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## **SECTION - 1**

### **SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES**

#### **1.1.0 SCOPE**

1.1.1 The scope of work under this specification is Civil Works of 220kV Yard of 765/400/220kV Sub-station Bhuj (New) at Bhuj in Gujrat being executed by BHEL on turnkey basis. The Customer is Powergrid Corporation of India Limited.

1.1.2 The Civil Works of 220kV Yard shall generally include, *but not limited to*, following:

- (i) 400kV Equipment Foundation Works.
- (ii) 220kV Tower & 220kV Equipment Foundation Works.
- (iii) 500MVA Transformer Foundations including associated misc. foundations, soak pit, grating and rail-cum-road, etc.
- (iv) Cable Trench Works including precast cover & sump pit works
- (v) Drainage Works
- (vi) Road works
- (vii) Culvert / Pipe Crossing Works for Cable Trenches/ Drains / Road
- (viii) Switchyard Panel Rooms (SPR) and including indoor cable trenches.
- (ix) De-weeding, removal of roots of grass, shrubs etc of the yard area. Micro leveling, anti-weed treatment. Laying of PCC and Stone spreading over PCC in the yard area.

Any other work required for the project.

1.1.3 The works to be performed in the above construction includes preparation of bar bending schedules, based on the drawings released for construction and getting the same approved by the Engineer-in-charge plus the execution of the work including providing of all labour, supervision, materials, scaffolding, power, fuel, construction equipments, tools and plants, supplies, transportation, all incidental items necessary for successful completion of the work including contractor's supervision and in strict accordance with the drawings and specifications and with inspection and testing standards. The nature of work shall generally involve excavation in all type of soil including dewatering, shoring, strutting, and filling under and around structures, backfilling with available excavated earth around completed structures, cable trenches with covers, disposal of surplus soil, steel/wooden ply formwork, providing necessary steel embedments and other inserts, drainage work, concreting, brickwork, flooring and finishing etc. and all other works in building all complete as per detailed specification, drawings and directions of Engineer-in-charge.

**1.2.0 SPECIFIC TECHNICAL REQUIREMENT**

**1.2.1** The specific technical requirements for the execution of civil works shall be as per Customer's specification / I.S. Codes/ CPWD Specification. In case of any conflict between these Customer's specification shall prevail.

**1.3.0 BILL OF QUANTITIES**

**1.3.1** The Bill of Quantity cum price schedule shall be as per page 1.3 to page 1.10.

**1.3.2** The quantities indicated in the 'Bill of Quantity cum price schedule' are indicative and can vary upto any extent, even may get deleted. Contractor shall not be entitled for any claim for any such variation in the quantities.

**1.3.3** The provision of Bill of Quantity cum price schedule, specifications and drawings shall be read in conjunction with each other and in case of conflict amongst them, the clarification shall be obtained from the Engineer-in-charge whose decision shall be final and binding.

**1.3.4** Method of measurement:

**1.3.4.1** Excavation shall be measured in cubic meters. The lateral dimensions to be considered for working out excavation quantity shall be the PCC dimension below the footing as per approved drawing. Nothing extra shall be paid for slope cutting, etc,. Backfilling & disposal quantities shall be worked out based on the above dimensions only. However the contractor shall maintain the required slope and working space as per the safety /statutory requirement and its cost is deemed to be included in the quoted rate.

Clause No. 2.1.0 of CPWD Specification Volume-I shall be followed for classification of soils.

Clause No. 12.0 (except Clause No. 12.2.4, 12.5, 12.8 & 12.9) of PGCIL Specification for mode of measurement shall not be applicable in this contract.

For other items, unless otherwise described the method of measurement as described in 'Method of Measurement of Building and Civil Engineering Works'-IS 1200(Part I to XXV) latest edition of BIS shall be followed.

## **SECTION - 2**

STANDARD TECHNICAL SPECIFICATION  
(N.A.)

## **SECTION -3**

### **ENCLOSURES TO THE SPECIFICATION**

(a) Customer Specification

## **SECTION: CIVIL**

### **1.0 GENERAL**

The intent of this technical specification covers the following:

All civil works shall be carried out as per design/drawings provided by the Employer / Contractor and as per these specification provided by the Employer. In case any item is not covered under specification then the same shall be carried out as per CPWD specification and applicable Standards and Codes. Any item for which specification is not provided herein and is not covered under CPWD specification shall be executed as per manufacturer guidelines. All materials shall be of best quality conforming to relevant Indian Standards and Codes. In case of any conflict between Standards/ Code and Technical Specification, the provisions of Technical Specification shall prevail.

The Contractor shall furnish all 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 drawings, specifications and direction of Employer.

All materials including cement, reinforcement steel and structural steel etc. shall be arranged by the Contractor. All testing required shall be arranged by the Contractor at his own cost. The Contractor shall execute the work as per the Field Quality Plan (FQP) attached with this document.

The bidder shall fully apprise himself of the prevailing conditions at the proposed site. Climatic conditions including monsoon patterns, local conditions and site specific parameters, soil parameters, availability of construction material and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.

Employer has standardized its technical specification for various items/ works. Specification for items which are covered in the scope and as defined in Section project & BPS need only be referred.

### **2.0 GEOTECHNICAL INVESTIGATION**

2.1 The Contractor shall perform a detailed soil investigation to arrive at sufficiently accurate conclusion regarding general as well as specific information about the soil profile and the necessary soil parameters of the site, in order to design and construct the foundation of the various structures safely and rationally.

A report to the effect shall be submitted by the Contractor for Employer's specific approval giving details regarding data proposed to be utilized for the design.

## **2.2 SCOPE**

This specification covers all the work required for detailed soil investigation and preparation of a detailed report. The work shall include mobilization of necessary equipment, providing necessary engineering supervision and technical personnel, skilled and unskilled labour etc. as required to carry out field investigation as well as, laboratory investigation, analysis and interpretation of data and results, preparation of detailed Geo-technical report including specific recommendations for the type of foundations and the allowable safe bearing capacity for different sizes of foundations at different founding strata starting from 0.5M from existing ground level for the various structures of the substation. The Contractor shall make his own arrangement for locating the co-ordinates and various test positions in field as per the information supplied to him and also for determining the reduced level of these locations with respect to the benchmark indicated by the Employer.

All the work shall be carried out as per latest edition of the corresponding Indian Standard Codes.

## **2.3 BORE HOLES**

Bore holes of 150 mm diameter in accordance with the provisions of IS: 1892 at the rate of minimum one number bore hole per hectare up to 15meter depth into virgin soil or to refusal whichever occurs earlier shall be drilled. Total area of substation plot (including of Switchyard, Township and Future area) shall be considered for arriving at number of bore holes to be drilled. In any case number of boreholes shall not be less than five and shall not exceed twenty. By refusal it shall mean that a standard penetration blow count (N) of 100 is recorded for 30 cm penetration. In case rock is encountered within five meter from existing ground level or three meter from FGL, coring in all the boreholes shall be carried out up to 3 meter in rock.

The Contractor shall carry out Standard Penetration Tests at approximately 1.5 m interval in the borehole starting from 0.5 m below ground level onwards and at every change of stratum. The disturbed samples from the standard penetrometer shall also be collected for necessary tests.

The Contractor shall collect 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 0.5 m below ground level onwards in clayey strata.

The depth of Water Table, if encountered, shall be recorded in each borehole. In case the soil investigation is carried out in winter/summer, the

water table for rainy season shall be collected from reliable sources and recorded in the report.

All samples, both disturbed and undisturbed, shall be identified properly with the borehole 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 boreholes shall be compiled immediately after the boring is completed and a copy of the bore log shall be handed over to the Engineer-in-charge.

## **2.4 TRIAL PITS**

Trial pits shall be carried out at minimum one location per hectare as directed by the Employer. Total area of substation plot (including of Switchyard, Township and Future area) shall be considered for arriving at number of bore holes to be drilled. Minimum number of trial pits shall be five and maximum number shall be ten. The trial pits shall be 2 m x 2 m in size extending to 4 m depths, or as specified by the Employer. Undisturbed samples shall be taken from the trial pits as per the direction of the Employer.

## **2.5 ELECTRICAL RESISTIVITY TEST**

### **2.5.1 GENERAL**

The resistivity of earth varies over a wide range depending on its moisture content, temperature, salt content and compactness. Therefore earth resistivity test shall be conducted preferably during the dry season in order to get conservative results.

### **2.5.2 TEST LOCATION**

In the evaluation of earth resistivity for the substations, at least eight test directions shall be chosen from the centre of the substation to cover the entire area including the future area. The number of test points shall be as per approved drawing.

### **2.5.3 PRINCIPLE OF TEST**

Wenner's four electrode method shall be used. In this method, four small electrodes shall be buried in four small holes in the earth along a straight line at equal intervals. A test current (I) by earth resistivity tester shall be passed between two outer electrodes and the voltage difference (V) between the two inner electrodes shall be measured. The test current (I) thus flowing into the earth, produces an electric field proportional to its



density and to the resistivity of the soil. The voltage (V) measured between the inner electrodes is proportional to the field. Consequently, the resistivity will be proportional to the ratio of the voltage to current. Thus the resistivity shall be calculated from the following equation.

$$\rho_a = \frac{4\pi aR}{1 + \frac{2a}{\sqrt{a^2+4b^2}} - \frac{a}{\sqrt{a^2+b^2}}}$$

Where,

$\rho_a$  is the apparent resistivity of the soil in  $\Omega$ -m

R is the measured resistance in  $\Omega$

a is the distance between adjacent electrodes in metres

b is the depth of the electrodes in m

#### 2.5.4 TEST PROCEDURE

In the selected test point and chosen direction, four electrodes with insulated connecting wires shall be driven into the earth along a straight line of equal intervals (a). The depth of the electrodes in the earth shall be of the order of 15 cm to 20 cm. The megger shall be placed on a steady and approximately level base, the link between terminals P1 and C1 shall be opened and the four electrodes connected to the instrument terminals. An appropriate range on the instrument shall be selected to obtain clear readings avoiding the two ends of the scale as far as possible.

Resistivity shall be calculated by substituting the value of R in the above equation. The test shall be repeated in a chosen direction with a number of different electrode spacing, increasing from 2m to 50m preferably in the steps of 2, 5, 10, 15, 25 and 50m. When the spacing is increased gradually from low values, at a stage, it may be found that the resistivity reading is more or less constant irrespective of the increase in the electrode spacing. The resistivity for this spacing is noted and taken as the resistivity for that direction. In a similar manner, resistivity for at least eight equally spaced directions from the centre of the test points shall be measured. These measurements shall be repeated for all test points.

NOTES:-

1. Soil resistivity points shall preferably be one number in each 100mx100m grid and number of test points shall be such that the entire substation including the future area is covered.
2. Average resistivity value of all eight directions shall be considered for design of earthing system.
3. Soil resistivity measurement may be done in dry season. Small amount of water may be applied at electrodes for making proper contact between the electrodes and soil.

## **2.6 PLATE LOAD TEST**

Plate load test shall be conducted to determine the bearing capacity, modulus of sub grade reaction 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. Modulus of sub grade reaction shall be conducted as per IS: 9214. Plate load test shall be conducted at two locations to be decided during detailed engineering at the proposed foundation depth below finished ground level for determining the bearing capacity.

Undisturbed tube samples shall be collected at 0.5 m and 2.5m depths from natural ground level for carrying out laboratory tests

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

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 load shall be increased in stages. Under each loading stage, record of Time v/s Settlement shall be kept as specified in IS: 1888.

Backfilling of the pit shall be carried out as per the directions of the Employer. Unless otherwise specified the excavated soil shall be used for this purpose. In cases of gravel-boulder or rocky strata, respective relevant codes shall be followed for tests.

## **2.7 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.

## **2.8 BACK FILLING OF BORE HOLES**

On completion of each hole, the Contractor shall backfill all bore holes as directed by the Employer. The backfill material can be the excavated material.

## **2.9 LABORATORY TEST**

- 2.9.1. The laboratory tests shall be carried out progressively during the field work after sufficient number of samples has 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.

- 2.9.2. All samples brought from field, whether disturbed or undisturbed shall be extracted/prepared and examined by competent technical personnel, and the test shall be carried out as per the procedures laid down in the relevant I.S. Codes.

