.5 x 25 mm at 230 mm c/c, including jointing and finishing to a flush finish of tapered and square edges of the board with recommended jointing compound, jointing tapes, finishing with jointing compound in 3 layers covering upto 150 mm on both sides of joint and two coats of primer suitable for board, all as per manufacturer's specification and also including the cost of making openings for light fittings, grills, diffusers, cutouts made with frame of perimeter channels suitably fixed, all complete as per drawings, specification and direction of the Engineer in Charge.

12.0 mm thick tapered edge calcium silicate board is to be provided. (In control Room)

6.10. Doors, Windows and ventilators

The details of doors and windows of the sub-station building shall be as under:

- a) Steel door: Steel doors with Door Frames made with 1.5 mm (16 gauge) thick galvanized steel sheet pressed multi bend to S/L Rebate of Size 120 x 60 mm and Door Shutter shall be made with 18 gauge thick GI sheet pressed formed to provide a 46 mm thick fully flushed Door leaf skin panel shell with lock seam joint at stile edges and filled with Honey comb structure with metallic reinforcement at top, bottom and side surroundings. The item also includes the provision for required iron mongery and Powder coated Finish in RAL Color shades. Each door leaf with 4 hinges (Make- Dauerhaft/ Hafele/ Equivalent), 1 no. of Door closure (make- Dauerhaft/ Hafele/ Equivalent), 1 no. of external trim (make- Dauerhaft/ Hafele/ Equivalent), 1 no. Three Point Panic Bar (Make-Dauerhaft / Hafele/ equivalent) with necessary screws etc all complete.
 - b) Fire proof doors: Providing and fixing of Hollow metal fire rated doors as per IS 3614 part-1 & part-2 for stability and integrity. Pressed Galvanized steel conforming to IS 277 with the following specification. Recommended fire door should have been tested earlier of similar design at CBRI for maximum rating of 2hrs tested with vision panel of minimum 0.1 Sqmtr per shutter as requirement & application. Individual Test certificates should also be available for glass used in vision lites confirming the required fire ratings /panels being a part of the fire door assembly. Doors should be finished in Thermosetting Powder Coating desired RAL Shades. Manufacturer test certificate shall cover doors both single & double leaf doors and Hardware should pass European certificate "CE" of conformity / UL with required fire ratings. Any deviation in specification and sheet thickness other than what is mentioned in the test certificates are not allowed. Proper label confirming the type of door and the hourly rating is mandatory. The manufacturer should be compliant to ISO 9001: 2008 and CE certified, manufacturer should be covered under IGBC scheme. Door frame shall be double rebate profile of minimum size 154mm X 77 mm made out of 1.60mm (16gauge) minimum thick galvanized steel sheet. NDRF 154x77 Frames shall be Butt jointed and field assembled with self bolted. The frames should be finished with Thermosetting Powder Coating in desired RAL Shade. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Door leaf shall be minimum 49mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 1.25mm (18gauge) minimum thick galvanised steel sheet. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. The infill material shall be Rockwool treated with Viper FRS 881 LH. All doors NSD 12049 shall be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4mm. For pair of doors astragals has to be provided on
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the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be provided as per manufacturers recommendation with a beeding and screws from inside. However the glass should be contraflam Door Lite 11 mm clear 120 min fire rated and partially insulated (EW120), **Non Wired Toughened, interlatered glass having a sound reduction of >37dB, LT of 86% and compliant to class 2(B)2 category of Impact Resistance as per EN 12600 standard from Saint Gobain.**

Each door leaf with 4 hinges (Make- Dauerhaft/ Hafele/ Equivalent), 1 no.of fire rated Door closure (make- Dauerhaft/ Hafele/ Equivalent), 1 no. of external trim (make- Dauerhaft/ Hafele/ Equivalent), 1 Fire Rated Wired Glass(200x300mm), (Make-Pilkington/ equivalent), 1 no. Three Point Panic Bar (Make-Dauerhaft / Hafele/ equivalent) with necessary screws

- c) Aluminium Doors, Windows & Ventilators: Aluminium doors, Windows & Ventilators are Powder coated Aluminium Hindalco/ Jindal or equivalent extruded sections (minimum 3.0 mm thick) as per IS 733 & 1285 for windows and ventilators (minimum thickness of powder coating 50 micron of approved colour). Glazing for windows and ventilators will be hermetically sealed double glazing (DGU) with (6+12+6) i.e. 06 mm clear toughened glass +12 mm air gap + 6 mm toughened Glass (Heat reflective colour glass).

Door/ Window frame	101.60x44.50x3.18mm Code: 20011(Jindal)
Door/ Window Shutter	83.50x44.45x3.18mm Code: 19583 (Jindal)
Door/Windows middle section	83.50x44.45x3.27mm Code: 19593 (Jindal)
Square Tube Inside window Beading	25x25x2mm
Beading in Doors	Code: 19377 (Jindal)
Ventilator frame	101.60x44.50x3.18mm Code: 20011(Jindal)
Ventilator Middle frame	101.60x44.50x3.18mm Code: 20010 (Jindal)
Ventilator outside beading Angle	35x35x2mm
Square Tube Inside ventilator Beading	25x25x2mm

- d) All entrance doors at ground floor/ cellar shall be steel doors. Partition door between adjacent panel rooms shall be 2 hours fire rated
- e) The details for all other doors and windows shall be as per finish schedule Table-I and tender drawings with the relevant IS code.
- f) Floor springs and hydraulic door closer of make Dorma or equivalent to be provided.
- g) To maintain proper size of opening for doors and windows, contractor shall provide rough round aluminum tube of size 40 x 20 mm around all opening before plaster work.
- h)The contractor shall provide a door and window sill of granite stone of size 18-20 mm.
- i) All windows at ground floor/ cellar shall be provided with MS Grill.

6.11. Internal Electrification

Contractor to provide electrical wiring in the building and shall be through heavy duty concealed conduits. All fixtures and wiring shall be of best quality and ISI marked. (Fixtures shall be provided as per provision of energy conservation act). Internal wiring shall include all fittings and fixtures, control panel boards, main switch MCB's, etc as required to successful completion of the project..

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- 6.12. Air-conditioning/HVAC System- Contractor to provide proper Air-conditioning/HVAC systems for the proposed building (Complete) excluding celler floor level including design of the system with standby arrangement. Brand Name-(L.G,Samsung,Hitachi,Daikin)
- 6.13. Plumbing & Sanitation
- a) All plumbing and sanitation works shall be executed to comply with the requirements of the appropriate bye-laws, rules and regulations of the Local Authority having jurisdiction over such matters. The Contractor shall arrange for all necessary formalities to be met in regard to inspection, testing, obtaining approval and giving notices etc.
 - b) PVC sintex or equivalent make Roof water tank of adequate capacity depending on the number of users for 24 hours storage shall be provided. Minimum 2 Nos. 1000 liters capacity shall be provided.
 - c) CPVC pipes & Fittings shall be used for internal & external piping (both concealed) work for potable water supply.
 - d) UPVC pipes shall be used for sanitary works above ground level.
 - e) Each toilet shall have minimum fittings
 - i) Wall Hung Water closet (European type W.C. pan) Jaquar/Kohler as per approval of Engineer Incharge
 - ii) Half Stall Urinal (580 x 380 x 350 mm) Jaquar/Kohler as per approval of Engineer Incharge
 - iii) Counter top Wash basin (630 x 450 mm) Jaquar/Kohler as per approval of Engineer Incharge
 - iv) Bathroom mirror (600 x 450 x 6 mm thick) hard board backing
 - v) CP brass towel rail (600 x 20 mm) with C. P. brass brackets.
 - vi) Soap holder and liquid soap dispenser.
 - f) Water cooler for drinking water with adequate water storage facility shall be provided and located near control room instead of near toilet block.
 - g) 1 No stainless steel A ISI 304(18/8) kitchen sink with Drain board (510 x 1040 x 225mm bowl depth as per IS 13893 for pantry shall be provided complete with all fittings
 - h) All fittings, fastener, grating shall be chromium plated.
 - i) All sanitary fixtures and fittings shall be of approved quality and type manufactured by well known manufacturers. All items brought to site must bear identification marks of the type of the Manufacturer.
 - j) Soil, waste and drain pipes, for underground works shall be UPVC Pipes for areas not subject to traffic load. Heavy-duty cast iron pipes/ RCC NP-04 Pipes shall be used otherwise.
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7.0 STORM WATER DRAINAGE FOR CONTROL ROOM BUILDING

The building drain shall be provided for the collection of storm water from the roofs. This water shall be collected in chambers and these chambers shall drain to the main drainage system of the station which shall in turn be connected to rain water harvesting recharge pits. Overflow of RWH Pits shall be connected to main drain

G.I Pipes of 150 MM dia rain water down comers shall be provided to drain off the rain water from the roof.. The number and size of down comers shall be governed by IS:1742 and IS:2527. Pipe will be covered by making suitable arrangement in structure and to be matched with external Finishes.

All external drains shall be covered with precast perforated RCC covers of suitable size and thickness.

For all buildings, suitable arrangement for draining out water collected from equipment blow down, leakages, floor washings fire fighting etc. shall be provided for each floor.

8.0 DEVELOPMENT OF YARD

8.1. Scope

8.1.1. The Contractor shall furnish all labour, equipments and materials required for complete performance of the work in accordance with the drawings, specifications and direction of the Owner.

8.1.2. Stone spreading shall be done in the Outdoor Sub-Station Yard area, Power Transformer, Capacitor Bank and wherever equipments and structures are to be provided under the present scope of work.

General Requirement:

The material required for site surfacing / stone filling shall be free from all types of organic materials and shall be of standard quality and as approved by the Owner.

Test for aggregates should be as follows:

a) Sieve Analysis limits (Gradation)

As per IS: 383-1970

The material to be used for stone filling / site surfacing shall be uncrushed / crushed / broken stone of 20 mm nominal size (ungraded single size) conforming to Table 2 of IS:383 - 1970.

Sieve Analysis (Gradation):
(IS: 383 - Table - 2)

Sieve size	% passing by weight
40mm	100
20mm	85-100
10mm	0 – 20

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4.75mm 0-5

One test shall be conducted for every 50 cum.

b) Hardness:

Abrasion value (IS: 2386 Part-IV) - not more than 40%

Impact value (IS: 2386 Part-IV) - not more than 30% and frequency shall be one test per 50 cum with a minimum of one test per source

c) Flakiness Index

As per IS: 2386 Part I

- 8.1.3. Before taking up the final yard treatment, anti-weed treatment shall be applied in the switchyard area wherever yard treatment is to be done, and the area shall be thoroughly de-weeded including removal of roots. The recommendation of local agriculture or horticulture department shall be sought wherever feasible while choosing the type of chemical to be used. Nevertheless the effectiveness of the chemical shall be demonstrated by the contractor in a test area of 10M x 10M (approx.) and monitored over a period of two to three weeks by the Engineer-in-Charge. The final approval shall be given by Engineer-in-Charge and final approval given based on the results.
- 8.1.4. The anti-weed chemical shall be procured from reputed manufacturers. The dosage and application of chemical shall be strictly followed as per manufacturer's recommendation. The contractor shall be required to maintain the area free of weeds for a period of 1 year from the date of application of 1st dose of anti-weed chemicals
- 8.1.5. After all the structures/equipments are erected and anti-weed treatment is complete, the surface of the substation area shall be maintained, rolled/compacted to the lines and grades as decided by Engineer-in-Charge. De-weeding including removal of roots shall be done before rolling is commenced. Engineer-in-Charge shall decide final formation level so as to ensure that the site appears uniform free from undulations. The final formation level shall however be very close to the formation level using manual or machine roller with suitable water sprinkling arrangement to form a smooth and compact surface.
- 8.1.6. After anti-weed treatment & compaction of earth, final yard treatment shall be carried out in the 4 layers as follows:
- Providing and laying in position 75mm thick base layer of cement concrete 1:5:10 (1 cement : 5 coarse sand : 10 brick aggregate 40mm nominal size).
 - Flat brick flooring with over burnt bricks /class designation 100 as per approval of BRPL on the bed of 12 mm thick cement mortar 1:6 (1 cement : 6 coarse sand) and filling the joints 12mm thick all around the bricks with same mortar.
 - Over the flat brick flooring a layer a final surface course of minimum 100 mm thickness of 20 mm nominal size (single size ungraded) broken stone shall be spread and uniformly leveled.
- 8.1.7. In areas that are considered by the Engineer-in-Charge to be too congested with foundations and structures for proper rolling of the site surfacing material by normal rolling
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equipments i.e., clear space between any 02 adjacent structures/foundation less than 01 meter, these adjoining structures/foundations shall constructed as a monolithic structure.

- 8.1.8. The sub grade shall be in moist condition at the time the cement concrete is placed. If necessary, it should be saturated with water for not less than 6 hours but not exceeding 20 hours before placing of cement concrete. If it becomes dry prior to the actual placing of cement concrete, it shall be sprinkled with water and it shall be ensured that no pools of water or soft patches are formed on the surface.

9.0 SUB-STATION TRENCHES

- 9.1. The cable trenches and precast removable RCC cover (with lifting arrangement) shall be constructed using RCC of minimum grade M25.
- 9.2. The RCC cable trench walls and raft shall not be less than 150 mm thick.
- 9.3. The cable trench wall shall be designed for the following loads.
- Dead load of 155 kg/m length of cable support + 75 Kg on one tier at the end.(Wall thickness Minimum-150 mm)
 - Triangular earth pressure + uniform surcharge pressure of 2T/m².
- 9.4. Cable trench covers shall be 50 mm thick. All trench covers/ drain covers shall have desired IRC Mesh of size 75x25mm (wire size 6 gauge/ 7.75 kg/m²) welded to M.S. frame of angle 50 x 50 x 6 mm all round the cover. Size of covers shall be as per site requirement / direction of Engineer in Charge.
- 9.5. Size of covers shall be per site requirement / direction of Engineer In Charge.
- 9.6. All cable trenches inside the buildings shall have covers comprising of 6 mm thick chequered plates fixed on angle 40 x 40 x 5 mm frame with arrangement of MS holes for lifting of cover.
- 9.7. Cable trench crossing the road/rails shall be designed for class AA loading of IRC/relevant IS Code and should be checked for transformer/reactor loading.
- 9.8. Trenches shall be drained. Necessary sumps be constructed and submersible sump pumps with stand by arrangement shall be supplied/ installed. Cable trenches shall not be used as storm water drains.
- 9.9. The top of cable trench shall be such that the surface rain water does not enter the trench.
- 9.10. All metal parts inside the trench shall be connected to the earthing system.
- 9.11. The trench bed shall have a perpendicular to the run. Trench wall shall not foul with the foundation. Suitable clear gap shall be provided.
- 9.12. The trench bed shall have a slope of 1/500 along the run & 1/250 perpendicular to the run.
- 9.13. All the construction joints of cable trenches i.e. between base slab to base slab and the junction of vertical wall to base slab as well as from vertical wall to wall and all the expansion, joints shall be provided with approved quality PVC water stops of approx. 230 x 5 mm size for those sections where the ground water table is expected to rise above the junction of base slab and vertical wall of cable trenches.
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- 9.14. Cable trenches shall be blocked at the ends if required with brick masonry in cement sand mortar 1:6 and plaster with 12mm/15mm thick 1:4 cement sand mortar.
- 9.15. Construction of Cable Trench 11Kv & 66Kv From the plot boundary wall to MG road shall be in the scope of Vendor.

10.0 SUB-STATION DRAINAGE SYSTEM

Adequate site drainage system shall be provided by the Contractor. The Contractor shall design the storm water drainage system covering all culverts, ditches, drains, etc. The run off shall be calculated on the basis of maximum rainfall intensity that is likely to occur over the catchment area in one hour period on an average of once in ten years. The surface of the site shall be sloped to prevent the ponding of water. Outfall of drainage shall be suitably connected to rainwater harvesting recharge pits. While designing the drainage system following points shall be taken care of:

1. The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8m/sec respectively. However, minimum non-silting velocity of 0.6m/sec shall be ensured. Longitudinal bed slope not milder than 1 in 1000 shall be provided.
2. For design of RCC pipes for drains and culverts, IS: 456 and IS: 783 shall be followed.
3. The Contractor shall ensure that water drains are away from the site area and shall prevent damage to adjacent property by this water. Adequate protection shall be given to site surfaces, roads, ditches, culverts, etc. to prevent erosion of material by water.
4. For pipe drains, concrete pipe of class NP3 shall be used. However, for road crossings etc. higher strength pipe of class NP4 shall be provided. For rail crossings, pipes conforming to railway loading standards or at least NP4 class shall be provided. Manholes shall be provided at every 30m interval, at connection points and at every change of alignment.
5. Pipe drains shall be connected through manholes at an interval of maximum 15mtrs. Effluents shall be suitably treated by the Contractor to meet all the prevalent statutory requirements and local pollution control norms and treated effluents shall be conveyed to the storm water drainage system at a suitable location for its final disposal.
6. All internal site drainage system, including the final connection/disposal to rainwater harvesting recharge pits shall be part of Contractor's scope including all required civil work, mechanical & electrical systems. The Contractor shall connect drain(s) at one or more points to rainwater harvesting recharge pits as feasible at site. The drainage layout of the substation shall be approved by the Owner & all works shall be carried out by the Contractor.
7. The drainage scheme and associated drawings shall be got approved from the Owner.

11.0 SUB-STATION ROAD

- 11.1. Inside substation roads to be provided for access along with car parking for at least three cars and two wheeler parking for three vehicles. Building, Roads and parking are in the scope of bidder. Layout of the roads shall be based on layout drawing for the substation. Parking areas shall be provided for Site
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personnel and visitors as per layout drawing. Adequate turning space for vehicles shall be provided and bend radius shall be set accordingly. It has to be connected suitably with roads.

- 11.2. All substation roads shall be constructed so as to permit transportation of all heavy equipment upto 60MT. The main approach roads upto Control Room Building and other relevant roads will be RCC/ Cement Concrete Roads. The other connecting roads and pathways shall be of Paver blocks/ CC Road as per site requirement. The pavers blocks used for the roads shall be minimum 80mm thick with compressive strength not less than 450Kg/cm².
- 11.3. Road construction shall be as per IRC standard.
- 11.4. Adequate provision shall be made for road drainage.
- 11.5. All the culverts and its allied structure (required for road/rail, drain trench crossings etc.) shall be designed for class AA loading as per IRC standard/IS code.

TRANSFORMER FOUNDATION, RAIL TRACK/ ROAD CUM RAIL TRACK

- 11.6. The Contractor shall provide a permanent transfer track system integrated with the power transformer foundation to enable installation and replacement of any failed unit by the spare unit located at the site. The transfer track system shall be suitable to permit the movement of any failed unit fully assembled with integral radiators and oil, without the de-energization of any other equipment in the station. This system shall enable the removal of any failed unit from its foundation to a repair area and the installation of the spare unit. This system, preferably, shall not interfere with the normal internal road and trench system. If trench/ drain crossings are required then suitable RCC culverts shall be provided in accordance with I.R.C Code/ relevant IS.
- 11.7. Rail track to be provided for all PTR foundations upto Grid Main Entry gate and shall be minimum of RCC M-25 grade. The space between the tracks shall be suitably filled with Concrete M-25. upto the formation level.. Suitable drainage system between the tracks shall be provided.
- 11.8. The rails shall be of first quality 52 kg/m medium manganese steel as per Indian Railway specification T-12-64 and its subsequent revision, joined together by fish plates as per Indian Railway specification T-1/57 and their drawing no. 090M and 27mm diameter fish bolts. No joint shall be provided at less than L/3 of the longest part.
- 11.9. The grating shall be made of MS flat of size 50mmx 5mm placed at 30mm center to center welded inclined (sideways) at an angle of 45-60 degrees from horizontal axis and 25mmx5mm MS flat at spacing of 150mm at right angle to each other. Maximum length of grating shall be 1500mm and width shall not be more than 500mm. The gratings supported on ISMB 150mm shall be placed at the formation level and will be covered with 100mm thick layer of broken/crushed/non-crushed stone having size 40mm to 60mm which acts as an extinguisher for flaming oil.

