



ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

CIVIL WORKS

CIVIL WORKS

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1. GENERAL

1.1 Scope of work

The scope of Civil works includes the following items.

The scope shall generally cover switch yard structures, including gantries and equipment support structures and their foundations, cable trenches along with covers, cable trench crossings of road and rails, sump pits, marshalling box/control cubicle foundations, switch yard levelling, site clearance, soil investigation, roads, drains, fencing, gravel filling, transformer / reactor foundations, firewalls, control room building, other auxiliary buildings. Any other items, not specifically mentioned here but required for the commissioning of switch yard/substation shall be deemed to be included in the scope of this Specification. The scope shall further cover design, engineering, erection, testing and commissioning of all civil works at each substation. All civil works shall also satisfy the General Technical Clauses specified in other sections of this specification and as detailed below.

Excavation, de watering, carriage of excavated earth, plain cement concrete (PCC), casting of reinforced cement concrete (RCC) foundations, super-structures for switch yard structures, equipment supports, their control cubicles, bus post supports, lighting poles and panels, brick and stone masonry, cable trenches, pipe trenches with necessary pre cast RCC removable covers, with lifting facility and sump pits, cable supports and their embodiment in cable trenches and cable trench crossings road or rail track with backfilling complete as per drawings approved by the OPTCL, shall be carried out by the contractor. The cable trenches inside the control room shall be provided with MS chequered plate with angle stiffeners at the bottom for mechanical strength and painting there of as per the standard practice.

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

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

2.0 SITE CLEARANCE

2.1 Clearing and Grubbing

The work shall consist of numbering of trees, removing and disposing of all materials such as trees, bushes, woods, shrubs, grass, stumps, rubbish, rank vegetation, roots, foreign materials, etc., which in the opinion of the Engg Incharge (Divisional Engr.) are unsuitable for incorporation in the works, from within the limits and such other areas as may be specified on the drawings or directed by the Engg Incharge (Divisional Engr.). Clearing and grubbing shall be performed in advance of earthwork operations and in accordance with the requirements of these Specifications. During clearing and grubbing, the contractor shall take all adequate precautions against soil erosion, water pollution etc., and where required undertake additional works to that effect.

2.1.1 Provision of plantation and developing a garden inside the sub-station.

At least, 100 nos. of fruit bearing different type plants as decided by OPTCL to be planted along the road side and in and around the control room, DG room ,FF&PH building and other building area after making surface treatment. Also, provision of developing a garden in front of the control room building or any suitable area and shall be of size as decided as per the availability of land. Garden grass, variety of flowering plants and decorative plants etc are to be provided after making proper surface treatment. Provision of water taps facilities at different locations for watering the plants. **Land scaping & provision for platform for hoisting of National Flags and** Provision of water tap with water sprinkler arrangement including water pipe laying with control at different location. Both side of the RCC roads shall also be provided with decorative plants as per the instruction of the Site Engineer. Adequate quantity of different varieties of

plants to be considered in consultation with Horticulturists & Owner. Construction of a platform with suitable GI pipe & other attachment for hoisting of National Flags As per the direction of Engineer in charge.

2.2 Setting out and making profiles

After the site has been cleared as per Clause 2.1 above, the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engg Incharge (Divisional Engr.). The Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete, etc., required in connection with the setting out of works and the establishment of bench marks. A grid system of co-ordinates shall be established by the Contractor at the site.

Masonry or concrete pillars shall be erected suitably at minimum of four places in the area to serve as bench marks for the execution of the work. Each bench mark shall be protected from damage or disturbance. These bench marks shall be connected with G.T.S. of any other permanent bench mark approved by the Engg Incharge (Divisional Engr.). Necessary profiles with pegs, bamboos and strings or "Burjis" shall be made to show the correct formation levels before the work is started and the same shall be approved by the Engg Incharge (Divisional Engr.).

2.3 Programme

The Contractor shall construct the works in compliance with the outline programme appended to the Bidding Document, and shall submit for the approval of the Engg Incharge (Divisional Engr.) a detailed programme in accordance with the requirements of this Specification.

2.4 Inclement weather

As per relevant Code, during hot weather, precautions shall be taken to avoid premature stiffening of the fresh mix and to reduce water absorption and evaporation losses. During hot weather (atmospheric temperature above 40 degree C) or cold weather (atmospheric temperature at or below 5deg.C) concreting shall be done as per the procedure set out in IS 7861.

3.0 STANDARDS

All Civil works shall be carried out as per applicable Indian Laws, latest revision of International Standards and Codes. All materials shall be of best quality confirming to relevant Indian Standards and Codes.

Civil works shall be designed to the required service conditions and /or loads as specified elsewhere in this Specification or implied as per National and International Standards.

A list of code of practice and standards used for civil works in general is enclosed for reference. In case of any conflict between I.S. Code and the Procedures specified herein, the later shall prevail.

3. SOIL INVESTIGATION

3.1 General

The Contractor shall perform a detailed soil investigation to arrive at sufficiently accurate general as well as specific information about the soil profile/strata and the necessary soil parameters of the site in order that the foundations of the various structures can be designed and constructed safely and rationally. Foundation systems adopted by the contractor shall ensure that relative settlement shall be as per provision in IS 1904 and any latest IS and other Indian Standards.

This Specification covers all the work required for detailed soil investigation and preparation of a detailed report. The work shall include mobilisation of necessary equipment, provision of necessary engineering supervision and technical personnel, skilled and unskilled labour etc., as required to carry out field investigation and tests, laboratory tests, analysis and interpretation of data and results, preparation of detailed soil report including specific recommendations for the type of foundations and the safe bearing capacity for different sizes of foundations at different founding strata for the various structures of the substation. The Contractor shall make his own arrangements for locating the coordinates and various test positions in field and also for determining the reduced level of these locations with respect to the bench mark .All the test are to be carried out before the OPTCL officials or before any agency engaged by OPTCL. Prior intimation in this effect has to be given to OPTCL.

A report to the effect will be submitted by the Contractor for the Engg Incharge (Divisional Engr.) specific approval giving details regarding his assumed data for Civil structures design.

Any variation in soil data shall not constitute a valid reason for any additional cost and shall not affect the terms and condition of the Contract. Nothing extra what so ever shall be paid to the Contractor on account of any variation in subsoil properties /or conditions. Tests must be conducted under all the critical locations i.e. Control room building, auto/power transformer, reactor, lightning mast, 400 kV/220 kV/132 kV column location etc. However, some of the soil parameters given below for substations have to be determined and submitted to Engg Incharge (Divisional Engr.).

- Dry density
- Bulk density
- Angle of internal friction/cohesion
- * Specific gravity
- Natural moisture content.

3.2 Bore holes

Drilling of a specified number of bore holes of 150 mm dia. in accordance with the provisions of IS 1892 at approved locations to specified depths or to refusal whichever occurs earlier. (By refusal it shall mean that a standard penetration blow count (N) of 100 is recorded for 30 cm penetration). However, at least 5 boreholes or as specified in BOQ shall be drilled to the required depth (15 mts. approximately).

Performing Standard Penetration Tests at approximately 2.0 m intervals in the bore hole starting from 0.5 m below ground onwards and at every change of stratum. The disturbed samples from the standard penetrometer shall also be collected for necessary tests.

Collecting undisturbed samples of 100/75 mm diameter 450 mm long from the bore holes at intervals of 2.5 m and every change of stratum starting from 1.0 m below ground level onwards.

The depth of Water Table shall be recorded in each bore hole.

All samples, both disturbed and undisturbed, shall be identified properly with the bore hole number and depth from which they have been taken. The sample shall be sealed at both ends of the sampling tubes with wax immediately after the sampling and shall be packed properly and transported to the Contractor`s laboratory without any damage or loss.

The logging of the bore holes shall be compiled immediately after the boring is completed and a copy of the borelog shall be handed over to the Engg Incharge (Divisional Engr.).

3.3 Dynamic cone penetration test

Two Dynamic cone penetration tests under the locations of auto transformers shall be carried out with the circulation of bentonic slurry at specified location and a continuous record of penetration resistance (NG) upto 15 metre from natural ground level or refusal, shall be maintained by the Contractor.

Dynamic cone penetration tests are conducted to correlate engineering properties such as stratification density, bearing capacity, settlement, etc., of soils which are primarily cohesive in nature. The tests shall be conducted by driving a standard size cone attached loosely or screwed to a string of drill rods. The specification for the equipment and accessories required for performing this test, test procedure, field observations and reporting of results shall confirm to IS 4968 part 11 latest revision. The driving system shall comprise of 65 kg weight having a free fall of 75 cm. The cone size shall be 65 mm diameter, and provided with vents for continuous flow of bentonite slurry through the cone and rods in order to avoid friction between the rods and soil. The location for tests shall be as directed by the Engg Incharge (Divisional Engr.). On completion of the test, the results shall be presented as a continuous record as the number of blows required for every 300 mm penetration of the cone into the soil.

3.4 Trial pits

Trial pits shall be made at two locations as approved by the Engg Incharge (Divisional Engr.). The trial pits shall two metres squar in size extending to (four) metres depth or as specified by the Engg Incharge (Divisional Engr.). Undisturbed samples shall be taken from the trial pits as per the direction of the Engg Incharge (Divisional Engr.).

3.5 Field California Bearing Ratio test

This test shall be carried out to obtain the properties of soil required for the construction of roads. The equipment and accessories required for carrying out the test, test procedure, recording of observations and presentation of results shall confirm to IS 2770 part XXXI. The test locations of CBR test shall be on the road locations as per GA drawing. These tests shall be performed on remoulded and undisturbed, soaked and un soaked samples.

3.6 Electrical resistivity test.

This test shall be conducted to determine the electrical resistivity of soil required for designing safety grounding system for the entire station area. The specifications for the equipment and other accessories required for performing electrical resistivity test, the test procedure, and reporting of field observations shall confirm to IS 3043. The test shall be conducted using Wagner's four electrode method as specified in IS 1892, Appendix-B2. Unless otherwise specified at each test location, the test shall be conducted along two perpendicular lines parallel to the coordinate axis.

3.7 Plate load test

Plate load test shall be conducted to determine the bearing capacity and load/ settlement characteristics of soil at shallow depths by loading a plane and level steel plate kept at the desired depth and measuring the settlement under different loads, until a desired settlement takes place or failure occurs. The specification for the equipment and accessories required for conducting the test, the test procedure, field observations and reporting of results shall conform to IS 1888. The location and depth of the test shall be given by the Contractor and approved by the Engg Incharge (Divisional Engr.). Undisturbed tube samples shall be collected at 1.0 m and 2.5 m depths from the natural ground level for carrying out laboratory tests.

The size of the pit shall not be less than five times the plate size and shall be taken upto the specified depth. All provisions regarding excavation and visual examination of pit shall apply here.

If the ground water table is at a depth higher than the specified test depth, the ground water table shall be lowered and maintained at the test depth for the entire duration of the test. Dewatering shall be at Contractor's cost.

Unless otherwise specified the reaction method of loading shall be adopted. Settlement shall be recorded from dial gauges placed at four diametrically opposite ends of the test plate. The test plate shall be 600 x 600 mm size and at least 25mm thick. The bottom of the pit shall be levelled before placing the plate in position for conducting the test.

A seating load of 70 gm/sq.cm shall be applied and after the dial gauge readings are stabilised, the load shall be released and the initial readings of the dial gauges recorded after they indicate constant reading. The load shall be increased in stages. These stages shall be 20, 40, 70, 100, 150, 200, 250, 300, 400, 500, 600 and 800 KN per sq.m. or as directed by the Engg Incharge (Divisional Engr.). Under each loading stage, record of time versus settlement shall be kept as specified in IS 1888.

The load shall be maintained for a minimum duration of one hour or till the settlement rate reduces to 0.02 mm/m. whichever is later. No extrapolation of settlement rate from periods less than one hour shall be permitted.

Loading shall be carried out in stages as specified above till one of the following conditions occurs:

- Failure of the soil under the plate i.e. the settlement of the plate at constant load becomes progressive and reaches a value of 40 mm or more.
- Total settlement of the plate is more than 40mm.
- Load intensity of 800 kN/sq.m is reached without failure of the soil.

Backfilling of the pit shall be carried out as per the directions of the Engg Incharge (Divisional Engr.). Unless otherwise specified the excavated soil shall be used for this purpose. The quoted rates shall include backfilling.

Dial gauge readings for settlement shall generally be taken at 1, 2, 4, 6, 9, 16, 25, 60, 90 and 120 minutes from the commencement of each stage of loading. Thereafter the readings shall be taken at hourly intervals upto a further four hours and at two hours intervals thereafter for another six hours.

3.8 Water sample

Representative samples of ground water shall be taken when ground water is first encountered before the addition of water to aid drilling of boreholes. The samples shall be of sufficient quantity for chemical analysis to be carried out and shall be stored in air-tight containers.

3.9 Laboratory Test

The laboratory tests shall be carried out progressively during the field work after a sufficient number of samples have reached the laboratory, in order that the test results of the initial bore holes can be made use of in planning the later stages of the field investigation and quantum of laboratory tests.

All samples brought from field, whether disturbed or undisturbed shall be extracted/prepared and examined by competent technical personnel, and the tests shall be carried out as per the procedures laid out in the latest edition of the relevant IS Codes and Standards.

The following laboratory tests shall be carried out:

- Visual and engineering classification.
- Liquid limit, plastic limit and and shrinkage limit.
- Natural moisture content, bulk density, dry density and specific gravity.
- Grain size distribution.
- Unconfined compression test.
- Unconsolidated undrained test.
- Swell pressure and free swell index determination.
- California bearing ratio.
- Consolidated undrained test.
- Consolidated drained test.
- Chemical tests on soil and water to determine the carbonates, sulphates, nitrates, chlorides, Ph value, and organic matter and any other chemicals harmful to the concrete foundation.

3.10 Test results and reports

The Contractor shall submit the detailed report in four (4) copies wherein information regarding the geological detail of the site, summarised observations and test data, bore logs, and conclusions and recommendations on the type of foundations with supporting calculations for the recommendations. Initially the report shall be submitted by the Contractor in draft form and after the draft report is approved, the final report in eight (8) copies shall be submitted.

The report shall include, but not be limited to the following :

- A plan showing the locations of an exploration work i.e. bore holes, dynamic cone penetration tests, trial pits, plate load test, etc.
- Bore logs: Bore logs of each bore holes clearly identifying the stratification and type of soil stratum with depth upto the refusal. The values of Standard Penetration Test (SPT) at the depths where the tests were conducted on the samples collected shall be clearly shown against that particular stratum.
- Test results of field and laboratory shall be summarised strata wise as well in combined tabular form. All relevant graphs, charts tables, diagrams and photographs, if any, shall be submitted along with report.
- **Recommendation** The report should contain specific recommendations for the type of foundation for the various structures envisaged at site. The Contractor shall acquaint himself about the type of structures and their functions from the Engg Incharge (Divisional Engr.). The observations and recommendations shall include but not be limited to the following :
 - Geological formation of the area, past observations or historical data, if available, for the area and for the structures in the nearby area, fluctuations of water table, etc..

- Recommended type of foundations for various structures. If piles are recommended the type, size and capacity of pile shall be given.
- Allowable bearing pressure on the soil at various depths for different sizes of the foundations based on shear strength and settlement characteristics of soil with supporting calculations for the recommendations.
- Recommendations regarding slope of excavations and dewatering schemes, if required.
- Comments on the chemical nature of soil and ground water with due regard to protective measures.
- If expansive soil is met with, recommendation on removal or retainment of the same under the structure/road etc. shall be given. In the latter case detailed specification of any special treatment required including specification for materials to be used, construction method and equipment to be deployed etc. shall be furnished.
- Recommendations for additional investigation beyond the scope of the present work, if Contractor considers such investigation necessary.

4. 0 MATERIALS AND WORKMANSHIP

4.1 General

All materials used in the works shall be new and of the best quality of their respective kinds. They shall comply with the requirements of the latest edition of any relevant Indian Standard or Code of Practice where such exist, and current at the date of tendering.

All workmanship shall be of the highest standard, and shall be executed by competent men skilled in their respective trades.

4.2 Samples

In addition to the special provisions made in this specification for sampling and testing of materials by particular methods, samples of any materials and workmanship proposed to be used in the Works may be called for at any time during the Contract by the Engg Incharge (Divisional Engr.) and shall be furnished by the Contractor without delay and at the expense of the Contractor. Samples when approved, shall be regarded as the acceptable standard, and any material or workmanship subsequently not complying with that standard shall be rejected and replaced by those of acceptable standard at the expense of the Contractor. Sample storage boxes shall be provided by the Contractor free of cost if requested by the Engg Incharge (Divisional Engr.).

4.3 Tests

Whenever considered desirable by the Engg Incharge (Divisional Engr.), Inspectors may be sent to manufacturer's or subcontractors' premises to test materials or supervise their manufacture.

Where specified or requested the Contractor shall obtain from the manufacturer and send to the Engg Incharge (Divisional Engr.) certificates of test, proof sheets, mill sheets, etc., showing that materials have been tested in accordance with this Specification or the relevant Indian Standard.

Notwithstanding any tests which may be directed to be carried out at a manufacturer's and/or subcontractor's works, the Engg Incharge (Divisional Engr.) may carry out any tests or further tests he considers necessary or desirable after delivery of materials to the Site.

The Contractor shall provide all labour, equipment and facilities necessary for carrying out the tests both in works and on site.

The cost of routine tests required by IS and this Specification shall be borne by the Contractor. The cost of other tests shall be borne in accordance with the Conditions of Contract.

4.4 Names of suppliers and copies of orders

If so required, and before ordering material of any description, the Contractor shall submit for approval the names of makers or suppliers proposed. Copies of orders shall also be submitted if so required. The Engg Incharge (Divisional

Engr.) may at any time withdraw his previously given approval to obtaining materials from any maker or supplier should such maker or supplier fail to supply materials of the specified quality or quantity in the requisite time.

4.5 Rejection of materials and workmanship

The Engg Incharge (Divisional Engr.) shall at any time have power to reject materials and workmanship not complying with this Specification or with the approved Drawings. Materials so rejected shall be immediately removed from site and replaced by materials of an approved standard at the expense of the Contractor. Rejected workmanship shall be broken out and replaced by work of an acceptable standard including the supply of new materials by the Contractor, at the expense of the Contractor, and without delay.

4.6 Explosives and Blasting

All rules under the Explosive Act or other local rules in force shall be fully observed. All blasting works shall be done in accordance with the stipulation contained in IS 4081. Written approval shall be obtained from the Engg Incharge (Divisional Engr.) before explosives are used for excavating foundations in rock and the Engg Incharge (Divisional Engr.) may impose conditions for their use. The Contractor shall be responsible for complying with local regulations concerning the use of explosives and for the safe-keeping and handling of explosives. Proper warning shall be given of all blasting operations. During operations involving the handling or use of explosives, the Contractor shall be responsible for the safety of personnel, Site Works and people or properties in the vicinity of the site. The Contractor shall make good at his own expense any damage caused by the use or mishandling of explosives.