The following laboratory tests shall be carried out

- a) Visual and Engineering Classification
- b) Liquid limit, plastic limit and shrinkage limit for C-Ø soils.
- c) Natural moisture content, bulk density and specific gravity.
- d) Grain size distribution.
- e) Swell pressure and free swell index determination.
- f) California bearing ratio.
- g) Consolidated drained test with pore pressure measurement.
- h) Chemical tests on soil and water to determine the carbonates, sulphates, nitrates, chlorides, Ph value, and organic matter and any other chemical harmful to the concrete foundation.
- i) In case of rock samples following tests shall also be conducted:
  - Rock quality designation (RQD), RMR.
  - UCC test.
  - Point load index test.

## **2.10 TEST RESULTS AND REPORTS**

- i) 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 Contractor shall submit draft report and after the draft report is approved, the final report in four (4) copies shall be submitted. The test data shall bear the signatures of the Investigation Agency, Vendor and also site representative of Employer.
- ii) The report shall include, but not limited to the following:-
  - a) A plan showing the locations of the exploration work i.e. bore holes, trial pits, Plate load test etc.
  - b) Bore Logs: Bore logs of each bore holes clearly identifying the stratification and the type of soil stratum with depth. The values of Standard Penetration Test (SPT) at the depths where the tests were conducted on the samples collected at various depths shall be clearly shown against that particular stratum.

Test results of field and laboratory tests shall be summarised strata wise as well as in combined tabular form. All relevant graphs, charts tables, diagrams and photographs, if any, shall be submitted along with report. Sample illustrative reference calculations for

settlement, bearing capacity, pile capacity shall be enclosed.

- c) 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 Employer. The observations and recommendations shall include but not limited to the following:
- i) 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.
  - ii) Recommended type of foundations for various structures.  
If piles are recommended the type, size and capacity of pile and groups of piles shall be given after comparing different types and sizes of piles and pile groups.
  - iii) 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. Minimum factor of safety for calculating net safe bearing capacity shall be taken as 2.5. Recommendation of liquefaction characteristics of soil and possible remedies shall be provided.
  - iv) Recommendations regarding slope of excavations and dewatering schemes, if required.
  - v) Comments on the Chemical nature of soil and ground water with due regard to deleterious effects of the same on concrete and steel and recommendations for protective measures.
  - vi) If expansive soil is met with, recommendations on removal or detainment of the same under the structure, road, drains, etc. shall be given. In the latter case detailed specification of any special treatment required including specification or materials to be used, construction method, equipments to be deployed etc. shall be furnished. Illustrative diagram of a symbolic foundation showing details shall be furnished.
  - vii) Recommendations for additional investigations beyond the scope of the present work, if considered such investigation as necessary.
  - viii) In case of foundation in rocky strata, type of foundation and recommendation regarding rock anchoring etc. should also be given based on RMR value.

### **3**

## **DRAWINGS**

Standard drawings have been developed for roads, road culverts, drains, cable trenches, cable trench crossing roads, sump, switchyard fence, fencing gates, rain water harvesting, fire fighting pump house (Super structure), control room building (Super structure) and fire water tank by

the Employer, as mentioned below, and are enclosed with the tender documents. These drawings are good for construction and are also available on POWERGRID website. Additional prints if required can be downloaded from the website.

All foundation drawings including foundations for buildings, towers, equipments etc shall be released to the Contractor after award and after receiving the geotechnical investigation report.

Drawings that have been mentioned to be issued by the Employer to the Contractor during detailed Engineering shall be made available to the Contractor as per the agreed work schedule finalised after award.

### **3.1 Control room building and Switchyard Panel Room**

Standard Architectural drawings are enclosed with the tender documents. These drawings are good for construction. The construction drawings for foundation shall be released, in a phased manner, to the successful bidder after award of work.

### **3.2 FIRE FIGHTING PUMP HOUSE BUILDING & FIRE WATER TANK**

Architectural/Construction drawings of superstructure are enclosed with the tender documents. These drawings are good for construction. However, foundation drawing matching with site requirement shall be released in a phased manner to the successful bidder after award of work.

### **3.3 TOWER & EQUIPMENT FOUNDATIONS**

Construction drawings for towers and equipments foundations, which are enclosed with the tender documents, have been standardised and are available on the POWERGRID website. However the Contractor shall confirm to use these drawings before execution as the type and dimensions depends on the soil parameters.

Drawings for any non-standard tower or equipment foundation, if required, shall be designed by the Employer and made available to the Contractor during detailed Engineering. Foundations for any miscellaneous requirements like electric poles, marshalling box, control cubicles, etc. shall be engineered by the Contractor and the design and drawings shall be submitted for Employer's approval.

Drawings for transformer, reactor foundations and fire wall are not enclosed and shall be made available to the Contractor by the Employer during detailed engineering. Firewall shall be finished with waterproofing cement paint of required shade.

In case the site conditions warrant any special type of foundations to be used, the same shall be designed and issued by the Employer to the Contractor during detailed engineering.

### **3.4 Transit Camp**

The Architectural and Construction drawings of transit camp and covered parking are enclosed with the tender documents.

#### **3.4.1 Septic tank and soak pit**

The construction drawings of septic tank and soak pit for control room building and transit camp are enclosed with the tender document.

### **3.5 Roads, road culverts and rail cum Road**

The construction drawings showing section detail for road, culverts as well as rail cum road are enclosed with the tender documents. The layout of roads shall be as per approved general arrangement drawing. The type of culverts i.e. the number and diameter of Hume pipes shall be as decided during detailed engineering.

### **3.6 Drains**

The construction drawing for the section of drain is enclosed with the tender documents. The Contractor shall develop an overall drainage layout for the new sub-station/ extension of substation during detailed engineering. The type of drains used shall be of the sections standardized and indicated in the drawings enclosed with the tender documents.

### **3.7 Chain link fencing and Switchyard gate**

The construction drawings are enclosed with the tender documents.

### **3.8 Rain water harvesting**

The construction drawings are enclosed with the tender documents.

### **3.9 External water supply from bore-well to fire water tank/Control building and Transit Camp**

(i) The drawing for the water supply from bore-well to fire water tank shall be developed by the Contractor. Water supply will be made available to the Contractor from a bore-well by the Employer at any one location within the sub-station. 80 mm dia GI pipe shall be provided by the Contractor from the bore-well to the fire water tank. From this a 25 mm dia tap off shall be connected by the Contractor to the roof water tank provided for

the control room building & transit camp.

(ii) The Contractor shall carry out all the external plumbing/erection works required for supply of water to the control room building, firewater tank and transit camp 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 Employer 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 well is not in the scope of Contractor.

### **3.10 Stone spreading and antiweed treatment**

The layout of the area, where anti-weed treatment and stone spreading is to be done, shall be developed by the Contractor during detailed engineering and the same shall be submitted to the employer for approval.

### **3.11 Cable Trenches**

The construction drawings of cable trenches, cable trench crossing road and sump are enclosed with tender documents. The Contractor shall develop an over all cable trench layout for the substation during detailed engineering. The layout should show type of cable trench, longitudinal slope and invert level calculated considering future extensions also. The types of cable trench shall be of the section indicated in the drawings enclosed with the tender documents and are also available on POWERGRID website.

## **4.0 EARTH WORK:**

Unless mentioned otherwise in section – Project, fairly levelled site with single level/terraces with different levels/ gradual slope shall be handed over to the Contractor, in the phased manner. The finished ground level (FGL) with a tolerance of (+/-) 100mm shall be the finished formation level furnished by the Employer. The layout and levels of all structure etc shall be made by the Contractor at his own cost from the general grids of the plot and benchmarks set by the Contractor and approved by the Employer. The Contractor shall provide all assistance in instruments, materials and personnel to the Employer for checking the detailed layout and shall be solely responsible for the correctness of the layout and levels.

### **4.1 EXCAVATION AND BACKFILL**

a) Excavation for foundations shall be in accordance with CPWD Specification/ the relevant code. Excavation shall include removal

of all materials of whatever nature at all depth and whether wet or dry necessary for the construction of foundations. The bottom of excavation shall be levelled both longitudinally and transversely unless otherwise mentioned in the drawings or as directed by Engineer-in-charge.

If required the sides of excavations should be supported in such a way as is necessary to secure these from falling in, and the shoring, if required, shall be provided and maintained in position as long as necessary. No extra payment shall be made for shoring.

- b) 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, The excavation shall be kept free from water:-
  - i) When concrete and/or masonry works are in progress and till they come above the natural water level
  - ii) Till the Employer considers that the concrete/ mortar is sufficiently set.
- c). Material unsuitable for foundations shall be removed and replaced by suitable fill material and to be approved by the Employer.
- d). Backfill material around foundations or other works shall be suitable for the purpose for which it is used and compacted. Excavated material not suitable or not required for backfill shall be disposed off in areas as directed by Employer up to a maximum lead of 2 km.
- e). Requirements regarding density / tests of backfilled earth shall be as specified in Field Quality Plan. The subgrade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor's density at OMC (optimum moisture content). Cohesion less material subgrade shall be compacted to 70% relative density (minimum).

## **4.2 REQUIREMENT FOR FILL MATERIAL UNDER FOUNDATION**

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. The filling shall be done in accordance with clause 4.10 of IS: 1080. For expansive soils the fill materials and other protections etc. to be used under the foundation is to be got approved by the Employer. Cohesive Non Swelling (CNS) soil, if required, for filling under / around the foundations, cable trenches, drains, roads etc shall confirm to IS: 9451: 1994 reaffirmed 2004.



## **5.0 ANTIWEED TREATMENT & STONE SPREADING**

### **5.1 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 Employer.

Stone spreading over cement concrete layer shall be done in the areas of the switchyard under present scope of work. The cement concrete layer shall also be provided in future areas within the fenced area. However the stone spreading in future areas shall be provided in case step potential without stone layer is not well within safe limits.

### **5.2 General requirement**

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

5.2.1 The material to be used for stone filling/site surfacing shall be stone aggregate of 40mm nominal size (ungraded single size) conforming to Table 2 of IS:383 – 1970. Hardness, flakiness shall be as required for wearing courses are given below:

- (a) Sieve Analysis limits (Gradation)  
(IS : 383 – Table – 2)

Sieve Size	% passing by weight
63mm	100
40mm	85-100
20mm	0-20
10mm	0-5

“One Test” shall be conducted for every 500 cu.m.

- (b) Hardness

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

Impact value (IS: 2386 Part-IV) – not more than 30% and frequency shall be one test per 500 cu.m. with a minimum of one test per source.

(c) Flakiness Index

One test shall be conducted for every 500 cu.m. of aggregate as per IS: 2386 Part – I and maximum value is 25%.

- 5.2.2 After all the structures/equipments are erected, antiweed treatment shall be applied in the switchyard where ever cement concrete is to be done and the area shall be thoroughly de-weeded including removal of roots. The recommendation of local agriculture or horticulture department may be sought where ever feasible while choosing the type of chemical to be used. The antiweed chemical shall be procured from reputed manufacturers. The doses and application of chemical shall be strictly done as per manufacturer's recommendation. Nevertheless the effectiveness of the chemical shall be demonstrated by the Contractor in a test area of 10MX10M (appx) and shall be sprinkled with water at least once in the afternoon everyday after forty eight hours of application of chemical. The treated area shall be monitored over a period of two to three weeks for any growth of weeds by the Engineer – in- charge. The final approval shall be given by Engineer – in –charge based on the results.
- 5.2.3 Engineer-in-charge shall decide final formation level so as to ensure that the site appears uniform devoid of undulations. The final formation level shall however be very close to the formation level indicated in the approved drawing.
- 5.2.4 After antiweed treatment is complete, the surface of the switchyard area shall be maintained, rolled/compacted to the lines and grades as decided by Engineer-in-charge. The sub grade shall be consolidated by using half ton roller/surface vibrator with suitable water sprinkling arrangement to form a smooth and compact surface. The roller shall run over the sub grade till the soil is evenly and densely consolidated and behaves as an elastic mass.
- 5.2.5 In areas that are considered by the Engineer-in-Charge to be too congested with foundations and structures for proper rolling of the site surfacing material by normal rolling equipments, the material shall be compacted by hand rammer, if necessary. Due care shall be exercised so as not to damage any foundation structures or equipment during rolling / compaction.
- 5.2.6 The sub grade shall be in moist condition at the time the cement concrete is placed. If necessary, it should be saturated with water for not less than 6 hours but not exceeding 20 hours before placing of cement concrete. If it becomes dry prior to the actual placing of cement concrete, it shall be sprinkled with water and it shall be ensured that no pools of water or soft patches are formed on the surface.
- 5.2.7 Over the prepared sub grade, 75mm thick base layer of cement concrete in 1:5:10 (1 cement: 5 fine/coarse sand: 10 burnt brick aggregate 40mm nominal size) shall be provided in the area excluding roads, drains, cable trenches as per detailed engineering drawing. The Contractor shall have option to use graded

stone aggregate 40mm nominal size in place of brick aggregate without any extra cost to employer. For easy drainage of water, the slope of 1:1000 is to be provided from the ridge to the nearest drain. The ridge shall be suitably located at the centre of the area between the nearest drains. The above slope shall be provided at the top of base layer of cement concrete in 1:5:10. A layer of cement slurry of mix 1:6 (1cement: 6 fine sand) shall be laid uniformly over cement concrete layer. The cement consumption for cement slurry shall not be less than 150 kg for every 100 sq.m.