12.0 OIL RECOVERY & BURNT OIL TANK

- 12.1. The oil recovery system shall be provided for all transformers (containing insulating oil or any flammable or polluting liquid) in order to avoid spread of fire by the oil and for environmental protection.
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- 12.2. Each transformer including oil conservator tank and cooler banks etc. shall be placed in a transformer pit surrounded by retaining walls (pit walls). The clear distance of the retaining wall from the transformer shall be 20% of the transformer height or 0.8m whichever is more. The transformer pit thus formed shall have a capacity equal to volume of oil in the transformers. The MS grating placed at the formation level shall be covered with 100mm thick gravel of 40mm nominal size which acts as an extinguisher for flaming oil.
- 12.3. Each transformer pit shall be drained towards a sump pit whose role is to recover the infiltrating water and the drained oil from the pit. The sump pit shall have sufficient capacity to receive without overflowing the oil content of large transformers plus the water content of any fixed fire fighting system and a certain quantity of rain water collected from the pit connected to it. The system shall be provided with air vents large enough to avoid over- pressure during operation. The whole internal surface of the sump pit should be impermeable.
- 12.4. The retaining walls which make up the transformer pit shall be made of reinforced cement concrete, with minimum grade of concrete as M-25.
- 12.5. The floor of the transformer pit shall be of Reinforced cement concrete of grade M25.
- 12.6. A Device showing level of sump pit shall be fitted along with the automatic submersible pumping system, which shall have sufficient capacity to evacuate the fire fighting & rainwater from the sump pit..
- 12.7. If the heights of the retaining wall which form the transformer pit exceed 60cm, steps shall be provided to facilitate access to the transformer and reactor.
- 12.8. When designing the transformer pit, the movement of the transformer must be taken into account.
- 12.9. It must be assured that the coefficient of crushed stone (granular material) penetration which fills the transformer pit will be retained regardless of the climatic conditions.

13.0 FIRE PROTECTION WALLS

- 13.1. General
- 13.1.1. Fire protection walls shall be provided, wherever required, in accordance with Tariff Advisory Committee (TAC) and certifying all mandatory safety clearances.
- 13.2. Material
- 13.2.1. The firewall shall be made up of reinforced cement concrete (at least M-25 grade) as per the system requirements. Materials used must conform to the standards of the National Fire Prevention Association & TAC Norms.
- 13.3. Fire Resistance
- 13.3.1. The firewall shall have a minimum fire resistance of 3 hours. The partitions, which are made to reduce the noise level of the transformers, shall have the same fire resistance where the partitions are also used as firewalls. The walls of the building, which are used as firewalls, shall also have a minimum fire resistance of 3 hours.
- 13.3.2. The firewall shall be designed to protect against the effect of radiant heat and flying debris from an adjacent fire.
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13.4. Dimensions

- 13.4.1. The barrier shall extend at least 500 mm above the transformer bushing and pressure relief vent and length wise 600 mm beyond the transformer including any radiators and tap changer enclosure.
- 13.4.2. These dimensions might be reduced in special cases, as per the approval of owner where there is lack of space. A minimum of 2.0 meter clearance shall be provided between the equipments e.g. Autotransformer/Power transformer.
- 13.4.3. The building walls, which act as firewalls, shall extend at least 1 m above the roof in order to protect it. Building wall adjacent to transformer shall act as fire resistance wall and shall be made up of solid concrete blocks

13.5. Mechanical Resistance

- 13.5.1. The firewall shall have the mechanical resistance to withstand local atmosphere conditions. If this wall shall serve as a support for equipment such as insulators etc, its mechanical rigidity must be increased. Connecting the walls by steel or other structures which may produce a reversing torque if overheated shall be avoided.

14.0 DESIGN CONSIDERATION FOR FOUNDATION

14.1. General

- 14.1.1. Work covered under this Clause of the Specification comprises the design and construction of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, drains, jacking pad, pulling block, control cubicles, bus supports, Power transformer/Reactors, marshalling kiosks and auxiliary equipments, tanks or for any other equipment or service and any other foundation required to complete the work. This clause is as well applicable to the other RCC constructions.
 - 14.1.2. Concrete shall conform to the requirements mentioned in IS: 456 and all the tests shall be conducted as per relevant Indian Standard Codes as mentioned in Standard field quality plan appended with the specification. A minimum grade of M25 concrete shall be used for all structural/load bearing members as per latest IS: 456 (latest revision).
 - 14.1.3. If the site is sloppy, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate such slopes.
 - 14.1.4. The switchyard foundation's plinths shall be minimum 300mm above finished yard level.
 - 14.1.5. Minimum 100mm thick lean concrete (1:4:8) shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction.
 - 14.1.6. Concrete made with Ordinary Portland cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering.
 - 14.1.7. The design and detailing of foundations shall be done based on the approved soil data and
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sub-soil conditions as well as for all possible critical loads and the combinations thereof. The Spread footing or pile foundation as may be required based on soil/sub-soil conditions and superimposed loads shall be provided.

- 14.1.8. If pile foundations are adopted, the same shall be cast-in-situ driven/bored or precast or under reamed type as per relevant parts of IS Code 2911. Only RCC piles shall be provided. Suitability of the adopted pile foundations shall be justified by way of full design calculations. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used. Necessary initial load test shall also be carried out by the bidder at their cost to establish the piles design capacity. Only after the design capacities of piles have been established, the Contractor shall take up the job of piling. Routine tests for the piles shall also be conducted. All the work (design & testing) shall be planned in such a way that these shall not cause any delay in project completion. The contractor shall go for vertical load testing or lateral load testing. The contractor may choose static or dynamic load testing upon site condition and time constraint.

14.2. Design

- 14.2.1. All foundation 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 M-25.
- 14.2.2. Limit state method of design shall be adopted unless specified otherwise in the specification.
- 14.2.3. For detailing of reinforcement IS: 2502 and SP: 16 shall be followed. TMT bars conforming to IS: 1786 shall be used as reinforcement. However, in specific areas mild steel (Grade I) conforming to IS: 432 can also be used. Two layers of reinforcement (on inner and outer face) shall be provided for wall & slab sections having thickness of 125 mm and above. For footings minimum cover shall be 50 mm.
- 14.2.4. RCC water retaining structures like storage tanks, etc. shall be designed as uncracked section in accordance with IS: 3370 (Part I to IV) by working stress method. However, water channels shall be designed as cracked section with limited steel stresses as per IS: 3370 (Part I to IV) by working stress method. Joints on each concrete lift shall be provided with approved quality PVC water stops of approx. 230 x 5 mm size to avoid water seepage through those joints
- 14.2.5. 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 produces the maximum stresses in the foundation or the foundation component and as per the relevant IS Codes of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.
- 14.2.6. Design shall consider any sub-soil water pressure that may be encountered following relevant standard strictly.
- 14.2.7. 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 / harmful to the concrete foundations.
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- 14.2.8. RCC columns shall be provided with rigid connection at the base. All columns shall be interconnected with RCC beams at Footing Level from all possible Directions/Suitable size raft footing will be provided.
- 14.2.9. All sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factor of safety for these cases shall be taken as mentioned in relevant IS Codes as stipulated elsewhere in the Specifications. For checking against overturning, weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.
- 14.2.10. Earth pressure for all underground structures shall be calculated using coefficient of earth pressure at rest. Co-efficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.
- 14.2.11. In addition to earth pressure and ground water pressure etc., a surcharge load of 2T/Sq.m shall also be considered for the design of all underground structures including channels, sumps, tanks, trenches, and substructure of any underground hollow enclosure etc, for the vehicular traffic in the vicinity of the structure.
- 14.2.12. Following conditions shall be considered for the design of water tank in pumps house, channels, sumps, trenches and other underground structures:
- a) Full water pressure from inside and no earth pressure, ground water pressure & surcharge pressure from outside (application only to structures, which are liable to be filled up with water or any other liquid).
 - b) Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.
 - c) Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.
- 14.2.13. Base slab of any underground enclosure shall also be designed for empty condition during construction and maintenance stages with maximum groundwater table (GWT). Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the super-imposed loadings.
- 14.2.14. Base slab of any underground enclosure like water storage tank shall also be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum GWT. Intermediate dividing piers of such enclosures shall be designed considering water in one pump sump only and the other pumps sump being empty for maintenance.
- 14.2.15. The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.
- 14.2.16. The foundations of transformer shall be of block type foundation. Minimum reinforcement
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shall be governed by IS: 2974 and IS: 456.

14.2.17. The 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 factors shall be used as partial safety factor over loads in limit state design also.

14.3. Admixture & Additives

14.3.1. Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labeled containers to enable identification.

14.3.2. Admixtures in concrete shall conform to IS: 9103. The waterproofing cement additives shall conform to IS: 2645. Owner shall approve concrete Admixtures/ Additives.

14.3.3. The contractor may propose and the Owner may improve the use of a water-reducing set-retarding admixture in some of the concrete. The use of such an admixture will not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operation and shall only be approved as an aid to overcoming unusual circumstances and placing conditions.

14.3.4. The water-reducing set-retarding admixture shall be an approved brand of Ligno-sulphonate type admixture.

14.3.5. The waterproofing cement additives shall be used as required/advised by the Owner.

14.3.6. Water proofing treatment on roof shall be as per Item No 22.7.1 - DSR 2012.

15.0 FENCING OF SUB-STATION (LIVE PART) AREA

15.1. General

Fencing shall be designed for the most critical loading combination taking care of wind force, stability, tension on wires, minimum requirements as per this clause for are materials IS 8910 and fabrication IS 800 as per recommendations

15.2. Areas Requiring Fencing

15.3. Fencing shall be providing for the following areas:

15.3.1. Site fencing for the complete Outdoor substation Yard area including Power transformer area. Gates shall be provided for men and machine / equipment to be taken out of the substation.

15.3.2. The IRC weld mesh Panels fencing of Capacitor Bank with roof cover (as per approved BRPL pattern).

15.3.3. Fencing of Aux. Substation Transformer (as per approved BRPL pattern).

15.4. Product Material

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15.4.1. The minimum requirements are as follows:

IRC Weld Mesh fencing in accordance to relevant IS Code

- Size of IRC mesh 25X75mm
- Nominal wire size 6 gauge/ 7.75 kg/m²
- Width of fencing panel 2400mm
- Height of fencing 2000mm
- Fabrication of panels 40mm Nominal bore M.S. Pipe (medium duty). Providing elbow/bend at corners & 40 x 5 mm M.S. flats in beading
- Paint Aluminum Paint

15.4.2. Posts

- Intermediate Straining Post : 65mm Nominal bore, M.S. Pipe (Medium duty)
- Base Plate : 12mm M.S. Plate with 4 nos of hole. Nuts & bolts of suitable diameter.
- Paint : shall be painted with a coat of approved steel primer and two coats of synthetic enamel paint

The IRC weld mesh Panels shall be fixed to the post at the top and bottom of the 65mm Nominal bore, M.S. Pipe by Nuts and bolts. The Intermediate straining Posts to be erected by using holding down bolts and nuts grouted in toe wall around the Yard (the height of Yard) Posts shall be set in 1:1.5:3 Reinforced cement concrete blocks of minimum dimension (340 mm x 340 mm x 750 mm deep) and Toe wall to be at least 450 mm below & 450 mm above the yard level and 340 mm wide matched with External facade of the building(Texture finish).

15.5. Installation

15.5.1. Fence shall be installed along switchyard line.

15.5.2. Post holes shall be excavated by approved methods.

15.5.3. Intermediate posts shall be spaced 2.5 m apart measured parallel to ground surface.

15.5.4. Concrete work shall conform to relevant clause. Post shall be braced and held in plumb position and true alignment and elevation until concrete has set.

15.5.5. Fence fabric shall not be installed until concrete has cured a minimum of 7 days.

15.5.6. Bottom and top of the fence panels shall be fixed with post by MS flats of 50 mm x 6 mm (min).

15.5.7. Toe wall of Brick masonry, with notches over 100 mm thick PCC (1:4:8) shall be provided below all fencing and shall be minimum 450 mm above and 450 mm below finished ground level. All exposed

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surfaces of brick toe wall shall be finished with Texture finish/Matched with Building façade.

- 15.6.
- 15.7. M.S. Gate
- 15.7.1. M.S. Gate of 6.0 m wide x 2.3 m height (2 nos) and 1.55 m x 2.3 m height (1 no) shall be provided to provide access through the fencing to the yard. M.S. Gate of 6.0 m wide x 2.3 m height shall be made in two leaf and 1.55 m x 2.3 m height shall be made in one leaf with locking arrangements. The gate shall be made with outer frame of 40 NB (Medium) M. S. Pipe. Weld mesh of opening size 25 x 75 mm and nominal wire size of mesh is 6 gauge/ 7.75 kg/m² (as per standard approved drawing of BSES).
- 15.7.2. Hinges, al-drops and other accessories shall be provided for effective working of the gate.

16.0 GATES (Not Applicable)

- 16.1. The gates shall be fabricated with welded joints to achieve rigid connections. The gate frames shall be painted with one or more coat of approved steel primer and two coats of synthetic enamel paint.
- 16.2. Gates shall be fitted with approved quality iron hinges. Hinges shall permit gates to swing through 180 degree.
- 16.3. Gates shall be fitted with galvanized chain hook or gate hold back to hold gates open. Double gates shall be fitted with centre rest and drop bolt to secure gates in closed position.
- 16.4. Main Gate shall be at least 6m wide. Gates shall be installed in locations shown on drawings. Next to the main gate, a small gate (1.25 m wide, single leaf) within main gate shall also be provided as a wicket gate.
- 16.5. Bottom of main gates (both at entry and exit) shall be set approximately 40mm above ground surface with necessary guiding mechanism i.e., wheels at bottom along with a track allowing its smooth movement on floor shall be fitted as per site requirement.
- 16.6. The gates shall be provided with suitable locking arrangement.

17.0 MISCELLANEOUS GENERAL REQUIREMENTS

- 17.1. Dense concrete with controlled water cement ratio as per IS-code shall be used for all underground concrete structures such as pump-house, tanks, water retaining structures, cable and pipe trenches etc. for achieving water tightness.
- 17.2. All joints including construction and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 5 mm and minimum width shall be 230 mm.
- 17.3. All mild steel parts used in the water retaining structures shall be hot-double dip galvanized. The minimum coating of the zinc shall be 610 gm/sqm. for galvanized structures and shall comply with IS:2629 and IS:2633. Galvanizing shall be checked and tested in accordance with IS:2633. The
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galvanizing shall be followed by the application of an etching primer and dipping in black bitumen in accordance with IS:3416.

- 17.4. A screed concrete layer not less than 100 mm thick and of grade not weaker than M10 conforming to IS: 456 shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structures.
 - 17.5. Bricks having minimum 100 kg/cm² compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 100 kg/cm² compressive strength before submitting his offer.
 - 17.6. Doors and windows on external walls of the building (other than areas provided, with insulated metal claddings) shall be provided with RCC sunshade over the openings with 150 mm projection on either side of the openings. Projection of sunshade from the wall shall be minimum 600mm over window & door openings.
 - 17.7. RCC staircase shall be provided for access to roof of the building. All stairs shall have maximum riser height of 150 mm and a minimum tread width of 300 mm Minimum width of stairs shall be 1500 mm. Steel doors shall be provided in the Mumty and height of Mumty should be at least 2.6m.
 - 17.8. Angles 50x50x6 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab, edges of drains supporting covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes supporting covers, supporting edges of manhole precast cover and any other place where breakage of comers of concrete is expected.
 - 17.9. Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc. as per IS: 6313 and other relevant Indian Standards.
 - 17.10. All reinforcement in RCC structures and structural steel members shall be of make TATA/ SAIL/Jindal or equivalent.
 - 17.11. The railing of staircase shall be 0.9 m average height comprising of stainless steel (Grade 304) Jindal Make member minimum 3 mm thick made of Hollow tubes, channels, plates etc., including welding, grinding, buffing, polishing and making curvature (wherever required) and fitting the same with necessary stainless steel nuts and bolts complete, i/c fixing the railing with necessary accessories & stainless steel dash fasteners , stainless steel bolts etc., of required size, on the top of the floor or the side of waist slab with suitable arrangement as per approval of Engineer-in-charge.
 - 17.12. Loading/Unloading Platform stainless steel (Grade 304) Jindal make Balcony Railing hollow pipe 80x40x3 mm hand rail, horizontal pipes 40x20x3 mm .
 - 17.13. All underground water retaining concrete structures shall have water proofing cement additive conforming to IS: 2645 water proofing for walls and base slab of all underground concrete structures like basements pump houses etc. shall be by "Injection Method".
 - 17.14. All buildings shall have 750mm wide plinth protection all round.
 - 17.15. Monorails, Monorail girders and fixtures shall be provided by the Bidder wherever required.
 - 17.16. All foundations embedment, inserts, blockouts required for equipments shall be provided by bidder.
 - 17.17. 50mm thick DPC shall be provided before laying of masonry (item no. 4.11 & 4.13-DSR 2012).
-

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- 17.18. BSES Display board is to be provided of required size (3.0mx1.20m) and as per approved pattern /drawing of BRPL with name of the grid- ACP sheet signage with reverse 2D matter with LED Module Light having Automatic Timer On & Off System .
- 17.19. Water and Sewer line connections to be done along with approval of CIVIC agency.
- 17.20. The details given in tender drawings shall be considered along with details available in this section of the specification while deciding various components of the building.
- 17.21. Balance Plot area should be covered with CC pavement/Pavers as per EIC
- Items/components of buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope

18.0 INTERFACING

The proper coordination & execution of all interfacing civil works activities like fixing of conduits in roofs/walls/floors, fixing of lighting fixtures, fixing of supports/ embedments, provision of cutouts etc for indoor illumination, ventilation & Air conditioning shall be the sole responsibility of the Contractor. He shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and dismantling, breakage etc. is reduced to minimum

19.0 FIELD QUALITY PLAN FOR CIVIL WORKS

The field quality plan for all civil works shall be in accordance with CPWD specification and other relevant Indian Standard Codes. All quality checks and procedures shall be followed as per relevant CPWD norms.

20.0 WATER SUPPLY

- 20.1. Water for construction work as well as drinking purpose shall be in the scope of Contractor.
- 20.2. The Contractor shall carry out all the plumbing/erection works required for supply of water in control room building.
- 20.3. A scheme shall be prepared by the Contractor indicating the layout and details of water supply which shall be got approved from the Owner before actual start of work including all other incidental items not shown or specified but as may be required for complete performance of the works.
- 20.4. Either Bore-well or Connection from respective owners/DJB water source along with required pumps for water supply shall be in the scope of contractor. Although contractor shall provide an underground water reservoir, near the gate of minimum 20 M3 or sufficient capacity for refill of one fire Tanker. The water reservoir shall be provided with a high-pressure pump and single point fire hydrant outlet for refilling the fire tender in case of fire and emergency with proper waterproofing treatment & ceramic tiles finish on walls & Floor. Necessary valve shall be provided in the outlet.
- 20.5. The details of tanks, pipes, fittings, fixtures etc for water supply shall be approved by engineer in
-

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charge.