5. 0 EXCAVATION AND BACKFILL

Excavation and backfill for foundations shall be in accordance with the relevant Code. The back fill around the foundations shall be compacted according to Clause 6.7 for Compaction.

Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom of the excavation level during excavation, concreting and backfilling.

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 faces shall measure not more than one metre in height.

Embankments adjacent to abutments, culverts, retaining walls and similar structures shall be constructed by compacting 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 Engg Incharge (Divisional Engr.). Rocks larger than ten centimetres shall not be placed in embankment adjacent to structures.

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.

5.1 Rock excavation

The rock to be excavated shall be classified under the following categories :

5.1.1 Ordinary rock

Rock which does not require blasting, wedging or similar means for excavation is considered as ordinary rock.. This may be quarried or split with crowbars or pickaxes and includes lime stone, sand stone, hard laterite, hard conglomerate and reinforced cement concrete below ground level. It will also include rock which is normally hard requiring blasting when dry but can be excavated without blasting, wedging or similar means when wet. It may require light blasting for loosening materials, but this will not any way entitle the material to be classified as hard rock.

5.1.2 Hard Rock

Any rock or boulder for the excavation of which blasting is required, for example quartzite stone, granite, basalt, reinforced concrete (reinforcement to cut through but not separated from concrete) below ground level.

5.1.3 Hard Rock (Blasting prohibited)

This shall cover any hard rock requiring blasting as described in above but where blasting is prohibited for any reason and excavation has to be carried out by chieselling, wedging or any other approved method.

5.1.4 Authority for classification

The classification of excavation shall be decided by the Engg Incharge (Divisional Engr.) and his decision shall be final and binding on the Contractor. Merely the use of explosives in excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engg Incharge (Divisional Engr.).

5.2 Excavations for foundations and other purposes

Excavations shall be of the minimum sizes necessary for the proper construction of the works, and excavations shall not be kept open for periods longer than that reasonably required to construct the works. The Contractor shall take all precautions necessary to ensure that the bottoms of excavations are protected from deterioration and that the excavations are carried out in such a manner that adjacent foundations, pipes or such like are not undermined, damaged or weakened in any way. Any excavation taken out below the proper level without approval shall be made good at the expense of the Contractor using concrete or other material as directed.

All excavated materials obtained from excavation shall remain OPTCL`s property. The useful portion shall be separated from the useless one and deposited in regular stacks at places indicated and as directed by the Engg Incharge (Divisional Engr.).

5.3 Support of excavations

The Contractor shall be responsible for the stability of the sides of the excavations. Excavations shall be close timbered or sheeted, planked and strutted as and when necessary during the course of the work and shall ensure the safety of personnel working within them. If any slips occur, they shall, as soon as practicable, be made good in an approved manner at the expense of the Contractor. Shoring shall not be removed until the possibility of damaging the works by earth pressure has passed. No payment for shoring or timber left in shall be made, unless agreed in writing by the Engg Incharge (Divisional Engr.).

5.4 Works to be in dry

All excavations shall be kept free from water and the Contractor shall take whatever action is necessary to achieve this. Pumping, well pointing and other means necessary to maintain the excavations free from water shall be at the expense of the Contractor, and carried out in an approved manner.

5.5 Backfill

As soon as possible after the permanent works are sufficiently hard and have been inspected and approved, backfill shall be placed where necessary and thoroughly consolidated in layers not exceeding two hundred (200) millimetres in depth.

On completion of structures, the earth surrounding them shall be accurately finished to the line and grade as shown on the drawings. Finished surfaces shall be free of irregularities and depressions.

The soil to be used for back filling purposes shall be from the excavated earth or from borrow pits, as directed by the Engg Incharge (Divisional Engr.).

5.6 Disposal of surplus

Surplus excavated material not required or not approved for fill or backfill shall be loaded and deposited either on or off site as directed. The Contractor shall not delay disposal of surplus material after receipt of instructions from the Engg Incharge (Divisional Engr.). The contractor shall arrange to transport the excavated earth by mechanical transport, not necessarily on Pucca roads. The soil so transported shall be stacked and levelled neatly and dressed. The location where the soil is to be stacked / disposed shall be as directed by the Engg Incharge (Divisional Engr.).

5.7 Compaction

The method and equipment used to compact the fill material to a density that will give the allowable soil bearing pressure required for the foundations, roads, etc. in each layer of fill material. Each layer of earth embankment when compacted

shall be as close to optimum moisture content (OMC) as practicable. Embankment material which does not contain sufficient moisture to obtain proper compaction shall be wetted. If the material contains an excess of 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 rockfills. No compaction shall be carried out in rainy weather.

At all times unfinished construction shall have adequate drainage. Upon completion of the road's surface course, adjacent shoulders shall be given a final shaping, true alignment and grade.

The density to which fill material shall be compacted shall be as per relevant IS and as per direction of Engg Incharge (Divisional Engr.). All compacted sand filling shall be confined as far as practicable. Backfilled earth shall be compacted to minimum 95% of the Standard Proctor's density at OMC. The subgrade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor's density at OMC

5.8 Requirement for fill material under foundations

The thickness of fill material under the foundations shall be such that the maximum pressure 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.

Where compacted fill is required it shall consist of suitable sand, or other selective inorganic material, subject to approval by the Engg Incharge (Divisional Engr.). The filling shall be done with locally available sand. The filled in sand shall be kept immersed in water for sufficient time to ensure compaction, if so desired by the Engg Incharge (Divisional Engr.).

6. 0 SITE SURFACING

6.1 Scope of Work

The contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings, specification and direction of the Engg Incharge (Divisional Engr.).

6.2 General Requirement

The material required for site surfacing/gravel filling shall be free from all types of organic materials and shall be of standard approved quality, and as directed by the Engg Incharge (Divisional Engr.).

The Contractor shall furnish and install the site surfacing to the lines and grades as shown in the drawing and in accordance with the requirements and direction of the Engg Incharge (Divisional Engr.). The soil of the entire switchyard area shall be levelled before placing the site surfacing/gravel fill material. After all the structures and equipment have been erected and accepted the site shall be maintained to the lines and grades indicated in the drawing and rolled or compacted by using three ton roller with suitable water sprinkling to form a smooth and compact surface condition, which shall be matching with finished ground level of the switchyard area. After due compaction of the surface of the entire switchyard area shall be provided with plain cement concrete of 75 mm thickness after proper compaction, and anti-weed treatment having cement concrete ratio 1:4:8. Care shall be taken for proper gradient for easy discharge of storm water.

After the PCC is applied and surface prepared to the required slope and grade a base layer of uncrushed/crushed broken gravel of 20 mm nominal size shall be spread, rolled and compacted by using 1/2 ton roller (30" width and 24" dia) with 4 to 5 passes and water sprinkling to form a minimum 50 mm layer on the designed finished formation level of the entire switchyard area.

As a final surface course minimum 50 mm. uniform layers of uncrushed /crushed broken metals (gravel) of 20 mm. nominal size shall be spread over the base layer/course. This final surface course shall be applied in all areas exclusive of roadways and shall extend beyond the fenced area as indicated in the drawing. This surface course shall then be compacted by light roller using 1/2 ton steel roller (width 30" x dia 24") and 4 to 5 passes or any other means with water sprinkling as directed by the Engg Incharge (Divisional Engr.). Water shall be sprinkled in such a manner that bulking does not take place. The 20 mm. nominal size (for both layers) shall pass 100% through IS sieve designation 37.5 mm and nothing through 16.0 mm. IS sieve.

In areas that are considered by the Engg Incharge (Divisional Engr.) to be too congested with foundations and structures for proper rolling of the site base course material by normal rolling equipments, the material shall be compacted by hand, if necessary. Due care shall be exercised so as not to damage any foundation structure or equipment during rolling or compaction.

Engg Incharge (Divisional Engr.) by no means shall relieve the contractor of their contractual obligations as stipulated in General and Special Conditions of Contract.

6.3 Measurements

7.2.1 Payment of gravel filling

The measurement shall be based on square metre of finished area of minimum specified compacted thickness of 100 mm above finished ground level. Nothing shall be paid extra for any additional material labour etc. used for achieving the specified compacted thickness of 100 mm. above finished ground level.

7. 0 SITE DRAINAGE

7.1 General

Adequate site drainage system shall be provided by the Contractor. The Contractor shall obtain rainfall data and design the storm water drainage system, (culverts, ditches, drains etc.) to accommodate the most intense rainfall that is likely to occur over the catchment area in one hour period on an average of once per ten years. The surfaces of the site shall be sloped to prevent the ponding of water.

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 1:1000 shall be provided.

For design of RCC pipes for drains and culverts, IS 456 and IS 783 shall be followed.

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.

The drainage system shall be adequate without the use of cable or pipe trenches.

For pipe drains, concrete pipes of class NP2 shall be used. However, for road crossings higher strength pipe of class NP3 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 30 m intervals, at connection points and at every change of alignment. All manholes deeper than 1.2 m shall be provided with galvanised M.S. foot rests. Foot rests shall be of 20 mm M.S. square bars.

Open surface drains shall be of RCC (1:1.5:3) type. Design and drawings shall have the approval of the Engg Incharge (Divisional Engr.). For expansive soils, the guide lines of IS 9451 shall be followed. Suitable expansion joints shall be provided as per standard.

In general, all plant effluent drainage shall be through buried concrete pipes and all storm water drainage shall be through open drains/pipe drains. Open storm water drains shall be provided on both sides of the roads and shall be designed to drain the road surface as well as all the free and covered areas.

Pipe drains shall be connected through manholes at an interval of maximum 30 m. Plant 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 their final disposal.

Invert of the drainage system shall be decided in such a way that the water can easily be discharged above the High Flood Level (HFL) outside substation boundary at suitable location and approved by Engg Incharge (Divisional Engr.). Pumping of drainage water, if required, shall be provided by Contractor.

All internal site drainage systems, including the final connection and disposal to Engg Incharge (Divisional Engr.) acceptance points shall be part of Contractor`s scope including all required civil work, mechanical and electrical systems. The Contractor shall connect his drain(s) at one or more points.

Precast manholes shall be preferred against cast-in-situ type. The drainage scheme may either employ open drain system or underground pipe system or a combination of both. A man hole shall be provided at every turn or corner in case of underground type in addition to the normal requirement.

Suitable pumping arrangement shall be provided by the Contractor to pump out the water from sump to the open channel; automatic float valve type pump shall be provided and installed by Contractor.

The Contractor shall locate the outfall point outside the substation vicinity and the substation storm drainage must be connected to this point.

The drainage scheme and associated drawings shall be subject to approval of the Engg Incharge (Divisional Engr.).

7.2 Excavation and backfill

Trench excavations for drains shall be carried out with the minimum disturbance to adjacent ground and in such a way that existing or new work shall not be undermined. No backfill shall be placed until pipes, etc. have been inspected, tested and approved. Backfill shall be carefully placed by hand tools round pipes, etc. and rammed in layers not exceeding one hundred (100) millimetres thick in a manner which will not cause damage. When a minimum thickness of three hundred (300) millimetres above the pipes has been so placed, normal methods of backfilling and ramming may be adopted.

7.3 Laying Of Pipes

Pipes and fittings shall be of the types, qualities and sizes specified and shown on the approved drawings. They shall be laid to the lines and levels shown, and the barrel of each pipe shall bear firmly and uniformly on the trench bottom or prepared foundation bed, any projections in the trench bottom which could cause damage to pipes being first removed. Pipes shall be kept clean during and after laying, and open ends shall be provided with the temporary plugs to prevent entry of foreign matter. Each pipe shall be accurately bonded to gradient between sight rails and drain. Laying shall commence at the lowest end and proceed uphill. Pipes shall be laid with the sockets leading uphill.

7.4 Testing of drains

All drains, other than open channels, stone filled drains and porous drains, shall be of watertight construction, and all soil drains shall be subjected to a water test before backfilling of trenches is commenced. Drains may be tested in sections, and manholes may be tested separately. The Contractor shall submit to the Engg Incharge (Divisional Engr.) for approval his proposals for testing. The drains shall withstand, without leakage, a water pressure of not less than one and one half (1.5) metres at any point for a period of 20 minutes or such other time as the Engg Incharge (Divisional Engr.) may direct. All necessary plugs, temporary connections and other equipment and all labour required for the tests shall be provided by the Contractor and at the expense of the Contractor. For testing of pipes in areas where an adequate supply of water is not readily available, the Engg Incharge (Divisional Engr.) will accept an air (smoke) pressure test, provided that the method of testing is approved by the Engg Incharge (Divisional Engr.). Further testing may be called for after backfilling of trenches to ensure that pipes have not been damaged during that operation.

7.5 Regulations

The regulations and recommendations of any relevant drainage or sanitary authority shall be fully observed, and the Contractor shall be responsible for acquainting himself with any such regulations.

8.0 SEWAGE SYSTEM

A sewage system shall be provided for all utility buildings including the Control room building and other auxiliary buildings.

The Contractor shall construct suitable septic tank and soak pit for the discharge of effluents.

Sewers shall be designed for a minimum self cleansing velocity of 0.6m/sec and the maximum velocity shall not exceed 2.4m/sec.

The sewage system shall consist of all necessary piping, pumps, if required, fittings, manholes, clean - outs, piping connections and all other materials required for safe and efficient sewage collection. Sewer pipes and fittings shall conform to the relevant Indian Standards.

Cast iron pipes shall be used below ground level for sewage disposal.

Manholes shall be provided at every 20 metres along the length, at connection points, and at every change of alignment, gradient or diameter of a sewer pipe line.

9. 0 ROADS AND CULVERTS

The Contractor shall be responsible for constructing approach roads, sub-station roads and service roads etc. within the substation area. Layout of the roads shall be based on general details and arrangement drawings for the substation. Parking areas shall be provided for Site personnel and a minimum of twenty numbers of visitors at convenient locations. Adequate turning space for vehicles shall be provided and bend radii shall be set accordingly. Roads to the transformer bays shall be as short and straight as possible. Where the substation layout warrants headroom safety barriers shall be installed to prevent vehicles coming into contact with overlying conductors. Such barriers shall be included as part of the scope of the work.

All substation roads shall be constructed so as to permit transportation of all heavy equipment. A minimum seven metres black topping with 1.6 m wide shoulders on either side of the road shall be constructed for double lane roads. The other service roads shall be with 3.75 m black topping and 1.3 m wide shoulders on either side of the road.

Finished top (crest) of roads shall be a minimum of 300 mm above the surrounding grade level (Formation level).

Road construction shall be as per Indian Road Congress (IRC) standards.

Adequate provision shall be made for road drainage.

All culverts and allied structures required for road/rail, drain, trench crossings etc. shall be designed for class AA loading as per IRC standard.

All roads shall be designed for class 'E' of traffic i.e. traffic intensity of 450-1500 vehicles per day (heavy vehicles exceeding 3 tonnes laden weight) as per IRC-37-1984, Guide-lines for the design of flexible pavements.'

California Bearing Ratio (CBR) method shall be followed for the design of roads. A detailed CBR test which is an adhoc penetration test shall be carried out as per the procedure outlined in IS 2720 (Part XVI).

The surface of the hardstanding shall be laid with falls to the drainage system. Care shall be taken during the construction that no materials enter the drainage system.

At the junction of the hard standing and roads due to different thickness of foundations, precautions shall be taken to ensure that sub-surface drainage from the hard standing does not have a detrimental affect upon the road foundations.

A) CONCRETE ROAD:

The side shoulder of all the roads shall be with kerb stone at two sides. The kerb stones shall be painted yellow and black alternatively. In case of switch yard road (concrete road) the shoulder would be compacted earth 600 mm wide on the sides of the road and shall be provided with cement chequered tiles of adequate strength as per standard practice. The concrete road shall have 100 mm thick PCC (1:2:4 nominal ratio). Below it 100 mm thick PCC (1:4:8) shall be provided. 300 mm thick water bound macadam (WBM) in three equal layers of 100 mm each at the bottom. PCC and WBM shall extend upto the shoulder width on both sides of the road outside switch yard area as per drawing and the shoulder shall be provided with cement chequered tiles of adequate strength as per standard practice. In case of road within the switch yard area the PCC and WBM shall be placed only up to the width of the road. Polythene sheet of 125 microns shall be placed between the RCC and PCC slab.

ASPHALT expansion joint shall be considered (composed of a blend of asphalts, vegetable fibers, and mineral fillers formed under heat and pressure between two asphalt-saturated liners)/FIBRE expansion joint (cellular fibers securely bonded together and uniformly saturated with asphalt to assure longevity, versatile, resilient, flexible, and non-extruding) for concrete road. It is waterproof, permanent, flexible, and self-sealing Expansion joints required thickness shall be provided at every 8 mtrs.

In addition, in case of 7 mtrs wide roads 100 mm Dia hume pipe (NP-3) shall be provided at every 100 mtrs interval across the length of the road for cable crossing. The width of the road shall be 7mtrs /3.5 mtrs.

B) BITUMINOUS ROAD:

The following procedure shall be followed for the construction of bituminous roads.

1. Compacted WBM at the bottom end of the road up to a thickness of 300 mm in three equal layers 100 mm each. The compaction shall be done by laying stone aggregates of size 100mm. each layer shall be laid and compacted with water spreading and using rollers as per the standard practice adopted in the CPWD guide line.
2. Above, the compacted WBM 1st layer as stated under (1), 200 mm thick consolidated WBM in two layers with stone aggregates of size 90 – 45mm shall be laid. Each layer shall be laid and compacted with water spreading and using rollers as per recommended.
3. Above the compacted 2nd layer of WBM, 75 mm thick consolidated WBM in two layers with stone aggregates of size 63mm-45mm shall be laid. Each layer shall be compacted with water spreading and using rollers as per recommended.
4. Above the compacted 3rd layer of WBM, 75 mm thick consolidated WBM in two layers with stone aggregates of size 53mm-22.4mm shall be laid. Each layer shall be compacted with water spreading and using rollers as per recommended.
5. Above the 4th layer of compacted WBM, 25mm thick pre mix carpet surfacing has to be done. The carpet surfacing shall be done with 2.25 cum and 1.12 cum of stone chippings of 13.2 mm size and 11.2 mm size respectively per 100 sq mtrs and 52 Kgs of hot bitumen per cum of stone chippings. Complete with paving ASPHALT 80/100 heated and thin mixed with solvent @70g/Kg of ASPHALT. Hot bitumen of grade 80/100 shall be spread on road surface @750g/Kg per sqmtr. There shall be shoulder on both side of the roads as per given data. The curvature of the road shall be R=7M and additional metalling for turning has to be maintained. The shoulder shall also be made compacted morrum filling and other as specified.