- 5.2.8 A final layer of 100mm thickness of stone aggregate of 40mm nominal size (conforming to clause 5.2.1) shall be spread uniformly over cement concrete layer after curing is complete.

## **6.0 RAINWATER HARVESTING:**

- 6.1 In addition to drainage of rainwater, the Contractor shall make arrangement for rainwater harvesting also.
- 6.2 Rainwater harvesting shall be done by providing recharge structures with bore wells. The recharge structures shall be suitably located within the sub-station. Branch drains from the main drain carrying rainwater from entire switchyard shall be connected to the recharge structures.

A drawing showing details of recharge structure for rainwater harvesting is enclosed with tender document and is also available on POWERGRID website.

## **7.0 ROADS AND CULVERTS**

- 7.1 All the roads in the scope of contract shall be of concrete road.
- 7.2 There would be two types of Roads. The wider road shall be 5.5m wide and the other road shall be 3.75m wide.

The road outside the switchyard fenced area and road leading to control room building shall be provided with kerb stone and interlocking tiles on shoulder. Width of shoulder shall be 1.75m in case of 5.5m wide road and 1.3m in case of 3.75m wide road.

In case of switchyard road the shoulder would be 600mm wide on the sides of both types of road. Well compacted 75mm thick PCC 1:4:8 (1Cement: 4 coarse sand: 8 graded stone aggregate 40mm nominal size) shall be provided in shoulder area. The top surface of PCC shall be finished smooth.

RCC Hume pipe (NP-3) of 100mm diameter shall be provided across the road at every 100M interval along the road.

- 7.3 Layout of the roads shall be as shown in the approved General Arrangement drawing for the substation. Adequate turning space for vehicles shall be provided

and bend radii shall be set accordingly. Road to the Autotransformer/Reactor shall be as short and straight as possible. Roads which are to be used for carrying transformers / reactors shall be provided with turning radius preferably 19.5M or more but not less than 16.5M. Turning radius of other roads may be decided at site depending on layout constraints.

- 7.4 All roads shall be rigid pavement type RCC road. Thickness of RCC, PCC and WBM shall be as per section details provided in the drawing. The concrete shall be laid and finished with screed board, vibration, vacuum dewatering process etc.
- 7.5 The details of roads and culverts are furnished in the drawing enclosed with tender document.
- 7.6 The shoulder of the road in case of substation extension shall match with the shoulder of the existing road.
- 7.7 The location of culverts, diameter of RCC Hume pipes shall be decided by the Contractor during detailed engineering while finalising drainage layout. The invert level of Hume pipes of culverts shall match with the invert level of drain meeting the culvert.

## **8.0 FOUNDATION / RCC CONSTRUCTION**

### **8.1 General**

- a). Work covered under this Clause of the Specification comprises the construction of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, drains, jacking pad, pulling block, control cubicles, bus supports, Autotransformer/Reactors, marshalling kiosks, auxiliary equipments & systems buildings, 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.
- b). Reinforced cement concrete shall be of grade M-25 conforming to IS: 456 or volumetric mix 1:1.5:3 (1 cement: 1.5 coarse sand: 3 well graded stone aggregate 20mm nominal size) conforming to CPWD specification as per BPS. Volumetric mix 1:1.5:3 shall be considered equivalent to M-20. All the tests shall be conducted as per relevant Indian Standard Codes as mentioned in Standard field quality plan appended with the specification. Type and grade of cement shall confirm to CPWD specification and reinforcement steel shall be thermo mechanically treated reinforcement bars of grade Fe 500 conforming to IS: 1786.
- c). 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 foundation's plinths and building plinths shall be minimum 300mm and 600mm above finished ground level respectively.

- d). Minimum 75mm thick lean concrete (1:4:8) shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction.
- e). Concrete made with OPC grade 53 and PPC shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering.
- f). 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 Spread footings foundation or pile foundation as may be required based on soil/sub-soil conditions and superimposed loads shall be provided.
- g). If pile foundations are adopted, the same shall be cast-in-situ bored or pre-cast or under reamed type as per relevant parts of IS: 2911. Only RCC piles shall be provided. Necessary initial load test shall be carried out by the Contractor at their cost to establish the pile design capacity. Only after the design capacity of pile has been established, the Contractor shall take up the job of piling. Routine tests for the pile shall also be conducted as per IS-2911. All the testing work shall be planned in such a way that these shall not cause any delay in project completion. RCC for pile works shall be Design Mix of minimum grade M-25 and also minimum cement content shall be 400Kg/ cu.m as per IS-2911 (Latest revision)

## **8.2 DESIGN**

The following clauses shall be applicable only for the foundation / structure which the Contractor may have to design

- a. All foundation shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS: 456. Grade of concrete can be volumetric mix 1:1.5:3 (1cement: 1.5 coarse sand: 3stone aggregate 20mm nominal size) equivalent to M-20 or designed concrete mix of grade M-25 or higher as specified in BPS or section- Project of Technical Specification.
- b. Limit state method of design shall be adopted unless specified otherwise in the specification.
- c. Thermo mechanically treated reinforcement bars of grade Fe 500 conforming to IS: 1786 shall be used as reinforcement. Detailing of reinforcement shall be done in accordance with IS: 2502 and SP: 34. Ductile Detailing shall conform to IS: 13920. Two layers of reinforcement (on inner and outer face) shall be provided for wall & slab sections having thickness of 150 mm and more. Clear cover to reinforcement shall be as per IS: 456 (latest).

- d. RCC water retaining structures like storage tanks, etc. shall be designed as uncracked section in accordance with IS: 3370 (Part I to IV) by working stress method. However, water channels shall be designed as cracked section with limited steel stresses as per IS: 3370 (Part I to IV) by working stress method.
- e. The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and/or superstructure and other conditions which produces the maximum stresses in the foundation or the foundation component and as per the relevant IS Codes of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.
- f. Design shall consider any sub-soil water pressure that may be encountered following relevant standard strictly.
- g. Necessary protection to the foundation work, if required shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental/harmful to the concrete foundations.
- h. RCC columns shall be provided with rigid connection at the base.
- i. All 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 taken as mentioned in relevant IS Codes or as stipulated elsewhere in the Specifications. For checking against overturning, weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.
- j. Earth pressure for all underground structures shall be calculated using co-efficient of earth pressure at rest, co-efficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.
- k. 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, substructure of any underground hollow enclosure etc., for the vehicular traffic in the vicinity of the structure.
- l. Following conditions shall be considered for the design of water tank in pumps house, channels, sumps, trenches and other underground structures:
  - i) Full water pressure from inside and no earth pressure & ground water pressure & surcharge pressure from outside (application only to structures which are liable to be filled up with water or any other liquid).
  - ii) Full earth pressure, surcharge pressure and ground water pressure from

outside and no water pressure from inside.

- iii) 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.
- m. Base slab of any underground enclosure shall also 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.
- n. Base slab of any underground enclosure like water storage tank shall also be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum GWT. Intermediate dividing piers of such enclosures shall be designed considering water in one pump sump only and the other pumps sump being empty for maintenance.
- o. 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.
- p. The tower and equipment foundations shall be checked for a partial factor of safety of 2.2 for normal condition and 1.65 for short circuit condition.
- q. **Transformer and Reactor Foundation:**

The foundations of Transformer & Reactor shall be of block type foundation. Minimum reinforcement shall be governed by IS: 2974 and IS: 456. In case of Reactor Plan dimension of block should not be less than size of base of reactor.

The Contractor shall provide a RCC Rail cum road system integrated with the Autotransformer / Reactor foundation to enable installation and the replacement of any failed unit. The transfer track system shall be suitable to permit the movement of any failed unit fully assembled (including OLTC, bushings) with oil. This system shall enable the removal of any failed unit from its foundation to the nearest road. If trench/drain crossings are required then suitable R.C.C. culverts shall be provided in accordance with I.R.C. standard / relevant IS.

The Contractor shall provide a pylon support system for supporting the fire fighting system.

Each Autotransformer/Reactor including oil conservator tank and cooler banks etc. shall be placed in a self-sufficient pit surrounded by retaining walls (Pit walls). The clear distance of the retaining wall of the pit from the Autotransformer/Reactor shall be 20% of the Autotransformer/Reactor/ cooler

bank height or 0.8m whichever is higher. The oil collection pit thus formed shall have a void volume equal to 200% volume of total oil in the Autotransformer/Reactor. In case of transformers of 132kV and below, where hydrant system for fire fighting is not provided, volume of pit may be reduced to 130% of total oil volume.

The minimum height of the retaining walls of pit shall be 20 cm above the finished level of the ground to avoid outside water pouring inside the pit. The bottom of the pit shall have a uniform slope towards the sump pit. While designing the oil collection pit, the movement of the autotransformer / reactor must be taken into account.

The grating shall be made of MS flat of size 30mm x 5mm placed at 30mm centre to centre and 6mm dia MS bar at spacing of 150mm at right angle to each other. Maximum length of grating shall be 2000mm and width shall not be more than 500mm. The gratings, supported on ISMB 150 mm, shall be placed at the formation level and will be covered with 100mm thick layer of stone aggregate having size 40mm to 60mm. All steel work used for grating and supports shall be painted with epoxy based zinc phosphate primer (two packs) confirming to IS: 13238- 1991. Contractor shall have option to provide factory made electro forged MS grating made of specified size MS flat and round bars without any extra cost to employer.

Each oil collection pit shall be drained towards a sump pit of size 1000X750mm and 500mm deep below the floor level within the collection pit whose role is to drain water and oil due to leakage within the collection pit so that collection pit remains dry.

#### **r. FIRE PROTECTION WALLS**

Fire protection walls shall be provided, if required

The firewall shall have a minimum fire resistance of 4 hours. The walls of the building, which are used as firewalls, shall also have a minimum fire resistance of 4 hours.

The firewall shall be designed to protect against the effect of radiant heat and flying debris from an adjacent fire.

The firewall shall extend 600 mm on each side of the Autotransformer / Reactors and 600 mm above the conservator tank or safety vent. A minimum of 2.0meter clearance shall be provided between the equipments e.g. Autotransformer/Reactors and firewalls. In case of space constraints, these dimensions can be reduced as per the approval of Employer.

The building walls, which act as firewalls, shall extend at least 1 m above the roof in order to protect it.



The firewall will be made of reinforced cement concrete and shall be finished with water proofing cement paint of grey colour.

### **8.3 ADMIXTURES & ADDITIVES**

- a). 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.
- b). 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 Employer (Engineer in charge).
- c). The Contractor may propose and the Employer 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 to overcoming unusual circumstances and placing conditions.
- d). The water-reducing set-retarding admixture shall be an approved brand of Ligno-sulphonate type admixture.
- e). The water proofing cement additives shall be used as required / advised by the Employer.

### **9.0 Chain link Fencing and Switchyard Gate:**

Fencing and Gate shall be provided at the locations shown in approved general arrangement drawing. Separate gate shall be provided for men and equipment. Fence shall also be provided for the various equipments (if) mounted on ground or a height lower than 2.5m. Necessary gates shall be provided for each area so surrounded. Fencing and Gate shall be constructed as per drawing attached with tender documents and are also available on POWERGRID website.