21.0 SEWERAGE SYSTEM

- 21.1. Sewerage system shall be provided for control room building.
- 21.2. The Contractor shall construct septic tank and soak pit suitable for 20 users or make connection with nearby existing sewerage system of Civic agencies/respective owners.
- 21.3. The system shall be designed as per relevant IS Codes.
- 21.4. External sewerage system including connection with internal services of building shall be within the scope of this contract. The connection and laying of sewer lines and manholes upto the point of connection with the sewer line of local civic agency if existing within 100m from any point of boundary of sub-station. If the sewer line of local civic agency does not exist in the area then septic tank with soak pit shall be constructed for control room building (suitable for 20 users). Vendor shall obtain necessary approval from civic agency for laying of sewer lines as aforesaid and connection thereof. Any municipal charges for approval and connection shall be paid by BRPL directly to the local authorities.

22.0 RAIN WATER HARVESTING

- (a) Providing two recharge structures with bore wells at different locations as per approved drawing for rainwater harvesting system. The recharge structures shall be suitably located within the sub-station. Branch drains from the main drain carrying rainwater from entire switchyard, constructed in accordance with clause 9 & 10 shall be connected to the recharge structures.
 - (b) The internal dimensions of recharge shafts shall be 3.0 m X 2.5 m with 230mm thick lining of brick work upto a depth of 2.0 meter from Finished Ground level and 345mm thick brickwork below 2.0 meter depth. The brickwork shall be constructed with cement mortar 1:6 (1cement: 6 coarse sand). The overall depth of shaft shall be 3.0 meter below invert level of drain. The shaft shall be covered with RCC slab for a live load of 300 kg. per sqm. Two openings of size 0.7 x 0.7 meter shall be provided in the RCC cover slab. An iron cover made of 5mm thick chequered plate with hinges shall be provided on the openings. Galvanized M.S. rungs of 16mm diameter at spacing of 300 mm shall be provided in the wall of shaft below the opening in the RCC slab to facilitate cleaning of shaft.
 - (c) A 300 mm diameter bore well shall be drilled in the centre of the shaft. The depth of bore well shall be 5.0 meter more than the depth of sub soil water.
 - (d) A 100 mm diameter medium duty MS pipe conforming to IS: 1161 shall be lowered in the bore well keeping bail plug towards bottom of bore well. The pipe shall have 1.58mm holes for 4.0 meter length starting from 1.0 meter from bottom of bore well. Holes of 3.0mm diameter shall be provided for a length of 2.0 meter starting from the bottom level of coarse sand and down wards. The overall length of pipe shall be equal to total depth of bore well plus depth of shaft.
 - (e) Gravel of size 3mm to 6mm shall be filled around 100 diameter MS pipe in the bore well. The shaft shall be filled with 500 mm thick layers each from the bottom of shaft with boulders of size 50mm to 150mm, gravel of size 5mm to 10mm, coarse sand having particle size 1.5mm to 2.0mm and boulders of size not less than 200mm respectively.
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- (f) Drawing based on above details of recharge structure for rainwater harvesting has to be prepared by contractor and to be approved from engineer in charge.

23.0 STATUTORY RULES

- 23.1. Contractor shall comply with all the applicable statutory rules pertaining to factories act (as applicable far the State), Fire Safety Rules of Tariff Advisory Committee. Water Act for pollution control, Energy Conservation Act, etc.
- 23.2. Provisions for fire proof doors, no. of staircases, fire separation wall, plastering on structural members (in fire prone areas) etc. shall be made according to the recommendations of Tariff Advisory Committee.
- 23.3. Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.
- 23.4. Foundation system adopted by Bidder shall ensure that relative settlement and other criteria shall be as per provision in IS: 1904 and other Indian Standards.
- 23.5. All water retaining structures designed as uncracked section shall also be tested for water tightness at full water level in accordance with clause no. 10 of IS :3370 (Part-I).
- 23.6. Construction joints shall be as per IS: 456.
- 23.7. All underground concrete structures like basements, pumps houses, water retaining structures etc. shall have plasticizer cum water proofing cement additive conforming to 1S:9103. In addition, limit on permeability as given in 1S:2645 shall also be met with. The concrete surface of these structures in contact with earth shall also be provided with two coat of bituminous painting for water/damp proofing. In case of water leakage in the above structures, Injection Method shall be applied for repairing the leakage.
- 23.8. All building/construction materials shall conform to the best quality specified in CPWD specifications if not otherwise mentioned in this specification.
- 23.9. All tests as required in the standard field quality plans of CPWD or as per sound engineering practices have to be carried out.
- 23.10. The type and treatment of all foundation shall be as per recommendation of geo-technical investigation reports.

24.0 TESTS FOR MATERIAL / WORKMANSHIP

All tests required for various bought out items, materials, quality of workmanship or any other tests as desired by Project Manager and as specified in technical specification shall be carried out by the Bidder at his own cost in the presence of the authorized representative of the Engineer.

The quality assurance check lists are given at the end of respective chapters / sections of these specifications. The Bidder shall submit comprehensive Quality Assurance plan for all materials, equipment, workmanship, services etc. and get it approved from the Engineer. This shall include setting up a test laboratory at site. However, such check list shall in no way limit the liability and

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responsibility of the Bidder in regard to quality of workmanship as detailed out in the specifications.

The sampling & testing of the construction materials shall be in accordance to latest CPWD Specifications related to all activities of the building and other civil construction works.

25.0 DRAWINGS

The successful Bidder shall first submit the structural design calculations along with general arrangement drawings for approval. After the approval of the design calculations by the owner detailed construction drawings shall be prepared and submitted for Employer's approval along with revised design calculations if required within 15 days. Required number of sets of design calculations, drawings and documents shall be submitted by the Bidder.

BOQ, Calculations and other documents etc. shall be on A4 size paper. All the drawings shall be drawn to the scale as far as possible on A1 size or larger size paper and should be legible. The submission shall be

- Three (03) Sets of approved and released for construction drawings/BOQ/Calculation for Owners reference.
- Six (06) Sets of final As Built drawings, design, BOQ, Calculation & O&M manual for all equipments supplied.
- Soft copies of all drawings/Documents/calculation in Auto CAD and Microsoft office file format as applicable.

Drawings shall be treated as submitted, only if provided with BOQ (If applicable). Transmittal sheet shall be mandatory to attach with all the drawing and documents. Format for transmittal shall be provided to successful bidder for drawing approvals etc.

26.0 ALTERATION IN SPECIFICATION AND DESIGN

The Project Manager shall have the power to make any alteration and omissions from, additions to or substitution for the original specifications, drawings, designs and instructions that may appear to him to be necessary during the progress of the work and the Bidder shall carry out the work in accordance with any instruction which may be given to him in writing signed by the Project Manager and such alterations, omissions, additions or substitutions shall not invalidate the contract and any altered, added or substituted work which the Bidder may be directed to do in the manner above specified as part of the work shall be carried out by the Bidder on the same conditions in all respects on which the Bidder agreed to do the original contract work. The time for completion of work shall be altered in the proportion that the altered, added or substituted work bears to the original contract work and the certificate of the Project Manager shall be conclusive as to such proportion.

The rates for the altered items of work shall be worked out on the following basis and necessary alternations in the total amount shall be made on that basis:

- (a) The rates to be reimbursed or recovered shall be taken as same as those given in CPWD-DSR (2021) for those items for which the rates are available in CPWD - DSR (2021).
 - (b) Rates for the items not covered under CPWD - DSR (2021) shall be derived from the rates of similar items of CPWD schedule of rates.
-

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- (c) In the event there is no similar class of work specified in the CPWD - DSR (2021), the Bidder shall work on a rate for such an item on the basis of the prevalent market rates for materials / men / machines and submit the same together with the detailed analysis to the Project Manager within 7 days. The Project Manager shall thereafter review the correctness and then conduct necessary negotiations with the Bidder to arrive at a mutually agreeable rate. Engineer's decision in regard to rates of such items shall be final and binding on the Bidder.

In case of conflict between this chapter and other Chapters of Technical Specifications, provisions given in this chapter shall govern.

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Table 1- Finishing Schedule

No	Location	Flooring	Wall Internal	Ceiling	Doors, Windows, Ventilators
1	Control room	52 mm thick CC flooring with concrete hardener topping & Dust proof Epoxy Paint & False Flooring.as per specification clause No-6.5.2	Plastic emulsion Paint on smooth surface applied with putty	Oil bound washable distemper on smooth surface applied with putty	Doors: 02 hours fire rated doors as per clause no. 6.10.b Windows & Ventilators: Aluminium Windows & Ventilators As per clause no. 6.10.c
2	Office rooms, maintenance room, Reception Lobby/ Passage, staircase area	Granite Flooring	Oil bound washable distemper on smooth surface applied with putty	Oil bound washable distemper on smooth surface applied with putty	Doors: Steel door as per clause no. 6.10.a Windows & Ventilators: Aluminium Windows & Ventilators As per clause no. 6.10.c
3	Toilet	Anti skid Ceramic tiles with white cement.	Ceramic glazed tile toilet, for pantry above working platform up to 750 mm.	Oil bound washable distemper on smooth surface applied with putty	Doors, Windows & Ventilators: Aluminium Doors, Windows & Ventilators As per clause no. 6.10.c
4	Cellar	52 mm thick CC flooring with concrete hardener topping	Oil bound washable distemper on smooth surface applied with putty	Oil bound washable distemper on smooth surface applied with putty	Doors: Steel door as per clause no. 6.10.a Windows & Ventilators: Aluminium Windows & Ventilators As per clause no. 6.10.c
5	Other areas not specified	Double charged Vitrified tile of size 600x600mm of make Kajaria or equivalent	Oil bound washable distemper on smooth surface applied with putty	Oil bound washable distemper on smooth surface applied with putty	Doors: Steel door as per clause no. 6.10.a Windows & Ventilators: Aluminium Windows & Ventilators As per clause no. 6.10.c

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6	Switchgear Room/GIS Room	Self leveling Epoxy flooring 2mm thick after application of 2mm thick screed over 52 mm thick CC flooring with concrete hardener topping	Oil bound washable distemper on smooth surface applied with putty	Oil bound washable distemper on smooth surface applied with putty	Doors: 02 hours fire rated doors as per clause no. 6.10.b Windows & Ventilators: Aluminium Windows & Ventilators As per clause no. 6.10.c
8	All external surfaces (S/stn building, boundary wall and other structures) shall have Texture finish of Make UTTPL (Ultratech Texture Paints Pvt. LTD) approved by BRPL.				
9	External finishing of the building on area other than the area of texture finish shall be done using Acrylic Smooth exterior paint (painting) of Asian paints or equivalent The paint shade as approved by BRPL				



GEOTECHNICAL REPORT

PROPOSED 66 kV GRID SUBSTATION PROJECT AT NAWADA, NEW DELHI

SUBMITTED TO:

M/S. BSES RAJDHANI POWER LIMITED

1st Floor, C-Block, BSES Bhawan, Nehru Place, Delhi – 110 019.

Project No. 19083

Dated. June, 2019

Revision-0

RAO ENGINEERING ENTERPRISES

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June 07th, 2019

Project No. 19083

M/s. BSES Rajdhani Power Limited
1st Floor, C-Block, BSES Bhawan,
Nehru Place, Delhi – 110 019

Sub: Final Report on Soil Investigation Work for Proposed 66 KV Grid Substation Project at Nawada, New Delhi

We have carried out the soil investigation work in accordance with your Work Order No. SER/DSC/23562190 dated May 24th, 2019. We thank you for your business, and hope that you are satisfied with our services rendered.

This Final Report presents our findings based on the soil investigation conducted by us at the project site. This report presents the field and laboratory test data along with our engineering recommendations, which shall help you in deciding the optimum foundation arrangement for use on site.

We have prepared this report based on our findings on site as well as our experience gained in our previous projects completed over the past 15 years. We appreciate the opportunity to perform this investigation for you and have pleasure in submitting this report. Please contact us when we can be of further service to you.

Yours faithfully,
RAO ENGINEERING ENTERPRISES

(G.R.RAO)





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1.0 **INTRODUCTION**

1.1 **Project Description**

This soil investigation work, whose results are being presented herewith, has been carried out for Proposed 66 KV Grid Substation Project at Nawada, New Delhi. M/s. Rao Engineering Enterprises has been retained by M/s. BSES Rajdhani Power Limited for carrying out the Geotechnical Investigation at the project site.

1.2 **Aim of Soil Investigation**

Soil investigation has been conducted at the site in order to evaluate the parameters required for design of foundations. These parameters are:

- a) Type of foundation on which the proposed super structure will be supported.
- b) Depth of foundation, and
- c) Allowable bearing pressure at the founding level.

To evaluate these parameters, following engineering properties of the Sub-Soil have been studied:

Sub-soil penetration resistance characteristics which have been determined insitu. Properties like particle size distribution, atterberg's limits, bulk density, moisture content, and shear strength parameters; which have been determined in the laboratory by conducting testing of both disturbed as well as undisturbed samples.

1.3 **Scope of Work**

The stipulated scope of work comprised of the following:

1. Mobilization of equipment and personnel to the site and back.
2. Sinking five (5) boreholes to 10.0 m depth or refusal whichever is encountered earlier, observing ground water table levels, conducting required field and laboratory tests and their analysis.
3. conducting one (1) electrical resistivity test (ERT's) to provide data for the grounding systems;
4. Preparation and submission of technical report in triplicate.

2.0 **FIELD INVESTIGATIONS**

2.1 **Soil Borings**

The boreholes were progressed using mechanized shell and auger drilling rig to the specified depth. The diameter of the borehole was 150 mm. Where caving of the borehole occurred, casing was used to keep the borehole stable. The work was in general accordance with IS: 1892-1979.



Standard Penetration Tests (SPT) were conducted in the boreholes at 1.5 m depth interval up to 15 m depth. The tests were conducted by connecting a split spoon sampler to 'A' rods and driving it by 45 cm using a 63.5 kg hammer falling freely from a height of 75 cm. The tests were conducted in accordance with IS: 2131-1981.

The number of blows for each 15 cm of penetration of the split spoon sampler was recorded. The blows required to penetrate the initial 15 cm of the split spoon for seating the sampler is ignored due to the possible presence of loose materials or cuttings from the drilling operation. The cumulative number of blows required to penetrate the balance 30 cm of the 45 cm sampling interval is termed the SPT value or the 'N' value.

Where the split spoon sampler did not penetrate the initial 15 cm seating in a total of 100 blows, it is indicated "Ref" for an indicated amount of penetration. The 'N' values are presented on the soil profile for each borehole.

Disturbed samples were collected from the split spoon after conducting SPT. The samples were preserved in transparent polythene bags. Undisturbed soil samples were collected by attaching 75 mm diameter thin walled 'Shelby' tubes and driving the sampler by light-hammering using a 63.5 kg hammer in accordance with IS: 2132-1986. The tubes were sealed with wax at both ends. All samples were transported to our laboratory for further examination and testing.

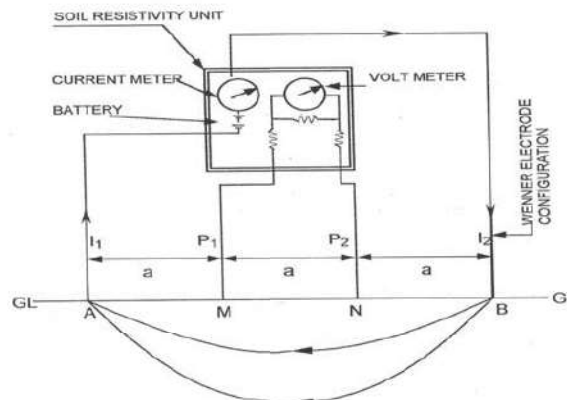
2.2 Groundwater

Groundwater level was measured in the boreholes after drilling and sampling was completed. The measured water levels are recorded on the individual soil profiles.

2.3 Electrical Resistivity Tests

Electrical resistivity of the substratum (soil) at the site was determined at specified locations. The electrical resistivity test is used for shallow subsurface exploration by means of electrical measures made at the ground surface. Resistivity measurements are made by driving four electrodes about 10 to 15 cm in to the ground at pre-selected electrode spacing. We used the Wenner's electrode configuration for this study.

The schematic arrangement of electrodes is shown below:



NOTE: I_1 AND I_2 ARE CURRENT ELECTRODES
 P_1 AND P_2 ARE POTENTIAL ELECTRODES



The four electrodes were spaced at equal distance along a line. The test procedure is in accordance with IS: 3043:1987 RA 2006.

Measurements are made by causing a current, 'I', to pass through the earth and distribute within a relatively large hemispherical earth mass. The portion of the current that flows along the surface produces a voltage drop, 'V'. The resistance 'R', ratio of voltage drop 'V' to current 'I' is directly measured by Digital Earth Resistance Tester. The resistivity is determined from the following equation:

$$\rho = 2 \pi a R$$

where:

ρ = apparent resistivity, ohm-m
 a = spacing between the electrodes, meter
 R = resistance, ohms

Results are presented as semi-logarithmic plot of apparent resistivity versus electrode spacing, as well as in the form of polar curves, as specified by IS: 3043:1987 RA 2006.

3.0 LABORATORY TESTS

Laboratory tests have been conducted on various selected soil samples in the laboratory:

Laboratory Test		IS Code Referred
Bulk Density		By calculations
Natural Moisture Content		IS : 2720 (Part-2)-1973, RA-2010
Specific Gravity		IS : 2720 (Part-3)-1980, RA-2007
Grain Size Analysis		IS : 2720 (Part-4)-1985, RA-2010
Liquid Limit and Plastic Limit		IS : 2720 (Part-5)-1985, RA-2010
Unconsolidated Undrained Triaxial Shear Test		IS : 2720 (Part-11)-1993, RA-2007
Consolidated Drained Direct Shear Test		IS : 2720 (Part-13)-1986, RA-2010
Chemical Analysis of soil	pH value	IS : 2720 (Part 26)-1987, RA-2007
	Sulphates	IS : 2720 (Part-27)-1977, RA-2010
	Chlorides	IS : 3025 (Part-32)-1988, RA-2009

4.0 GENERAL SITE CONDITIONS

4.1 Site Stratigraphy

The surficial soils at the site consist of sandy silt to about 6.0-9.0 m depth below EGL. However at BH-2 & 5 locations, a heterogenous fill of sandy silt with polyethene was met to about 1.0 m depth below EGL. Further, silty sand was encountered to the final explored depth of 10.45 m below EGL.

The field SPT N-values generally range from 9 to 17 to about 4.5 m depth and range from 12 to 31 to about 7.5 m depth below EGL. Further, field SPT-N value range from 34 to 56 to the final explored depth of 10.45 m below EGL.



All test results are presented on the individual soil profiles on Sheet No. 1 to 5. A summary of the borehole profiles is illustrated on Sheet No. 6. Plots of field and corrected SPT values versus depth are presented on Sheet No. 7 & 8, respectively.

4.2 Groundwater

Based on our measurements in the completed boreholes, groundwater was not met to final explored depth of 10.45 m below EGL during the period of our field investigations (June, 2019). Fluctuations may occur in the measured ground levels due to seasonal variations in rainfall, surface evaporation rates.

5.0 FIELD TEST RESULTS

5.1 Electrical Resistivity Test Result

One (1) electrical resistivity test was conducted at the project site as per IS: 3043-1987. The test was conducted using the Wenner's configuration. The apparent resistivity value obtained has been analyzed to generate the polar curve. The polar curve is used to compute the mean resistivity.

Mean resistivity value at the electrical resistivity test (ERT) location is summarized in the table below:

Test Designation	Mean Resistivity, ohm-m	Corrosion potential*	Presentation of Results
ERT-1	6.2	Severely Corrosive	Sheet No. 9 & 10

* As per Clause 8.6.1 of Amendment No. 2 to IS: 3043-1987, dated January 2010.

The above value may be used for design of the electrical grounding system. The data may also be used to assess the corrosion potential for buried utility lines as per the guideline given in IS 3043-1987.