1.1 Periphery roads outside the fencing:

Periphery roads to be constructed outside the fencing. The width of the road is 3.5 mtrs having borm of 1 mtr each at both sides of the roads. The roads shall be concrete road with general specifications as in 10(A).

1.2 The width and type of other roads are:

- a) Approach roads shall be 7 mtr wide with both side shoulder of 1.75 ` mtrs. The roads shall be of bitumen grade type wherever specifically mentioned.
- b) Other roads shall be (peripheral and colony) 3.75 mtrs width having shoulder of 1.3 mtr at both the side. The roads shall be of bituminous type.
- c) Main road shall be 7 mtr wide with both side shoulder of 1.75 ` mtrs. The road will be Concrete(SPECS. 10(A))

Note: The shoulder shall be provided with cement chequered tiles of adequate strength as per standard practice.

10. 0 AUTO TRANSFORMER / TRANSFORMER/REACTOR FOUNDATION, RAIL TRACK / ROAD CUM RAIL TRACK

10.1 General

The Contractor shall provide a permanent transfer track system integrated with the auto transformer foundation to enable installation and the replacement of any failed unit with a spare unit. The transfer track system shall be suitable to permit the movement of any failed unit fully assembled (including OLTC, bushings) with integral radiators and oil, without the de-energization of any other equipment in the station. The system shall enable the removal of any failed unit from its foundation to a repair area and the installation of a spare unit. The system shall not interfere with the normal internal road and trench system. If trench or drain crossings are required then suitable R.C.C culverts shall be provided in accordance with IRC Code and /or relevant IS.

Rail tracks shall be of RCC, M20(1:1.5:3 mix) grade. The space between the tracks shall be suitably filled with local sand and 75 mm thick PCC of grade 1:3:6 placed over sand filling. The top of PCC shall be up to the formation level. In case of road cum rail track, 75mm thick PCC of grade 1:1.5:3 shall be placed up to the road level. Suitable drainage system between the tracks shall be provided.

The rails shall be 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 27 mm diameter fish bolts.

A pylon support system shall be provided for supporting the fire fighting system by the Contractor.

For design of foundation for transformer refer the weightage of the transformer indicated in the BPS (civil works)

10.2 Oil Recovery System

10.2.1 General

An 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.

10.2.2 Description

Each auto transformer/transformer/Reactor 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 0.8 m whichever is greater. The transformer pit thus formed shall have a capacity equal to volume of oil, usually 125%, in the transformers. The MS grating placed at the formation level shall be covered with 100mm thick gravel of 40 mm nominal size which acts as an extinguisher for flaming oil. The bottom of the pit shall have an uniform slope towards the sump pit.

Each transformer pit shall be drained towards a common sump pit whose role is to recover the infiltrating water and the drained oil from of 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.

10.2.3 Materials

The retaining walls which make up the transformer pit shall be made of fire resistant material such as reinforced cement concrete, fire brick etc., and shall be impervious to oil.

The minimum height of the retaining walls shall be 15 cm above the finished level of the ground to avoid ingress of water from outside.

The floor of the transformer pit shall be of plain cement concrete of concrete grade 1:2:4

10.2.4 Drainage

A device showing level of sump pit shall be fitted along with an automatic pumping system which shall have sufficient capacity to evacuate the fire fighting and rain water from the sump pit. The water/oil separation and drainage scheme shall be provided as described in the paper (23-07/1972 Cigre Session) presented by working group 23.04 regarding oil pollution. The Contractor may propose an alternative better scheme, which will be subject to the approval of the Engg Incharge (Divisional Engr.).

10.2.5 Particular Specification

If the height of the retaining walls which form the transformer pit exceed 60 cm, steps shall be provided to facilitate access to the transformer or auto transformer and reactor

When designing the transformer pit, the movement of the auto transformer must be taken into account.

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.

11. 0 FIRE PROTECTION WALLS

11.1 General

Fire protection walls shall be provided in accordance with Tariff Advisory Committee (TAC) recommendations.

11.2 Application criteria

A fire wall shall be erected between the transformers and or the reactors if the free distance between the various pieces of equipment is less than 10 m, to protect each one from the effects of fire on another.

Fire walls shall also be erected between the transformers, reactors, and auxiliary services transformers if the free distance is less than ten metres.

11.3 Fire resistance

The fire wall shall have a minimum fire resistance of three hours. Partitions which are made to reduce the noise level of the transformers shall have the same fire resistance where they are also used as fire walls. The walls of buildings which are used as fire walls, shall also have a minimum fire resistance of three hours.

Fire walls shall be designed in order to protect against the effect of radiant heat and flying debris from an adjacent fire. The column of the fire walls shall be type RCC, M20 (1:1.5:3 mix).

11.4 Mechanical resistance

Fire walls shall have the mechanical resistance to withstand local atmospheric conditions. If the wall is intended to serve as a support for equipment such as insulators etc., its mechanical rigidity must be increased accordingly.

Connecting the walls by steel or other structures, which may produce a reversing torque if overheated, shall be avoided.

11.5 Dimensions

Fire walls shall extend at least two metres on each side of the power transformers or reactors and at least one metre above the conservator tank or safety vent.

These dimensions might be reduced in special cases, and if TAC permits so, where there is lack of space. A minimum of two metres clearance shall be provided between the equipments e.g. reactors, transformers and fire walls.

Building walls which act as fire walls shall extend at least one metre above the roof in order to protect it.

11.6 Materials

Fire walls may be made of reinforced concrete (M20 grade), fire brick, concrete blocks or corrugated iron on a steel structure as per the system requirements. Materials used must conform to the standards of the National Fire Prevention Association and TAC norms.

12.7 BOUNDARY WALL/COMPOUND WALL:

The scope includes the design, engineering and construction of the boundary wall all along the property line of the OPTCL on each sub-station.

Construction of Boundary wall: The boundary wall shall be constructed to a height of 2 mtrs above finished ground level of the substation area with 10" wide brick masonry work with RCC(1:1.5:3) ground tie beam to be rested on the RCC pillars (**pillar to pillar distance @ 3mtrs**) as detailed below.

The boundary wall shall be designed based on the soil investigation data.

Salient points to be considered at the time of design:

- (1) **The boundary wall shall be designed as per actual soil investigation report.**
- (2) **It will have two components. Below FGL it should serve as retaining wall for 1.5 mtr filled soil whenever required and it should be designed. Above FGL, it should be the normal boundary wall of two meter height.**
Or,
A boundary wall of 3.5 meter height (1.5 meter below FGL or top of tie beam and 2.00 meter above tie beam.).
- (3) Brick works: 1st Class Brick of size 250 mm all along the boundary wall to be provided. Cement sand mortar of ratio (1:5) to be provided for brick masonry works. The height of the brick wall shall be minimum 2 mtrs height from the top of the tie beam provided at the finished ground level. A 50mm height of finished concrete (ratio 1:2:4) shall be provided on the top of the boundary wall.
250mm Brick masonry work of 500mm depth below the tie beam also to be considered where ever required.

Suitable GI post @ distance of 1 mtr along the B/W to be provided at the top of the B/W, single concertina wire runs in loops on fence GI post with blade tape with BT-10 to BT-60 concertina wire CBT-65 with OD: 450-960 mm, hot dipped galvanised razor wire with bright & beautiful blade for fixing to the GI post and other materials as per standard drg

fencing shall be provided on top of the boundary wall as mentioned above. All corner of the B/W should be provided minimum two nos extra post for getting adequate strength.

BRICK: The brick shall be machine moulded and made from suitable fly ash, cement, lime, gypsum, etc. They shall be free from cracks and nodules of free lime. They shall have smooth rectangular faces with sharp corners and shall be of uniform colour. The bricks shall be moulded with the frog of 100mm x 40 mm and 10mm to 20mm deep on one of its flat sides. The bricks shall not break when thrown on the ground from a height of 600mm.

The size of the modular bricks shall be 190 x 90 x 90 mm.

The size of the conventional bricks shall be 250 x 125 x 75mm.

Only bricks of one standard size shall be used on one work. The following tolerance shall be permitted in the conventional size adopted in a particular work. Length +3.0mm, Width + 1.50mm, Height +1.50mm.

The crushing strength of the brick shall not be less than 75.0 Kg / Sq cm. The average water absorption shall be within 13-15% by weight. Similarly, the porosity of the fly ash bricks shall be within 12-20%. Necessary test for crushing strength and water absorption shall be carried out as per IS 3495 : (Part I to Part IV) 1976.

- (4) Cement Plastering works: Cement sand mortars of ratio(1:5) to be provided both the sides of the boundary wall.
- (5) Galvanised barbed wire fencing shall be provided on top of the boundary wall to a height of 0.5 mtr. 'Y' Type anti climbing device with inclined length of each angle 640mm and vertical height 500 mm with 6 rows of 12 gauge Galvanised barbed wire with U clip, hooks etc. at 2mtr c/c along the B/W to be provided at the top of the B/W, single concertina wire runs in loops on fence GI post with blade tape with BT-10 to BT-60 concertina wire CBT-65 with OD: 450-960 mm, hot dipped galvanised razor wire with bright & beautiful blade for fixing to the GI post and other materials as per standard drg fencing shall be provided on top of the boundary wall as mentioned above. All corner of the B/W should be provided minimum two nos extra post for getting adequate strength.
A minimum length of 450 mm (bottom portion of the Y shaped frame) shall be grouted on the top of the concrete pillar and a clear height of 500 mm from the finished portion of the top of the wall shall be maintained for the Y shaped frame with GI barbed wires. The "Y" post shall be galvanised one and the size of the GI angle shall be 65X65X6 mm.
- (6) Colouring: After the cement wash on the entire boundary wall two coats of weather coats paint to be applied.
- (7) In case the boundary wall to be designed considering pile foundation, the minimum dia of the pile shall be 250mm of required length as per the design based on soil investigation. Rest of the boundary wall shall be in line with the above description from Sl. No-2 to Sl. No.-6.
- (8) Boundary shall have one main gate as per stipulation elsewhere in the spec. The gate shall be supported by gate pillars of RCC (1:1.5:3).A separate wicket gate shall be provided adjacent to the main gate. Suitable Cow catcher(using solid MS rod of minimum 40mm dia duly painted) of adequate strength to withstand the load of the trailer loaded with Transformer/any heaviest mass of the Project may be considered.

12.8 CABLE AND PIPE TRENCHES

12.8.1 General

Cable trenches and pre-cast removable RCC covers (with lifting arrangement) shall be constructed using RCC of M20 grade.

The cable trenches shall be designed for the following loads.

- Dead load of 155 kg/ m length of cable support plus 75 kg on one tier at the end.
- Triangular earth pressure plus uniform surcharge pressure of 2 tonnes per sq.metre.
- Cable trench covers shall be designed for (i) self weight of top slab plus concentrated load of 200 kg at centre of span on each panel and a surcharge load of 2 tonnes per sq. metre.

Cable trench crossings of road and rails shall be designed for class AA, class A and class 7OR loading of IRC or relevant IS Code and should be checked for transformer loading.

Trenches shall be drained. Necessary sumps be constructed and sump pumps shall be supplied. Cable trenches shall not be used as storm water drains.

The top of trenches shall be kept at least 250 mm above the finished ground level. The top of cable trench shall be such that the surface rain water does not enter the trench.

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

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

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

A clear (vertical) space of at least 300 mm shall be available for each tier in cable trench. From trench bed to lowest tier, a minimum clearance of 200 mm shall be available for one tier trench and 300 mm for trenches having more than one tier. The spacing between stands shall be 400mm.

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

All 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 expansion joints shall be provided with approved quality PVC water stops of approximately 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.

Cable trenches shall be blocked at the ends if required with brick masonry in cement sand mortar 1:6 and plaster with 12mm thick 1:6 cement sand mortar.

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

Concrete troughs shall be provided with concrete covers of suitable load bearing strength. Where the cable troughs are run across or within 3 m of substation roads, the trough covers shall be capable of bearing an accidental wheel load of 20 kN.

MORE ON CABLE TRENCH.

All the cable trenches shall be RCC type with mixing ratio 1:1.5:3. The size of MS rod to be used for the same are of 8mm top and 6mm. All the vertical rod shall be 8 mm continuous and the wall and raft shall contain 2 nos 8 mm rods at two layers and spacing shall be 150mm. The horizontal binders shall be of 6mm rod two nos in two layers and to be placed at 200mm centre to centre for both on the wall and raft portion of the trench. The mentioned rod placements are for section 1-1, 2-2, and 3-3. For section 4-4 instead of two 8mm and 6mm rods single rods can be used.

A frame of hot dip galvanized angles of size 50X50X6 mm having provision of MS chairs on the grouting side on to the walls of the trench preferably at two locations(at top and bottom) of the frame (these chairs have to be welded with the rods of the wall for better rigidity). For section 1-1 there shall be of 4 tier mechanism for fixing of cable tray having width of the angle 450mm (3 nos) and the top angle shall be of 300 mm, and the quantity of such type of frame shall be 2 (for both way). For section 2-2 only one frame of the above mentioned one shall be used. For section 3-3 there shall be one frame but with three tier mechanism for fixing the cable trays. For section 4-4 two tier system of angle width shall be 200 mm width at the bottom and 100 mm width at the top. Fixing of the cable tray support stand (Frame) is to be fixed at a distance of 1 mtrs from one frame to the other.

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

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

The other dimensions of the cable trench are as below.

Sl No	Section	No of tiers in each frame/ and no of such frame	Gap between the two angles in mm	Inside clearance in mm		Outside clearance in mm		Concrete thickness in mm	
				Top to Bottom	Wall to wall	Top to bottom of wall	Raft width	Wall	Raft
1	1-1	Four tiers/ Two (both way)	200	1275	1400	1350	1750	100	75
2	2-2	Four tiers/single(one way)	200	1275	900	1350	1450	100	75
3	3-3	Three/single	200	1075	900	1150	1450	100	75
4	4-4	Two/single	200	545	250	620	350	100	75

The covers of the slab are also of RCC with ratio mixing 1:1.5:3. The thickness of the slab shall be 75mm for section 1-1 (MS Rods to be used 10mm & 8mm), section 2-2, 3-3 shall be 60mm (MS Rod to be used 8mm) and section 4-4 shall be 50mm (MS Rods to be used 8mm & 6mm). The MS rods to be used shall be placed at 100 mm centre to centre both way and properly binded. The cover slab shall have provision of lifting hooks at two points for easy lifting of the slabs. Slabs having lifting hooks shall be placed at every 10th slabs. The lengths of the cable trench cover slabs are as below.

Section	Length of the slab	Thickness of the slab
1-1	1600mm	75mm
2-2	1100mm	60mm
3-3	1100mm	60mm
4-4	400mm	50mm

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

12.9 Excavation

Excavation for cable ducts shall generally be carried out in accordance with Clause no. 6.2 of this specification.

12.10 Back fill

Except where ducts are to be encased in concrete, sand is to be packed and well tamped round the duct until it is covered to a depth of 75 mm above the upper surface of the duct. Filling above this level is to be with suitable excavated material free from large stones. In multiple duct runs the interstices between the ducts are to be filled with sand and compacted. A

cover of 75 mm above the uppermost ducts shall be maintained. The sand used shall be the same quality as approved for use in making concrete.

12.11 Laying of ducts

Telephone and electrical cable ducts shall be laid and jointed in accordance with the Manufacturer's instructions.

12.12 Multiple runs to ducts

Electrical cable ducts in multiple runs whether encased in concrete or not, shall be laid at approved centres vertically and/or horizontally. The minimum concrete encasement where required is to be 150 mm. The final jointing of ducts in multiple runs shall be done in the trench, i.e. the duct shall be lowered and jointed singly not in groups, and duct joints shall be staggered by approximately half the duct length in alternate lines.

12.13 Cutting of ducts

The Contractor shall carry out any necessary cutting of pipe ducts according to the requirements of the work. Except where ducts enter the cable trench at an angle, they shall be cut at right angles to the length of the duct. The inside edges of cut ducts shall be thoroughly rounded off or so dressed before being placed in position so that there can be no possibility of damage to cables from the edges of the ducts. All electrical ducts entering draw pits shall be provided with suitable bellmouths.

12.14 Cleaning and testing of ducts

On completion of all electrical cable ducting, two mops of appropriate size connected one to each end of an iron mandrel shall be passed twice through each way to clean the conduit and to remove any foreign matter which may have entered. If any obstruction or other defect be discovered it shall be removed or rectified forthwith.

12.15 Sealing of electrical ducts

As soon as every duct or set of ducts has been proved and its draw wire material installed, the ends of the cut or its bellmouth where provided, shall be sealed to a depth of 5 mm with an appropriate sealer, and a single coat of bitumastic paint shall then be applied over the end of the ducts and the seal. The length of draw wire installed shall be such that at least one metre of draw wire extends from each end of each duct. After the ends of ducts have been sealed the free ends of draw wires shall be neatly coiled.

12.16 Concrete cable and pipe trenches

In-situ concrete trenches are to be provided inside and outside the Substation. The trenches are to have falls in the floor and must be drained at regular intervals.

All trenches must have trench covers suitable for their location and loading. Any beams or supporting covers must be as shallow as possible to avoid interfering with the pipes and cables in the trench.

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

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

12.17 Buried cables

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

12. 0 FOUNDATION / RCC DESIGN

12.1 General

All foundations/RCC Design 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 M20 corresponding to 1:1.5:3 (M20) nominal mix ratio with 12-20 mm coarse aggregate. Higher grades of concrete than specified above may be used at the discretion of the Bidder without any financial implication to the owner. Work covered under this clause of the specification comprises the construction of foundations and other RCC constructions for switchyard structures, equipment support, trenches, drains, jacking pad, pulling block, control cubicles, bus supports, Auto transformer/power transformer/reactors, marshalling kiosks, auxiliary equipments and system buildings, tank or for any other equipment or service and any other foundation required to complete the work. Also applicable to other RCC constructions.

If the site is sloping, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate such slopes.

The switchyard foundations plinths and building plinths shall be minimum 300mm above finished ground level respectively. Minimum 75 mm thick lean concrete shall be provided below underground structures, foundations, trenches etc to provide a base for construction.

The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof. The special footing or pile foundations as may be required based on soil/sub-soil conditions and superimposed loads shall be provided.

Admixtures in concrete shall conform to IS:9103. The water proofing cement additives shall conform to IS:2645. Concrete Admixtures/Additives shall be approved by the owner.

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

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

For detailing of reinforcement IS 2502 and SP:34 shall be followed. Cold twisted deformed bars (Fe= 415 N/sq mm) conforming to IS 1786 shall be used as reinforcement. However, in specific areas, mild steel (Grade1) conforming to IS 432 can also be used. Two layers of reinforcement (on inner and outer face) shall be provided for wall and slab sections having thickness of 150 mm and above. Clear cover to reinforcement towards the earth face shall be minimum 40 mm.