Chain link galvanised fence fabric with 3.15mm dia wire and 75mm mesh size conforming to IS: 2721 shall be used. MS tube used shall be of grade YST22 and conform to IS: 1161. All other structural steel shall conform to IS: 2062. In case the substation is located within 30km from sea coast, the zinc coating shall be 900gm/ sq.m.

The whole assembly of tubular post and frame of panels shall be hot dip galvanized. The zinc coating shall be minimum 610 gram per sq. meter. The purity of zinc shall be 99.95% as per IS: 209.

The gate shall be made of medium duty M.S. pipe with welded joints. The main frame (outer frame) of the gate shall be made of 40mm dia pipe and vertical pipes of 15mm dia @ 125mm spacing (maximum) shall be welded with the main frame. Gate shall be painted with one coat of approved steel primer and two or more coats of synthetic enamel paint to give an even shade.

The height of the fencing shall be 1500mm on a toe wall of 300mm. Other details shall be as shown in the drawing.

## **10.0 TECHNICAL DETAILS OF THE BUILDINGS** (DESIGN AND DRAWING TO BE DEVELOPED BY CONTRACTOR)

### **10.1 BUILDINGS - GENERAL REQUIREMENTS**

The scope include the design, engineering and construction including anti-termite treatment, Plinth protection, DPC, Peripheral drain, Sanitary, Water supply, Electrification etc. of control room building and GIS building.

The Contractor shall appoint a reputed architect (To be approved by POWERGRID) for RCC framed control room building.

Control room building shall be so designed that most of the area of switchyard is visible from control room. Control room building shall be a double story building.

### **10.2 BUILDING DESIGN**

- a) The buildings shall be designed:
  - i) To the requirements of the National Building Code of India, and the standards quoted therein.
  - ii) For the specified climatic & loading conditions.
  - iii) 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.
  - iv) With a functional and economical space arrangement.
  - v) To be aesthetically pleasing. Different buildings shall show a uniformity and consistency in architectural design.
  - vi) To allow for easy access to equipment and maintenance of the equipment.
  - vii) With, wherever required, fire retarding materials for walls,

ceilings and doors, which would prevent supporting or spreading of fire.

viii) With materials preventing dust accumulation.

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

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

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

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

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

f) The building auxiliary services like 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 section or elsewhere in this Specification.

### **10.3 DESIGN LOADS**

Building structures shall be designed for the most critical combinations of dead loads, super- imposed loads, equipment loads, crane load (if any), wind loads and seismic loads.

Dead loads shall include the weight of structures complete with finishes, fixtures and partitions.

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 wherever these loads are expected. 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% (lifted weight + trolley) shall be considered in the analysis of frame according to provisions of IS:875. The horizontal surge shall be 5% of the static wheel load.

The wind loads shall be computed as per IS 875 - 1987, Seismic Coefficient method/Response Spectrum method shall be used for the seismic analysis as per IS 1893 with importance factor 1.5.

Wind and Seismic forces shall not be considered to act simultaneously.

Floors/slabs shall be designed to carry loads imposed by equipment, cables and other loads associated with building. Floors shall be designed for live loads as per relevant IS. Cable load shall also be considered additionally for floors where these loads are expected.

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

For consideration of loads on structures, IS: 875 -1987 shall be followed, the following minimum superimposed live loads shall, however, be considered for the design.

- |    |                       |                        |  |
|----|-----------------------|------------------------|--|
| a. | Roof                  | 1.5 kN/m <sup>2</sup>  | for accessible roofs   |
|    |                       | 0.75 kN/m <sup>2</sup> | for in-accessible roofs  |
| b. | RCC-Floor             | (i)                    | 5 kN/m <sup>2</sup> for offices  |
|    |                       | (ii)                   | 10 kN/m <sup>2</sup> (min.) for equipment floors or actual requirement, if higher than 10kN/m <sup>2</sup> on equipment component and layout plans |
| c. | Stairs & balconies    | 5 kN/m <sup>2</sup>    |  |
| d. | Toilet Rooms          | 2 kN/m <sup>2</sup>    |  |
| e. | Chequered plate floor | 4 kN/m <sup>2</sup>    |  |
| f. | Walkways              | 3 kN/m <sup>2</sup>    |  |

Any additional load coming on the structure shall be calculated as per IS: 875 -1987.

#### **10.4 DESIGN**

- a) All structures shall be designed for the worst combination of dead loads, live loads, wind loads as per IS-875, seismic forces as per IS-1893,
- b) The design of steel structures for the GIS building shall be done in accordance with IS: 800.

- c) The design of R.C.C. structures for the GIS building shall be done in accordance with IS: 456.
- d) Permissible stresses for different load combinations shall be taken as per relevant IS Codes.

## 10.5 SUBMISSION

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

1. Soft as well as hard copies of structural design calculations and drawing (including construction/fabrication) for all reinforced concrete and structural steel structures.
2. Fully, dimensioned concept plan including floor plans, cross sections, longitudinal sections, elevations and perspective view of each building. These drawings shall be drawn at a scale not smaller than 1:50 and shall identify the major building components. Auto cad drawings shall also be submitted.
3. 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.
4. Product information of building components and materials, including walls partition flooring ceiling, roofing, door and windows and building finishes.
5. A detailed schedule of building finishes including colour schemes.
6. A door & 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.

## 10.6 AREA REQUIREMENT:-

### (A) CONTROL ROOM BUILDING

Carpet area requirements are given below:

- |   |                     |
|---|---------------------|
| • Control room  | 40 sq.m.            |
| • ACDB & DCDB room  | As per requirement. |
| • Battery room  | As per requirement. |
| • Electrical lab.   | 25 sq.m.            |
| • Conference room plus attached toilet                      | 45 sq.m.            |
| • S/stn. In charge office plus attached Toilet Plus PS room | 35 sq.m.            |
| • Room for executives                                       | 65 sq.m.            |

• Room for non-executives	30 sq.m.
• Lobby	30 sq.m.
• Corridor	Minimum width of corridor shall be 1800mm
• Portico	25 sq.m. (approx.)
• Common toilet	16 sq.m.
• Toilet for handicap	4.5 sq.m.
• Janitor room	4 sq.m.
• Pantry	10 sq.m.

## **(B) GIS BUILDING:-**

GIS building consist of GIS hall, Room for control, protection & communication panels and AHU room. Dimensions of the building shall be as per requirement specified in section- Project. Provision for extension in future of the building shall be made. A corridor having minimum width of 1500 mm shall be provided all around GIS to facilitate maintenance of equipments. Provision for service bay shall also be made.

### **10.7 Control Room and GIS Hall**

The GIS building shall be of pre-engineered steel structure. Control room building, if attached to GIS hall, shall be of pre-engineered steel structure similar to GIS hall and shall be RCC framed structure, if it is not connected with GIS hall. In case of steel control room building all walls shall be of brick masonry and roof of ground floor shall be of RCC. Internal access to the GIS hall from control room building shall be provided.

Material specification and other details for construction of Pre-engineered steel building shall be as described in subsequent paragraphs. The base plate of steel columns shall be mounted on the RCC foundation by means of foundation bolts. In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. The built up frame shall be applied with a priming coat of red oxide zinc chromate primer before taken out of workshop. Separate fire escape doors shall also be provided in the GIS Building.

Panels shall be kept in an air-conditioned enclosure preferably within the GIS hall. This enclosure shall be separated from main GIS hall by providing a glazed partition made of aluminium frame and 5.5mm thick glass.

Walkway of width not less than 1.0m shall be provided at gantry girder level on the two longer side of GIS hall along with climbing arrangement to facilitate maintenance of crane. All steel work shall be painted with one coat of steel primer and two coats of synthetic enamel paint after erection.

All the material required for Pre-engineered (steel) building shall be procured from TATA Blue Scope/ Era buildsys/ Vardhman/ Kirby building Systems/ Zamil Steels/ Phoenix Construction Technologies/ Interarch Building Products/ Aster Building Solutions Pvt. Ltd. or any other reputed manufacturer for which prior approval shall be obtained. Manufacturing of various parts of the building shall start only after approval of "Manufacturing Quality Plan". Complete material shall

be offered for inspection by CC QA&I department before dispatch. Inspection shall be carried out based on assembly (fabrication) drawings approved by Employer and "BILL OF MATERIAL" & Shop drawing prepared by the Manufacturer and certified by the Contractor for its correctness. Approval of BOM and shop drawing from employer is not required.

#### 10.7.1 **Material Specification**

10.7.1.1 Primary members fabricated from plates and sections with minimum yield strength of 345 Mpa or to suit design by continuous welding.

10.7.1.2 Secondary members for Purlins and Girts shall conform to the physical specification of ASTM A570 (Grade 50) or equivalent IS Standards having a minimum yield strength of 345 MPa. The minimum thickness of secondary members shall be 2.5mm.

10.7.1.3 Rod / ANGLE bracing shall conform to the physical specification IS 2062 of minimum 245Mpa Yield Strength

10.7.1.4 All hot rolled sections shall conform to the physical specifications IS 2062. All other miscellaneous secondary members shall have minimum yield strength of 250 MPa.

#### 10.7.2 **DESCRIPTION**

##### 10.7.2.1 **PRIMARY MEMBERS:**

Primary structural framing shall include the transverse rigid frames, columns, corner columns, end wall wind columns and crane gantry girders and Frames at Door openings.

##### 10.7.2.2 **SECONDARY MEMBERS:**

Secondary structural framing shall include the purlins, girts, eave struts, wind bracing, flange bracing, base angles, clips, flashings and other miscellaneous structural parts. Suitable wind bracings sag rods to be reckoned while designing the structure.

##### 10.7.2.3 **PURLINS:**

Purlins should be of Pre Galvanised steel of 345 Mpa having a coating thickness of 275 gsm.

##### 10.7.2.4. **ROOF SHEETING**

50mm thick puff (density 40kg/cu.m.) sandwiched panels shall be provided. These panels shall be made of puff insulation sandwiched between two number SMP coated galvalume steel sheets. These sheets shall be made out of 0.5mm thick high tensile steel having min. yield strength of 345 Mpa conforming to ASTM- A446. Galvalume sheets shall conform to AZ 150 of AS 1397 or ASTM 792 with hot dip metallic coating of 55% Al and 45% Zn alloy having total coating mass of minimum 150gms/sq.m inclusive of both sides. Total coat thickness (TCT) of sheets shall be minimum 0.55mm with base metal thickness.

##### 10.7.2.5 **Wall Panels**

Wall panel material specifications shall be same as roof panels.

**10.7.2.6 SHEETING FASTENERS:**

Standard fasteners shall be self tapping zinc plated metal screws with EPDM bonded zinc plated washers. All screws shall be colour coated to match roof and wall sheeting.

**10.7.2.7 SEALER:**

This is to be applied at all side laps and end laps of roof panels and around self flashing windows. Sealer shall be pressure sensitive elastomeric Butyl tapes. The sealer shall be non-asphaltic, non-shrinking and non toxic and shall be superior adhesive metals, plastics and painted at temperatures from 51°C to + 104°C.

**10.7.2.8 CLOSURES:**

Solid or closed cell closures matching the profiles of the panel shall be installed along the eaves, rake and other locations specified on drawings.

**10.7.2.9 FLASHING AND TRIM:**

Flashing and / or trim shall be furnished at the rake, corners, eaves, and framed openings and wherever necessary to provide weather tightness and finished appearance. Colour shall be matching with the colour of wall. Material shall be 26 gauge thick conforming to the physical specifications of sheeting.

**10.7.2.10 SKY LIGHTS:**

Skylight is translucent corrugated sheets matching the profile of Roof. The translucent sheets are made from 2mm thick Polycarbonate sheets and shall provide an economic form of general-purpose day lighting. Skylights shall be provided for 5% of the roof area. Colour of the panel shall be white with smooth surface finish with a light transmitting capacity of 60%  $\pm$  5%.

**10.7.2.11 GUTTERS AND DOWN SPOUTS:**

Gutters and downspouts shall be adequately designed to ensure proper roof drainage system. Material shall be same as that of sheeting.