6.0 FOUNDATION ANALYSIS

6.1 General

For designing the foundation system, the following parameters are required:

- a) Suitable type of foundation on which the proposed super-structure can be supported.
- b) Depth of these foundations, and
- c) Allowable bearing pressure at the founding level corresponding to various footing sizes.

A suitable foundation for any structure should have an adequate factor of safety against exceeding the bearing capacity of the supporting soils. Also, the vertical movements due to compression of the soils should be within tolerable limits for the structure. We consider that foundation designed in accordance with the recommendations given herein will satisfy these criteria.



6.2 Liquefaction Susceptibility Assessment

Liquefaction is defined as the transformation of a granular material from a solid to a liquefied state as a consequence of increased pore-water pressure and reduced effective stress (Marcuson, 1978)⁽¹⁾. Increased pore pressure may be induced by the tendency of granular materials to compact when subjected to cyclic shear deformation, such as in the event of an earthquake.

As per IS: 1893-2016, liquefaction is likely in loose fine sand (SP) below water table. The following points are highlighted for the soils encountered at the site, with reference to the liquefaction susceptibility.

- As discussed in section 4.1, the soil at the site consist of sandy silt to the final explored depth of 10.45 m depth below EGL. The sandy silt stratum is not likely to liquefy in the event of earthquake due to high fines content.
- Groundwater was not met at the time of our field investigation (May, 2019).

Based on our initial assessment, reviewing the all soil parameters like in-situ density, groundwater level, fines content, SPT values, etc., we are of the opinion that soils at the site are not likely to liquefy at the project site in the event of the earthquake.

According to Fig.1 of IS: 1893 (Part1)-2016 showing seismic zones, the proposed site falls under Zone-IV. The design for seismic forces should be done considering the project in Zone-IV.

6.3 Foundation Type and Depth

Type of foundation to be adopted for a particular structure depends upon the loading intensity at the foundation level and the configuration of loading points.

Reviewing the stratigraphy of the site on the basis of boreholes data, SPT values & laboratory test results, we are of the opinion that open foundation is feasible foundation scheme to support the structural load.

Our recommended values of net allowable bearing pressures at minimum 1.5 m depth (at least 0.5 m into the natural strata) for open foundation are presented in Section 7.0.

Interconnecting beams should be provided either at plinth level or at foundation level in order to restrict differential settlements and to provide rigidity to the structure during earthquakes.

6.4 Allowable Bearing Pressure

Following criterion have been considered for evaluating the bearing capacity values:

- (a) Settlement criteria

⁽¹⁾ Marcuson, W.F. (III) (1978), "Definition of terms related to liquefaction", J. Geotech Engg. Div., SCE, 104(9), 1197-1200.



(b) Shear failure criterion

Shear failure condition as per I.S. 6403 has been considered for allowable bearing pressure computation. Allowable settlement value of 40 mm & 50 mm has been considered for deducing shear strength value.

6.5 Sample Calculations (Open Foundation)

Type of foundation	Open foundation
Depth of foundation	1.5 m below EGL
Width of foundation	3.0 X 3.0 m

I. SETTLEMENT CRITERIA (AS PER IS - 8009, PART-1, 1976, FIG.9, PAGE-17)

Weighted Average minimum Corrected 'N' value	13
Settlement undergone by footing per unit pressure	23.9 mm
Total Settlement undergone by footing (considering water table Correction factor taken as 0.6 for Worst condition)	49.6 mm
Allowable bearing pressure Corresponding to 50 mm allowable Settlement.	13.0 T/m ²

III. SHEAR FAILURE CRITERION

The bearing capacity equation used is as follows:

$$q_{net\ safe} = \frac{1}{F} [cN_c\zeta_c d_c + q(N_q - 1)\zeta_q d_q + 0.5 B\gamma N_\gamma \zeta_\gamma d_\gamma R_w]$$

Where:

- $q_{net\ safe}$ = safe net bearing capacity of soil based on the shear failure criterion.
- q = overburden pressure
- R_w = water table correction factor
- F = Factor of safety, taken as equal to 2.5 in accordance with IS: 1904-1986.
- $\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors. For Strip footings, $\zeta_c = \zeta_q = \zeta_\gamma = 1$
For Square footing, $\zeta_c = 1.3, \zeta_q = 1.2, \zeta_\gamma = 0.6$
- d_c, d_q, d_γ = Depth factors

- For $\phi \leq 10$, $d_c = 1 + 0.2 \tan (45 + \phi / 2) D / B$, $d_q = d_\gamma = 1$
- For $\phi > 10$, $d_q = d_\gamma = 1 + 0.1 \tan (45 + \phi / 2) D / B$

Cohesion, $c = 6.0 \text{ T/m}^2$
Angle of shearing resistance, $\phi = 5 \text{ degrees}$



Bearing Capacity factors:

General Shear Failure :	$N_c =$	6.49	$N_q =$	1.57	$N_\gamma =$	0.45
Local Shear Failure :	$N'_c =$	5.99	$N'_q =$	1.35	$N'_\gamma =$	0.27

Density at Foundation Level, $\gamma = 1.70$ gms/cc
 Net Safe Bearing Capacity, $q_{net\ safe} = 17.7$ T/m²
 (considering average of local & general shear criteria)

6.6 Definition of Gross and Net Bearing Pressure

For the purposes of this report, the net allowable bearing pressure should be calculated as the difference between total load on the foundation and the weight of the soil overlying the foundation divided by the effective area of the foundation. The gross bearing pressure is the total pressure at the foundation level including overburden pressure and surcharge load.

The following equations may be used –

$$q_{net} = [(P_s + W_f + W_s) / A_f] - S_v$$

$$q_{gross} = q_{net} + S_v = (P_s + W_f + W_s) / A_f$$

where:

- q_{net} = net allowable bearing pressure
- q_{gross} = gross bearing pressure
- P_s = superimposed static load on foundation
- W_f = weight of foundation
- W_s = weight of soil overlying foundation
- A_f = effective area of foundation
- S_v = overburden pressure at foundation level prior to excavation for foundation.

It may please be noted that safe bearing pressures recommended in this report refer to “**net values**”. Where filling is done, it should be treated as a surcharge over the foundation.

7.0 RECOMMENDATIONS

The following table presents our recommended values of net allowable bearing pressures for open foundations bearing at 1.5-2.0 m depth below EGL:

Foundation Depth below EGL, m	Recommended Net Allowable Bearing Pressure, T/m ²	
	Total Settlement = 40 mm	Total Settlement = 50 mm
1.5	10.4	13.0
2.0	11.6	14.5



The above values include a safety factor of 2.5. The appropriate value of net bearing pressure may be selected as per the permissible settlement criterion.

Net bearing pressure for foundations at intermediate depths may be interpolated linearly between the values given above. Fill placed above EGL should be treated as surcharge load. Foundation should be seated 0.5 m into natural soil.

In order to restrict the influence of adjacent footings on each other, the lateral edge-to-edge spacing between the foundations should at least be equal to "0.8B" where "B" is the width of the larger footing.

8.0 **CHEMICAL ATTACK**

Results of chemical test on selected soil and groundwater samples are presented on Sheet No. 16.

The results indicate that the soils contain 0.10-0.13 percent sulphates and 0.09-0.14 percent chlorides. The pH value of soil is 7.2-7.5.

IS: 456-2000 recommends that precautions should be taken against chemical degradation of concrete if

- sulphates content of the soils exceeds 0.2 percent, or
- groundwater contains more than 300 mg /litre of sulphates (SO_3).

Comparing the test results with these specified limits, the sulphate content of the soil is in the specified limit. Groundwater was not encountered and is not likely to influence foundation concrete. Therefore, strata at the site may be treated in Class-1 category as described on IS: 456-2000.

In our opinion, the soils at site are not aggressive to foundation concrete. We recommend the following as a good practice to limit the potential for chemical attack:

- (1) The cement content in concrete for open foundation should be at least 280 kg/m³.
- (2) Water cement ratio in foundation concrete should generally not exceed 0.55.
- (3) A clear concrete cover over the reinforcement steel of at least 50 mm should be provided for all foundations.
- (4) Foundation concrete should be densified adequately using a vibrator so as to form a dense impervious mass.

9.0 **VARIABILITY IN SUBSURFACE CONDITIONS**

Subsurface conditions encountered during construction may vary somewhat from the conditions encountered during the site investigation. In case significant variations are encountered during construction, we request to be notified so that our engineers may review the recommendations in this report in light of these variations.

SOIL PROFILE: BH-1







Depth, m		Sample No.	Field SPT 'N' Value	Symbol	SOIL DESCRIPTION	Depth of Strata, (m)	Grain Size Analysis				Atterberg Limits			Specific Gravity	Density and Moisture			Shear Tests		
							Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Plasticity Index (%)		Bulk Density (gms/cm ³)	Dry Density (gms/cm ³)	Moisture Content (%)	Type of Test	Cohesion Intercept, c (kg/cm ²)	Angle of Internal Friction, φ (degrees)
0.50	1.00	DS-1			Light grey sandy silt of low plasticity (ML-CL)															
1.50	1.95	SPT-1	11			3.00	2	24	69	5										
2.25	2.55	UDS-1			Light grey sandy silt of non plasticity (ML)					23.6	17.7	5.9	2.66	1.73	1.56	11.2	UUT	0.55	10	
3.00	3.45	SPT-2	10				0	37	60	3										
4.50	4.95	SPT-3	12								20.4		N.P	2.64	1.77	1.61	10.1			
5.25	5.55	UDS-2			Light grey silty sand (SM)															
6.00	6.45	SPT-4	19			7.50	0	43	54	3										
7.50	7.95	SPT-5	46				0	58	42	0				2.63						
8.25	8.55	UDS-3			Light grey silty sand (SM)									1.83	1.67	9.6	DST	0.00	32	
9.00	9.45	SPT-6	53																	
10.00	10.45	SPT-7	55			10.45	0	57	43	0										

UUT : Unconsolidated Undrained Triaxial Shear Test

DST: Drained Direct Shear Test, UCS : Unconfined Compressive Strength

Remoulded Sample +

SOIL PROFILE: BH-2

Depth, m		Sample No.	Field SPT 'N' Value	Symbol	SOIL DESCRIPTION	Depth of Strata, (m)	Grain Size Analysis				Atterberg Limits			Specific Gravity	Density and Moisture			Shear Tests		
							Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Plasticity Index (%)		Bulk Density (gms/cm ³)	Dry Density (gms/cm ³)	Moisture Content (%)	Type of Test	Cohesion Intercept, c (kg/cm ²)	Angle of Internal Friction, φ (degrees)
0.50	1.00	DS-1			Fill: sandy silt with polythene bags	1.00														
1.50	1.95	SPT-1	11		Light brown sandy silt of low plasticity (ML-CL)	4.50				24.2	17.6	6.6	2.66	1.73	1.56	11.2	UUT	0.60	10	
2.25	2.55	UDS-1					4	22	69	5										
3.00	3.45	SPT-2	12		Light grey sandy silt of non plasticity (ML)	7.50				23.4	17.1	6.3	2.64	1.79	1.63	9.7	DST	0.00	29	
4.50	4.95	SPT-3	18				0	33	64	3										
5.25	5.55	UDS-2								21.3	N.P									
6.00	6.45	SPT-4	23		Light grey silty sand (SM)	10.45							2.64	1.82	1.66	9.6				
7.50	7.95	SPT-5	34				0	61	39	0										
8.25	8.55	UDS-3																		
9.00	9.45	SPT-6	51																	
10.00	10.45	SPT-7	54				0	58	42	0										

UUT : Unconsolidated Undrained Triaxial Shear Test

DST: Drained Direct Shear Test, UCS : Unconfined Compressive Strength

Remoulded Sample +

SOIL PROFILE: BH-3

Depth, m		Sample No.	Field SPT 'N' Value	Symbol	SOIL DESCRIPTION	Depth of Strata, (m)	Grain Size Analysis				Atterberg Limits			Specific Gravity	Density and Moisture			Shear Tests		
From	To						Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Plasticity Index (%)		Bulk Density (gms/cm ³)	Dry Density (gms/cm ³)	Moisture Content (%)	Type of Test	Cohesion Intercept, c (kg/cm ²)	Angle of Internal Friction, φ (degrees)
0.50	1.00	DS-1			Light grey sandy silt of low plasticity (ML-CL)	1.50	0	22	72	6										
1.50	1.95	SPT-1	13		Light grey sandy silt of non plasticity (ML)						21.2	N.P								
2.25	2.55	UDS-1				3.00	6	32	59	3			2.63	1.72	1.56	10.1	DST	0.00	29	
3.00	3.45	SPT-2	17																	
4.50	4.95	SPT-3	25		Light grey silty sand (SM)		0	63	37	0			2.64							
5.25	5.55	UDS-2				6.00								1.78	1.63	9.2				
6.00	6.45	SPT-4	31								20.9	N.P								
7.50	7.95	SPT-5	39		Light grey sandy silt of low plasticity (ML-CL)		3	36	58	3			2.63							
8.25	8.55	UDS-3				9.00					20.5	N.P		1.84	1.66	10.6	DST	0.00	32	
9.00	9.45	SPT-6	42				0	61	39	0										
10.00	10.45	SPT-7	56		Light grey silty sand (SM)	10.45														

UUT : Unconsolidated Undrained Triaxial Shear Test

DST: Drained Direct Shear Test, UCS : Unconfined Compressive Strength

Remoulded Sample +

SOIL PROFILE: BH-4





Depth, m		Sample No.	Field SPT 'N' Value	Symbol	SOIL DESCRIPTION	Depth of Strata, (m)	Grain Size Analysis				Atterberg Limits			Specific Gravity	Density and Moisture			Shear Tests		
From	To						Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Plasticity Index (%)		Bulk Density (gms/cm ³)	Dry Density (gms/cm ³)	Moisture Content (%)	Type of Test	Cohesion Intercept, c (kg/cm ²)	Angle of Internal Friction, φ (degrees)
0.50	1.00	DS-1			Light grey sandy silt of low plasticity (ML-CL)	1.50	0	22	72	6										
1.50	1.95	SPT-1	10		Light grey sandy silt of non plasticity (ML)		0	38	59	3	21.2	N.P	2.63	1.73	1.57	10.2	DST	0.00	29	
2.25	2.55	UDS-1																		
3.00	3.45	SPT-2	15																	
4.50	4.95	SPT-3	18																	
5.25	5.55	UDS-2			6.00		3	36	58	3			2.65	1.80	1.63	10.5				
6.00	6.45	SPT-4	26		Light grey sandy silt of low plasticity (ML-CL)		3	22	70	5	24.2	18.9	5.3	2.65	1.89	1.68	12.3	UUT	1.20	10
7.50	7.95	SPT-5	31																	
8.25	8.55	UDS-3			9.00		3	22	70	5	23.7	17.5	6.2	2.63	1.89	1.68	12.3	UUT	1.20	10
9.00	9.45	SPT-6	45		Light grey silty sand (SM)		0	63	37	0			2.63							
10.00	10.45	SPT-7	53																	

UUT : Unconsolidated Undrained Triaxial Shear Test

DST: Drained Direct Shear Test, UCS : Unconfined Compressive Strength

Remoulded Sample +

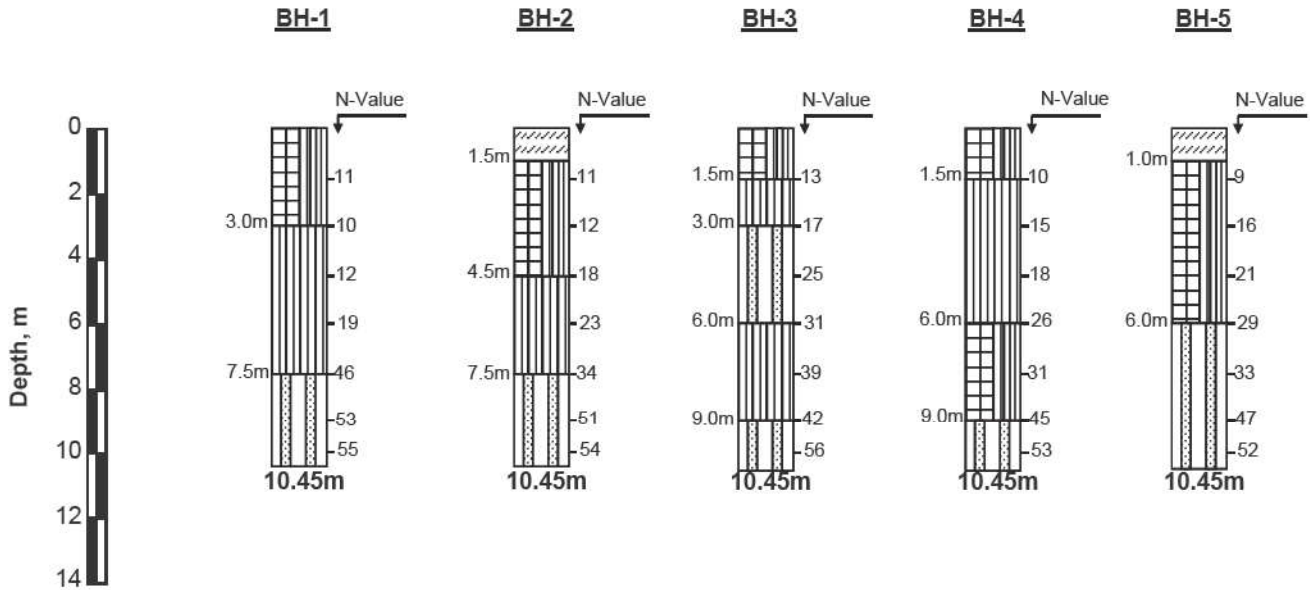
SOIL PROFILE: BH-5

Depth, m		Sample No.	Field SPT 'N' Value	Symbol	SOIL DESCRIPTION	Depth of Strata, (m)	Grain Size Analysis				Atterberg Limits			Specific Gravity	Density and Moisture			Shear Tests			
							Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Plasticity Index (%)		Bulk Density (gms/cm ³)	Dry Density (gms/cm ³)	Moisture Content (%)	Type of Test	Cohesion Intercept, c (kg/cm ²)	Angle of Internal Friction, φ (degrees)	
0.50	1.00	DS-1			Fill: sandy silt with polythene bags	1.00															
1.50	1.95	SPT-1	9		Light grey sandy silt of low plasticity (ML-CL)	6.00	0	27	67	6											
2.25	2.55	UDS-1										24.1	18.9	5.2	2.65	1.74	1.55	12.3	UUT	0.55	11
3.00	3.45	SPT-2	16																		
4.50	4.95	SPT-3	21																		
5.25	5.55	UDS-2							3	26	66	5	23.5	17.4	6.1		1.84	1.65	11.5		
6.00	6.45	SPT-4	29		Light grey sandy silt of low plasticity (ML-CL)	10.45	0	56	44	0				2.63							
7.50	7.95	SPT-5	33																		
8.25	8.55	UDS-3														1.84	1.66	10.7	DST	0.00	32
9.00	9.45	SPT-6	47						0	59	41	0									
10.00	10.45	SPT-7	52										2.64								

UUT : Unconsolidated Undrained Triaxial Shear Test

DST: Drained Direct Shear Test, UCS : Unconfined Compressive Strength

Remoulded Sample +



LEGEND	
SYMBOL	DESCRIPTION
	Fill: Silty sand with polythene bags
	Sandy silt (ML)
	Sandy silt (ML-CL)
	Silty sand (SM)