RCC water retaining structures such as storage tanks, cooling water basin etc. shall be designed as uncracked sections in accordance with IS 3370 (Part 1 to IV) by working stress method and shall also be tested for water tightness at full water level. However, water channels shall be designed as cracked sections with limited steel stresses as per IS 3370 (Part 1 to IV) by working stress method.

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

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

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

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

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

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

Earth pressure for all underground structures shall be calculated using coefficient of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.

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 substructures of any underground hollow enclosure etc., to allow for vehicular traffic in the vicinity of the structure.

The following conditions shall be considered for the design of water tanks, pump houses, channels, sumps, trenches and other underground concrete structures such as basements etc.

- Full water pressure from inside and no earth pressure, ground water pressure and surcharge pressure from outside (applicable only to structures which are liable to be filled with water or any other liquid).
- Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

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.

Base slabs of any underground enclosures shall be designed for empty condition during construction and maintenance stages with maximum ground water table (GWT). Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the super-imposed loadings.

Base slab of underground enclosures such as 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 pump sump being empty for maintenance.

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.

The foundation of the transformer and circuit breaker shall be of block type foundation. Minimum reinforcement shall be governed by IS:2974 and IS:456.

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

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

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

12.2 Machine Foundations

All machine foundations shall be designed in accordance the provisions of the relevant parts of the latest revisions of IS 2974, IS 456 and IS 2911. The provisions of DIN 4024 (latest) shall also be followed.

All block foundations resting on soil or piles shall be designed using the elastic half space theory.

The mass of the RCC block shall not be less than three times the mass of the machine. Dynamic analysis shall be carried out to calculate natural frequencies in all the modes including coupled modes, and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down by the relevant IS codes and/or machine manufacturers, shall be satisfied. Minimum reinforcement shall be governed by IS 2974 and IS 456.

For the foundations supporting minor equipments weighing less than one tonne, or if the mass of the rotating parts is less than one-hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structures, floors etc. suitable vibration isolation shall be provided by means of springs, neoprene pads etc. and such vibration isolation system shall be designed suitably.

12.3 Other Foundations

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

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

A minimum three piles shall be provided in any pile group.

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

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

13. 0 FOUNDATIONS AND R CC CONSTRUCTION

13.1 General

Work covered under this Clause of this Specification comprises the design, supply and installation of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, rains, jacking pads, pulling blocks, fencing, control cubicles, bus supports, transformers, marshalling kiosks, auxiliary equipments and systems, buildings and 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.

Concrete shall conform to the requirements of IS 456 and all the tests shall be conducted as per relevant Indian Standard Codes.

If the site is sloping, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate for such slopes.

Switchyard foundation plinths and building plinths shall be minimum 300 mm and 500 mm above finished ground level respectively.

A minimum of 75 mm thick lean mix concrete (1:3:6) shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction.

Concrete made with portland cement(OPC-43 grade or higher grade) shall be carefully cured and special consideration shall be given during the placing of concrete and removal of shuttering.

The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and combinations thereof. Spread footing foundations or pile foundations as may be required based on soil and subsoil conditions and superimposed loads shall be provided.

If pile foundations are adopted, the same shall be cast-in-situ, driven, bored, precast or underreamed type as per relevant IS. 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 contractor showing complete details of piles and pile groups proposed to be used. Necessary initial load tests shall also be carried out by the contractor at their entire cost to establish the pile design capacity. Only after the design capacity of piles has been established, shall the Contractor commence of piling. All the design and testing work shall be planned in such a way that these shall not cause any delay in project completion.

13.2 Cement

The cement to be used shall be the best quality of its type.

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

Cement shall be Ordinary Portland Cement as per I.S.269-1976 or Portland Slag Cement as per I.S. 455-1976

The Ordinary Portland cement(OPC-43 grade or higher grade) used in concrete shall confirm to IS 269.

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

High Alumina cement shall NOT be used.

13.3 Delivery and storage of cement

Cement shall be delivered to the site in bulk or in sound and properly sealed bags and while being loaded or unloaded whether conveyed in vehicles or by mechanical means, and during transit to the concrete mixers, must be protected from the weather by effective coverings. Efficient screens are to be supplied and erected to prevent wastage of cement during strong winds.

If the cement is delivered in bulk, the Contractor shall provide at his own cost approved silos of adequate size and number to store sufficient cement to ensure continuity of work. The cement shall be placed in these silos immediately it has been delivered on the site. Suitable precautions shall be taken during unloading to ensure that the resulting dust does not constitute a nuisance.

If the cement is delivered in bags, the Contractor shall provide at his own cost perfectly waterproof and well-ventilated sheds having a floor of wood or concrete raised at least 150 mm above the ground. The sheds shall be large enough to store sufficient cement to ensure continuity of work. Each consignment of each type of cement shall be stacked separately therein. On delivery at site the cement shall at once be placed in these sheds and shall be used in the order in which it has been delivered.

All cement shall be used within 3 months of the date of manufacture.

13.4 Aggregate

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

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

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

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

13.5 Storage of aggregates

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

13.6 Approval of Supplies

As soon as possible after the Contract has been placed the Contractor shall submit a list giving details of the sources from which he proposes to obtain concrete and mortar materials. Only materials from approved sources shall be brought to site, but the Engg Incharge (Divisional Engr.) will be prepared to extend his approval to other satisfactory sources of supply which may be proposed by the Contractor. Approval of a source of supply shall not imply acceptance of material found not to conform to this Specification

13.7 Water

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

13.8 Steel bar reinforcement (FE500 D)

Reinforcement shall comply with the appropriate Indian Standards.

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

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

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

13.9 Bending of reinforcement

All steel bars are to be accurately bent cold to the shapes and sizes indicated on the Drawings and Schedules unless otherwise approved. Re-bending of bars and bending in position in the works shall not generally be allowed.

13.10 Welding of reinforcement

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

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

13.11 Fixing of reinforcement

Before fixing in the works bars shall be seen to be free from pitting, mud, oil, paint, loose rust or scale or other adherents harmful to the bond or strength of the reinforcement. Bars shall be fixed rigidly and accurately in position in accordance with the working drawings, unless otherwise approved by the Engg Incharge (Divisional Engr.). Reinforcement at all intersections shall be securely tied together with 1.5 mm soft annealed tying wire the ends of which shall be cut and bent inwards. Cover to the reinforcement shall be in accordance with Clause 15.12 of this specification and sufficient spacers and chairs of precast concrete of approved design shall be provided to maintain the specified cover and position. No insertion of bars in previously placed concrete shall be permitted. Projecting bars shall be adequately protected from displacement. The fixing of reinforcement in the works shall be approved by the Engg Incharge (Divisional Engr.) before concrete is placed. Measurement will be based on the calculated weights of steel actually used in tonnes corrected to second place of decimal.

13.12 Concrete cover to reinforcement

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

Concrete above ground.

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

Concrete below ground (including piles).

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

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

13.13 Formwork

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

Form work shall be erected true to line, level and shapes required using a minimum of approved internal ties. Faces in contact with the concrete shall be true and free from defect, jointed to prevent loss of water or fines, in panels or units

which permit easy handling, and designed to permit side forms to be struck independently of soffit shuttering. Ties or spaces remaining embedded shall have the minimum cover specified for reinforcement. Forms for exposed concrete beams, girder casings and columns shall provide for a twenty five millimetre chamfer on external corners.

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

13.14 Grades of concrete

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

13.15 Ordinary concrete

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

In proportioning concrete, the minimum quantity of cement shall be as specified in Table 15.15.1 of this clause and the amount to be used shall be determined by actual weight. The quantities of fine and coarse aggregate may be determined by volume, but preferably by weight.

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

Grade of Concrete	Minimum cement content per cum. of finished concrete
M 10	236 kg
M 15	323 kg
M 20	410 kg
M 25	530 kg

Table - 15.15 Minimum Cement content.

13.16 Controlled concrete

13.16.1 Mix proportions

The mix proportions for all grades of concrete shall be designed to obtain strength corresponding to the values specified in IS 456 for respective grade of concrete. Preliminary tests as specified in the IS Code or as required by the Engg Incharge (Divisional Engr.), shall be carried out, sufficiently ahead of the actual commencement of the work, with different grades of concrete made from representative samples of aggregate and cement expected to be used on the job. The purpose of this test is to ascertain the water cement ratio required to produce a concrete having specified strength, and to demonstrate sufficient workability to enable it to be well consolidated and to be worked into corners of shuttering and around the reinforcement.

13.16.2 Mix design

As a guide to perform the mix design properly, the relationship between water cement ratio, aggregate to cement ratio, workability and strength of concrete will be as per relevant IS.

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

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

13.17 Strength requirements

The mix proportions for all grades of concrete shall be designed to produce the grade of concrete having the required workability and a characteristic strength not less than the value given table 15.17.

Grade Designation	Characteristic Compressive Strength at 28 days (minimum)
M 10	10 N / sq. mm
M 15	15 N / sq. mm
M 20	20 N / sq. mm
M 25	25 N / sq. mm

Table - 15.17 Strength Characteristic

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

13.18 Workability

The workability of concrete shall be checked at frequent intervals by slump test, where facilities exist and if required by the Engg Incharge (Divisional Engr.), alternatively the compaction factor test in accordance with IS 1199 shall be carried out.

13.19 Mixing of Concrete

Unless otherwise approved, concrete for foundations will be M 20/M25 grade, corresponding to nominal mix of 1:1.5:3/1:1:2 as per IS 456. The proportions of fine and coarse aggregate, cement and water shall be as determined by the mix design or according to fixed proportions in case of nominal mix concrete and shall always be approved by the Engg Incharge (Divisional Engr.). The quantities of the cement, fine and coarse aggregates shall be determined by weight, the water shall be measured accurately after giving proper allowance for surface water present in the aggregate. Water shall be added to make a workable mix and it is important to maintain the water-cement ratio at its correct value of 0.55 in accordance with the requirements of IS 456.

Water shall not be added to the mix until all the cement and aggregates constituting the batch are already in the drum and dry mix for at least one minute. Mixing of each batch shall be continued until there is uniform distribution of materials and the mass done for less than 2 minutes and at least 40 revolutions after all the materials and water are in the drum.

When hand mixing is permitted by the Engg Incharge (Divisional Engr.) for concrete to be used in unimportant locations it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand mixing, an extra 10% of cement shall be added to each batch and additional cost due to extra cement will be borne by the Contractor.

13.20 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of final laying as rapidly as practicable by approved means before the initial setting cement starts. Concrete should be conveyed in such a way which will prevent segregation or loss of any of the ingredients. If segregation does occur during the transport of concrete same shall be re-mixed. The requirements to be fulfilled during transportation are :

- No segregation or separation of materials in the concrete, and
- Concrete delivered at the point of placing should be uniform and of proper consistency.

13.21 Placing Concrete

Form work and reinforcement shall be approved in writing by the Engg Incharge (Divisional Engr.) before concrete is placed. The forms shall be well wetted and all shavings, dirt and water that may have collected at the bottom shall be removed before concrete is placed. Concrete shall be deposited in its final position without segregation, re-handling or flowing. As far as possible concrete shall be placed in the formwork by means approved by the Engg Incharge (Divisional

Engr.) and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 180 cm. shall have to be approved by the Engg Incharge (Divisional Engr.). Once the concrete is deposited in its final position, it shall not be disturbed. Care should be taken to avoid displacement of reinforcement or movement of formwork.

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

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

13.22 Compaction of Concrete

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

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

13.23 Curing of Concrete

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

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

13.24 Construction joints

Construction joints are a potential source of weakness and should be located and formed with care and their number is kept to a minimum.

When the work is to be interrupted, the concrete shall be rebated at the joint to such shape and size as may be required by the Engg Incharge (Divisional Engr.) or as shown on the drawings. All vertical construction joints shall be made with water bars which are rigidly fixed and shall provide a positive barrier against movement of water through the joint. Great care shall be taken when placing concrete around water bars because the space is often congested. Concreting shall be

carried out continuously up to construction joints. Construction joints, if not described on the drawings, shall be in accordance with the following:

- In a column, the joint shall be formed about 75 mm below the lowest soffit of the beams framing into it, at the meeting points of the columns and the raft, and at the point of contraflexure in the columns.
- Concrete in a beam shall be placed throughout without a joint. However if the provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.
- A joint in a suspended floor slab shall be vertical at one of the quarter points of the span and at right angle to the principal reinforcement.
- Additional reinforcements and shear keys shall be provided at the construction joints.

In forming a joint, concrete shall not be allowed to slope away to thin edge. The locations of construction joints shall be planned by the contractor well in advance of pouring and be approved by the Engg Incharge (Divisional Engr.).

Construction joints in foundation of equipment shall not be provided without the approval of Engg Incharge (Divisional Engr.).

13.25 Expansion and separation joints

Expansion joints shall be as shown on the drawings or as specified in the schedules. Expansion joint filler boards conforming to IS 1838 and sealing strips shall have minimum transverse joints. Joints shall be vertical and straight except where otherwise approved and concrete surfaces and faces shall be flush on both sides of the joint.

Separation joints shall be with standard water proof paper or with alkathene sheets about 1 mm in thickness. Lap length and sealing of laps shall be to the satisfaction of the Engg Incharge (Divisional Engr.).

13.26 Removal of form work

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

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

- | | |
|---|---------|
| • Removal of shuttering to sides of rafts, walls, beams and columns | 2 days |
| • Removal of shuttering to slabs, beams and arches (props left under) | 6 days |
| • Removal of props to slabs, beams and arches | 16 days |
| • Lifting of pre cast members | 16 days |

13.27 Pre cast concrete members

Pre cast concrete members shall be used in the works only where specified on the Drawings or approved by the Engg Incharge (Divisional Engr.).

The technical specifications for cement concrete, formwork and reinforcement covered under earlier clauses shall form a part of these specifications and shall be followed for carrying out pre cast concrete work.

Pre cast members shall not be disturbed or lifted until the minimum periods specified for formwork removal have elapsed.

13.28 Load Test on Parts of Structures

The load test on concrete, if desired by the Engg Incharge (Divisional Engr.) shall be carried as soon as possible after the expiry of 28 days from the time of placing of concrete as per the clause 16.5 to 16.6 of IS : 456. The structure shall be subjected to a load equal to full dead load of the structure plus 1.25 times the imposed load for a period of 24 hours and then the imposed load shall be removed. The entire cost of load testing shall be borne by the contractor and if any portion of the structure found unacceptable under the relevant clause of IS : 456, the same shall be dismantled and replaced by a new structure as per specification at no extra cost to the Employer. If during dismantling any of the adjacent structure is

damaged, the same shall be made good free of charge by the contractor to the satisfaction of the Engg Incharge (Divisional Engr.).

13.29 Finish of concrete surface

13.29.1 Concrete cast against formwork.

The following finishes to concrete surfaces, unless otherwise specified or shown on the drawings, shall be as follows—

- **Class A1:** All permanently exposed surfaces, including exposed sides of foundations.
- **Class A2:** Surfaces to be covered by backfill, plasters or the like.

Class A1 surfaces shall be dense, fair, smooth, even, free from honeycombing, water and air holes and other blemishes, true to line and surface and free from board or panel marking. They shall be of uniform colour. Rendering of defective surfaces shall not be permitted, and, if ordered by the Engg Incharge (Divisional Engr.), the Contractor shall at his own expense cut out to expose reinforcement and make good any unsatisfactory work. All areas so treated shall be rubbed down and kept moist for several days.

Class A2 surfaces shall be dense, even, free from honeycombing and true to line and surface.

Any special finishes will be to details or instructions given by the Engg Incharge (Divisional Engr.).

13.29.2 Concrete not cast against form work.

The following finishes shall be provided unless otherwise specified or shown on the drawings—

- **Class B1:** All permanently exposed surfaces, including tops of equipment foundations, wall copings, window sills, precast items (except paving flags).
- **Class B2:** Paving flags and paths. Floors and slabs to be surfaced with blocks, tiles or waterproofing materials.
- **Class B3:** Roads, buried concrete and floors or slabs to be covered by screed.

Class B1 surfaces shall first be levelled and screened to produce a true surface. After the moisture film has disappeared, and the concrete has hardened sufficiently, the surface shall be finished with a steel trowel under firm pressure to give a smooth, dense, even and hard surface free from all marks and defects.

Class B2 surfaces shall be levelled and screened to produce a true surface, and be finished with wooden or steel float to give a level surface free from screed marks. Excessive floating shall be avoided.

Class B3 surfaces shall be levelled and screened to produce a true and uniform surface.

13.30 Holes, pockets, threaded inserts, etc.

The threaded inserts for casting into concrete shall be electro-galvanized and of malleable iron or mild steel. Holes, cavities and fixings shall be provided in the works only at the positions indicated on the drawings or as directed and they shall be incorporated as necessary during the work of concreting. Unless otherwise agreed a tolerance in position of plus or minus five millimetres shall be allowed. Inserts and bolts shall be fixed square in the works by means of temporary bolts or nuts, and then concrete cast around them. The projecting portions of such fixings, and concrete within fifty millimetres of them, shall be bitumastic painted and all threads well greased on completion of the work. Holes and pockets shall be stripped down clean on completion.

13.31 Blinding

Blinding concrete shall be made with nominal aggregate sizes of both 20mm and 40mm diameter. They shall be referred to respectively as grade M 10/20 and M 10/40.

Under all foundations and elsewhere as indicated on the drawings a layer of concrete grade M10 (1:3:6) shall be laid immediately the excavation is carried down to foundation level. The blinding surface shall be thoroughly cleaned before foundation concrete is deposited thereon. Sumps shall be provided where necessary to facilitate the control of drained water. The grade shall be applied as shown in Table 15.31.1

Location	Grade	Thickness of layer
Foundations and bases	M 10 / 1:3:6	75 mm
Floors of ducts, trough and reinforced slabs not exceeding 100 mm	M 10 / 1:3:6	50 mm

Table 15.31.1. Blinding layer thickness values

13.32 Admixtures and Additives

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 labelled containers to enable identification.

Admixtures in concrete shall conform to IS:9103. The water proofing cement additives shall conform to IS:2645. Concrete admixtures and additives shall be approved by the Engg Incharge (Divisional Engr.).

The Contractor shall use an approved neutralized vinsol resin air-entraining agent in all concrete. The Air entraining agent shall be supplied and batched as a solution with a solids content not exceeding 15 percent by weight with suitable, stable and consistent pH.

The Contractor may propose and the Engg Incharge (Divisional Engr.) may approve 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 operations and shall only be approved as an aid overcoming unusual circumstances and placing conditions.

Water-reducing set-retarding admixture shall be an approved brand of Igno-sulphonate type admixture.

Water proofing cement additives shall be used as required or advised by the Engg Incharge (Divisional Engr.).