**10.7.3 CONNECTIONS:**

**10.7.3.1 SITE CONNECTIONS**

- a) All primary bolted connections shall be provided with galvanized high strength bolts, washers, nuts conforming to specifications of grade 8.8 OF IS 1367
- b) All secondary bolted connections shall be furnished with bolts, nuts, washers conforming to the specifications of grade 4.6 of IS 1367 or ASTM-A307.



#### 10.7.3.2 **SHOP CONNECTIONS**

All shop connections shall be welded with appropriate arc welding process and welding shall be in accordance with IS: 816, IS -819 ,IS1024, IS:1261, IS1323, IS-9595, AWS D 1.1. as appropriate. The Webs should be welded on to the flanges at both the faces at top and bottom for columns, beams and crane girders. Weld material should have strength more than the parent metal.

#### 10.7.4 **ROOF & WALL BRACINGS**

Roof and wall bracings shall have minimum yield strength of 250 Mpa and shall conform to the specifications IS 2062.

### 10.8 **INTERNAL FINISH SCHEDULE**

The finishing schedule is given in subsequent clauses and table-1. Areas not specified in finish schedule shall be provided with vitrified tile flooring, and Premium Acrylic emulsion paint oil bound washable distemper over two mm thick putty. Paints used in the work shall be of best quality specified in CPWD specification.

### 10.9 **FLOORING**

Flooring in various rooms of control room building and GIS hall shall be as per detailed schedule given in Table -1.

### 10.10 **WALLS**

Control room building shall be of framed superstructure. All walls shall be non-load bearing walls. Min. thickness of walls shall be 230 mm (one brick) with 1:6 cement sand mortar. Partition walls (115mm thick) in toilets and pantry can be half brick walls with 1:4 cement sand mortar and two nos. 6mm dia MS bars at every third course.

In GIS building and the attached relay room 230mm thick brick wall shall be provided up to roof level of relay room attached to GIS hall. 50mm thick puff sandwiched panels as described above shall be provided above brick wall.

### 10.11 **ROOF**

#### (A) Control Room

All RCC roofs of the buildings shall be treated with a water proofing system which shall be integral cement based treatment conforming to CPWD specification (item no. 22.7 of DSR 2013).

#### (B) GIS Building and Control Room( if steel structure)

**Roofing Panel:** 50mm thick puff (density 40kg/cu.m.) sandwiched panels shall be provided as described in previous clauses.

## 10.12 CABLE TRENCH IN GIS HALL

All cable trenches in GIS hall shall be covered with minimum 6mm thick steel chequered plate with suitable stiffeners. Chequered plate shall be painted with two or more coats of Epoxy paint as per item 13.52 of DSR'2013.

## 10.13 EXTERNAL PLASTER AND PAINTING

External plaster 18mm thick shall be of 1:6 cement sand plaster in two layers. External surface of the control room building and GIS building (brick wall portion) shall be painted with Premium acrylic smooth exterior paint with silicon additives over and including priming coat of exterior primer as per item 13.47.1 of DSR'2013.

## 10.14 INTERNAL FINISH SCHEDULE

Internal finish Schedule for control room building and GIS hall is given in Table - 1 below:

**Table -1**

S.No.	LOCATION	FLOORING & SKIRTING 150MM HIGH	WALL (INTERNAL)	CEILING	DOOR, WINDOWS & VENTILATOR
1.	Control Room	Vitrified tiles size 600 x 600mm (DSR Item 11.46)	Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)	False ceiling and White wash above False Ceiling	Windows shall be of powder coated aluminium (outer frame) with 6mm thick toughened glazing without intermediate mullions. All doors shall be glazed powder coated aluminium doors with 5.5.mm thk. Glazing.
2.	Conference	Vitrified tiles size 600 x 600mm (DSR Item 11.46)	Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)	False ceiling and White wash above False Ceiling	Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5.mm thk. Glazing.
3.	DGM 's Room (S/S In-charge Room)	Vitrified tiles size 600 x 600mm (DSR Item 11.46)	Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)	False ceiling and White wash above False Ceiling	Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5.mm thk. Glazing.
4	Other Office Rooms	Vitrified tiles size 600 x 600mm (DSR Item 11.46)	Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)	False ceiling and White wash above False Ceiling	Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5.mm thk. Glazing.
5.	Electronics Test Lab.	Vitrified tiles size 600 x 600mm (DSR Item 11.46)	Premium Acrylic emulsion paint on smooth surface applied with plaster	False ceiling and White wash above False Ceiling	Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium

S.No.	LOCATION	FLOORING & SKIRTING 150MM HIGH	WALL (INTERNAL)	CEILING	DOOR, WINDOWS & VENTILATOR
			of paris (2 mm thick)		doors with 5.5.mm thk. Glazing.
6.	ACDB & DCDB Room	62mm thick cement concrete flooring with metallic hardener topping (DSR item code 11.5)	Oil bound washable distemper (DSR item 13.41.1) on smooth surface applied with plaster of paris putty (DSR item 13.26)	Oil bound washable distemper on smooth surface applied with plaster of paris putty	Steel door 45mm thick double sheet 18 gauge MS steel suitably reinforced and filled with mineral wool. Windows/ventilator shall be of powder coated aluminium with 4mm glazing.
7.	Battery room	Vitrified tiles size 600 x 600mm (DSR Item 11.46)	Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)	False ceiling and White wash above False Ceiling	Steel door 45mm thick double sheet 18 gauge MS steel suitably reinforced and filled with mineral wool. Windows/ventilator shall be of powder coated aluminium with 4mm glazing.
8.	Lobby	18mm thick granite flooring ( DSR Item 8.12)	Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)	False ceiling and White wash above False Ceiling	Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5.mm thk. Glazing.
9.	Corridor	Vitrified tiles size 600 x 600mm (DSR Item 11.46)	Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)	False ceiling and White wash above False Ceiling	Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5.mm thk. Glazing.
10.	Portico	18mm thick granite flooring ( DSR Item 8.12)	Granite cladding	Acrylic emulsion paint over a coat of cement primer on smooth surface applied with readymade putty 1 mm thick (DSR item no. 13.80 & 13.83)	All doors shall be glazed powder coated aluminium doors with 5.5.mm thk. Glazing.
11.	Toilet	Ceramic tiles (DSR item 11.38)	DADO glazed tile 2100mm high, oil bound washable distemper above DADO	Acrylic emulsion paint over a coat of cement primer on smooth surface applied with readymade putty 1 mm thick (DSR item no. 13.80 & 13.83)	Windows/ ventilator shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be flush door shutters made of pre-laminated particle board (DSR 9.131 & 9.132) with powder coated aluminium frame.
12.	Janitor room	Ceramic tiles (DSR item 11.38)	DADO glazed tile 2100mm high, oil bound washable distemper above DADO	Acrylic emulsion paint over a coat of cement primer on smooth surface applied with readymade putty 1 mm thick (DSR item no. 13.80 & 13.83)	Windows/ ventilator shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be flush door shutters made of pre-laminated particle board (DSR 9.131 & 9.132) with powder coated aluminium frame.
13.	GIS Hall	62mm thick cement concrete flooring with metallic hardener topping (DSR item code 11.5)	Oil bound washable distemper (DSR item 13.41.1) on smooth surface applied with plaster of paris putty (DSR item 13.26)	-----	Windows/ ventilator shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be flush door shutters with powder coated aluminium frame.

S.No.	LOCATION	FLOORING & SKIRTING 150MM HIGH	WALL (INTERNAL)	CEILING	DOOR, WINDOWS & VENTILATOR
14.	Panel/Relay Room	Vitrified tiles 8mm thick size 600 x 600mm	Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)	False ceiling and White wash above False Ceiling	Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5mm thk. Glazing.
15.	AHU Room	62mm thick cement concrete flooring with metallic hardener topping (DSR item code 11.5)	Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)	Acrylic emulsion paint over a coat of cement primer on smooth surface applied with readymade putty 1 mm thick (DSR item no. 13.80 & 13.83)	Windows/ ventilator shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be flush door shutters with powder coated aluminium frame.

**10.15** Staircase shall be provided with stainless steel railing and 18mm thick granite slab in risers and treads.

#### **10.16 DOORS AND WINDOWS**

The details of doors and windows of the control room building shall be as per finish schedule Table-1 conforming to relevant IS code. Rolling steel shutters shall be provided as per layout and requirement of buildings. Main entrance door to control room building shall be made of powder coated aluminium frame with 5.5 mm thick glazing.

#### **10.17 PARTITION**

Partitions, if required, shall be made of powder coated aluminium frame provided with 5.5 mm thick clear glass or pre- laminated board depending upon the location of partition.

#### **10.18 FALSE CEILING**

Fifteen millimeter thick densified tegular edged eco friendly light weight calcium silicate false ceiling as per item 12.53 of DSR'2013 shall be provided in the areas specified in Finish Schedule.

#### **10.19 PLUMBING & SANITATION**

- (i) All plumbing and sanitation 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.
- (ii) PVC "SYNTEX" or equivalent make Roof water tank of adequate capacity depending on the number of users for 24 hours storage shall be provided. Minimum 2 Nos 1500 liter capacity shall be

provided.

- (iii) Galvanized MS pipe of medium class conforming to IS: 1239 shall be used for internal & external piping work for potable water supply.
- (iv) Sand CI pipes with lead joints conforming to IS: 1729 shall be used for sanitary works above ground level and RCC pipe shall be used for works below ground.
- (v) Each toilet shall have the following minimum fittings.
  - (a) WC (Western type) 390 mm high with toilet paper roll holder and all fittings in toilets attached to conference and sub-station in charge office.

and

WC (Indian Type) Orissa Pattern (580 x 440 mm) with all fittings shall be provided in common toilets.

- (b) Urinal (430 x 260 x 350 mm size) with all fittings.
  - (c) Wash basin (550 x 400 mm) with all fittings.
  - (d) Bathroom mirror (600 x 450 x 6 mm thick) hard board backing
  - (e) CP brass towel rail (600 x 20 mm) with C.P. brass brackets
  - (f) CP Soap holder and CP liquid soap dispenser.
  - (g) All urinals and washbasins shall be provided with built in sensors.
- (vi) Water cooler for drinking water with adequate water storage facility shall be provided and located near control room and not near toilet block.
- (viii) 1 no. stainless steel kitchen sink with Drain board (510 x 1040 x 178 mm bowl depth) for pantry shall be provided.
- (ix) All fittings, fastener, grating shall be chromium plated.
- (x) All sanitary fixtures and fittings shall be of approved quality and type manufactured by well known manufacturers. All items brought to site must bear identification marks of the type of the Manufacturer.
- (xi) Stoneware pipes may be used for soil, waste and drain pipes in the areas not subjected to heavy loads otherwise Heavy duty cast iron

pipes may be used.

- (xii) Contractor shall provide septic tank and soak pit of adequate capacity to treat the sewage / sullage from the building.
- (xiii) Contractor shall implement all other jobs required to complete and commission the building.

## **11.0 BUILDINGS (AS PER EMPLOYER'S DRAWING)**

This clause is applicable for Buildings, which are to be constructed as per drawings provided by employer such as control room building, transit camp, switchyard panel room and fire water pump house with fire water tank. Standard Architectural drawings of buildings covered in the scope, are enclosed with the tender documents and are also available on website. These drawings are good for construction except for foundation drawings of the buildings which will be issued to the successful bidder after award of work and after receipt of soil investigation report depending upon soil parameters.