Summary of Borehole Profiles

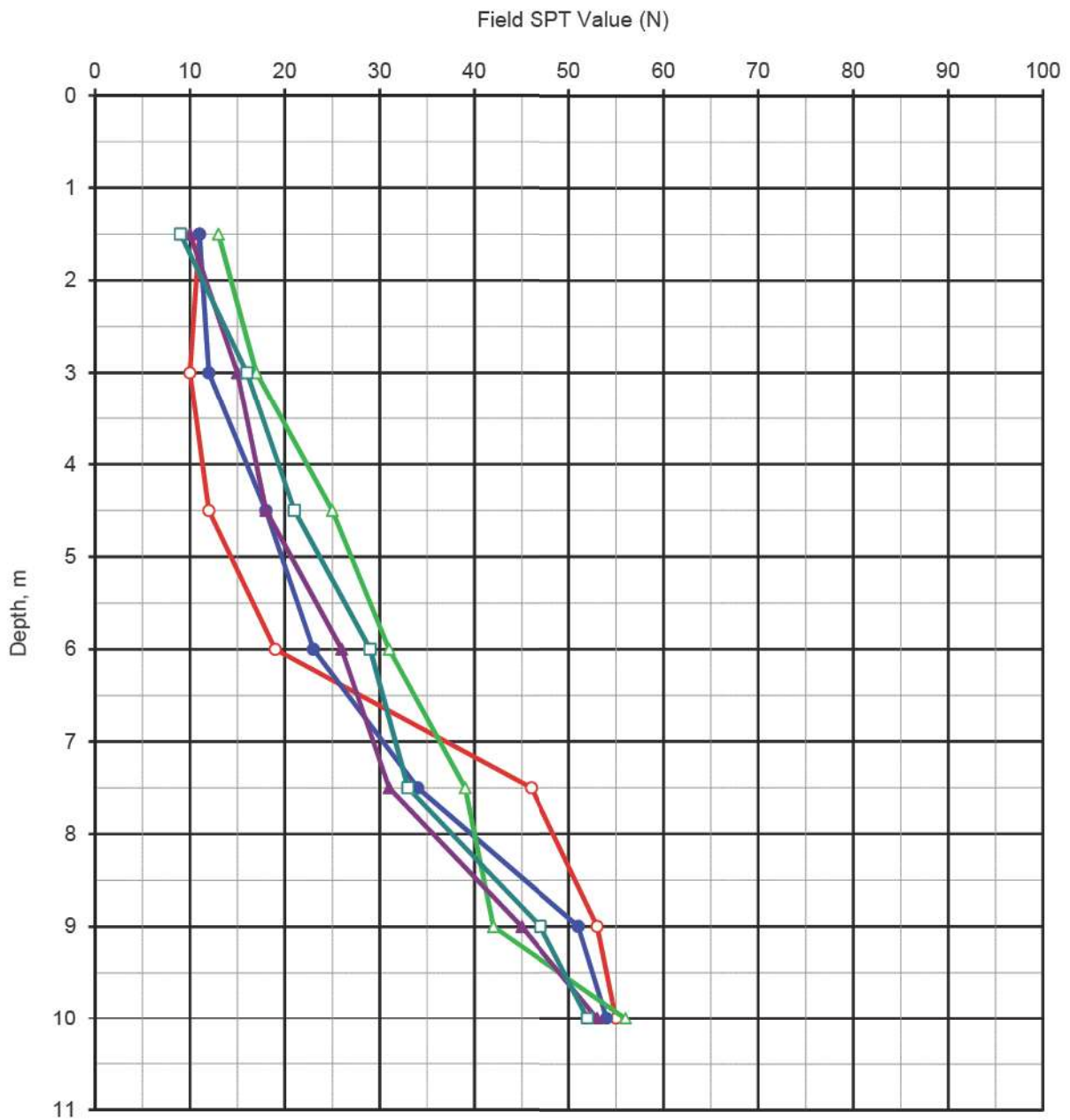
Proposed 66 KV Grid Substation Project at Nawada, New Delhi



Standard Penetration Test

IS : 2131-1981, RA-2007

Borehole Details	
Symbol	Borehole Number
	BH-1
	BH-2
	BH-3
	BH-4
	BH-5



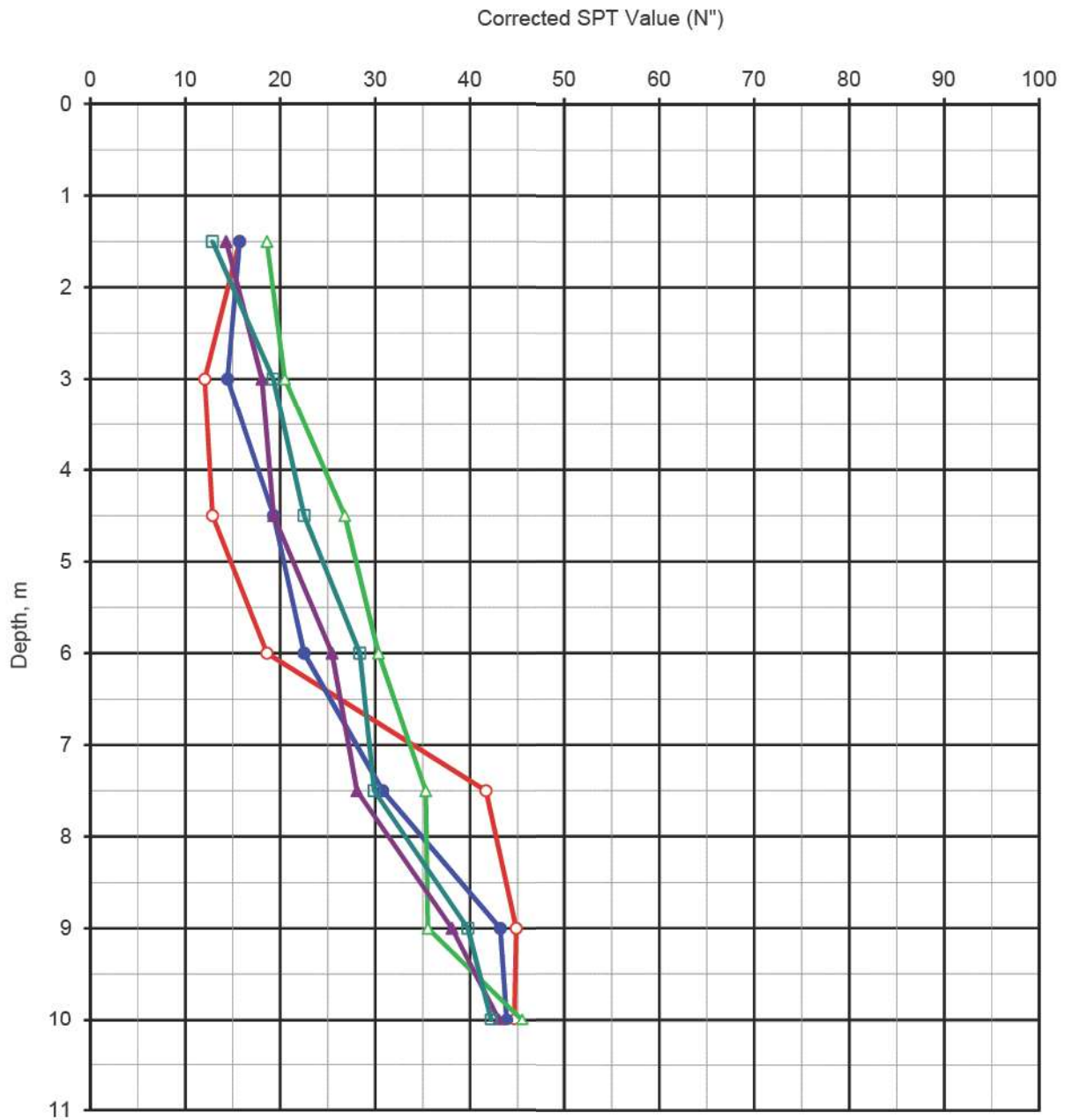
Field SPT Values vs. Depth



Standard Penetration Test

IS : 2131-1981, RA-2007

Borehole Details	
Symbol	Borehole Number
	BH-1
	BH-2
	BH-3
	BH-4
	BH-5

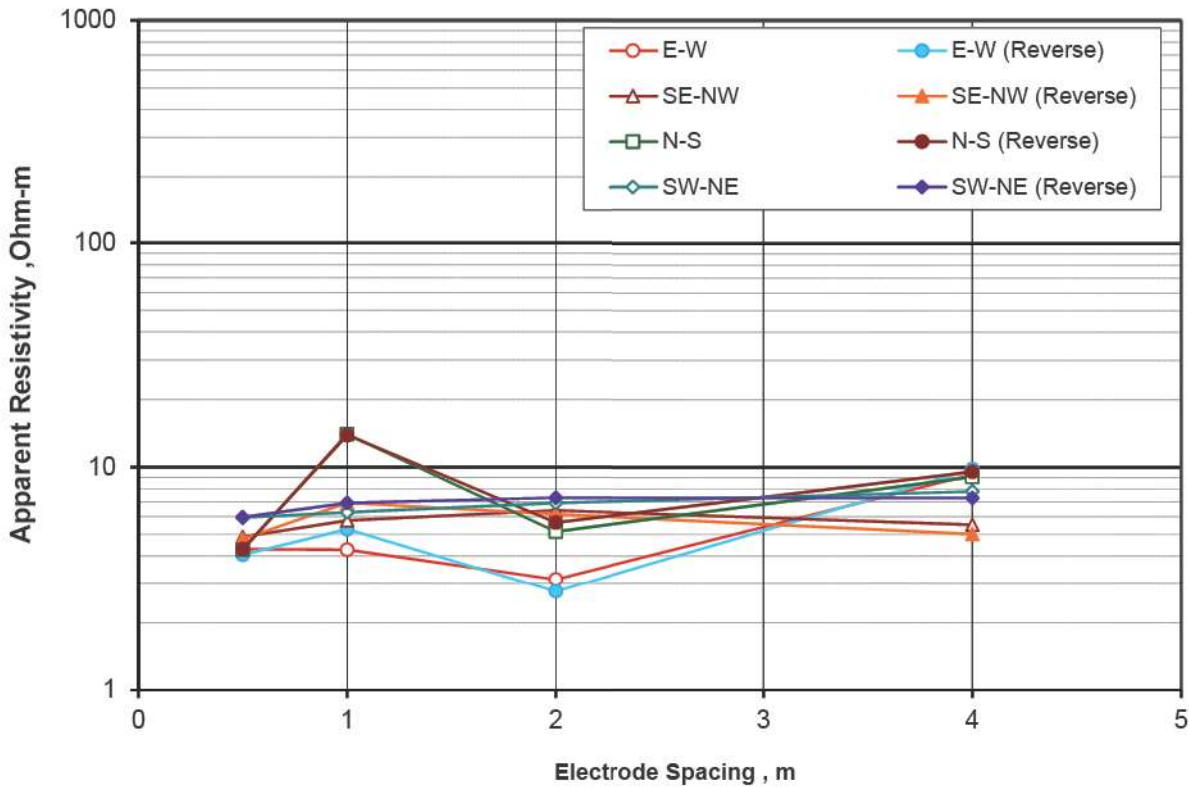


Corrected SPT Values vs. Depth



Electrical Resistivity Test No.: ERT-1
IS: 3043-1987, RA-2006

Test Details
Test No. : ERT-1



Electrode Spacing, m	Apparent Resistivity, Ohm-m							
	E-W	E-W (Reverse)	SE-NW	SE-NW (Reverse)	N-S	N-S (Reverse)	SW-NE	SW-NE (Reverse)
0.5	4.3	4.1	4.9	4.8	4.3	4.3	5.9	6.0
1.0	4.3	5.3	5.8	6.9	14.0	13.9	6.3	6.9
2.0	3.1	2.8	6.4	6.2	5.2	5.7	6.9	7.3
4.0	9.3	9.8	5.5	5.0	9.0	9.6	7.8	7.3
6.0	Space Not Available							
8.0								
10.0								
Mean Resistivity	5.3	5.5	5.6	5.7	8.1	8.3	6.7	6.9

Mean Resistivity Value, ohm-m : 6.2 ohm-m

Apparent Resistivity Values & Curves

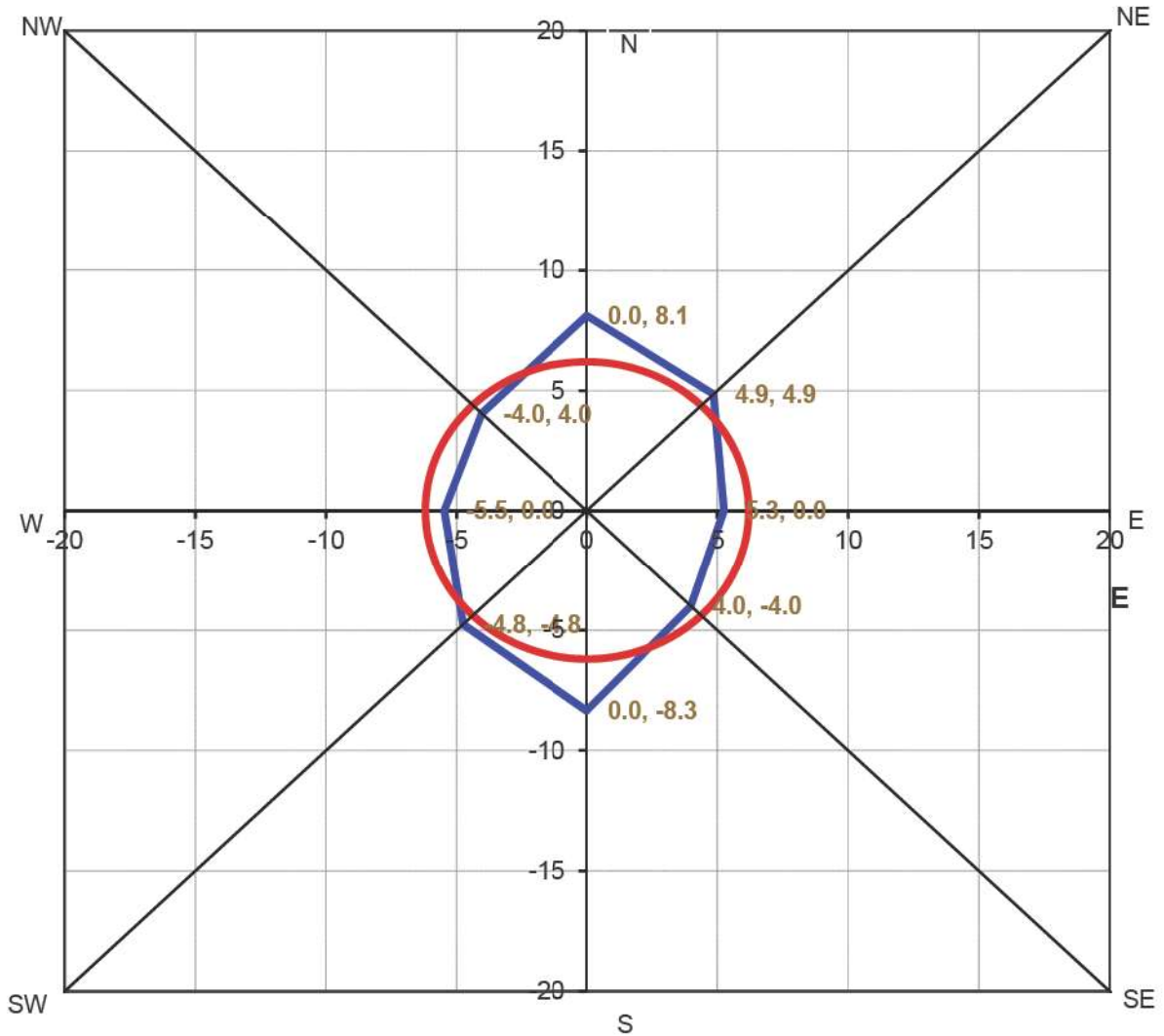
Proposed 66 KV Grid Substation Project at Nawada, New Delhi