14. 0 FENCING

14.1 General

Fencing shall be designed for the most critical loading combination taking into account wind forces, stability, tension on wires, minimum requirements as per this clause and relevant IS recommendations.

The un climbable or security, or anti-intruder fencing shall consist of chain link mesh, all as shown on the drawings and as specified below, supported on approved sections of structural steel. The posts shall be erected truly vertical, and all posts and struts shall be set in concrete block foundations.

Concrete kerbing shall be provided between the fence posts as shown on the drawings.

14.2 Areas requiring fencing

Fencing shall be provided for the following areas:

- Site fencing for the complete station, complete with barbed wires on top. Separate gates shall be provided for men and equipment.
- Internal fence surrounding the various equipments (if) mounted on ground or a height lower than 2.5 m, without barbed wires on top. Necessary gates shall be provided for each area so surrounded.
- Wherever necessary anti-reptile fixture/arrangement shall be provided along with fencing.

14.3 Product materials

14.3.1 General

Chain Link fence fabric in accordance to IS :2721, and shall also meet the following requirements.

- Size of mesh 75 mm

- Size of coated wire 3.15 mm diameter
- Width of chain link 2000 mm
- Class of zinc coating medium
- Zinc coated after weaving

Posts shall be as shown in Table.

The posts shall be of medium M.S tube heavy gauge of 50 mm diameter confirming to Yst-22 (Kg / sq. mm). The tubes shall also confirm to IS:1161/IS 806. The length of the tubular post shall be 3200mm.

An M.S base plate of size 160X160X6mm thick shall be welded with the tubular post. The post shall be provided on the top with M.S plate.

The tubular post shall be welded with 8 numbers of M.S flat of size 50X6mm – 75 mm long. Two numbers of 13.5 mm dia holes on each cleats shall be provided to bolt the fence fabric panel. The cleats shall be welded at equal spacing in such a way that 4 nos of cleats are on the opposite side and remaining 4 nos cleats are on the opposite side of the post. The cleats on the corner posts shall be welded in such a way that it suits the site requirement.

The whole assembly of tubular post shall be hot dip galvanised. The zinc coating shall be minimum 615 gram per sq mm. The purity of the zinc shall be 99.95% as per IS:209.

Fence fabric panel:

Chain link fencing shall be fabricated in the form of panel 2000X1928 mm. GI angle frame (50X50X6 mm) with bracing of 50X6 mm GI flat on both the corners shall be welded all round fence fabric to form a panel. Four pairs of 13.5 mm diameter holes on the vertical MS flat matching the spacing of holes in cleats fixed with pipe shall be provided to fix the fence panel with tubular posts. A washer shall also be provided below each nut. 12 mm diameter bolts and nuts including washers **shall also be supplied. All bolts, nuts and washer shall be hot dip galvanised.** The fence panel shall be provided with two GI flats of size 50X6 mm placed cross wise for rigidity of chain link.

Installations:

Fence shall be installed along switch yard line as per the approved GA drawing. Post holes shall be excavated by approved method. All posts shall be 2 mtrs apart measured parallel to ground surface.

Posts shall be set in 1:2:4 plain cement concrete block of minimum 0.4X0.4X1.2mtr depth. 75 mm thick PCC 1:4:8 shall be provided below concrete block.

Fence posts shall be erected in vertical and kept for minimum 7 days curing before fence fabri erection.

Fence fabric panel shall be fixed to the post at 4 nos. M.S flat each of 50X6 mm, 75mm long through 2 nos of 12 mm dia bolts on each flat.

Paintings as per decision of the Engineer in charge have to be carried out.

Continuous running earth by using 50 X 6 mm GI flats to be provided for safety purpose.

A 345/380 mm thick (one and a half brick size) toe wall of Brick/Rubble masonry, or concrete with notches shall be provided below all fencing and shall be minimum 200 mm above and 500 mm below finished ground level. All exposed surfaces for brick toe wall shall be provided with 15 mm 1:6 cement sand plaster and coated with two coats of water proofing weather paint. In case if rubble masonry is provided suitable pointing shall be done.

GATES:

Gates shall be installed in locations shown on drawings. Next to the main gate, a men gate (1.25 m wide, single leaf) shall also be provided.

Bottom of gates shall be set approximately 40 mm above ground surface and necessary guiding mechanism (with roller on the bottom of the gate and fixed guider in the road) shall be fitted to avoid hanging of the main gate.

14.3.2 Gates

Gate frames shall be of galvanized steel of 40 mm dia main pipe and vertical pipes of 15mm dia @ 125 mm spacing (pipe to relevant IS) welded to the main pipe for frames or Black steel pipe to relevant IS for frames with welded joints and shall be painted with one coat of steel primer and two coats of synthetic enamel paints.

Gates shall be fabricated with welded joints or other approved methods to achieve rigid connections. The gate frames shall be hot dip galvanized after welding.

Gates shall be fitted with galvanized malleable iron hinges, latch and latch catch. Latch and latch catch shall be suitable for attachment and operation of padlock from either side of gates. Hinges shall permit gates to swing through 180 degree back against fence.

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.

14.3.3 Patching

Damaged galvanized surfaces shall be repaired. Damaged surfaces shall be cleaned with wire brush removing loose and cracked spelter coating. Two coats of approved zinc pigmented paint shall be applied to damaged areas in accordance with manufacturers instructions.

There shall be one gate located on boundary wall as main gate having wicket gate and one gate as switchyard gate, located on the fencing.

15. 0 BUILDING

15.1 General

The scope includes the design, engineering and construction of control room and colony quarters building. For control room and colony quarter building the tentative layout showing the facilities to be provided is indicated some where and also to be proposed by the bidders for better utility and aesthetic view. However, the size and layout of the building may be modified as per requirements of Single Line Diagram (SLD) with the approval of the Engg Incharge (Divisional Engr.).

15.2 Dimensions

An open space of one metre minimum shall be provided on the periphery of the rows of panels, and equipment generally, in order to allow easy operator movement and access as well as maintenance.

The building design shall also take into consideration the layout of the panels, switchboards, switchgear and other equipment in order to allow enough area for the future extension of switchyard depending upon the availability of substation area.

15.3 Design

The buildings shall be designed:

- to the requirements of the National Building Code of India. and the standards quoted therein
- for the specified climatic and loading conditions
- 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
- for a life expectancy of structure, systems and components not less than that of the equipment which is contained in the buildings, provided regular maintenance is carried out
- to be aesthetically pleasing. Different buildings 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 material preventing dust accumulation

Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns.

Individual members of the building frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion etc.

Permissible stresses for different load combinations shall be taken as per relevant IS Codes.

All cable vaults shall be located above ground level i.e. cable vaults shall not be provided as basements in the buildings.

The building lighting shall be designed in accordance with the requirements of relevant section.

The building auxiliary services such as air conditioning and ventilation systems, fire protection and detection systems and all other miscellaneous services shall be designed in accordance with the requirements specified in relevant sections of this Specifications.

The doors and windows of the building shall be of aluminium extruded channels, angles etc. The windows shall be provided with sliding shuttering facilities and also to be provided with aluminium make grills.

15.4 Design Loads

Building structures shall be designed for the most critical combinations of dead loads, super-imposed loads, equipment loads, crane loads, wind loads, seismic loads, and temperature loads. In addition, loads and forces developed due to differential settlement shall also be considered.

Dead loads shall include the weight of structures, complete finishes, fixtures and partitions and should be taken as per IS:1911 (latest revision).

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.

For crane loads an impact factor of 30% and lateral crane surge of 10% of (lifted weight plus trolley weight) shall be considered in the analysis of frame according to provisions of IS:875 (latest revision). The horizontal surge shall be 5% of the static wheel load.

For temperature loading, the total temperature variation shall be considered as two thirds 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 loads shall be computed as per IS:875. Seismic coefficient method shall be used for the seismic analysis as per IS 1893 (latest revision), wind and seismic forces shall not be considered to act simultaneously.

Floors/slabs shall be designed to carry loads imposed by equipment, cables, piping travel of maintenance trucks and equipment and other loads associated with the building. In general, floors shall be designed for live loads as per relevant IS and cable and piping loads not less than 5 kN/ sq.m hanging from the underside. In addition, beams shall be designed for incidental point loads of 20 kN to be applied at any point along the beams. The floor loads shall be subject to the approval of the Engg Incharge (Divisional Engr.).

For consideration of loads on structures, IS 875, “Code of practice for structural safety of buildings” shall be followed. The minimum superimposed live loads shown in Table 17.4.1. shall be considered for the design.

Roof	150 kg / sq m.	for accessible roofs.
	75 kg / sq m.	for non - accessible roof.

R C C Floors.	500 kg / sq m.	for offices and minimum 1000 kg / sq m. for equipment floors or actual requirement, if higher than 1000 kg / sq m., based on equipment component weight and layout plans.
Stairs and balconies.	500 kg / m.	
Toilet Rooms.	200 kg / m.	
Chequered plate floor.	400 kg /sq. m	
Walkways.	300 kg /sq. m.	

Table 17.4.1. Superimposed live loads

15.5 Submission of data for approval

The following information shall be submitted for review and approval to the Engg Incharge (Divisional Engr.):

- Design criteria for structural steel and reinforced concrete design. The criteria shall comprise the codes and standards used, applicable climatic data including wind loads, earthquake factors and 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.
- Structural design calculations and drawings including those for construction and fabrication for all reinforced concrete and structural steel structures.
- Fully dimensioned floor plans, cross sections, longitudinal sections and elevations of each building. These drawings shall be drawn at a scale not less than 1:50 and shall identify the major building components.
- 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.
- Product information of building components and materials, including walls, partitions, flooring, ceilings, roofing, doors and windows and building finishes.
- A detailed schedule of building finishes including colour schemes.
- A door and window schedule showing door types and locations, door lock sets and latch sets and other door hardware.

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

15.6 Electrostatic radio interference shielding

The building inside the energized area of the stations shall be electrostatically shielded to limit the exposure of the equipment and personnel to specified electric field strengths. The shielding system shall be grounded properly.

15.7 Control Room Building/Colony quarters

Design and construction, including anti termite treatment of control room building and colony quarters for each sub-station or switchyard shall be in the scope of the contract. The control room buildings and colony quarters shall be of RCC framed structure of concrete M20 grade. The control room and some other rooms of the control room building shall be fully air conditioned.

15.8 Finish Schedule

The preliminary indicative finishing schedule is given in subsequent clauses. However, at the time of detailed engineering, the Engg Incharge (Divisional Engr.) reserves the right to alter the finishing schedule and specifications and such changes shall have no additional financial implication whatsoever to the Employer.

15.9 Flooring (52 mm Thick)

50mm thick cement concrete 1:2:4. & finishing with vitrified tiles in the main control room area, conference room and MCCDB (AC & DC) room. The other area flooring shall be with vitrified tiles of reputed make. There shall be dado of 9 inches by the same. The toilets and bath rooms shall be provided with antiskid ceramic tiles and the walls are also to be provided with ceramic tiles of adequate height as per standard practice. The battery room floorings and walls (up to 3mtrs height) shall be provided with acid proof industrial based tiles. The left over portion of the walls shall be painted with acid proof paints.

15.10 Walls

Control room buildings shall have framed superstructure. All walls shall be non-load bearing walls. Minimum thickness of external walls shall be 230 mm with 1:6 cement sand mortar. A 50 mm thick DPC shall be provided at plinth level before starting masonry work.

15.11 Plastering

All internal walls shall have minimum 12mm thick 1:6 cement sand plaster. The ceiling shall have 6mm thick 1:4 cement sand plaster.

15.12 External Finish

All external surfaces shall have painted with weather proof synthetic paints over 18mm thick cement sand plaster in two layers. Under layer 12mm thick cement plaster 1:5 (1 cement:5 coarse sand) and a top layer 6mm thick cement plaster 1:3 (1 cement:3 coarse sand) finished rough with sponge.

All ceilings shall be white based plastic emulsion paints and the internal walls are also to be provided with plastic emulsion synthetic paints. The outer of the building shall be provided with weather seal coats of synthetic paints.

Painting details:

Following colour paints of *M/s Berger paints India Ltd., M/s Asian Paints India Ltd. & M/s Kansai Nerolac Paints Ltd.* with specified standards are to be followed for all type of buildings.

Sl. No.	Description	Berger Paints	Asian Paints	Nerolac Paints
1	Interior wall	3P 0778- Soft Light (Easy Clean)	7907-Candle Wick (AP Royale)	2016P- Lemon balm (Lotus Touch)
2	Exterior wall (body)	2P 0229-Calming Touch (Weather Coat Smooth)	8564- Sweet Dreams (Apex)	4051- Lightest Peach (Excel)
3	Exterior wall (border)	2A 0232- Cookie Crisp (Weather Coat Smooth)	8645-Rich Chocolate (Apex)	2798C- Kitty Kat (Excel)

The following procedure need be adopted for maintaining optimum quality & durability in painting the walls (both internal & external walls).

(a) Internal wall:

- (i) The walls are to be applied with 2 coats of putty (JK/ Birla/ Bison make) of minimum 2 mm of thickness. After the first coat is applied, minimum of 2 days may be spared for drying up the wall. Then the second coat may be applied over the first coat so that 2mm thickness is achieved & uniformity is maintained.
- (ii) After applying the second coat, another 2 days may be spared & then sand paper is to be applied to remove the undulation of the wall.

(iii) White primer (water thin-able / solvent thin-able) of one coat (Berger/Nerolac/ Asian Paints) is to be applied.

(iv) Then two coats of colour paints are to be applied on the wall.

(b) External wall:

(i) One coats of primer (Weather Coat) are to be applied.

(ii) Then two coats of weather coat need to be applied on the wall. The two coats should be applied with an minimum interval of 12 hours in between.

15.13 Roof

Roof of the building shall consist of cast in situ R.C.C. slabs. Extra heavy water proofing treatment shall be done after grading underbed with 1:4 cement sand plaster of 25mm thickness. The under bed shall be laid to provide an ultimate run off gradient of 1:120. The extra heavy treatment shall be concrete based with water proof treatment as per the standard to protect the roof from damage due to water logging. Proper slope and adequate no of water drains outlets shall be provided for easy discharge of water from the roof. These drains shall be connected to the main drain.

15.14 Glazing (glass)

Minimum thickness of glazing shall be 6 mm. The glazing for the control room area which will be air-conditioned shall be provided with double toughned glass each of 6mm thickness. Other areas shall also have 6mm thick toughned glass.

15.15 False Ceiling

The control room and all other air conditioned areas shall have closed aluminium ceiling system comprising 84mm wide, 12.5mm deep panels of approved colour with a recessed flange of 23.9mm roll formed out of 0.5mm thick aluminium alloy 5050/5052/3003 or equivalent, coated with chromatised and stone enamelled on both sides, panels to be fixed on roll formed carriers 32 mm wide 39 mm deep out of minimum 0.9 mm thick aluminium alloy strip with cut outs to hold panels in a module of 100mm minimum at maximum 1.6 mc/c carrier suspended from roof by 4mm diameter galvanised steel wire rod hangers with special height adjustment springs/clips made out of spring steel at maximum spacing of 1.5 m c/c hangers fixed to roof, J'hooks and nylon insert including providing laying and fixing 25mm thick resin bonded mineral wool of approved quality, encased in 100 G black polythene and laid over top of places panels, all complete. The system is subject to approval by the Engg Incharge (Divisional Engr.) before installation

15.16 Doors and Windows

The doors and windows of the control room building shall be of uPVC (**Finesta/Vika make:** the size, thickness and model to be selected by the Owner) with aluminium grill (for windows: Ground floor of control room building & For all floor of Quarters/Transit house) and all the frames of doors and windows also of uPVC of higher suitable sections in accordance with the relevant IS/ISO/Any international Codes. Size and shapes shall be adequate for entering in to the room. In the Air conditioned area shall be double glass (toughened) and doors suitably made to have efficient air conditioning. The windows shall be of sliding type. Anodised aluminium. The anodised transparent or dyed to required shade according to IS:1868 (minimum anodic coating of grade AC 15) fixed with rawl plugs and screws with fixing clips, or with expansion hold fastners including necessary filling up of gaps at junctions at top, bottom and sides with required PVC/neoprene felt etc and joined mechanically wherever required including cleat angle, Aluminium snap beading for glazing/panelling, C.P brass/stainless steel screws including glazing and fittings as specified) window grills work for windows to be considered, ventilators and other partitions shall be provided and fixed in the building with uPVC and other sections approved make confirming to IS/ISO standard.

Note: Doors and windows shall be of clear openable (door) and sliding (window) type with adequate locking facility. The door window frame shall be of uPVC of reputed make heavy sections with toughened glaze of 6mm & windows shall have aluminium grills (only GF external window). Windows shall be provided with vertical window blinder to protect from the sun ray. In the Air Conditioned area the glaze shall be double toughened.

The main entrance door of the control room building shall be Transparent Automatic Sensor Glass Door(Features 1. Open and close single or both the door.2. Sequence of adjustment 3. Can be integrated with most of access control system (RFID, Biometric etc) 4. Can be paired with upto 100 remote 5. Safely 12volts DC motors eliminating the dangers

of electric shock hazard.6. Overload sensor provide instant stop upon contact with obstacle.7. Starting opening force adjustment 8. Open speed adjustment 9. Soft start and stop.10. Open buffer distance adjustment when open). The bath/toilet door & its frame shall be of uPVC of reputed make.

15.17 Plumbing And Sanitation

All plumbing and sanitation work 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.

An overhead water tank of adequate capacity depending on the number of users for 24 hours storage shall be provided.

PVC (Chlorinated polyvinyl chloride) pipes (IS 4985 (2000): Un plasticized PVC Pipes for Potable Water Supplies) water pipe of reputed manufacturer shall be used for internal piping works for portable water supply.

Sand C I pipes with lead joints conforming to IS:1729 shall be used for sanitary works above ground level.

A list of toilet fittings will be approved by the Engg Incharge (Divisional Engr.), before procurement by the contractor and same will be inspected by the Engg Incharge (Divisional Engr.) before installation. Sufficient nos of toilets and bath rooms including separate urinal provision shall be provided at both ground and first floors. Required nos of wash basins (stand type) with good quality mirrors and other accessories as required are also to be provided at both ground and first floor of control room building. Same procedure for colony quarters also.

Note: Provision of PHD and other fittings of reputed make (JAQUAR) for the control room building (in Toilets, wash room, overhead water tank of adequate capacity etc) of reputed make, provision of rain water discharge pipes at different locations and etc as per requirement and approved drawing. There shall be septic tank and soak pit of required capacity including complete sewage system as per approved drawing & technical specification & as per instruction of Engg- in-Charge. It includes supply of all types of materials of reputed make, labour etc to complete the work. Toilets (Provision of comboard & granite platform base standalone type wash basin) for Gents & Ladies to be provided including all good quality reputed fittings as per specification. The toilets & wash room shall have antiskid floor tiles & wall tiles of ceramic up to height of 8 feet. Provision of rain water discharge pipes at different locations and two nos of overhead water tank of 2000 ltrs capacity etc as per requirement and approved drawing. All bath room & toilet shall have water & termite proof doors and provision of sliding louvers with exhaust fan.