The details like size finish details etc shall be as mentioned in the drawings enclosed with tender documents. However, descriptions of some of the items to be used in the buildings are given below:

1. 12mm cement plaster of mix 1:6 (1 cement: 6 fine sand) shall be provided on the smooth side of internal walls. However rough side of walls shall be provided with 15mm cement plaster of mix 1:6 (1 cement: 6 fine sand)
2. 6 mm cement plaster of mix 1:3 (1 cement: 3 fine sand) to all ceiling.
3. External plaster in two coats - 18mm Cement plaster in two coats under layer 12mm thick cement plaster 1:5 (1 cement: 5coarse sand) finished with a top layer 6mm thick cement plaster (1cement : 6 fine sand).
4. Internal walls shall be painted with minimum two coats of premium acrylic emulsion paint having VOC (volatile organic compound) content less than 50gm per litre of approved brand and manufacture including applying additional coats wherever required, to achieve even shade and colour over and including water thinnable priming coat with cement primer.
5. Providing and applying white cement based putty of average thickness one mm, of approved brand and manufacture, over the plaster surface to prepare the surface even and smooth complete.
6. Painting with synthetic enamel paint of approved brand and manufacture of required colour to give an even shade shall be

provided on the steel doors 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.
8. 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 neat cement. 21 mm thick in ACDB/DCDB room
9. Polished vitrified tiles in 60x60 cm size (thickness to be specified by the manufacturer) in flooring and skirting, with water absorption's less than 0.08% and conforming to IS: 15622 of approved make in all colours and shades, laid on cement mortar 20mm thick for flooring & 12mm thick for skirting 1:4 (1 cement: 4coarse sand) including grouting the joints with white cement and matching pigments etc., complete.
10. Glazed Ceramic floor tiles 300x300mm (thickness to be specified by the manufacturer) of 1st quality conforming to IS:15622 of approved make in colours as approved by Engineer-in-charge in toilet and pantries area on 20mm thick cement mortar 1:4 (1 cement : 4coarse sand) including grouting the joints with white cement and matching pigments etc., complete.
11. Ceramic glazed wall tiles of 1<sup>st</sup> quality conforming to IS: 15622 (thickness to be specified by the manufacture) of approved make in all colours, shades as approved by Engineer-in-Charge in skirting, risers of steps and dados 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.
12. Rajnagar plain white marble/Udaipur Grade Marble/Zebra black marble work gang socket (Polish and machine cut) of thickness 18mm for staircase in cement mortar 1:3 (1 Cement : 3 coarse sand) including rubbing, curing, pointing with an additional mixture of pigment to match the marble shade.
13. 18mm polished granite in 20mm thick cement mortar 1:4, 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 granite. Wherever granite is 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 by moulding / beveling of granite at top.

14. Granite counter shall be provided and fixed with 18mm thick gang saw cut, mirror polished, premoulded and pre-polished, machine cut for kitchen platform, vanity counters, window sills, facias and similar locations of required size, approved shade, colour & texture laid over 20mm thick base cement mortar 1:4 ( 1cement : 4 Coarse sand) joints treated with white cement, mixed with matching pigment, epoxy touch ups, including rubbing, curing moulding and polishing to edges to give high gloss finish etc complete at all levels.
15. 230mm thick brickwork shall be provided with cement mortar 1:6 (1cement: 6 coarse sand). Half brick (115mm thick) work masonry shall be provided with cement mortar 1:4 (1cement: 4coarse sand) and two no 6mm dia ms bar at every third course. FPS Bricks of clay/Fly ash used shall be of class – 75.
16. Anti termite treatment shall be carried out for all buildings as per DSR item no. 2.34 & 2.35.
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 27.5 cm long wire springs grade No. 2 and M. S top cover of required thickness for rolling shutters. 80 x 1.25 mm M. S laths with 1.25 mm thick top cover. In case area of rolling shutters exceeds 10 sq.m, Mechanical device chain and crank operation for operating shutters shall be provided.
18. Circular/hexagonal M.S. sheet ceiling fan box shall be provided in the ceiling with clamp of internal dia. 140 mm, 73 mm height, 3 mm thick rim, top and bottom lid of 1.5 mm M.S. Sheet. Lids shall be screwed in to M. S. box by means of 3 mm round headed screws, clamps shall be made of 12 mm dia. M. S. bar bent to shape as per standard drawing with overall length as 80 cm.
19. Powder Coated (minimum thickness 50 micron) aluminium work for doors, windows, ventilators and partitions shall be provided and fixed in – building with extruded built up standard tubular and other sections of approved make conforming to IS:733 and IS : 1285, fixed with rawl 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 / panelling, C.P. brass/ stainless steel screws including glazing and fittings as specified. All doors except for toilet and kitchen shall have 100mm 6 lever CP Brass mortice latch and lock with a pair of lever handle. Sliding door bolt of ISI marked (300x16mm) size shall be provided for toilet, kitchen and main door of control room/residential buildings. All works shall be carried out as per drawings.

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

- (a) A slurry coat of neat cement using 2.75 kg/m<sup>2</sup> 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 40mm nominal size) admixed with proprietary water proofing compound conforming to IS: 2645 over 20mm thick layer of cement mortar of min 1:5 (Cement: 5 coarse sand) admixed with proprietary water proofing compound conforming to IS: 2645 to required slope and treating similarly the adjoining walls up to 300mm height including rounding of junctions of walls and slabs.
- (c) After two days 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 20mm thick joint less cement mortar of mix 1:4 (1 cement : 4 coarse 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 and as directed and specified by the Engineer-in-charge.

21. Unplasticised rigid PVC rain water pipes of 110mm dia shall be provided and fixed on the wall face conforming to IS:13592 type A as per drawing including jointing with seal ring conforming to IS: 5382 leaving 10mm gap for thermal expansion single socketed pipes including all fittings like bends, bat clamps gratings etc..

22. Unplasticised PVC Moulded fittings/accessories including 110mm bend and 110mm shoes shall be provided and fixed for unplasticised rigid PVC rain water pipes conforming to IS:13592 type A including jointing with seal ring conforming to IS: 5382 leaving 10mm gap for thermal expansion.
23. Unplasticised PVC pipe clips of approved design shall be provided and fixed to unplasticised 110mm PVC rain water pipes by means of 50x50x50mm 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.
24. 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 / Transit Camp/Recreation Centre.
  - b. Substation In charge room.
  - c. Conference Room
  - d. Control Room
25. 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.
26. Coloured vitreous china pedestal type water closet (European type) shall be provided with seat and lid, 10 litre low level vitreous china flushing cistern & C.P. flush bend with fittings and C.I. brackets, 40mm flush bend, overflow arrangement and mosquito proof coupling of including painting of fittings and brackets, cutting and making good the walls and floors wherever required.
27. Providing and fixing coloured wash basin counter type of (630x450mm size) and flat back wash basin of (550 x400mm size) with C.I. Brackets 15mm C.P. brass pillar taps, close hole basin mixer 32mm C.P. brass waste and bottle trap of standard pattern, including painting of fittings and brackets, cutting and making good the walls wherever required. Other details shall be as per the drawings.

28. All urinals shall be coloured vitreous china flat back half stall urinal of 580x380x350mm 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.
29. Following fittings shall be provided in the toilets as per the drawings:
- i) Toilet paper roll holder.
  - ii) Double type coat & hat hooks with flanges, fixed to wall / shutter, etc. with necessary screws, washers & plugs.
  - iii) CP liquid soap holder of approved make fixed with each wash basin to the wall with necessary CP brackets, CP screws, washers, plugs etc.
  - iv) 100mm 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 .
  - v) CP brass bib cock 15mm nominal bore of approved quality conforming to IS: 8931.
  - vi) CP brass angle valve of 15mm nominal bore provided and fixed in position for basin and cistern points of approved quality conforming IS :8931.
  - vii) Best quality marble partition slab provided and fixed in position for urinals, of size 610x1150mm, 20mm thick, polished on both sides & machine cut, exposed corners rounded etc.
  - viii) Towel rail of approved make of 600mm length, 25mm 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.
  - ix) 6mm thick beveled edge mirror 1000x600mm shall be provided and fixed mounted on 12mm 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.
30. Stainless steel AISI 304 (18/8) Kitchen sink of 460x915 mm bowl

with depth of 178mm with drain board shall be provided and fixed as per IS 13983 with C.I brackets, and stainless steel plug 40mm with provision of 2 nos. CP brass long body bib cock conforming to IS Standard and weighing not less than 650 gm for CP bottle trap etc. including painting of fittings and brackets, cutting and making good the wall.

31. GI Pipe work for Internal and External works:

- i) All GI types and fittings shall conform to IS-1239 Part I & II for medium grade. All accessories shall be ISI Marked.
- ii) All concealed GI pipe shall be painted with anticorrosive bitumastic paint including cutting of chases and making good the wall.
- iii).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.
- iv).Wherever GI pipes are buried the same shall be provided and laid in position including trenching sand cushion and refilling, painted with anticorrosive bitumastic paint etc.
- v).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.

32. 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 100 mm. Top diameter, 160 mm bottom dia and 180 mm deep (inside) with chained lid and RCC top slab 1:2:4 mix (1cement : 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 40 mm 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.

33. Polyethylene water storage tanks conforming to ISI: 12701 shall be provided of approved brand and manufacture with cover and suitable locking arrangement, float valve and making necessary holes for inlet, outlet and overflow pipes. Capacity of water tank shall be 2x1500 litres for control room, 2X2000 litres for Transit Camp.

34. 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 150 mm thick PCC 1:2:4, providing & fixing of top tile & strainer of CP or PVC on top of the trap etc.
35. 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
36. Brick Masonry road gully chamber of 50x45x60cm shall be provided with brick with cement mortar 1:4 including 500x450mm pre cast RCC Horizontal/vertical grating with frame complete.
37. 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 (1cement :1 fine sand ) including testing of joints etc. complete.
38. Cement concrete 1:5:10 (1 cement: 5 coarse sand: 10 graded stone aggregate 40 mm nominal size) shall be provided and laid around S.W pipes including bed concrete.
39. 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 : 2coarse sand : 4 graded stone aggregate 20 mm nominal size ) foundation concrete 1:4:8 mix ( 1cement : 4 coarse sand :8 graded stone aggregate 40 mm nominal size ) inside plastering 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand ) finished with floating coat of neat cement and making channels in cement concrete 1:2:4 ( 1 cement: 2 coarse sand :4 graded stone aggregate 20 mm nominal size ) finished with a floating coat of neat cement complete 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./fly ash 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) 500mm 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.

40. MS foot of 20 x 20mm square rests shall be provided and fixed in manholes with 20 x 20 x 10 cm cement concrete blocks 1:3:6 ( 1 cement :3 coarse sand :6 graded stone aggregate 20 mm nominal size ) as per standard design.
41. Asbestos cement 6mm thick corrugated sheets roofing shall be provided and fixed with G, I, J or L hooks, bolts and nuts 8mm diameter G, I plain and bitumen washers complete excluding the cost of purlins, rafters and trusses for water tank.
42. Water closet squatting pan (Indian type W.C. pan ) (white vitreous china Orissa pattern W.C. pan of size 580x440mm with integral type foot rests) shall be provided with 100mm sand cast iron P or S trap. 10 litre low level white P.V.C flushing cistern with manually controlled device (handle lever) conforming to IS:7231, with all fittings and fixtures complete including cutting and making good the walls and floors wherever required.
43. Coloured vitreous china pedestal type water closet (European type) shall be provided with seat and lid, 10 litre low level white vitreous china flushing cistern & C.P. flush bend with fittings and C.I. brackets, 40mm flush bend, overflow arrangement with specials of standard make and mosquito proof coupling of approved municipal design complete including painting of fittings and brackets, cutting and making good the walls and floors wherever required.
44. Coloured vitreous china flat back half stall urinal of size 580x380x350mm shall be provided with 5 litre PVC automatic flushing cistern, 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.
45. Wash basin counter type (630x450mm) and flat back wash basin (550 x400mm) shall be provided with C.I. Brackets 15mm C.P. brass pillar taps, close hole basin mixer 32mm C.P. brass waste and bottle trap of standard pattern, including painting of fittings and brackets, cutting and making good the walls wherever required. Other details shall be as per the drawings.
46. Ward Robes for transit camp shall be as per the drawing. Hardware fittings shall have 100mm CP brass handle, 50mm CP Brass cupboard locks, Nickel Plated finishing, Piano hinges as per IS:3818, Magnetic catchers, heavy type hanger rods of 20mm dia, Anodized (Grade AC-10) Aluminium tower bolts(10o x10m) of ISI marked of

required shade. All doors of Transit Camp shall have tubular type Hydraulic Door closer conforming to IS-3564.