Electrical Resistivity Test No.: ERT-1

IS: 3043-1987, RA-2006

Test Details
Test No. : ERT-1

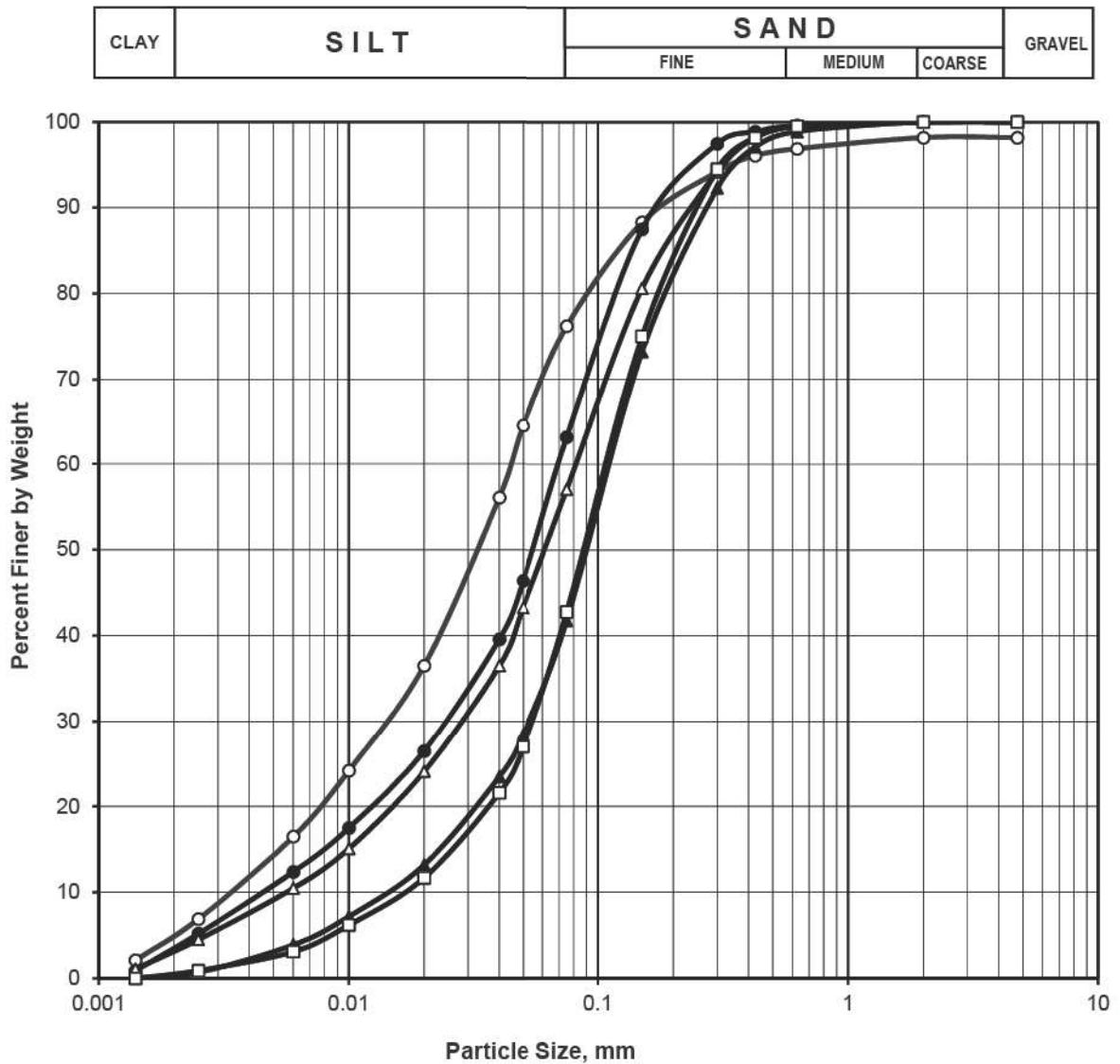


Total Area of Polygon : 120

Radius of Equivalent Circle=Mean Resistivity : 6.2 ohm-m

Polar Resistivity Curves

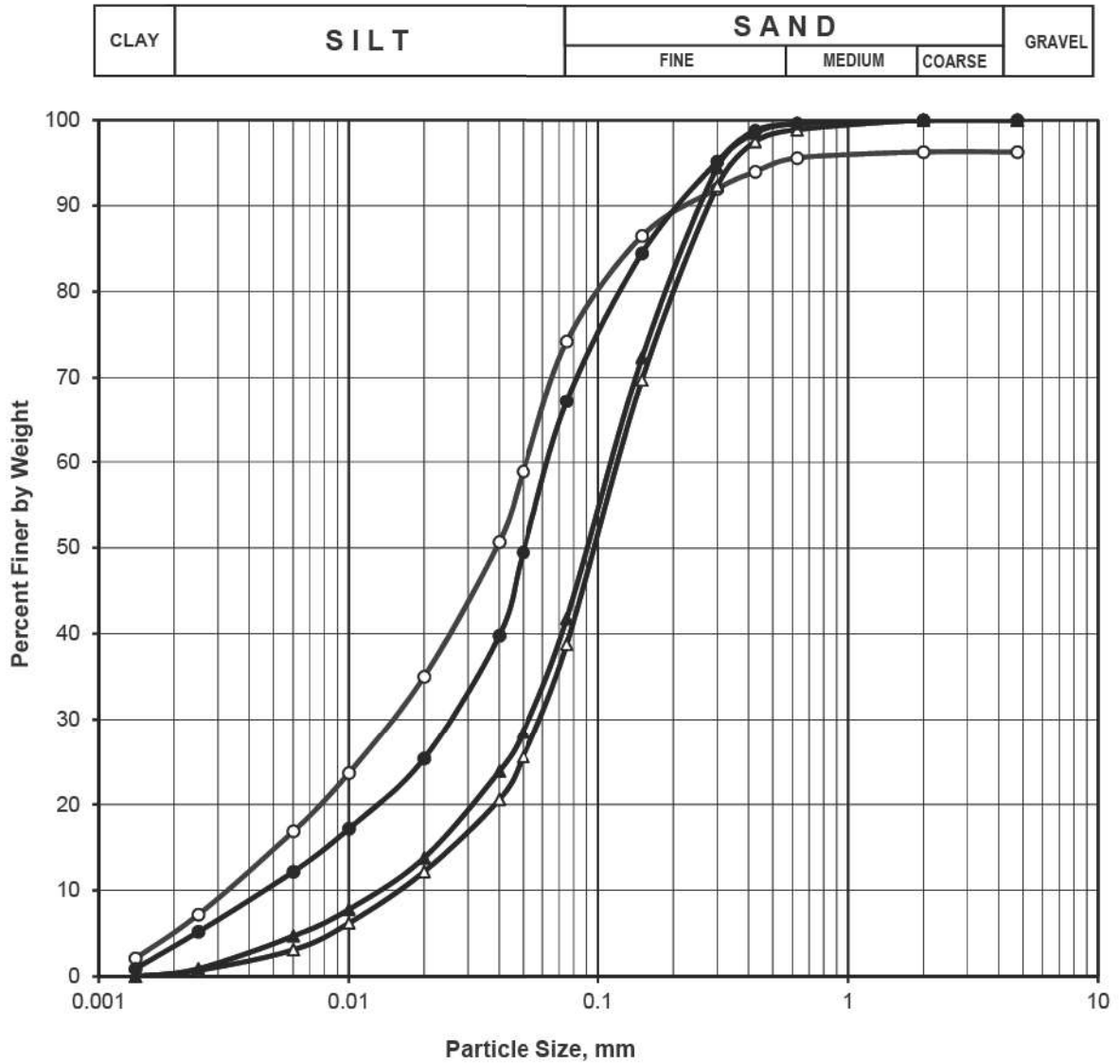
Proposed 66 KV Grid Substation Project at Nawada, New Delhi



SYMBOL	BH	DEPTH (m)	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
○	1	1.50	Sandy silt (ML-CL)	2	24	69	5
●	1	3.00	Sandy silt (ML)	0	37	60	3
△	1	6.00	Sandy silt (ML)	0	43	54	3
▲	1	7.50	Silty sand (SM)	0	58	42	0
□	1	10.00	Silty sand (SM)	0	57	43	0

Grain Size Analysis

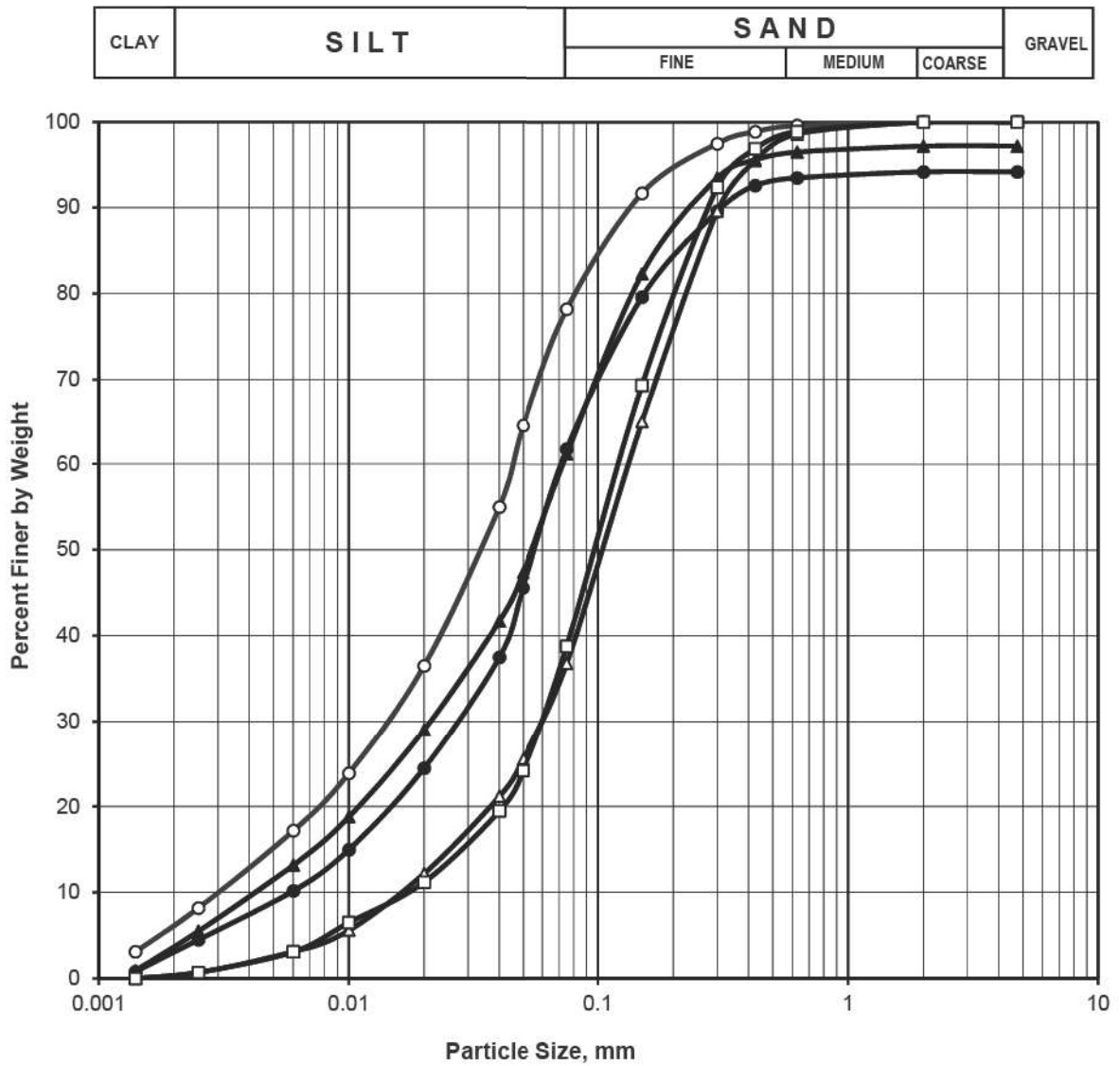
Proposed 66 KV Grid Substation Project at Nawada, New Delhi



SYMBOL	BH	DEPTH (m)	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
○	2	2.25	Sandy silt (ML-CL)	4	22	69	5
●	2	4.50	Sandy silt (ML)	0	33	64	3
△	2	7.50	Silty sand (SM)	0	61	39	0
▲	2	10.00	Silty sand (SM)	0	58	42	0

Grain Size Analysis

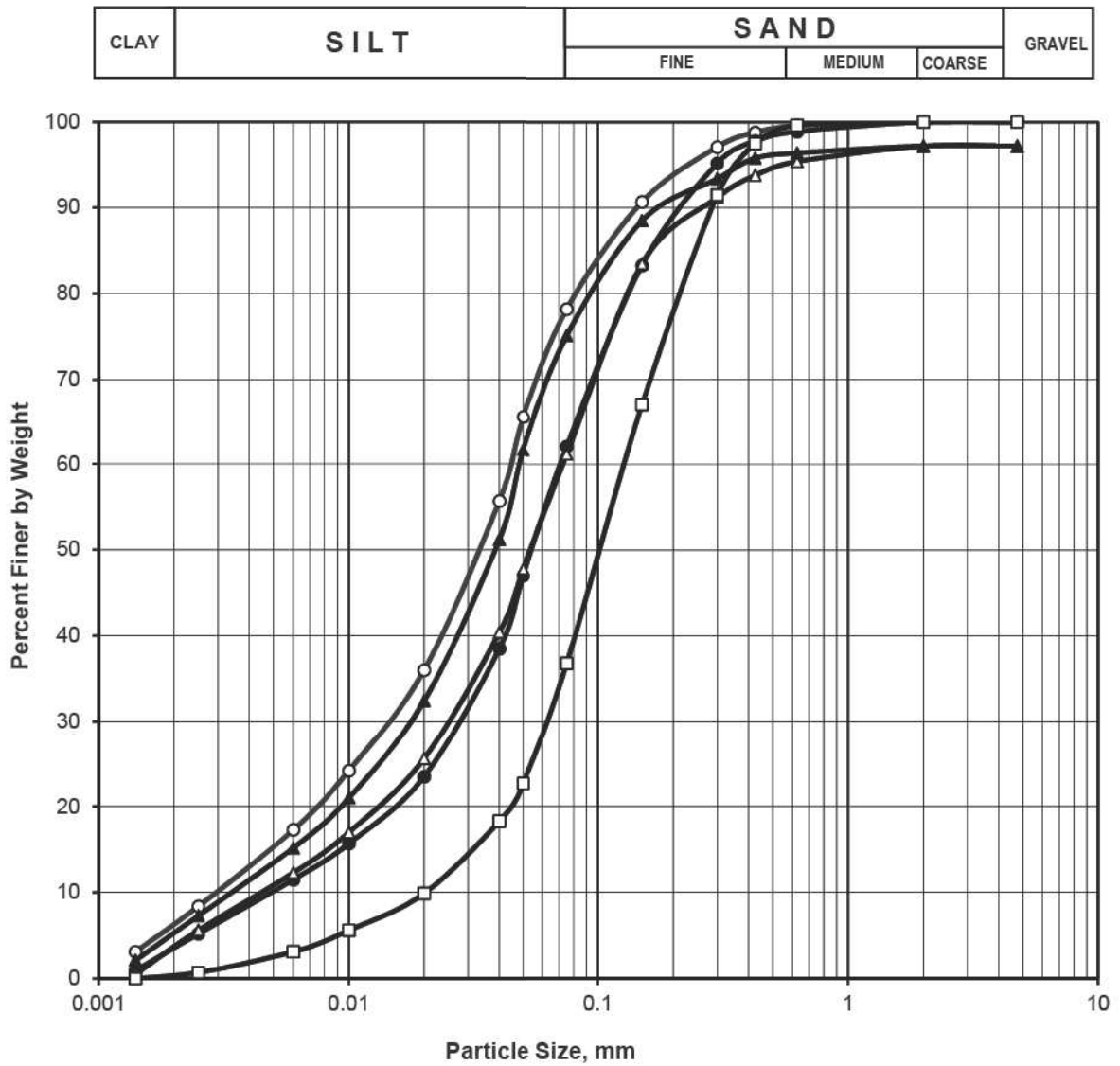
Proposed 66 KV Grid Substation Project at Nawada, New Delhi



SYMBOL	BH	DEPTH (m)	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
○	3	0.50	Sandy silt (ML-CL)	0	22	72	6
●	3	2.25	Sandy silt (ML)	6	32	59	3
△	3	4.50	Silty sand (SM)	0	63	37	0
▲	3	7.50	Sandy silt (ML)	3	36	58	3
□	3	9.00	Silty sand (SM)	0	61	39	0

Grain Size Analysis

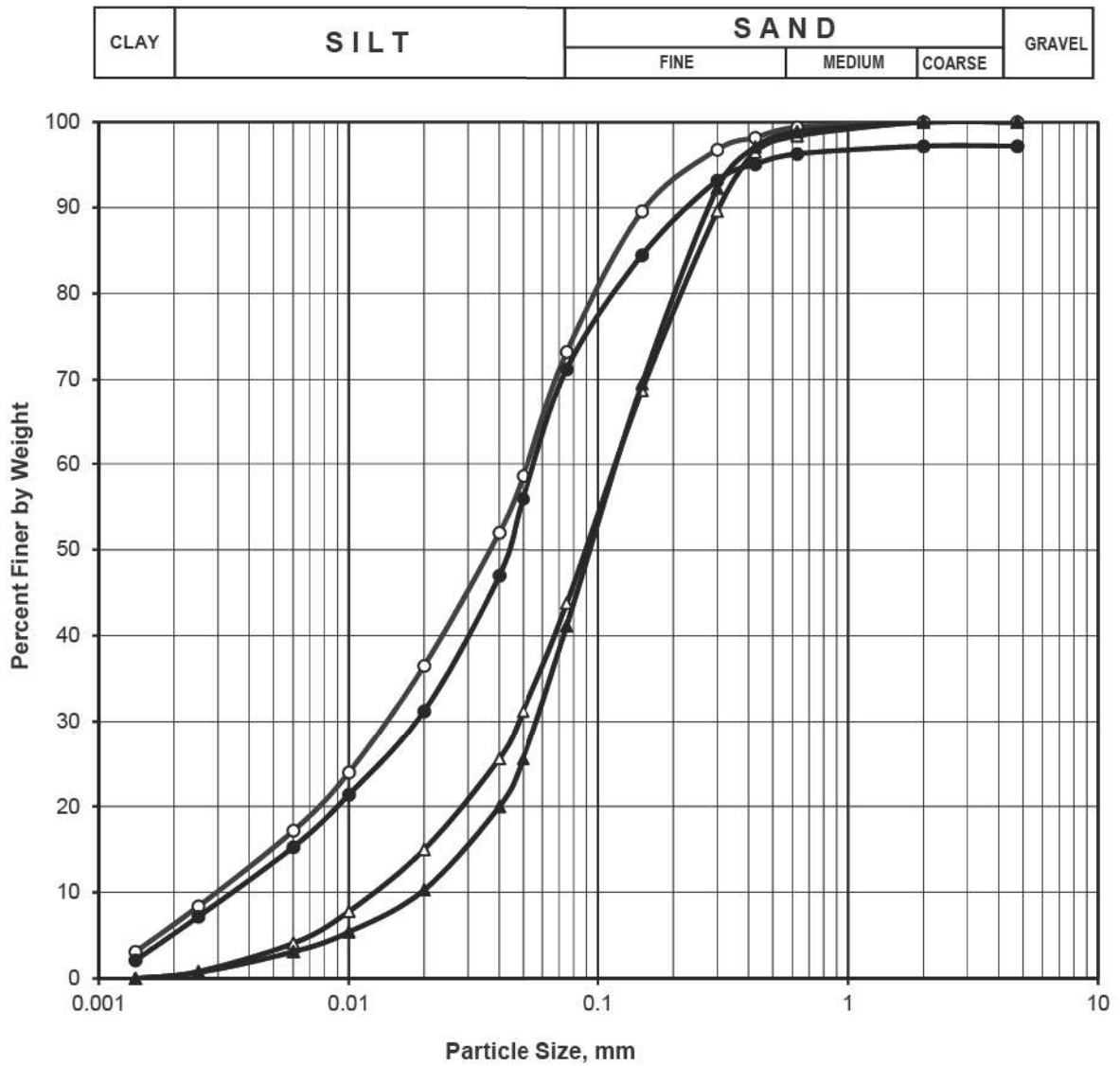
Proposed 66 KV Grid Substation Project at Nawada, New Delhi



SYMBOL	BH	DEPTH (m)	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
○	4	0.50	Sandy silt (ML-CL)	0	22	72	6
●	4	2.25	Sandy silt (ML)	0	38	59	3
△	4	5.25	Sandy silt (ML)	3	36	58	3
▲	4	8.25	Sandy silt (ML-CL)	3	22	70	5
□	4	10.00	Silty sand (SM)	0	63	37	0

Grain Size Analysis

Proposed 66 KV Grid Substation Project at Nawada, New Delhi



SYMBOL	BH	DEPTH (m)	DESCRIPTION	GRAVEL %	SAND %	SILT %	CLAY %
○	5	1.50	Sandy silt (ML-CL)	0	27	67	6
●	5	5.25	Sandy silt (ML-CL)	3	26	66	5
△	5	6.00	Silty sand (SM)	0	56	44	0
▲	5	9.00	Silty sand (SM)	0	59	41	0

Grain Size Analysis

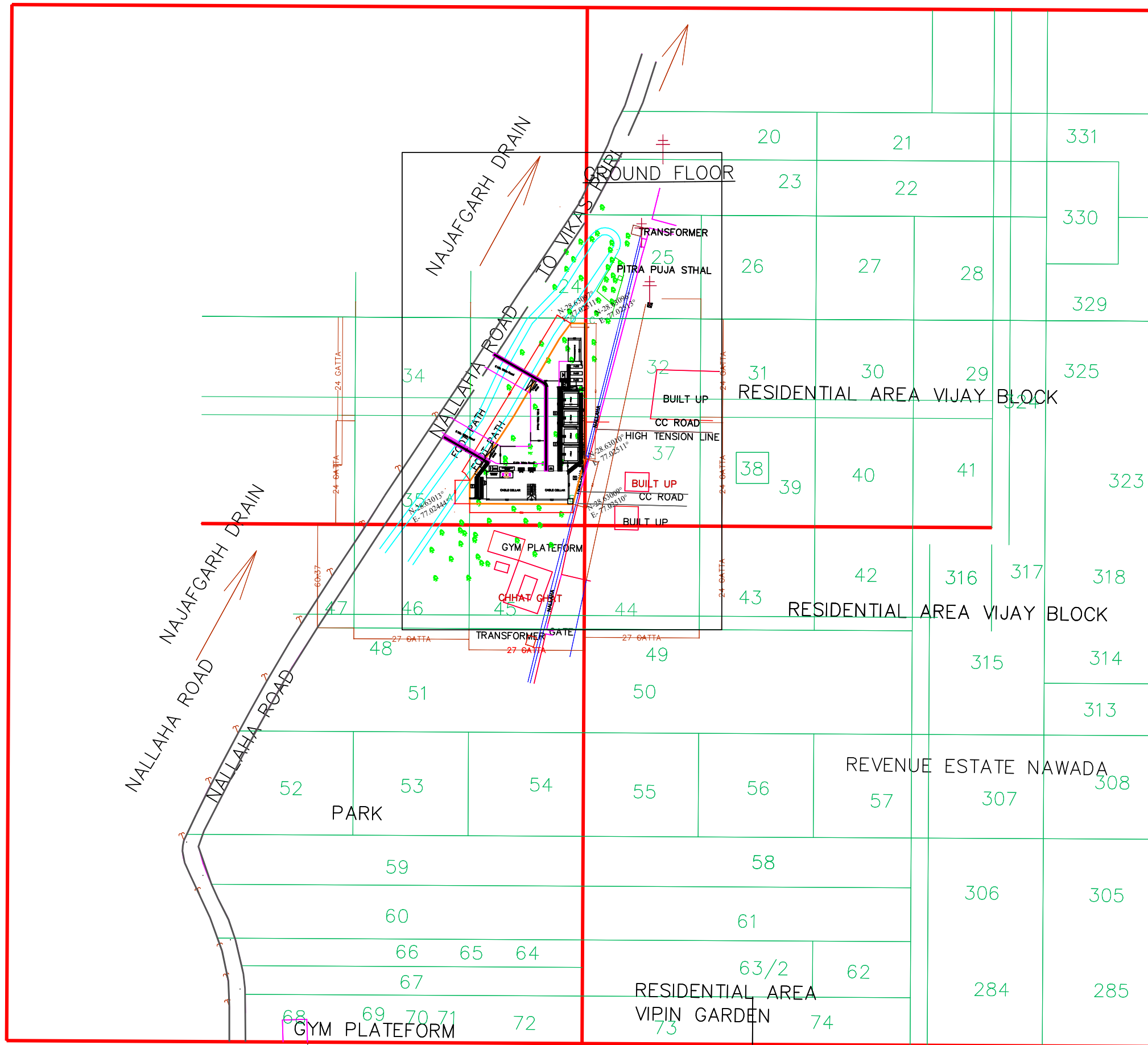
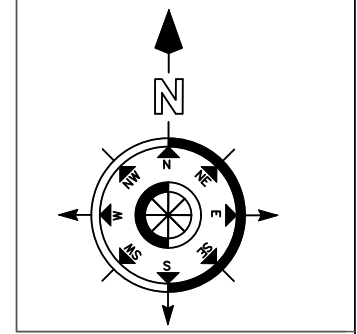
Proposed 66 KV Grid Substation Project at Nawada, New Delhi