15.18 Building storm water drainage

The building design shall provide for the collection of storm water from the roofs. This water shall be collected in junction boxes and these boxes shall drain to the main drainage system of the station.

Cast iron rain water downcomers conforming to IS:1230 with water tight lead joints or medium class galvanised mild steel pipes conforming to IS:1239/ IS:3589, shall be provided to drain off the rain water from the roof. These shall be suitably concealed with masonry work of cement concrete or cladding material. The number and size of downcomers shall be governed by IS:1742 and IS:2527.

All drains inside the buildings shall have minimum 40 mm thick grating covers and in areas subject to movement heavy equipment loads, precast RCC covers shall be provided in place of steel grating.

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

1.3 Flooring

Entire area around the control room building (out side) shall be provided with PCC paving starting from the building upto 2 mtrs clear distance for the full length of the building. The Paving shall be provided with chequered ceramic tile.

The above specified PCC paving shall be with M15 mix grade concrete over suitable under bed arrangement as specified for other ground floor slab.

Above the PCC paving suitable Cement pavers chequered plate of size as per the standard to be provided. The colour of the chequered plate shall be fixed over the PCC paving by using cement mortar and the colour of such plate shall be red.

The cable vault below the main control room shall have 50 mm thick smooth floor finish units of cement concrete.

1.4 Provision of rooms in the control room building.

a) 220/132/33 KV S/S Building: (NA)

>The plinth area for the control room building shall be as below:-

Ground floor: 50mtrX25mtr

Ground floor portico: 5mtrX5mtr (at two locations)

First floor: 25 mtr X 25 mtr

i)Ground floor shall have cable vault, Battery room, Office rooms(3 nos),MCCB room, Library, Conference room, Testing lab, Pantry room, Toilets and bath room(two nos and one attached), Corridor with lounge, Portico at front and side, Ramp etc.

ii) First floor shall have control room, PLCC room, office room, toilets and bath room etc.

* All internal walls shall 125 mm thick. (Excluding cement plastering)

* All external walls shall 250 mm thick. (Excluding cement plastering)

* For RCC works refer the relevant specification.

* The quarter shall be of framed RCC structure based.

* Concrete grade shall be 1:1.5:3 for all RCC works

* Reinforcement shall be Fe 500D Grade, confirming to IS:1786. All hooks,bands,laps shall be as per IS:456-2000.All laps shall be staggered and minimum lap length shall be 50XDia of Bar.

* Clear cover to main reinforcement for footing = 50mm,column=50mm,beam=25mm & slab=20mm.

* Rain water pipes 100 sq mm to be provided at suitable location.

* The stair case width=1100mm, Tread=300mm, riser=148/150mm and suitable platform at different level.

* The height of the ground floor of the building from the finished plinth level (minimum 1.0 mtr from the finished ground level) shall be 3.9 mtrs and the height of the parapet wall shall be 750mm. The height of the first floor from the top of the roof of the first floor shall be 3.4 mtrs and the height of the parapet wall shall be 750mm.The stair case top shall be at a height of 2.75 mtrs from the top of the parapet top.

* The stair case shall be RCC having Granite stone fixing.

b) 132/33 KV & 220/33 KV S/S Building:

>The plinth area for the control room building shall be as below:-

Ground floor: 25.75 mtr X 12.75 mtr = 328.3125 Sqm

Ground floor portico: 8mtrX5mtr

First floor: 25.75 mtr X 12.75 mtr = 328.3125 Sqm

i)Ground floor shall have Control room(also can be kept on the first floor for better visibility of switch yard area),PLCC room, Battery room, MCCDB room, ,Toilets and bath room, Verandah & Portico etc..

ii) First floor shall have office rooms (3 Nos), a Library, a Conference room, a Rest room, ,Pantry room ,toilets(2 No.) and toilet cum bath room (1 no.) etc.

* All internal walls shall 125 mm thick. (Excluding cement plastering)

* All external walls shall 250 mm thick. (Excluding cement plastering)

* For RCC works refer the relevant specification.

* The quarter shall be of framed RCC structure based.

- * Concrete grade shall be 1:1.5:3 for all RCC works
- * Reinforcement shall be Fe 500D Grade, confirming to IS:1786. All hooks,bands,laps shall be as per IS:456-2000.All laps shall be staggered and minimum lap length shall be 50XDia of Bar.
- * Clear cover to main reinforcement for footing = 50mm, column=50mm,beam=25mm & slab=20mm.
- * Rain water pipes 100 sq mm to be provided at suitable location.
- * The stair case width=1100mm, Tread=300mm, riser=148/150mm and suitable platform at different level.
- * The stair case shall be RCC having Granite stone fixing.
- * The height of the ground floor of the building from the finished plinth level (minimum **1.0** mtr from the finished ground level) shall be 3.9 mtrs and the height of the parapet wall shall be 750mm. The height of the first floor from the top of the roof of the first floor shall be 3.4 mtrs and the height of the parapet wall shall be 750mm.The stair case top shall be at a height of 2.75 mtrs from the top of the parapet top.
- ** **Stair case of all type of buildings shall have stainless steel pf 304 grade in hand railing using 50mm dia of 2mm thick circular pipe with balustrade of size 32mmx32mmx32mm @0.90mtr C/C and stainless square pipe bracing of size 32mmx32mmx32mm in three rows in staircase as per approved design and specification, buffing, polishing.**
- *** **Flooring with double charged vitrified digital tiles with dado in all the rooms, Bath and toilets shall be provided with anti skid ceramic digital tiles (wall of the same also to be provided with ceramic digital tiles),Acid proof industrial tiles to be provided on the floor and full wall of the battery room as per technical spec & approved drawings. Stair case & its landing platforms are to be provided with Granite flooring with single granite having round shape at the edge.**

1.5 Provision of rooms in the colony quarter (building).

- a) **“D” Type quarter:** Tentative plinth area shall be **120 sq mtrs (excluding the area of the portico)**. D type quarter shall have two bed rooms of size 3.6 mtrX3.6 mtr having porticos; one bed rooms of size 3.9 mtrX3.3 mtr having portico; one living room of size 4.2 mtrX3.6 mtr; one dining cum lobby of size 4.2 mtrX4.7 mtr; one kitchen of size 2.75mtrX3.3 mtr; Two nos attached toilet cum bath room of size 2.15 mtr X 1.5mtr, one no common toilet cum bath room of size 1.5mtr X 2.2 mtr, Portico and space for vehicle parking. The kitchen shall have provision of Kitchen platform (granite one) two sides of the wall with stainless steel sink having water tap provision as per standard practice. Kitchen room shall have provision of cupboard for storing the kitchen utensils and other items including locking arrangement of the cupboard. Provision of cup-boards in all other rooms as per standard practice shall be provided. Shall have stair case to go to the top of the roof and have stair case head room. A portico of adequate size in front of the quarter/flat to be provided to park the four & two wheeler vehicle.
 - b) **“E” Type quarter:** Tentative plinth area shall be **90 sq mtrs (excluding the area of the portico)** E type quarter shall have two bed rooms of size 3.3 mtrX3.3 mtr having porticos; one no attached toilet cum bath room of size 2.15 mtr X 1.5mtr, one no common toilet cum bath room of size 1.5mtr X 2.2 mtr, one living room of size 4.5 mtrX3.3 mtr Portico and space for vehicle parking. The kitchen shall have provision of Kitchen platform (granite one) two sides of the wall with stainless steel sink having water tap provision as per standard practice. Kitchen room shall have provision of cupboard for storing the kitchen utensils and other items including locking arrangement of the cupboard. Provision of cup-boards in all other rooms as per standard practice shall be provided. Shall have stair case to go to the top of the roof and have stair case head room. A portico of adequate size in front of the quarter/flat to be provided to park the four & two wheeler vehicle.
- * All internal walls shall 125 mm thick. (Excluding cement plastering)
 - * All external walls shall 250 mm thick. (Excluding cement plastering)
 - * For RCC works refer the relevant specification.
 - * The quarter shall be of framed RCC structure based.
 - * Concrete grade shall be 1:1.5:3 for all RCC works
 - * Reinforcement shall be Fe 500D Grade, confirming to IS:1786. All hooks, bands, laps shall be as per IS:456-2000.All laps shall be staggered and minimum lap length shall be 50XDia of Bar.

- * Clear cover to main reinforcement for footing = 50mm,column=50mm,beam=25mm & slab=20mm.
- * Rain water pipes 100 sq mm to be provided at suitable location.
- * The stair case width=1100mm,Tread=300mm, riser=148/150mm and suitable platform at different level.
- * The stair case shall be RCC having Granite stone fixing.
- * The height of the building from the finished plinth level (0.5 mtr from the finished ground level) shall be 3.15 mtrs i.e. up to the terrace level. A clear 1.15 mtrs shall be above the terrace and up to the top of the parapet. The stair case top shall be at a height of 2.75 mtrs from the top of the parapet top.
- ** **Stair case of all type of buildings shall have stainless steel pf 304 grade in hand railing using 50mm dia of 2mm thick circular pipe with balustrade of size 32mmx32mmx32mm @0.90mtr C/C and stainless square pipe bracing of size 32mmx32mmx32mm in three rows in staircase as per approved design and specification, buffing, polishing.**
- *** **Flooring with double charged vitrified digital tiles with dado in all the rooms, Bath and toilets shall be provided with anti-skid ceramic digital tiles (wall of the same also to be provided with ceramic digital tiles),Acid proof industrial tiles to be provided on the floor and full wall of the battery room as per technical spec & approved drawings. Stair case & its landing platforms are to be provided with Granite flooring with single granite having round shape at the edge.**
- **** All other provisions shall be as per the Control Room Building.
- * Details of doors & windows to be provided in the colony quarters are as indicated below.

Doors & Windows for Quarter:

- (a) Doors shall be of wooden finished, weather resistant and anti - termite with Supplying, fitting and fixing in position with well-dressed and well-seasoned Sal wood work framed and fixed (wrought and put up) small beams, purlins, burghs, truss, rafter and post of door including cost of iron work cutting grooves or holes and mending size where necessary.
- (b) Window shall be fully openable of UPVC (**Finesta/Vika make**: the size, thickness and model to be selected by the Owner) having 6mm toughened glaze with other accessories like locking, handle, stopper etc. in complete shape as per TS.

Size and shapes shall be adequate for entering in to the room. The windows shall be provided with MS grill. The M.S grill and care should be taken while designing the grill frame that the entering of cat should be restricted. The MS Grill Surface cleaning, application of red oxide primer paint and two coats of synthetic enamel paint (Asian paints/Berger/Nerolac).

The door for the toilet cum bath room shall be of standard adequate size PVC door of best quality shall be provided.

The size of door & windows shall be of standard designed as National Building Code standard.

The building design shall provide for the collection of storm water from the roofs. This water shall be collected in junction boxes and these boxes shall drain to the main drainage system of the station.

Cast iron rain water down comers conforming to IS:1230 with water tight lead joints or medium class galvanised mild steel pipes conforming to IS:1239/ IS:3589, shall be provided to drain off the rain water from the roof. These shall be suitably concealed with masonry work of cement concrete or cladding material. The number and size of down comers shall be governed by IS:1742 and IS:2527.

All drains inside the buildings shall have minimum 40 mm thick grating covers and in areas subject to movement heavy equipment loads, precast RCC covers shall be provided in place of steel grating.

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

16. 0 MISCELLANEOUS GENERAL REQUIREMENTS

Dense concrete with controlled water cement ratio, preferably 0.45, 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.

All joints including construction and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stops with general 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.

All steel sections and fabricated structures which are required to be transported by sea shall be provided with anti-corrosives paint.

All mild steel parts used in the water retaining structure shall be hot-dip galvanised. The minimum coating of the zinc shall be 750 gm/sq.m. for galvanised structures and shall comply with IS:2629 and IS:2633. Galvanizing shall be checked and tested in accordance with IS:2629. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen.

A screed concrete layer not less than 100 mm thick and of grade not weaker than M10 conforming to IS:456- 1978, 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.

Bricks having minimum 75kg/sq.cm compressive strength can only be used for masonry work. Bidder shall ascertain himself at site regarding the availability of bricks of minimum 75kg/ sq.cm compressive strength before submitting his offer.

Monorails, monorail girders and fixtures shall be provided, wherever required.

Doors and windows on external walls of buildings other than areas provided with insulated metal claddings shall be provided with a RCC sun-shade over the openings with 300 mm projection on either side of the openings. Projection of sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings.

All stairs shall have maximum riser height of 180 mm and a minimum tread width of 250 mm. Minimum width of stairs shall be 1200 mm. There shall be provision of stair case to the roof of the building.

Angles of 50x50x6 mm minimum with lugs shall be provided for edge protection all round cut out and openings in floor slab, edges of drains with grating covers, edges of RCC cable/pipe trenches with covers, edges of manholes with covers, edges of precast covers and any other place where breakage of corners of concrete is expected.

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.

Hand railing of a minimum height of 900 mm shall be provided around all floor or roof openings, projections and balconies walk ways, platforms, steel stairs etc. All handrails and ladder pipes shall be The railing of the staia-rcase shall be made of proper aluminium sections. All rungs for ladders shall also be of aluminium as per IS:.

For RCC stairs, also hand railing with aluminium sections are to be provided.

17. 0 INTERFACING

Proper coordination and execution of all interfacing civil works activities such as fixing of conduits in roofs/walls/floors, fixing of foundation bolts, fixing of lighting fixtures, fixing of supports/embodiments, provision of cut-outs etc. 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 such that dismantling, breakage etc. is reduced to minimum.

18. WATER SUPPLY

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

There shall be separate bore wells for the control room building and colony quarters. There shall be pump houses for the bore wells and approach road to the pump houses shall be provided.

The Contractor shall have overall responsibility to provide a suitable arrangement for permanent supply for and retention of water within switch yard building and to the yard for watering to the earth pits, drinking purposes as well as for township and other miscellaneous purposes. The scope is inclusive of supply and erection of all tanks, pipes, fittings etc. required for the water supply to be taken from the terminal point/points to the respective buildings. A scheme shall be prepared by the contractor indicating layout and details of water supply which shall be subject to the approval of the Engg Incharge (Divisional Engr.) before commencement of work. Any extra bore holes required shall be within the scope of this contract. The capacity of each submersible pump shall be 5 HP and all control as per standard has to be provided. The no of bore holes shall be two nos , one for colony township and the other one for the switch yard building. Two nos pump house as per standard are also within the scope of this contract. The height of the pump house (LXW=3mtrsX3mtrs) shall be 3 mtrs and shall have RCC roof and brick walls having MS doors. The capacity of RCC overhead tank for control room building shall be 2000 liters each .Two nos of overhead water tank for control room building and for colony quarters each quarter shall have 1000 liters capacity.

There shall be interconnection between tow pump sections in order to meet any exigencies.

19. 0 STATUTORY RULES

The Contractor shall comply with all the applicable statutory rules pertaining to Factories Act (as applicable for ORISSA State), Fire Safety Rules of Tariff Advisory Committee, Water Act for pollution control etc.

Provisions for fire proof doors, numbers 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.

Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.

21.0 SECURITY WATCH TOWERS:

There shall be provision of security watch tower at the corners of the switch yard. These watch towers shall be of RCC type. Standard practice in this effect shall be followed. The maximum numbers of such towers shall be 4. The size of the tower platform shall be 2.5mtrsX2.5mtrs and height as per standard practice.

22.0 SECURITY SHED NEAR THE MAIN GATE.

There shall be one RCC type security shed near the main gate to be provided. The shed shall have also provision of sitting arrangement for the guests. The shed shall be provided with telephone internal, electrical lighting and ceiling fan facilities. There shall be provision of gate lights. The size of the security cum guest shed shall be 5mtrsX3.5mtrsX3.5mtr (LengthXwidthXHeight). A portion of the shed shall be used for the guest who comes for visit the sub-station. Adequate no of MS doors and windows are also to be provided. Necessary paintings as per standard are also to be done.

23.0 PROVISION OF STORE SHED, PLAT FORM, RAMP AND WINCH FOR LIFTING MATERIALS & VEHICLE PARKING SHED.

23.1 One no store shed of size 10X10 mtr having brick walls and plastering with RCC roof of 10X10 meters. The flooring shall be of 75 mm thickness PCC (mix ratio 1:2:4) over RR masonry works (as per standard practice of flooring). Provision of adequate nos of MS racks (proper paintings also to be done as per the direction of site in charge) for keeping the spare materials. The height of the shed shall be 4mtrs above the plinth.

23.2 One no platform outside the store shed RR masonry (compacted) with PCC at the top for storing the transformer bushings, Instrument transformers, transformer oil drums etc. The size of the platform shall be 15mtrX10 mtr. Details of flooring as mentioned under 23.1. The platform shall have top covers by using TATA GC sheets.

23.3 Provision of a RCC based ramp of adequate size for loading and unloading of the materials from the lorry near the store shed.

23.4 A winch is to be provided near the ramp for lifting and lowering of materials up to 5 tons capacity. The two side vertical pillars shall be by MS Rail/joist and the top horizontal also of same type. A chain pulley of 5 ton capacity is to be provided at the centre of the frame on the horizontal bar.

23.5 Erection of Isolator Mechanism Box.

Separate RCC foundation to be provided for the Isolator Mechanism boxes.

23.6 There shall be one no vehicle parking shed inside the sub-station area. The size of the parking area shall be 15mtrs X 15 mtrs, out of the entire area there shall be provision of shed for 5 mtrs X 15 mtrs and rest of the area shall be without shed. The flooring of the entire area of the vehicle parking shall be as mentioned under 23.1.

24.0 ANTIWEED TREATMENT AND SITE SURFACING

SCOPE OF WORK

The contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings, specification and direction of the Engg Incharge (Divisional Engr.).

General Requirement

The material required for site surfacing/gravel filling shall be free from all types of organic materials and shall be of standard approved quality, and as directed by the Engg Incharge (Divisional Engr.).

The Contractor shall furnish and install the site surfacing to the lines and grades as shown in the drawing and in accordance with the requirements and direction of the Engg Incharge (Divisional Engr.). The soil of the periphery area of the switchyard area shall be subjected to sterilisation or anti-weed treatment before placing the site surfacing/gravel fill material or strictly as per instruction or requirement of the manufacturer of the chemical required for soil sterilisation or anti-weed treatment. After all the structures and equipment have been erected and accepted, and soil sterilisation of the peripheral area (except the switch yard area) as specified is complete, the site shall be maintained to the lines and grades indicated in the drawing and rolled or compacted by using three ton roller with suitable water sprinkling to form a smooth and compact surface condition which shall be matching with finished ground level of the switchyard area.