47. All doors except toilet and kitchen shall have 100mm 6 liver mortice lock and a pair of lever handles with necessary screws complete etc.
48. Cement Jali of (1:2:4) ( 1 Cement: 2 fine aggregate : 4 coarse aggregate ) 50mm thick, shall be reinforced with 1.6mm dia with Mild steel wire including centring and shuttering cleaning fixing and furnishing with cement mortar 1:3).
49. Providing and fixing 15mm thick densified tegular edged eco friendly light weight calcium silicate false ceiling tiles of approved texture spintone/cosmos/ Hexa or equivalent of size 595x595 mm in true horizontal level, suspended on inter locking metal grid of hot dipped galvanised steel sections (galvanising @ 120 grams per sqm. Including both side) consisting of main 'T' runner suitably spaced at joints to get required length and of size 24x38 mm made from 0.33 mm thick (minimum) sheet, spaced 1200 mm centre to centre, and cross 'T' of size 24x28 mm made out of 0,33 mm (minimum) sheet, 1200 mm long spaced between main 'T' at 600 mm centre to centre to form a grid of 1200x600 mm and secondary cross 'T' of length 600 mm and size of 24x28 mm made of 0.33 mm thick (minimum) sheet to be interlocked at middle of the 1200x600 mm panel to form grid of size 600x600 mm, resting on periphery walls/partitions on a perimeter wall angle precoated steel of size (24x24x300 mm made of 0.40 mm thick (minimum) sheet with the help of rawl plugs at 450 mm centre to centre with 25 mm long drywall screws @230 mm interval and laying 15 mm thick densified edges calcium silicate ceiling tiles of approved texture (Spintone/ Cosmos/ hexa) in the grid, including, cutting/making openings for services like diffusers, grills, light fittings, fixtures, smoke detectors etc., Wherever required. Main 'T' runners to be suspended from, ceiling using G.I. slotted cleats of size 25x35x1.6 mm fixed to ceiling with 12.5 mm dia and 50 mm long dash fasteners, 4 mm G.I. adjustable rods with galvanised steel level clips of size 85x30x0.8 mm, spaced at 1200 mm centre to centre along main 'T', bottom exposed with 24 mm of all T-section shall be pre-painted with polyester baked paint, for all heights, as per specifications, drawings and as directed by engineer- in-charge.

## **12.0 MODE OF MEASUREMENT**

### **12.1 Earthwork**

This shall include excavation in all kinds of soil including rock, all leads

and lifts including back filling, compacting, dewatering (if required) and disposal of surplus earth/ rock to a suitable location within a lead up to two km. The quantity of excavation for foundations of towers, equipment structures, all transformers, firewall, cable trenches, water tank, reactors, buildings, marshalling kiosks, underground water tanks and covered car parking shall only be measured. The quantity of excavation for roads, rail cum road, drains, culverts, rainwater harvesting, septic tank, soak pit, external water supply system, site surfacing, 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/ electric poles, plinth protection, flooring, sewerage system, manholes, pipes, earth mat, pipe support etc. shall also not be paid for. The measurement of excavation for all concrete works shall be made considering dimension of the pit keeping 150mm gap around the base pad (lean concrete) or actually excavated pit, whichever is less. The quantity shall be measured in cubic metres.

## **12.2 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.

- 12.2.1 PCC 1:2:4 (1 cement : 2 coarse 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.
- 12.2.2 PCC 1:3:6 (1 cement : 3 fine sand : 6 stone aggregate, 40mm nominal size) shall be measured below all foundations including buildings, underground water tanks, covered car parking cable trench, roads, under flooring, rail-cum-road, transformer foundation, reactor foundation, drain, water tank, culverts, gate, tower/equipment etc. as indicated in the drawings.
- 12.2.3 PCC 1:4:8 (1 cement : 4 fine sand : 8 stone aggregate, 40mm nominal size) shall be measured below all foundations including buildings, underground water tanks, covered car parking cable trench, roads, under flooring, rail-cum-road, transformer foundation, reactor foundation, drain, water tank, culverts, gate, tower/equipment etc. as indicated in the drawings.
- 12.2.4 PCC 1:5:10 (1 cement: 5 fine sand: 10 brick aggregate/ stone aggregate 40mm nominal size) shall be provided for site surfacing in switchyard. This shall include providing and laying cement slurry in case of site surfacing in switchyard.



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, water proofing of roof etc. shall not be measured and deemed to be included in the composite rates quoted by the bidder for respective works. Water proofing compound wherever specified shall be added without any extra cost.

### **12.3 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. This shall also include pre-cast RCC work and addition of water proofing compound & admixtures 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.

### **12.4 Steel Reinforcement**

Reinforcement shall be measured in length (actual or 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.

### **12.5 Stone filling**

Measurement of stone (40-60mm size) for transformer/ reactor 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 cu.m.

### **12.6 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 including factory made electro forged 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 / anti corrosive bitumastic paint/ synthetic enamel paint etc. wherever specified ( For gratings and its supports epoxy zinc phosphate primer shall be used) setting of all types of embedment in concrete, etc. Steel required for foundation bolts & fasteners (other than towers and equipment support structures), doors, windows, ventilators, louvers, rolling shutters, chain link fencing, gratings in drains, soil pipes, plumbing pipes, floor traps, embedment's 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 measurements. Quantity shall be measured in MT.

## **12.7 Roads**

- A). The measurement for the concrete road shall be made on the basis of area in square meter ( $M^2$ ) of top concrete completed surface of the road and shall be deemed to include all items such as excavation, compaction, rolling, watering, WBM, Kerb stone, grating, shoulder, 100mm dia RCC Hume pipe to be provided at every 100M etc where ever indicated complete as per drawing but excluding concreting, reinforcement and interlocking tiles.
- B) The measurement of bituminous road shall be made on the basis of area in square meter ( $M^2$ ), of the top bituminous completed surface of the road and shall include all items such as excavation, compaction, rolling, watering, sub base course, WBM, shoulder, premix carpet etc complete as per drawing.
- C) Interlocking concrete tiles required to be provided on the shoulders of the road shall be measured in square meter ( $M^2$ ).

## **12.8 Antiweed Treatment**

The measurement shall be done for the actual area in square metres of antiweed treatment which will include supplying required chemicals and doing the treatment complete in all respect as per the specification for the specified area.

## **12.9 Stone spreading in switchyard**

The measurement shall be done for the actual area in square meters of stone spreading in the switchyard which will include supplying and laying of 100mm thickness of stone aggregate as per specification for the specified area.

## **12.10 Chain Link Fencing and gate**

The measurement shall be made in running metres of the fence provided as per drawing. The rate shall be inclusive of post, wire mesh, MS Flat etc.

complete but excluding the concrete. The gate shall be measured in numbers.

#### **12.11 Cable Trench Crossing and Road Culverts through Hume Pipes**

Cable trench crossings and road culverts shall be measured by length (in running meters) of individual Hume pipe which will be laid as per the drawings. The item shall be inclusive of excavation, laying, back filling, jointing, brickwork, plastering etc complete in all respect but excluding concrete which will be measured and paid separately under respective items.

#### **12.12 Building**

**a) Employer Supplied Drawings:** Payment for this item shall be made on plinth area basis for each building including internal foundations, cable trenches, internal & external finishes, etc complete in all respect. However, the quantity of excavation, concrete and reinforcement steel shall be measured and paid separately as per clause nos. 12.1, 12.2, 12.3 & 12.4 described above. Plinth area shall be calculated based on IS 3861-2002.

**b) Pre-engineered Buildings (Steel Buildings):** Payment for this item shall be made on plinth area basis for each building including internal foundations, cable trenches, internal & external finishes, etc complete in all respect. However, the quantity of excavation, concrete and reinforcement steel shall be measured and paid separately as per clause nos. 12.1, 12.2, 12.3 & 12.4 described above. Plinth area shall be calculated based on IS 3861-2002.

**c) Extension of RCC GIS hall:** Payment for this item shall be made on plinth area basis for each building including internal foundations, cable trenches, internal & external finishes, etc complete in all respect. However, the quantity of excavation, concrete and reinforcement steel shall be measured and paid separately as per clause nos. 12.1, 12.2, 12.3 & 12.4 described above. Plinth area shall be calculated based on IS 3861-2002.

**d) Internal Electrification and Fire Fighting:** Payment for Internal electrification as well as internal Fire fighting works is not included in items covered in clause 12.12 a, b & c and shall be paid as per relevant clauses and BPS.

#### **12.13 Rain Water Harvesting**

This is a lump sum item. The Contractor shall be required to complete the work in all respect as per drawings furnished by the Employer. All the items including excavation, miscellaneous steel, brick work, fillings of

boulders, gravel, sand, pipes etc. shall be deemed to be included in this lump sum rate. However, the concrete (all types) and the reinforcement shall be measured and paid under the clause no. 12.2, 12.3 & 12.4 mentioned above.

**12.14 Rail cum Road**

The measurement for the rail cum road shall be made in square metres of top concrete completed surface of the rail cum road and shall include all items such as excavation, compaction, rolling, watering, WBM etc. complete as per drawing but excluding concrete, reinforcement, structural steel and rails.

**12.15 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 furnished by the Employer. All the clause including excavation, masonry work, all types of fillings, all types of pipes including plumbing and vent pipes, all type of fittings etc. shall be deemed to be included in this lump sum rate. However, the concrete (all types) and the reinforcement shall be measured and paid under the clause no. 12.2, 12.3 & 12.4 mentioned above.

**12.16 Fire Water Tank**

This is a lump sum item. The Contractor shall be required to complete the work in all respect as per drawings furnished by the Employer. All the items including excavation, compaction, brick work, roof truss, purlins, roofing, all types of miscellaneous steel, internal and external plastering, painting etc. shall be deemed to be included in this lump sum cost. However, concrete (all types) and reinforcement shall be measured and paid under the clause no. 12.2, 12.3 and 12.4 mentioned above.

**12.17 External water supply from Bore-well to Fire water tank, Control Room Building and Transit camp.**

The external water supply from Bore-well shall be measured in running meters of GI pipe of various diameters. It shall include all the items such as excavation, piping, pipe fittings, painting, brickwork, sand filling, concrete, valves, chambers cutting chases in walls, openings in RCC and repairs, etc. required to complete the job.

**12.18 External Sewage System of the Transit camp and control room building shall be measured diameter wise in running meters. It shall include all the items such as excavation, piping, pipe fittings, manholes, gully trap, gully chamber, encasing in concrete and repairs etc required to complete the job. Any modification in the existing sewage system, if required, shall be**

done by the Contractor without any extra cost implicated to Employer.

#### **12.19 Cable Trenches**

Various items like earthwork, PCC, RCC, reinforcement steel and miscellaneous steel required for construction of cable trenches shall be measured under respective clauses mentioned above.

#### **12.20 Drains**

The item PCC (1:2:4 and 1:4:8) for drains shall be measured under clause 12.2.1 and 12.2.3. All other items required for completion of drains shall be deemed to be included in the rate of items quoted for the drain. The quantity for each type of drain section shall be measured in meters along the centre line of drain.

#### **12.21 Soil Treatment**

CNS or sand filling or boulder packing with interstices filled with sand under or sides of the foundations, roads, cable trenches, drains etc shall be measured in cubic meters.

#### **12.22 Pile Foundation**

- a). For payment purpose pile of different diameter shall be measured separately in length (running meter) from bottom of pile cap to the lowest point of pile. The rate shall include boring, providing, installing etc complete in all respect except for concrete and reinforcement steel which will be paid separately under respective items.
- b). In case pile foundation is not envisaged originally in the LOA then concrete and reinforcement steel shall be measured and paid as per items mentioned under clause 12.3 & 12.4 and boring installing including casing and bentonite treatment etc of pile will be paid as an extra item. In case extra quantity of cement is required to meet the provisions of IS: 2911, it will be paid as an extra item.

#### **12.23 Contractor Designed Foundations**

Contractor designed foundations shall be measured and paid as per clause 12.1, 12.2, 12.3, 12.4, 12.5 and 12.6 unless otherwise specified.

#### **12.24 Billing break up of Lump sum items for payment purpose shall be decided at site by Engineer in charge for the work.**

#### **12.25 Civil works for Pipe supports and deluge valve housing for firefighting shall be deemed to be included in the items for fire fighting and shall not be**

paid under civil works.