CHEMICAL TEST RESULTS

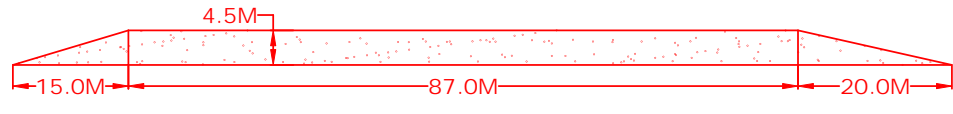
SOIL-EXTRACT WATER:

Borehole No.	Depth, m	Sulphate Content (SO ₃), %	Chloride Content (CL), %	pH Value
1	2.25	0.10	0.12	7.3
2	4.50	0.12	0.14	7.2
3	6.00	0.11	0.09	7.5
4	1.50	0.13	0.10	7.2
5	3.00	0.12	0.12	7.3

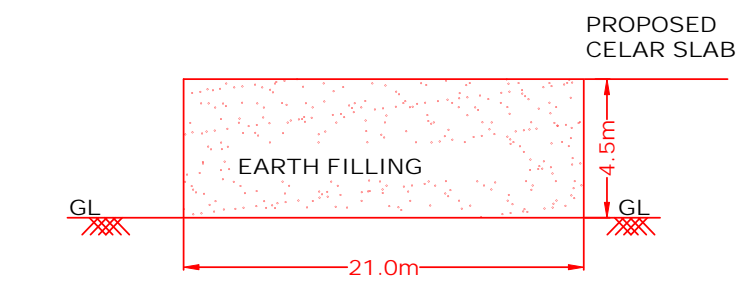


LEGEND	
FOOT PATH	
BOUNDARY WALL	
ROAD	
BUILT UP	
KILLA LINE	
GRID SUB STATION	
ELECTRIC POLE	
TREE	

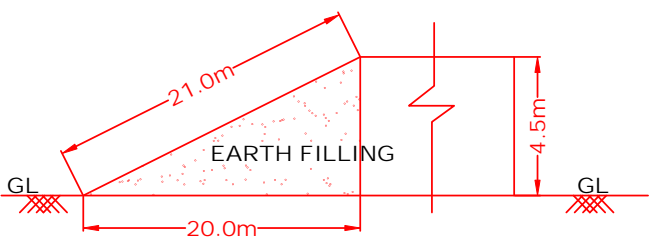
REFERENCES: ALL THE DIMENSIONS ARE IN METER / GHATTA	
PROJECT - DEMARCATION OF LAND FALLING IN KHASRA NOS. 33, 34, 35 & 36 SITUATED AT NAWADA VILLAGE FOR 66 KV GRID SUBSTATION (BSES RAJDHANI POWER LIMITED)	
CLIENT - BSES RAJDHANI POWER LTD. DELHI	
CONSULTANT - P.R. MOHA <small>Senior Survey Geoscientist D-5/20 On Vihar Phase - Lilliam Nagar New Delhi-59 Mobile: +919899000070 981003227 E-mail: tallesurvey@prmo.com, prmo@gmail.com</small>	
Surveyed By: TSC	Drawn By: TSC
Checked By: TSC	
Dwg.No: TSC/BSES /01	
SCALE 1:100	Date: 27 NOV. 2020



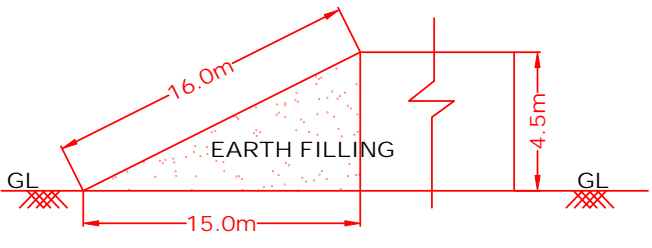
SECTION 'D-D'



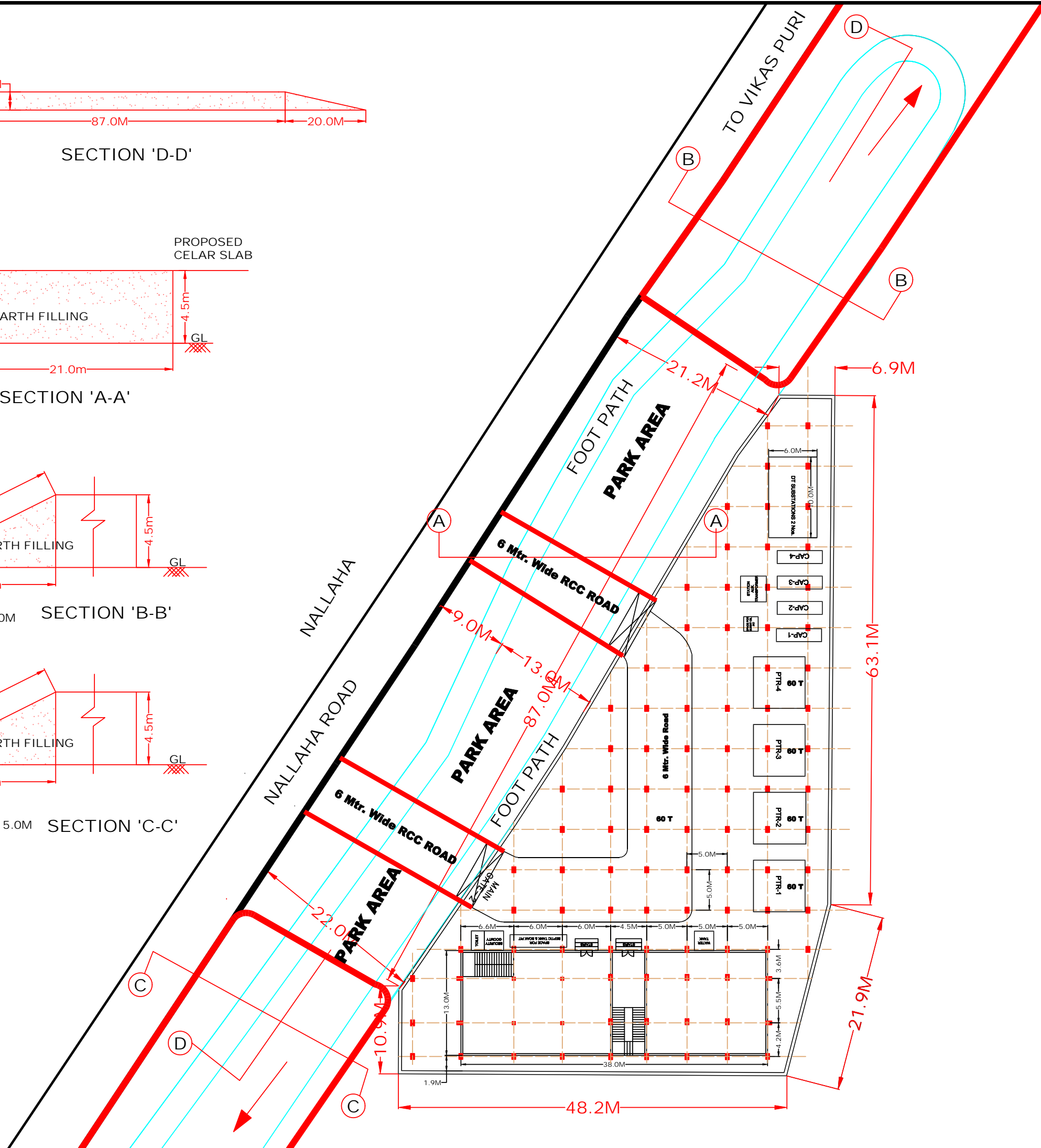
SECTION 'A-A'



SECTION 'B-B'



SECTION 'C-C'



- ### NOTES
1. ALL DIMENSIONS ARE IN MILLIMETRES.
 2. ONLY WRITTEN DIMENSION TO BE FOLLOWED AND DRAWING NOT TO BE SCALED.
 3. READ THIS DRAWING IN CONJUNCTION WITH ARCHITECTURAL DRGS FOR THIS PROJECT.
 4. LAYOUT DIMENSIONS AND ALL LEVELS SHALL ALWAYS BE CROSS CHECKED WITH ARCHITECTURAL DRAWINGS.
 5. DISCREPANCIES IF ANY MUST BE GOT CLARIFIED BEFORE START OF ACTUAL WORK.
 6. RCC GRADE SHALL BE M25 UNLESS OTHERWISE NOTED.
 7. THE REINF. SHALL BE WITH THERMO MECHANICALLY TREATED (TMT) BARS HAVING YIELD STRENGTH NOT LESS THAN 500 N/MM² AND CONFORMING TO IS:1786-1985.
 8. THE DEVELOPMENT LENGTH, ANCHORAGE AND LAP LENGTH OF THE BARS SHALL BE 50D WHERE D IS DIA OF THE BAR
 9. THE CLEAR COVER TO MAIN REINF. SHALL BE:-
 - (a) FOUNDATION=75mm BOTTOM & 50 mm SIDES +TOP
 - (b) COLUMNS = 40 mm
 - (c) WALLS = 40 mm
 - (d) BEAMS = 30 mm
 - (e) SLABS = 20 mm
 10. COLUMNS/FOOTINGS ARE CONCENTRIC ABOUT CENTRE LINES UNLESS NOTED OTHER WISE.
 11. SUB GRADE TO BE WELL COMPACTED AND PREPARED FOR BASE OF BUILDING.
 12. R.W.P.OR SANITARY PIPES NOT TO PASS THROUGH RCC BEAMS OR COLUMNS.
 13. REINF. OF BEAMS TO BE GIVEN FULL ANCHORAGE IN COLUMNS.
 14. LAP IN R/F IF REQUIRED TO BE AS/DUCTILE DETAIL CODE (IS13920)
 15. THE NET SAFE BEARING CAPACITY IS 120KN/M2
 16. THE STRUCTURE HAS BEEN DESIGNED FOR G+1+TERRACE.
 17. BACK FILLING / PLINTH FILLING SHALL BE DONE WITH APPROVED EARTH COMPACTED IN LAYERS AND EXCAVATED BLACK COTTON SOIL SHALL BE REMOVED.
 18. THE STRUCTURE HAS BEEN DESIGNED FOR SEISMIC LOAD ZONE.

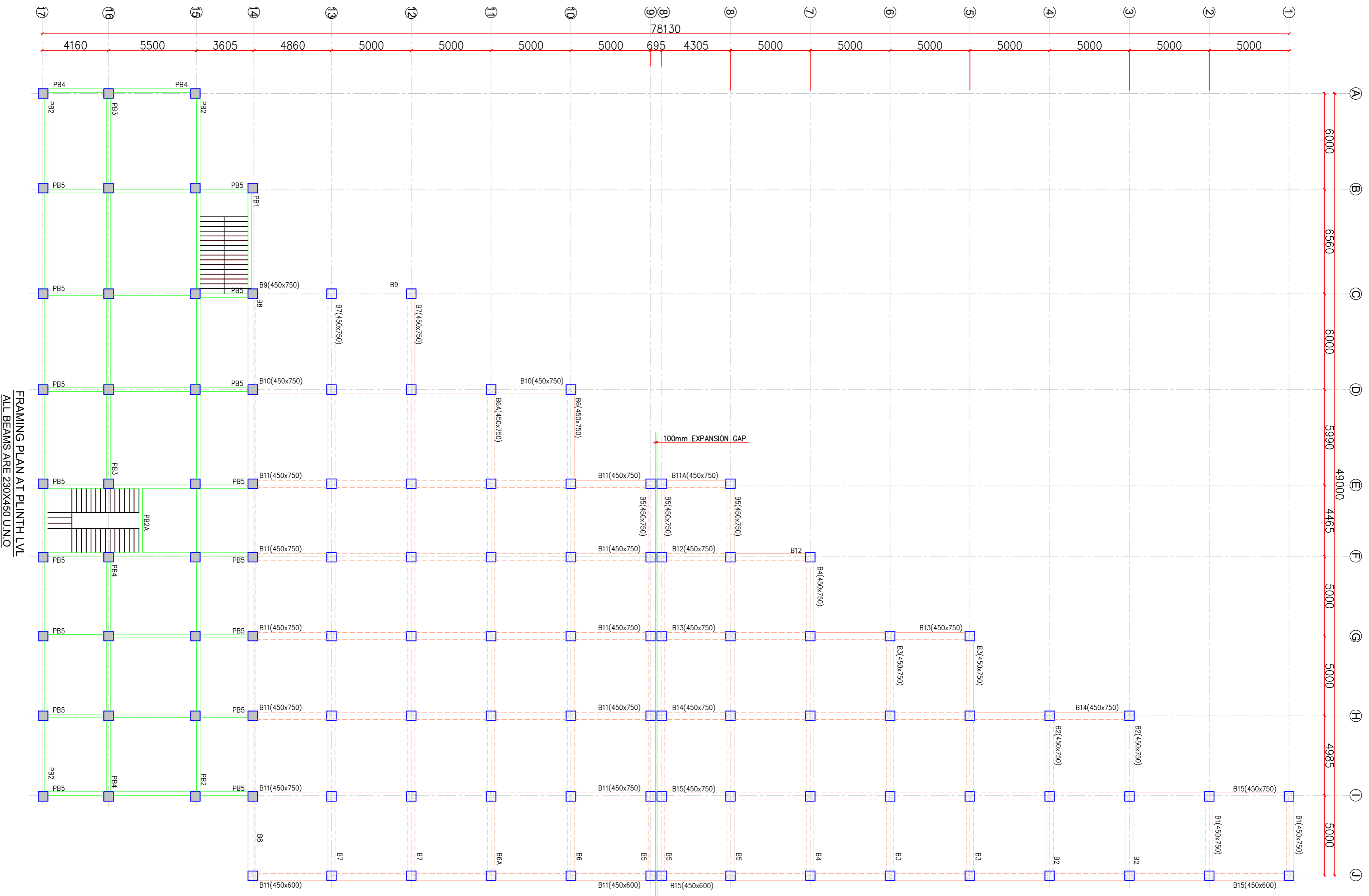
THIS DRAWING IS ISSUED TO THE PARTY FOR THE SPECIFIC PURPOSE AS STATED IN THE AGREEMENT AND IT SHALL NOT BE REPRODUCED, COPIED, LENT OR OTHERWISE DISPOSED OFF DIRECTLY OR INDIRECTLY, NOR USED FOR ANY OTHER PURPOSE OTHER THAN FOR WHICH IT IS FURNISHED.

BSES CLIENT: **BSES Rajdhani Power Ltd.**

PROJECT
Switching Substation at NAWADA SITE

DRN.	EKTA	DRG.GROUP: STRUCTURAL	
CHKD.	R.R.S.	-	16-12-2024
APPR.	R.R.S.	TITLE: LAYOUT PLAN OF 66/11KV GIS GRID AT NAWADA SITE	
DRAWING No. BSES-N-01		JOB. NO: 2021-25	Rev. 0

D&R CONSULTANT
100A 3rd FLOOR BHARAT NAGAR
NFC NEW DELHI
Tel. 9810592984
Email: revati_raman1@yahoo.com



- ### NOTES
- ALL DIMENSIONS ARE IN MILLIMETRES.
 - ONLY WRITTEN DIMENSION TO BE FOLLOWED AND DRAWING NOT TO BE SCALED.
 - READ THIS DRAWING IN CONJUNCTION WITH ARCHITECTURAL DRGS FOR THIS PROJECT.
 - LAYOUT DIMENSIONS AND ALL LEVELS SHALL ALWAYS BE CROSS CHECKED WITH ARCHITECTURAL DRAWINGS.
 - DISCREPANCIES IF ANY MUST BE GOT CLARIFIED BEFORE START OF ACTUAL WORK.
 - RCC GRADE SHALL BE M25 UNLESS OTHERWISE NOTED.
 - THE REINF. SHALL BE WITH THERMO MECHANICALLY TREATED (TM) BARS HAVING YIELD STRENGTH NOT LESS THAN 500 N/MM² AND CONFORMING TO IS:1786-1985.
 - THE DEVELOPMENT LENGTH, ANCHORAGE AND LAP LENGTH OF THE BARS SHALL BE 50D WHERE D IS DIA OF THE BAR
 - THE CLEAR COVER TO MAIN REINF. SHALL BE:-
(a) FOUNDATION=75mm BOTTOM & 50 mm SIDES + TOP
(b) COLUMNS = 40 mm
(c) WALLS = 40 mm
(d) BEAMS = 30 mm
(e) SLABS = 20 mm
 - COLUMNS/FOOTINGS ARE CONCENTRIC ABOUT CENTRE LINES UNLESS NOTED OTHER WISE.
 - SUB GRADE TO BE WELL COMPACTED AND PREPARED FOR BASE OF BUILDING.
 - R.W.P OR SANITARY PIPES NOT TO PASS THROUGH RCC BEAMS OR COLUMNS.
 - REINF. OF BEAMS TO BE GIVEN FULL ANCHORAGE IN COLUMNS.
 - LAP IN R/F IF REQUIRED TO BE AS/DUCTILE DETAIL CODE (S13920)
 - THE NET SAFE BEARING CAPACITY IS 130KN/M² (WITH ONE FLOOR FUTURE PROVISION AND ALSO).
 - THE STRUCTURE HAS BEEN DESIGNED FOR -----
17. BACK FILLING / PLINTH FILLING SHALL BE DONE WITH APPROVED EARTH COMPACTED IN LAYERS AND EXCAVATED BLACK COTTON SOIL SHALL BE REMOVED.
 - THE STRUCTURE HAS BEEN DESIGNED FOR SEISMIC LOAD ZONE.