Chemical to be used for soil sterilisation /anti-weed treatment:

The details of quantities and method of application of chemicals used for soil sterilisation /and anti-weed treatment shall be as per manufacturer`s recommendations. Bidders are required to submit the details of chemicals proposed to be used and recommendations of manufacturer with required guarantee alongwith their bids for necessary approval of the Engg Incharge (Divisional Engr.). Approval of the Engg Incharge (Divisional Engr.) by no means shall relieve the contractor of their contractual obligations as stipulated in General and Special Conditions of Contract.

25.0 PROVISION OF GARDEN INFRONT OF CONTROL ROOM BUILDING AND PLANTATION OF PLANTS (FRUIT BEARING & OTHER SHOW PLANTS):

A garden in front of the control room building is to be developed. It includes treatment of the land of size (30mtrsX10mtrs), manuring, and plantations of sufficient flower based, show based, crotons and entire portion shall be provided with garden grass. Proper land slope also to be maintained for better and aesthetic looking. Provision of water taps and garden lights at different locations are to be provided for watering the plants and lighting of the garden.

100 nos fruit bearing plants and 100 nos other show plants along the road side, near colony quarters and near control room building are required to be planted. Treatment of the soil and manuring are to be done before plantation of these plants. Water taps at different locations are to be provided for watering the plants.

26.0 RAIN WATER HARVESTING:

In addition to drainage of rainwater, the contractor shall make arrangement for rainwater harvesting also.

Rainwater harvesting shall be done by providing two numbers recharge structures with bore wells. The recharge structures shall be suitably located with in the S/S. Branch drains from the main drain carrying rainwater from entire switchyard shall be connected to the recharge structures.

The internal diameter of recharge shafts shall be 4.5 meter with 230mm thick lining of brick work upto a depth of 2.0 meter from ground level and 345mm thick brickwork below 2.0 meter depth. The brickwork shall be constructed with cement mortar 1:6 (1 cement : 6 coarse sand). The overall depth of shaft shall be 5.0 meter below invert level of drain. The shaft shall be covered with RCC slab for a live load of 300Kg. per Sq.m. two openings of sizes 0.7X0.7 meter shall be provided in the RCC cover slab as shown in the drawing. An iron cover made of 5mm thick chequered plate with hinges shall be provided in the openings. Galvanized M.S. rungs of 20mm diameter at spacing of 300mm shall be provided in the wall of the shaft below the opening of the RCC slab to facilitate cleaning of shaft.

A 300mm 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 the sub soil water.

A 100mm diameter medium duty MS pipe confirming 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 dia. Shall be provided for a length of 2.0 meter starting from the bottom level of coarse sand and downwards. The overall length of the pipe shall be equal to the total depth of the bore well plus depth of shaft.

Gravel of size 3mm to 6mm shall be filled around 100 dia MS pipe in the bore well. The shaft shall be filled with 500mm 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.

27.0 **Fire water Tank**: This is a lump-sum item. The contractor shall be required to complete the work in all respect as per requirement. All the items including excavation, compaction, brick work, roof truss, corrugated A.C.Sheet roofing, all types of miscellaneous steel internal and external plastering, concrete (all types), reinforcement and the steel embedments painting, etc shall be deemed to be included in this lump-sum water tank.

MORE ON CIVIL WORKS

I) WATER SUPPLY (EXTERNAL)

- (i) Water shall be made available by Owner (unless stated otherwise elsewhere) at any feasible point near scope boundary at single point to the contractor. Contractor shall state the total water requirement both in terms of quantity and head to the Owner.
- (ii) The contractor shall carry out all the external plumbing/erection woks required for supply of water to the control room building beyond the single point as at (i).
- (iii) The contractor shall carry out all the plumbing/erection woks required for supply of water to fire water tank beyond the single point as at (i).
- (iv) 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.

- (v) Bore wells and pumps for water supply is not in the scope of contractor.

II) TECHNICAL DETAILS OF THE BUILDINGS

1. 12mm cement plaster of mix 1:6 (1 cement: 6 fine sand) shall be provided on the smooth side of internal walls.
2. 6mm cement plaster of mix 1:3 (1 cement: 3 fine sand) to all ceiling.
3. 15mm cement plaster of mix 1:6 (1 cement: 6 fine sand) on rough side of single or half brick wall.
4. 12mm thick per-laminated three layer medium density (exterior grade) particle board Grdel, Type II conforming to IS: 12823 bonded with phenol formaldehyde synthetic resin, of approved brand and manufacture shall be provided in paneling fixed in aluminium doors, windows shutters and partition frames with C.P. brass/stainless steel screws etc. complete as per architectural drawings and directions of engineer-in charge.
5. Dis tempering on all internal walls and ceilings with oil bound washable distemper of approved brand and manufacture to give an even shade (two or more coats) over and including priming coat with cement primer.
6. Enamel Painting with synthetic enamel paint of approved brand and manufacturer of required colour to give an even shade shall be provided on the steel glazed doors, windows, ventilators and rolling shutters in various buildings as specified in drawings. Two or more coats over an under coat of suitable shade with primer paint of approved brand and manufacture.
7. Two or more coats of French spirit polishing with a coat of wood filler shall be provided on the wooden doors of Control Room building.
8. ACDB and DCDB room in Control Room building and FPH building shall be provided 52mm thick cement concrete flooring with "Hardcrete" concrete hardener topping under layer 40mm thick cement concrete 1:2:4 (1 cement :2 coarse sand : 4 graded stone aggregate 20mm nominal size) and top layer 12mm thick metallic concrete hardener consisting of mix 1:2 (1 cement hardener mix:2 stone aggregate 6mm nominal size) by volume with which "Hardcrete" hardening compound of "Snowcem India Ltd" or equivalent is mixed @ litre "hardcrete" per 50kg of cement including cement slurry, complete. (In ACDB/DCDB Room and FPH building only).
9. Cement plaster skirting (up to 15 cm height) with cement mortar 1:3 (1 cement:3 coarse sand) mixed with metallic concrete hardener in same ratio as for floor finished with a floating coat of heat cement. 21 mm thick in ACDB/DCDB room.
10. Floor tiles of Polished porcelain (vitrified) in different sizes with water absorption less than 1% and flexural strength not less than 30 N/mm² in all colours and shades, laid on 20mm thick cement mortar 1:4 (1 cement: 4 coarse sand) including grouting the joints with white cement and matching pigments shall be provided as mentioned in drawings. Size of Tile shall be 50X50 cm.
11. 1st Quality Ceramic glazed floor tiles (anti-skid) 300 x 300mm (thickness to be specified by the manufacturer) of 1st quality conforming to IS:13755 of NITCO, ORIENT, SOMANY, KAJARIA or equivalent shall be provided in toilet/pantry area in all colour shades as approved by Engg-incharge laid on 20mm thick cement mortar 1:4 (1 cement: 4 coarse sand) including pointing the joints with white cement and matching pigment etc complete.
12. 1st quality ceramic glazed tiles conforming to IS:13753 of minimum thickness 5mm of approved make like NITCO, ORIENT, SOMANY, KAJARIA or equivalent make shall be provided in toilet/pantry area in all

colours shades of any size as approved by Engg-incharge in dados (height as specified in drawings) over 12mm thick bed of cement mortar 1:3 (1 cement:3 coarse sand) and jointing with grey cement slurry @3.3kg per sqm including pointing in white cement mixed with pigment of matching shade complete.

13. 13mm polished granite in cement mortar 1:4, 20mm thick made to a level cut to size shall be provided and laid as specified in drawings. The joints are filled with jointing compound matching to the tiles. Wherever granite tiles are specified for the floor, 100mm granite skirting shall be provided with the walls. The granite outer surface shall be flushed to the plaster finish of the wall.

14. Granite counter shall be provided and fixed in the pantry with 18mm granite slab mounted on 75mm RCC slab supported by 115mm brick wall plastered on all sides as per the drawing. The shelves are made of 18mm thick well cut and polished white marble slabs. The outer side of the brick wall and the RCC slab visible in the front is finished with 18mm granite with edges molded on the exposed end. The shutters shall be finished with 19mm particle finished laminate edge lapping. The shutters are to be provided with 100mm handless and shutter locks. The inside of the shutter shall be painted with synthetic enamel paint.

15. All Brick work shall be with cement mortar 1:6 (1 cement :6 coarse sand). Half brick work masonry shall be with cement mortar 1:4 (1 cement: 4 coarse sand). Bricks used shall be of class-75.

16. Anti termite treatment shall be carried out for all buildings.

17. M.S. Rolling shutters as per drawing shall be provided and fixed interlocked together through their entire length and jointed together at the end by end locks mounted on specially designed pipe shaft with brackets along with ball bearing for rolling shutter, side guides and arrangements for inside and outside locking with push & pull operation including the cost of providing and fixing necessary 15.5 cm long wire springs grade No.2 and M.S. top cover of required thickness for rolling shutters. 80 x 1.25mm M.S. laths with 1.25mm thick top cover.

18. Circular/hexagonal M.S. sheet ceiling fan box shall be provided in the ceiling with clamp of internal dia. 140mm, 73mm height, 3mm thick rim, top and bottom lid of 1.5mm M.S. sheet. Lids shall be screwed in to M.S. box by means of 3mm round headed screws, clamps shall be made of 12mm dia M.S bar bent to shape as per standard drawing with over all length as 80 cm.

19. Anodised aluminum work for doors, windows, ventilators and partitions shall be provided and fixed in control room building with extruded built up standard tubular and other sections of approved make conforming to IS: 7333 and IS:1285, anodized transparent or dyed to required shade according to IS:1868 (Minimum anodic coating of grade AC 15) fixed with raw plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions at top, bottom and sides with required PVC/neoprene felt etc and joined mechanically wherever required including cleat angle, Aluminium snap beading for glazing/paneling, C.P. brass/stainless steel screws including glazing and fittings as specified.

Shutters of doors, windows and ventilators shall be provided and fixed with hinges/pivots fittings wherever required including PVC/neoprene gasket.

(a) SECTION FOR AL. WINDOWS:

Shutters bottom section-61.85x37x45.5 WS 1027, 1.058 Kg/mt, side and top section 61.85X31.75, WS 1029, 0.650 Kg/mt, shutter sections, one side and both side open 40X18X10 WS 1023, 0.433 Kg/mt, Interlock sections 40X18X26.5X10, WS 1022, 0.530 Kg/mt, with 4 mm plain float glasses, PVC gaskets, Nylon wheels, Aluminium handles cum locks. Indal/Indal/Hinalco make as per drawing.

(b) SECTION FOR AL. DOORS:

Anodised aluminum work for doors, windows, ventilators and partitions shall be provided and fixed in control room building with extruded built up standard tubular and other sections of approved make

conforming to IS: 7333 and IS:1285, anodized transparent or dyed to required shade according to IS:1868 (Minimum anodic coating of grade AC 15) fixed with raw plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions at top, bottom and sides with required PVC/neoprene felt etc and joined mechanically wherever required including cleat angle, Aluminium snap beading for glazing/paneling, C.P. brass/stainless steel screws including glazing and fittings as specified.

Shutters of doors, windows and ventilators shall be provided and fixed with hinges/pivots fittings wherever required including PVC/neoprene gasket. Anodised aluminum work for doors, windows, ventilators and partitions shall be provided and fixed in control room building with extruded built up standard tubular and other sections of approved make conforming to IS: 7333 and IS:1285, anodized transparent or dyed to required shade according to IS:1868 (Minimum anodic coating of grade AC 15) fixed with raw plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions at top, bottom and sides with required PVC/neoprene felt etc and joined mechanically wherever required including cleat angle, Aluminium snap beading for glazing/paneling, C.P. brass/stainless steel screws including glazing and fittings as specified.

Shutters of doors, windows and ventilators shall be provided and fixed with hinges/pivots fittings wherever required including PVC/neoprene gasket. with 5.5 mm plain float glasses and rubber gasket with bottom three feet pre-laminated sheet of 12mm thick of colour grey,ivory Jindal/Indal/Hindalco make as per drawing.

(c) SECTION FOR AL. PARTITION:

Outer frames 2-1/2 x 1-1/2, 63.5 x 38.10 X 1.5mm, DP 1212, 0.700 Kg/mt, to work as fixed partition & door with door verticals 44.45 x 47.62 x 1.5mm, DP 2022, 0,.850 Kg/mt, top and center pieces as per drawing.

20. Cement based water proofing treatment of roofs, balconies, terraces etc. shall be provided with average thickness of 120 mm and minimum thickness at Khurra as 65 mm and laid consisting of following operations:

- (a) A slurry coat of neat cement using 2.75 kg/m² of cement admixed with proprietary water proofing compounds conforming to IS: 2645 shall be applied and grouted over the RCC slab including cleaning the surface before treatment.
- (b) Plain Cement concrete 1:5:10 (1 Cement : 5 fine sand : 10 burnt brick aggregate of 40 mm nominal size) admixed with proprietary water proofing compound conforming to IS:2645 over 20 mm thick layer of cement mortar of min :5 (Cement :5 coarse sand) admixed with proprietary water proofing compound conforming to IS: 2645 to required slope an treating similarly the adjoining walls upto 300 mm height including rounding of junctions of walls and slabs.
- (c) After two day of proper curing, a second coat of cement slurry admixed with proprietary water proofing compound conforming to IS:2645 shall be applied.
- (d) The surface shall be finished with 20 mm thick joint less cement mortar of mix 1:4 (1 cement :4 course sand) admixed with proprietary water proofing compound conforming to IS : 2645 and finally the surface shall be finished with trowel with neat cement slurry and making of 300 x 300 mm square.
- (e) The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations shall be done in order an as directed and specified by the Engineer-in charge.

21. Unplasticised rigid PVC rain water pipes 110 mm dia shall be provided and fixed on the wall face conforming to IS : 13592 type A as per drawing including jointing with seat ring conforming to IS:5382 leaving 10 mm gap for themal expansion single socketed pipes.

22. Unplasticised PVC Moulded fittings / accessories including 110 mm bend and 110 mm shoes shall be provided and fixed for unplasticised rigid PVC rain water pipes conforming to IS : 13592 type A including jointing with seat ring conforming to IS : 5382 leaving 10 mm gap for thermal expansion.

- Unplasticised PVC pipe clips of approved design shall be provided and fixed to unplasticised 110 mm PVC rain water pipes by means of 50x50x50 mm hard wood plugs, screwed with MS screws of required length including cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand) and making good the wall etc.
- Double action hydraulic floor spring of approved brand and manufacture IS: 6315 marked “hardwyn” make (model 3000) or equivalent for doors shall be provided and fixed at the following door including cost of cutting floors as required, embedding in floors and cover plates with brass pivot and single piece MS sheet outer box with slide plate etc. as per the direction of Engineer- in charge. With stainless steel cover plate:
 - (a) Main Entrance to Control Room Building.
 - (b) Sub-Station In charge room
 - (c) Conference Room
 - (d) Control Room.
- Plinth protection 50 mm thick of cement concrete 1:2:4 (1 cement :2 coarse sand : 4 graded stone) aggregate 20 mm nominal size) shall be laid over 75 mm bed of dry brick ballast 40 mm nominal size well rammed and consolidated and shall be grouted with fine sand including finishing the top smooth.
- Coloured vitreous china pedestal type water closet (European type) with seat and lid, 40 mm flush bend, overflow arrangement with specials of standard make and mosquito proof coupling of approved municipal design including painting of fittings and brackets, cutting and making good the walls and floors shall be provided for all toilets.
- Coloured vitreous china wash basin of size 630 x 450 mm with C.I / M.S brackets alongwith single 15 mm C.P brass pillar taps, Kingston / Gem / Techno / Parko. 32 mm C.P brass waste of standard pattern, shall be provided and fixed in the toilets including painting of fittings and brackets, cutting and making good the walls wherever required alongwith C.P brass trap and C.P brass union.
- All urinals shall be coloured vitreous china flat back half stall urinal of 580 x380x350 mm with 10 litre PVC automatic flushing cistern, Parryware / Hindware / Seabird / Orient (Coral) with fittings, standard size C.P. brass flush pipe, spreaders with unions and clamps (all in C.P. brass) with waste fitting as per IS : 2556 C.I. trap with outlet grating and other couplings in C.P brass including painting of fittings and cutting and making good the walls and floors wherever required.
- Following fittings shall be provided in all the toilets :
 - (a) Toilet paper roll holder.
 - (b) Double type coat & hat hooks with flanges, fixed to wall / shutter, etc. with necessary screws, washers & plugs.
 - (c) CP / PP liquid soap holder of approved make fixed with each wash basin to the wall with necessary CP / PP brackets, CP screws, washers, plugs etc.
 - (d) 100 mm dia vitreous chinaware half round channel of approved make fixed to correct grade, level, opening for floor trap below urinals set in CM 1:3 & pointed using white cement etc.
 - (e) CP brass bid cock 15 mm nominal bore of approved quality conforming to IS : 8931.