ARCHITECT

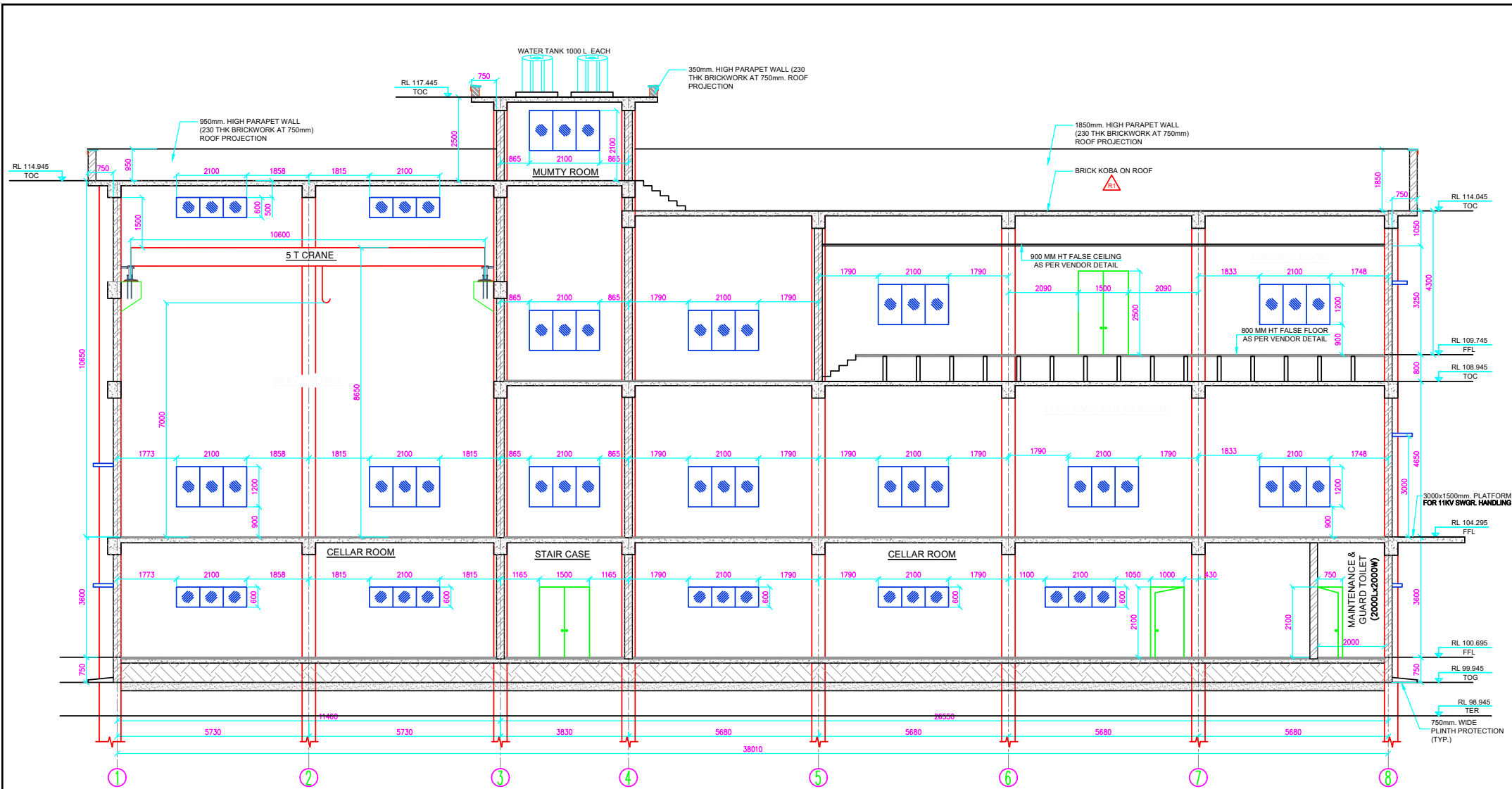
ISSUED FOR:-
 INFORMATION
 TENDER
 PLANNING
 CONSTRUCTION/FABRICATION

CLIENT :
 PROJECT :
LAYOUT OF 66/1KV GIS GRID AT NAWADA

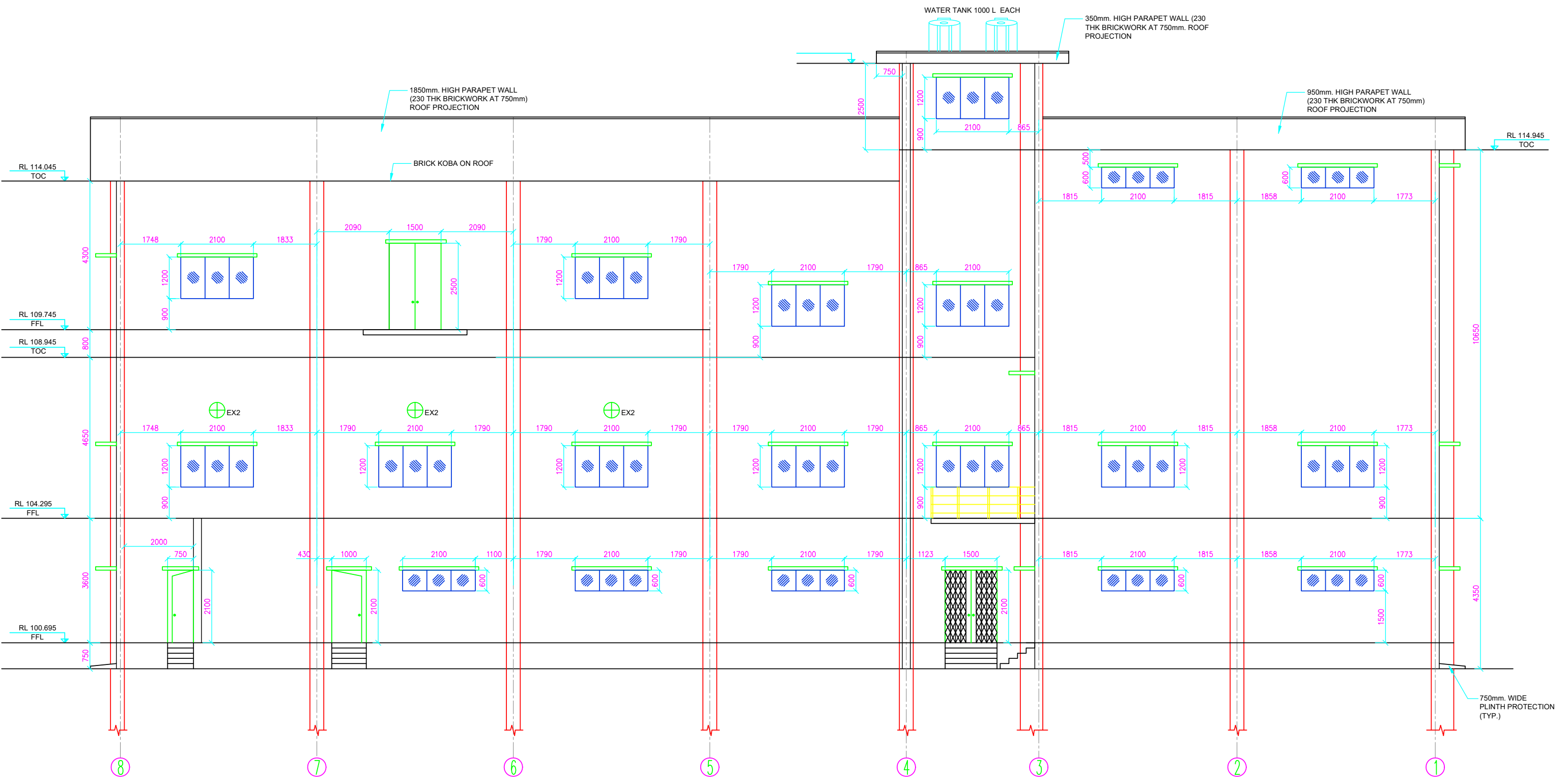
DRN.	EXTRA	DRG.GROUP:	STRUCTURAL
CHKD.	R.R.S.		27-06-2024
APPR.	R.R.S.	TITLE:	FRAMING PLAN AT PLINTH LVL
DRAWING No. S-03		JOB NO.:	2021-25
D&R CONSULTANT		Rev.	
100A 3rd FLOOR BHARAT NAGAR			
NFC NEW DELHI			
Tel. 9810592984			
Email: reviti_damoni@phoo.com			

DATE	DESCRIPTION	REVNO	DATE	REVISIONS	REV.BY.

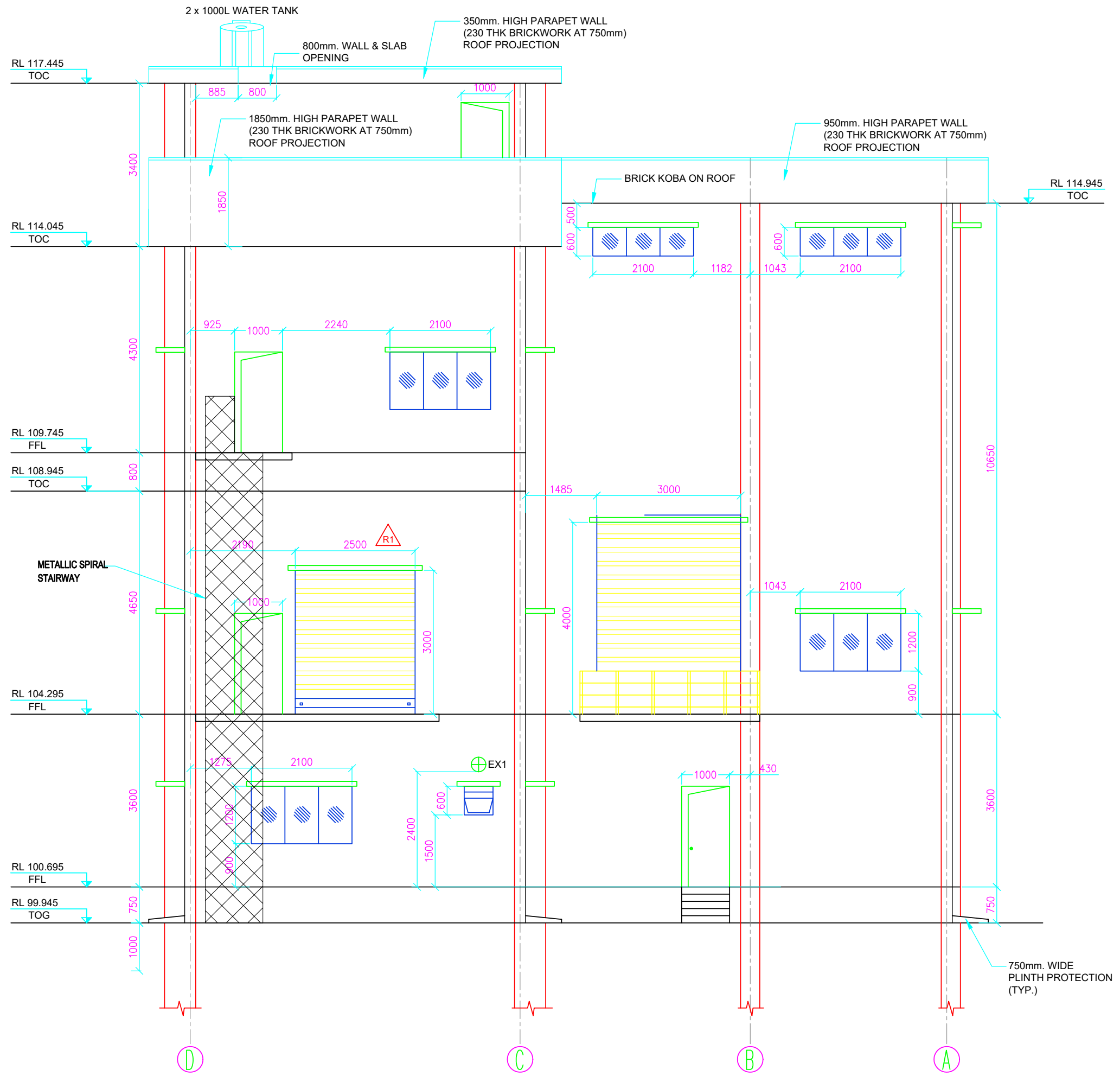
DISTRIBUTION OF PRINTS.



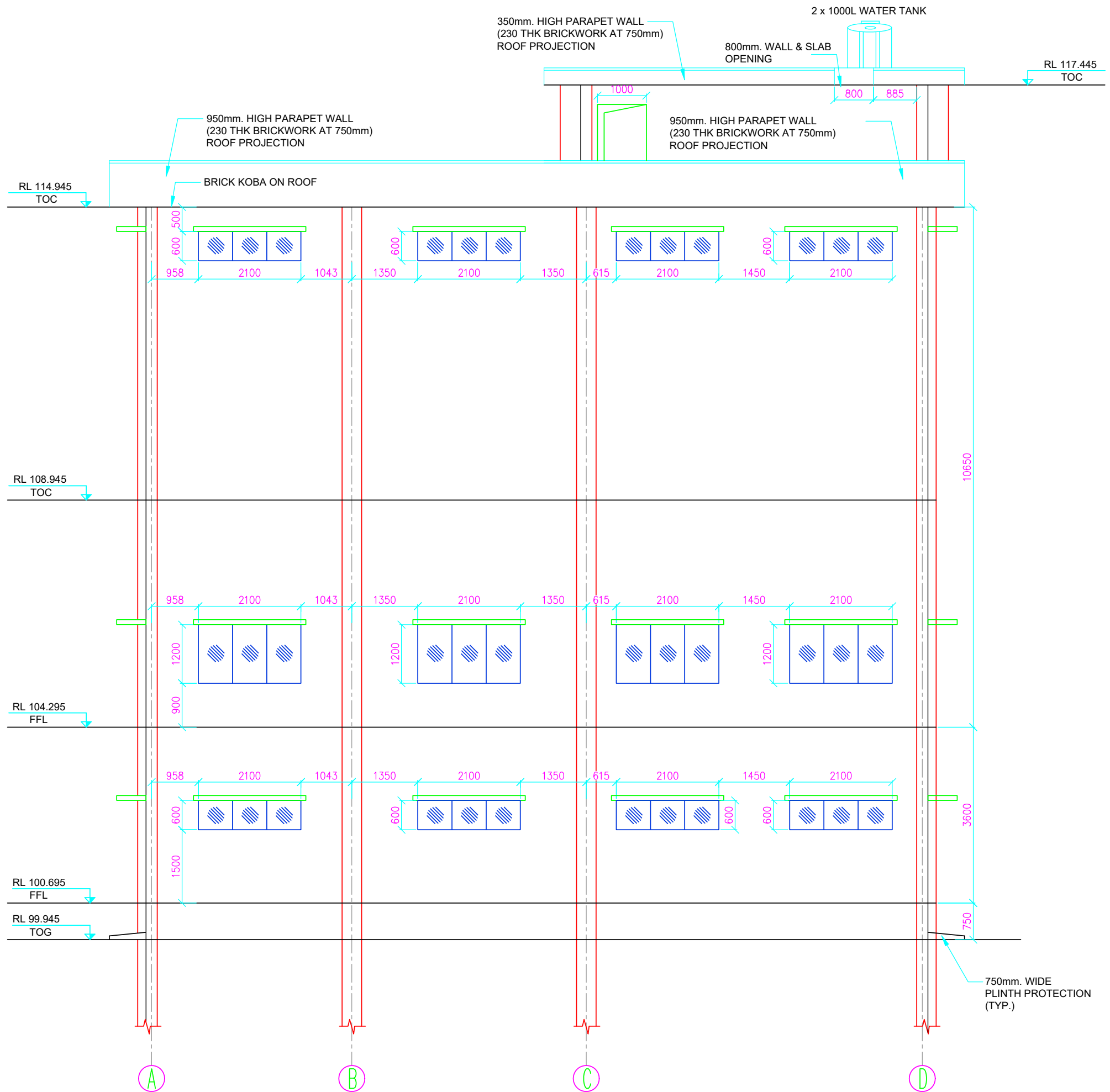
ELEVATION VIEW
BUILDING INTERNAL SECTION



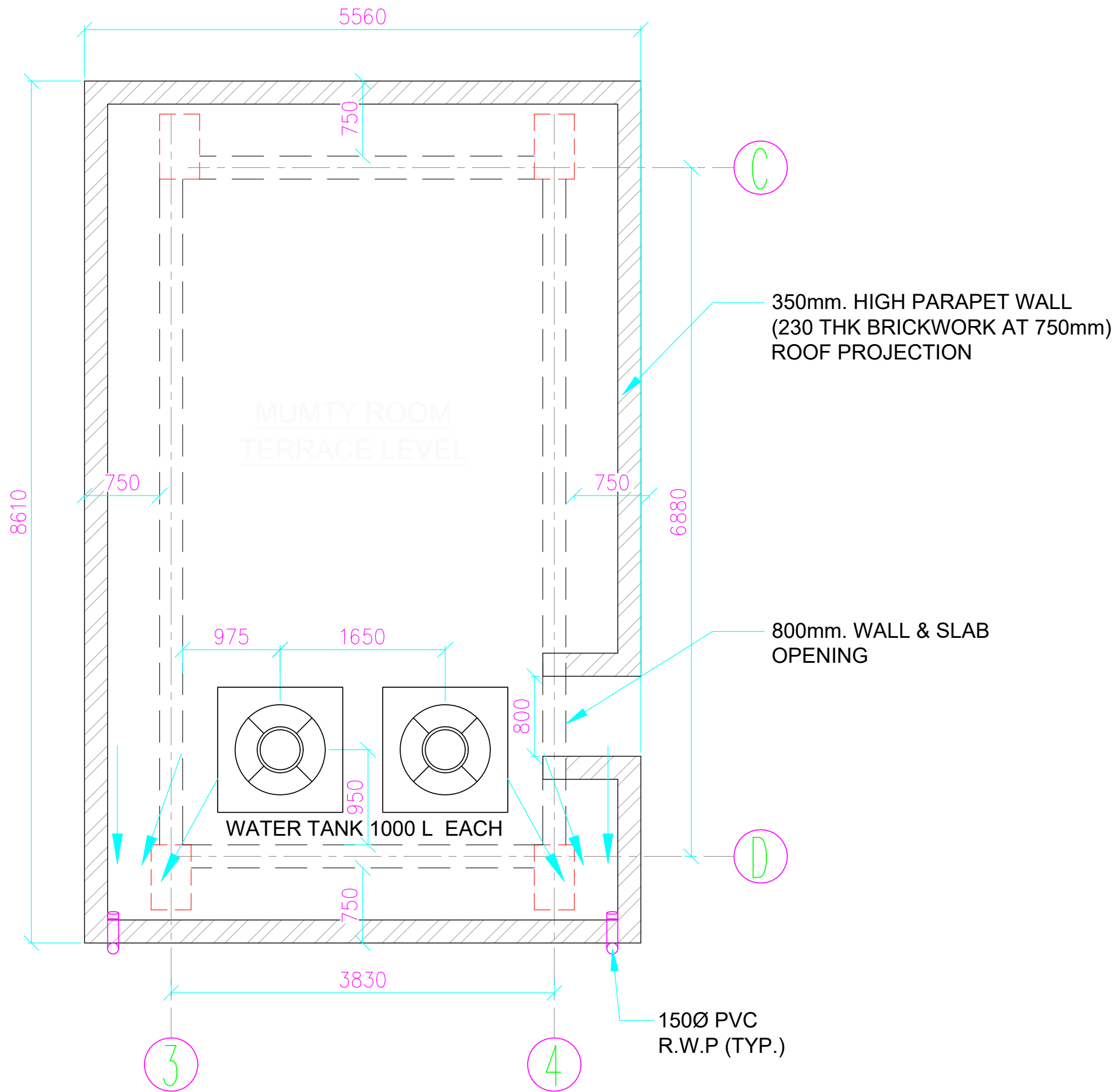
ELEVATION VIEW



SECTION VIEW



SECTION VIEW



MUMTY ROOM TERRACE PLAN