- (f) CP brass angle valve of 15 mm nominal bore provided and fixed in position for basin and cistern points of approved quality conforming IS : 8931.
- (g) Best quality marble partition slab provided and fixed in position for urinals, of size 610 x 1150 mm, 20 mm thick, polished on both sides & machine cut, exposed corners rounded etc.
- (h) Towel rail of approved make of 600 mm length, 25 mm dia with a pair of brackets or flanges provided and fixed to wall beside each wash basin / set of wash basin with necessary screws, plugs, etc.
- (i) 6 mm thick beveled edge mirror 1000 x 600 mm shall be provided and fixed mounted on 12 mm thick water proof plywood backing and hardwood beading all-round and mirror fixed to the backing with 4 Nos. of CP cap screws & washers, including fixing the mirror to the wall with necessary screws, plugs & washers etc, with each wash basin.
- (j) Salem Stainless steel A ISI 304 (18/8) Kitchen sink of 510 x 1040 mm Bowl depth 178 mm with drain board shall be provided and fixed as per IS: 13983 with C.I. Brackets and stainless steel plug 40 mm including painting of fittings and brackets, cutting and making good the wall.
- 23) GI Pipe work for Internal and External works:
- i) All concealed GI pipe shall be painted with anticorrosive bitumastic paint including cutting of chases and making good the wall.
 - ii) All exposed GI pipes and fittings shall be painted with synthetic enamel paint of desired shade over a ready mixed priming coat, both of approved quality for new work.
 - iii) Wherever GI pipe are buried the same shall be provided and laid in position including trenching sand cushion and refilling, painted with anticorrosive bitumastic paint etc.
 - iv) Gun metal ball valve with operating levers, non-return valves conforming to IS specification shall be provided and fixed in position as per drawing or direction of Engineer-in-charge.
- 24) Masonry chamber for sluice valve shall be 600x600mm size in plan and depth 750mm, or matching with the site condition inside with 50 class designation brick work in cement mortar 1:5 (1 cement :5 fine sand) with CI surface box 100mm. Top diameter, 160mm bottom dia and 180mm deep (inside) with chained lid and RCC top slab 1:2 :4 mix (1 cement :2 coarse sand: 4 graded stone aggregate 20 mm nominal size) necessary excavation foundation concrete 1:5:10 (1 cement:5 fine sand :10 graded stone aggregate 40mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12 mm thick finished with a floating coat of neat cement complete as per standard design with FPS bricks of class 75.
- 25) Polyethylene water storage tanks (2 nos. of 2000 litres capacity each) shall be provided and placed on roof of control room building of approved brand and manufacturer with cover and suitable locking arrangement, float valve and making necessary holes for inlet, outlet and overflow pipes.
- 26) PVC floor traps of self cleansing design shall be provided & fixed in position with outlet size of 75mm diameter of approved make, including making connection with PVC soil/waste pipes using rubber gaskets, embedding the trap in 150mm thick PCC 1:2:4, providing & fixing of top tile & strainer of CP or PVC on top of the trap etc.
- 27) Square-mouth SW gully trap grade "A" 100x100mm size P type with FPS Bricks class designation 75 shall be provided and fixed complete with CI grating brick masonry chamber with water tight C.I. cover with frame of 300x300mm size (inside) the weight of cover to be not less than 4.5 Kg and frame to be not less than 2.70 Kg as per standard design.
- 28) Glazed stoneware pipes of 150mm diameter grade 'A' shall be provided, laid and jointed with stiff mixture of cement mortar in the proportion of 1:1 (1 cement: 1 fine sand) including testing of joints etc. complete.

- 29) Cement concrete 1:3:6 (1 cement:3 coarse sand:6 graded stone aggregate 40 mm nominal size) shall be provided and laid around S.W. pipes including bed concrete.
- 30) Brick masonry manhole shall be constructed in cement mortar 1:4 (1 cement:4 coarse sand) RCC top slab with 1:2:4 mix (1 cement:2 coarse sand: 4 graded stone aggregate 20mm nominal size) foundation concrete 1:4:8 mix (1 cement:4 coarse sand:8 graded stone aggregate 40mm nominal size) inside plastering 12mm thick with cement mortar 1:3 (1 cement:3 coarse sand) finished with floating cot of neat cement and making channels in cement concrete 1:2:4 (1 cement:2 coarse sand:4 graded stone aggregate 20mm nominal size) finished with a floating coat of neat cement complete³ as per standard design.
- a) Inside size shall be 90 x 80 cm and 60 cm deep including CI cover with frame (light duty) 455 x 610 mm internal dimensions total weight of cover and frame shall not be less than 38 kg (weight of cover 23 kg and weight of frame 15 kg) and shall be constructed with F.P.S. bricks with class designation 75.
- b) Inside size shall be 120 x 90 cm and 90 cm or more deep including CI cover with frame (medium duty) 500 mm internal diameter total weight of cover and frame to be not less than 116 kg (weight of cover 58 Kg and weight of frame 58 kg) with FPS Bricks class designation 75.
- 31) MS foot of 20 x 20 mm square rests shall be provided and fixed in manholes with 20 x 20 x 10 cm cement concrete blocks 1:3:6 (cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size) as per standard design.
- 32) Steel glazed doors, windows and ventilators of standard rolled steel section shall be provided and fixed in FFPH building, joints mitred and welded with 15 x 3 mm lugs, 10cm long, embedded in cement concrete blocks 10 x 10 x 10 cm of 1:3:6 (1 cement 3 coarse sand : 6 graded stone aggregate 20 mm nominal size) or with wooden plugs and screws or rawls plus and screws or with fixing clips or with bolts and nuts as required, including providing and fixing of glass panes with glazing clips and special metal sash putty of approved make complete including applying a priming coat of approved steel primer, necessary hinges or pivots as required.
- 33) Pressed steel door frames manufactured from commercial mild steel sheet fo 1.25 mm thickness shall be provided and fixed in FFPH building including hinges jamb, lock jamb, bead and if required angle threshold of mild steel angle of section 50x 25 mm or base ties of 1.25 mm pressed mild steel welded or rigidly mixed together by mechanical means, adjustable lugs with split end tail to each jamb including steel butt hinges 2.5 mm thick with mortar guards, lock strike-plate and shock absorbers as specified and applying a coat of approved steel primer after pre-treatment of the surface as directed by Engineer-in-charge.
- 34) Asbestos cement 6 mm thick corrugated sheets roofing shall be provided and fixed with G, I, J or L hooks, bolts and nuts 8 mm diameter G, I plain and bitumen washers complete excluding the cost of purlins, rafters and trusses for water tank.

(III) MODE OF MEASUREMENT ON CIVIL WORKS

(a) Earthwork

This shall include excavation in all kinds of soil including rock, all leads and lifts including back filling, compacting, de-watering (if required) and disposal of surplus earth to a suitable location. The quantity of excavation for foundations of towers, equipment structures, all transformers, rail-cum-road, firewall, cable trenches, water tank, reactors and buildings shall only be measured. The quantity of excavation for roads, drains, rainwater harvesting, septic tank, soak pit, external water supply system, site surfacing (graveling), chain link fencing (including gate) shall not be measured separately and shall be deemed to be included in the composite rates quoted by the bidder for the respective works. All other excavation required for the completion of the work including fixing of lamp posts, plinth protection, flooring sewerage system, manholes, popes, earthmat etc. shall also not be paid for. The measurement of excavation of all concrete works shall be made considering dimension of the pit leaving 150 mm gap around the base pad (lean concrete) or actually excavated pit, whichever is less. The quantity shall be measured in cubic meters.

(b) PCC

Providing and laying Plain Cement Concrete of all types and at all locations including all leads and lifts. The quantity shall be measured in cubic meters as per lines and levels indicated in the drawings.

- (i) PCC 1:2:4 (1 cement : 2 sand : 4 coarse aggregate 20 mm nominal size) shall be measured in flooring of buildings, plinth protection, fencing, transformer foundation, reactor foundation, rail track, drain, culverts, septic tank, chain link fencing, gate etc. as indicated in the drawings.
- (ii) PCC 1:4:8 (1 cement : 4 coarse sand : 8 stone aggregate, 40 mm nominal size) shall be measured below all foundations of buildings, cable trench, roads, under flooring, rail-cum-road, transformer foundation, reactor foundation, drain, water tank, culverts, gate etc. as indicated in the drawings.
- (iii) All other PCC required for the completion of the work including hold fasts of doors / windows / rolling shutters, fixing of plumbing pipes, bedding concrete for sewer lines, embedment of electrical conduits etc. shall not be measured and deemed included in the composite rates quoted by the bidder for respective works. Water proofing compound wherever specified shall be added without any extra cost.

(c) RCC

Measurement of reinforced cement concrete at all locations shall be made and shall include all leads, lifts, formwork, grouting of pockets and underpinning, (but shall exclude reinforcement) of mix 1:1.5:3 (1 cement : 1.5 coarse sand : 3 stone aggregate 20 mm nominal size). This shall also include pre-cast RCC work and addition of water proofing compound wherever required for which no additional payment shall be made. The quantity shall be measured in cubic meters as per lines and levels indicated in the drawings. No deduction shall be made for volume occupied by reinforcement / inserts sleeves and for openings having cross-sectional area up to 0.1 sq.m.

(d) Steel Reinforcement

Reinforcement shall be measured in length (actual of theoretical as per drawing whichever is less) including hooks, if any, separately for different diameters as actually used in work, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in tones on the basis of sectional weights as adopted by Indian Standards. Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers and annealed steel wire or other methods for binding and placing shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.

(e) Stone filling

Measurement of stone (40mm nominal size) for transformer foundations shall be made as per theoretical volume of the space to be filled in the transformer foundation as per drawings. This shall be measured in cum.

1.1 Miscellaneous structural steel.

Measurement for Supply, fabrication, transportation and erection of all miscellaneous structural steel work for mono rails (RS joists), rails for transformers/ reactors, trusses, frame work, purlins, gratings, steel tubes, built up sections along with all other steel fittings and fixtures, inserts and embedment in concrete shall be made as per drawings. The unit rate for this item shall be inclusive of cutting, grinding, drilling, bolting, welding, pre-heating of the welded joints, applying a priming coat of steel primer and anti corrosive bitumastic paint/ synthetic enamel paint etc. (wherever specified), setting of all types of embedment in concrete, etc. steel required for foundation bolts, nuts and bolt, doors, windows, ventilators, louvers, rolling shutters, chain link fencing, gratings in drains, soil pipes, plumbing pipes, floor traps, embedments required for rainwater harvesting, septic tank, soak pit, roof truss and purlins required for fire water tank, etc. shall not be considered for payment and measurement.

Quantity shall be measured in Kg.

1.2 Roads

The measurement for the concrete roads shall be measured as per the UNIT OF MEASUREMENT specified in the BOQ along with the entire line of the road and shall include all items such as excavation, compaction, rolling, watering, WBM, Kerb stone, grating, inter locking tiles, concrete and reinforcement etc. complete in all respect as per drawing.

The measurement of bituminous road shall be measured on LOT basis along the center line of the road and shall include all items such as excavation, compaction, rolling, watering, sub case course, WBM, Bitumen, premix carpet etc. complete in all respect as per drawing.

1.3 Drain

The measurement of drains shall be measured on LOT basis along the center line of the drain and shall include excavation, compaction, brickwork, plastering, grating, weep holes, concreting etc. complete in all respect as per drawing.

(f) Antiweed Treatment and Stone Spreading

The measurement shall be done as per the UNIT OF MEASUREMENT specified in the BOQ for the actual area in square meters of stone spreading provided in the switchyard and shall include anti weed treatment including material and providing and spreading of 100mm thickness of uncrushed/crushed/broken stone of 40mm nominal size as per the specification for the specified area.

(g) Chain Link Fencing and gate.

The measurement shall be made in running meters of the fence provided as per drawing. The rate shall be including the post, fencing, MS Flat, concreting, brick work etc. complete in all respect as per drawing. The gate shall be measured in numbers.

(h) Fire Fighting Pump House

This is lump sum item, Contractor has to assess the quantity as per drawings of control room cum administrative building, Fire Fighting Pump House and quote for the same for each building separately as per BOQ.

(i) Hume Pipe

Hume pipe shall be measured diameter-wise and laid as per the drawings and shall be measured in running metres. The item shall be inclusive of excavation, laying, back filling, jointing, concrete and reinforcement (if any) etc. complete in all respect.

(j) Building.

This is a lump sum item for each building. The entire work required to complete the building in all respect as per the drawings approved by the Owner shall be deemed to be included in this lump sum rate.

(k) Rain Water Harvesting:

This is a lump sum item. The contractor shall be required to complete the work in all respect as per drawings approved by the Owner. All the items including excavation, miscellaneous steel, bricks work, fillings of boulders, gravel, sand, pipe, concrete (all types) and the reinforcement etc. shall be deemed to be included in this lump sum rate.

(l) Septic Tank and Soak Pit.

This is a lump sum item. The contractor shall be required to complete the work in all respect as per drawings approved by the Owner. All the items including excavation, masonry work, all types of fillings all types of pipes including plumbing and vent pipes, all type of fittings, concrete (all types) and the reinforcement etc. shall be deemed to be included in this lump sum rate.

(m) Fire Water Tank.

This is a lump sum item. The contractor shall be required to complete the work in all respect as per drawings approved by the Owner. All the items including excavation, compaction, brick work, roof truss, corrugated AC Sheet roofing, all types of miscellaneous steel, internal and external plastering, painting, concrete (all types) and the reinforcement etc. shall be deemed to be included in this lump sum cost.

(n) External water supply from Bore-well to Fire water tank.

The external water supply from Bore-well shall be on LOT basis. It shall include all the items such as excavation, piping, fittings, painting, brick work, sand filling, concrete, valves, chambers cutting chases in walls, openings in RCC and repairs etc. required to complete the job.

(III) MISCELLANEOUS GENERAL REQUIREMENTS:

- (a) 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.
- (b) 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 1230 mm.
- (c) All mild steel parts used in the water retaining structures shall be hot-double dip galvanized. The minimum coating of the zinc shall be 750 gm/sq.m. for galvanized structures and shall comply with IS:2629 and IS:2633. Galvanizing shall be checked and tested in accordance with IS:2633. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS:3416.
- (d) Bricks having minimum 75 kg/cm² compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 75 kg/cm² compressive strength before submitting his offer.
- (e) Angles 50x50x5 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab, edges of drains supporting grating 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.
- (f) 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.
- (g) For all civil works covered under this specification, nominal mix by volume batching as per CPWD specification is intended. The relationship of grade of concrete and ratio of ingredients shall be below:

	Nom Mix.	Cement	Sand	Coarse aggregate of 20mm down grade as per IS: 383
1.	M 10	1	3	6
2.	M 15	1	2	4
3.	M 20	1	1.5	3

(h) The material specification, workmanship and acceptance criteria shall be as per relevant clauses of CPWD specification and approved standard Field Quality Plan, 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.

(IV) INTERFACING

The proper coordination & execution of all interfacing civil works activities like fixing of conduits in roofs/walls/floors, fixing of foundation bolts, fixing of lighting fixtures, fixing of supports/embedment, provision of cut cuts etc. 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.

(V) STATUTORY RULES.

* Contractor shall comply with all the applicable statutory rules pertaining to factories act (as applicable for the State). Fire safety Rules of Tariff Advisory Committee. Water Act for pollution control etc.

* Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.

* Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the Indian Standards based on the findings of the detailed soil investigation.

* All building/construction materials shall conform to the best quality specified in CPWD specifications if not otherwise mentioned in this specification.

* All tests as required in the standard field quality plans have to be carried out.

ODISHA POWER TRANSMISSION CORPORATION LIMITED

STANDARD FIELD QUALITY PLAN FOR SWITCHYARD CIVIL WORKS.
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Section: FOUNDATION MATERIALS

Sl. No.	Component/Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance	Testing Agency.	Remarks	Check
1.	CHECKING OF FOUNDATION MATERIAL					
A)	CEMENT					
i) ii) iii) iv) v)	Fineness Compressive Strength Initial & final setting time Soundness Heat of Hydration for low heat cement (Not applicable for OPC & PPC)	One sample per lot of 100 MTR or part thereof from each source for MTCs and one sample per lot of 200 MT or part thereof from each source for site	IS:456, IS:269,IS:8112 IS:12269, IS:1489 & OPTCL specification.	Manufacturer/ As per OPTCL approved lab.	Review of manufacturers test certificates (MTCs) and laboratory test results by OPTCL	

vi)	Chemical Composition of Cement.	testing. One sample per lot of 100 MT or part thereof from each for MTCs	IS:456, IS:269,IS:811 2 IS:1489 & OPTCL specification.	Manufacturer	Review of manufacturers test certificates by OPTCL	
B)	COARSE AGGREGATES					
i) ii) iii) iv) v) vi) vii) viii) ix)	Determination of Particle size (Sieve Analysis) Flakiness Index Crushing Value Specific Gravity* Bulk Density* Absorption Value* Moisture Content* Soundness of Aggregate** Presence of deleterious materials. * Applicable Design concretes only	One sample per lot of 100 cubic meter or part thereof from each source for each size. ** Applicable to concrete work subject to frost action.	IS:383, IS:2386 and OPTCL specification	OPTCL approved lab. However, Moisture content test for design mix concrete shall be done on all day of concreting at site.	Each source to be approved by OPTCL Review and acceptance of test result by OPTCL.	
C)	FINE AGGREGATE					
i) ii) iii) iv) v) vi) vii)	Gradation/Determination of particle size (Sieve Analysis) Specific Gravity and density Moisture content Absorption Value Bulking Silt Content Test Presence of deleterious materials.	One sample per lot of 100 cubic meter or part thereof from each source	IS:383,IS:2386, IS:456 and OPTCL specification	OPTCL approved lab. However, Moisture content test for design mix concrete shall be done on all days of concreting at site.	Each source to be approved by OPTCL Review and acceptance of test result by OPTCL.	
D)	BRICKS					
i) ii) iii) iv)	Dimension tolerance Compressible Strength Water Absorption Efflorescence		OPTCL Specification.	OPTCL approved Lab.	Approved by OPTCL	
E)	WATER					

i)	Cleanliness (Visual Check)	Random	IS:456, IS:3025 and OPTCL specification. The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalies, organic materials, or other deleterious materials.	Contractor.	Each source to be approved by OPTCL	
	Chemical & Physical properties of water for checking its suitability for construction purposes	One sample per source	IS:456, IS:3025 & OPTCL specification.	Contractor/ OPTCL Approved Lab.	Approved by OPTCL	
	* Applicable to design mix concrete only.					

ODISHA POWER TRANSMISSION CORPORATION LIMITED
(Quality Assurance & Inspection Deptt.)

Sl. No.	Component/Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norm	Testing Agency.	Remarks	Check
1.	REINFORCEMENT STEEL					

i)	Identification & size	Random	IS:432, IS:1139, IS:1786 & OPTCL	Contractor	Approved by OPTCL
ii)	Chemical Analysis test	One sample per heat.	Specification. IS:432, IS:1139, IS:1786 OPTCL	Manufacture r	Review of manufacturer s test certificate by OPTCL
iii)	Tensile Test	One sample per lot of 40MT or part thereof for each size of steel conforming to IS:1139 and 5 MT or part thereof for HDS wire for each size of steel as per IS:432. For steel as per IS:1786 under 10mm 1 sample for each 25 MT or part thereof. 20 mm-16 mm 1 sample for each 35 MT or part thereof. Over 16mm 1 sample for each 45 MT or part thereof.	Specification. IS:432, IS:1139, IS:1786 OPTCL Specification.	Manufacture rs/ OPTCL approved Lab.	Review of manufacturer s test certificates as well as lab. Test results by OPTCL
iv)	Yield stress/proof stress				
v)	Percentage Elongation				
vi)	Bent/re-bend Test	One sample per lot of 20MT or part thereof for each size of steel as per IS:432, IS:1139. For steel as per IS:1786 under 10mm- 16mm 1 sample for each 25MT or part thereof 10mm-16mm 1 sample for each 45 Mt or part thereof.	IS:432, IS:1139, IS:1786 OPTCL Specification.	Manufacture rs/ OPTCL	Review of manufacturer s test certificates as well as lab. Test results by OPTCL
vii)	Reverse Bend Test for HDS wire.			Manufacture rs/ OPTCL approved Lab.	Review of manufacturer

		One sample per lot of 5MT or part thereof for each size.	IS:432, IS:1139, IS:1786 OPTCL Specification.		s test certificates as well as lab. Test results by OPTCL	
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