### **13.0 MISCELLANEOUS GENERAL REQUIREMENTS**

- 13.1** Reinforced cement concrete with controlled water cement ratio as per IS-code shall be used for all underground concrete structures such as pump-house, tanks, and water retaining structures for achieving water-tightness.
- 13.2** All joints including construction and expansion joints for the water retaining structures (RCC tank for Fire Fighting and underground water tank) shall be made water tight by using PVC ribbed water stops with central bulb. The minimum thickness of PVC water stops shall be 5 mm and minimum width shall be 230 mm.
- 13.3** All mild steel parts used in the fire fighting water tank and under ground water tank shall be hot-double 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: 2633. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS: 3416.
- 13.4** FPS Bricks of clay having minimum 75 kg/cm<sup>2</sup> compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 75 kg/cm<sup>2</sup> compressive strength before submitting his offer. However, Contractor can propose to use of fly ash based bricks/ hollow concrete blocks or solid concrete blocks of compressive strength not less than 75kg/cm<sup>2</sup>. for which no extra payment shall be made.
- 13.5** Angles 50x50x6 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab.
- 13.6** 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.
- 13.7** The material specification, workmanship and acceptance criteria shall be as per approved standard Field Quality Plan attached with this document. In case certain item is not covered in FQP, it shall be constructed as per CPWD specification.
- 13.8** Ready mix concrete pertaining to M25 grade of reputed manufacturer such as Lafarge, ACC, Ultra Tech, RMC Readymix India etc. or manufacturer of similar repute shall also be accepted for use in construction activity. Materials specification shall conform to IS: 456 and acceptance criteria of readymix concrete shall be as per IS: 4926-2003.

**13.9** 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.

**14.0 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 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 dismantling, breakage etc. is reduced to minimum.

**15.0 STATUTORY RULES**

**15.1** 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.

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

**15.3** 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.

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

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

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					Agency	Extent		
1	Checking of foundation Material							
	A. Materials	1. Cement	1. Brand approval	Cement of approved brands according to the COV in POWERGRID web site may be procured.	Contractor	As proposed by Contractor	Any new brand PROPOSED BY Contractor shall be submitted to CC-QA&I, after assessment by the FQA-RHQ for Approval.	FQA-RHQ
			2. Physical tests	As per document at Annexure-I of this FQP	Contractor Samples to be taken jointly with POWERGRID and tested at POWERGRID accepted lab	Review of 100% MTC's and one sample for every Batch No. of Manufacturer.	100% review of lab test results and MTC.  Test results shall be sent by the Lab, by E mail directly to POWERGRID; further, hard Copy of Test Certificate shall also be sent by the Lab directly to POWERGRID by Postal Address.	Site in charge
			3. Chemical Tests Chemical composition of Cement	-do-	Contractor to submit MTC	Review of all MTC's	100% review of MTC results	Site In charge
		2 a) Reinforcement Steel	1. Source approval	May be procured either from main producers directly or through the authorised dealers who can produce MTC from main producers with traceability.  Refer COV in	Contractor	As proposed by contractor.	To verify credentials	Site in charge.





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				POWERGRID web site, for List of Main Producers of Re- inforcement Steel.				
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S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
					Agency	Extent		
			2. Physical and Chemical analysis test	As per annexure-2 of this FQP	Contractor to submit MTC	100% MTC's  One sample* / 500 MT / Manufacturer shall be jointly sealed by POWERGRID and tested at POWERGRID approved Lab.  *Note: All sizes of 10mm and above shall be taken for testing in every 500MT.	100% review of MTC, and embossing.  Review of lab test results . Test results shall be sent by the Lab, by E mail directly to POWERGRID; further, hard Copy of Test Certificate shall also be sent by the Lab directly to POWERGRID by Postal Address.	site In charge
		2. b) Miscellaneous structural steel excluding cable trench, transformer & reactor fdn.	Source to be proposed by contractor.	Source with material meeting POWERGRID Specification	contractor	As proposed by contractor	To verify documents.	site In charge
			1. Dimensional check	POWERGRID specification and	Contractor	100%	random	Site Engr



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			2. Visual check for damages rusting pitting etc	approved drawing				
		2.c) Structural steel used in cable trenches, transformer & reactor fdn.	Source to be proposed by contractor.	POWERGRID Specification	contractor	As proposed by contractor	To verify documents.	
			1. Dimensional check	POWERGRID specification and approved drawing	Contractor	100%	random	Site Engr
			2. Visual check for damages rusting pitting etc.	POWERGRID specification and approved drawing	Contractor	100%	random	Site Engr
S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
					Agency	Extent		
			3. Visual check for welding defects primer coating and painting/ galvanizing as applicable	POWERGRID specification and approved drawing	Contractor	100%	Random	Site Engr
			4. Physical properties of Structural steel	IS:2062 POWERGRID specification and approved drawing	Contractor	1 sample per lot of 40MT or part thereof for tensile tests and 1 sample per lot of 20MT or part thereof for bend test of each size.	Review of lab test results by POWERGRID.	Site Engr
		3. Coarse	1. Source approval	Source meeting	Contractor	Proposed by the	To review the proposal based	Project in charge.

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		Aggregates		POWERGRID Specification		Contractor, indicating the location of the quarry and based on the test results of Joint samples tested in POWERGRID accepted lab	on the documents	Once approved, the particular source shall be used for all the running contracts under various Packages.
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S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
					Agency	Extent		
			2. Physical tests	As per document at Annexure-3 of this FQP	Samples to be taken jointly and tested in POWERGRID accepted lab	One sample per 200 cum or part thereof, Samples to be tested by Contractor in POWERGRID accepted lab.	100% review of lab test results.  Out of these 100% samples, POWERGRID shall witness at TPL, 5 samples selected at random, spread during the overall execution period of contract.	Site In charge
		4. Fine aggregate	1. Source approval	Source meeting POWERGRID Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the results of Joint samples tested in POWERGRID accepted lab.	To review the proposal based on the documents.	<u>Project In-charge</u>  Once approved, the particular source shall be used for all the running contracts under various Packages.
			2. Physical test	As per Annexure-4 of this FQP	Samples to be taken jointly and tested in POWERGRID accepted	One sample per 200 cum or part thereof, Samples to be tested by Contractor in POWERGRID accepted	100% review of lab test results.  Out of these 100% samples, POWERGRID shall witness at TPL, 5 samples selected at	Site In charge





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					lab	lab.	random, spread during the overall execution period of contract .	
		5. Water	1. Cleanliness	POWERGRID Specification (Water shall be fresh and clean)	Contractor	100% visual check at Field	Verification at random	Site Engineer

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
					Agency	Extent		
			2. PH Value	- do -	Contractor	One sample per source	100% review of the test results Ph value not less than 6	Site Engineer
		6.Finishing materials of building	Physical verification of Different items as per specification	As per Spec.	Contractor	100%	MTC/Manufacturer catalogue To be reviewed by POWERGRID .	Site In charge.
	B. Concrete Works a)Before concreting							
		1. Dimensions of excavation	Dimension & Depth of foundation	Appd. Drgs.	Contractor	100% at Field	100% check by POWERGRID	Site. Engr.
		2. Stub setting/Setting of Foundation Bolts, Embedments etc.	1) Centre Line	-do-	-do-	-do-	-do-	*.*-do-



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			2) Diagonals	-do-	-do-	-do-	-do-	*-do-
			3) Level of stubs./ Foundation bolts	-do-	-do-	-do-	-do-	*-do-
		3. Reinforcement steel	Placement	Bar bending schedule	-do-	-do-	-do-	-do *-At least 5% locations shall be cross verified by immediate Reporting officer/ Site In charge, at Random with respect to stub setting and reinforcement steel placement
S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
					Agency	Extent		
	b) During concreting	1. Workability	Slump test	Range 25 mm to 75 mm refer document at Annexure-5 of this FQP	Contractor	Minimum 01 sample per day	20% check at random	Site Engr.
		2. Concrete Strength	Cubes Comp Strength	CPWD SPEC as referred in document at annexure-5 of this FQP	Contractor Casting of cubes at site. Cubes to be tested at	One sample of 3 cubes for every 20 Cum or part thereof ignoring any part less than 5	100% review of lab test results. Cubes at 100% location are to be taken in	Site in charge.



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					days strength at POWERGRID appd. Lab /POWERGRID Lab/At site- (if testing machine installed by contractor, is duly calibrated by NABL Lab.)  Cubes at 100% location are to be taken in presence of POWERGRID officials	Cum for each day concrete	presence of POWERGRID officials.  Normally testing shall be carried out at the Cube Testing Facility installed by contractor at POWERGRID premises, in the witness of POWERGRID. Alternativ y, samples shall be tested at POWERGRID approved Labs/POWERGRID Lab. In this case, test results shall be sent by the Lab, by E mail directly to POWERGRID; Further, hard Copy of Test Certificate shall also be sent by the Lab directly to POWERGRID by Postal Address.  Further, POWERGRID to witness testing on 20% samples and also to review 100% test results.	Out of testing on 20% samples to be witnessed at TPL by POWERGRID, at least 5% samples at random, shall be witnessed by Site In-charge.
	c) Backfilling	Watering & Ramming for compaction	a) Visual	POWERGRID Spec	Contractor	100%	Random	Site Engr.
S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
					Agency	Extent		
			b) Compaction Test	POWERGRID Spec	Contractor  At Site/ Power grid Accepted Lab	a) 1 Sample of three specimen for 50% of tower location                      b) One Sample of three specimen for 20% of	Physically at Random & 100% review of Test results	Site In charge





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						Equipment Foundation location c) 3 Samples ( three specimen for one sample) for every Building (The depth of sampling and the locations shall be decided by Site Engineer)		
2.	Pile foundations	REFER SFQP OF SWITCHYARD PILE WORK						
3.	Brick Masonry							
		a) BRICKS	1. Dimensional tolerance	POWERGRID Specification/enclosed annexure 6	Contractor (samples to be taken jointly and tested in POWERGRID accepted lab)	Enclosed Annexure 6	Review 100% of test results	Site Engineer
S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
					Agency	Extent		
			2. Compressive strength	POWERGRID Specification/enclosed annexure 6	-Do-	-Do-	-do-	Site Engineer
			3. Water Absorption	POWERGRID Specification/enclosed	-Do-	-Do-	-do-	Site Engineer



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				annexure 6				
			4.Efflorescence	POWERGRID Specification/enclosed annexure 6	-Do-	-Do-	-do-	Site Engineer
		b) Mortar Mix	Cement sand Proportion	As per POWERGRID Spec	Contractor	100%	random	Site Engr
5.	P.C.C	Grade , thickness, plan dimension	completeness	IS:456 and POWERGRID approved foundation drawings & specification	Joint Inspection by POWERGRID and CONTRACTOR	For all locations	Joint Inspection by POWERGRID and CONTRACTOR	Site Engr.
6.	PLASTERING							
		1.Plastering	thickness and evenness	As per POWERGRID Spec.	Contractor	100%	Random	Site Engr
		2. ingredients	Mortar Mix/Proportion	As per POWERGRID Spec.	Contractor	100%	Random	Site Engr
7.	Switchyard earthing							
		1. Check for dimension of earth mat	Physical check	POWERGRID spec & approved drawings	contractor	100%	Random	Site Engr
S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
					Agency	Extent		
		2. Depth of excavation	Physical check	POWERGRID spec & approved drawings	Contractor	100%	Random	Site Engr
		3. Check for weld joints and anti corrosion treatment	Physical check	POWERGRID spec & approved drawings	Contractor	100%	Random	Site Engr





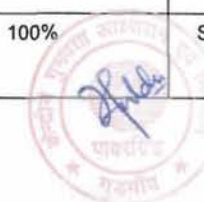
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8.	Site surfacing							
		1.Leveling,Level & Height & evenness	Physical Check	POWERGRID spec & approved drawings	Contractor	100%	Random	Site Engr
		2. Soil sterilization : spraying of chemicals	Physical Check	POWERGRID spec & manufacturers recommendations	Contractor	100%	random	Site engineer
		'3.P.C.C (Grade, thickness & Size) 'a) PCC 1:5:10 (1 cement:5 coarse/fine sand:10 burnt brick aggregates) -Burnt brick aggregate of nominal size 40 mm	Completeness	POWERGRID specifications	Joint Inspection by POWERGRID and Contractor	100%	Random	Site Engr
			Grading	As per Annexure-8	Samples to be taken jointly & tested in POWERGRID accepted lab	1 sample per 500 cu.mtr	100% review of lab test results	Site Incharge
		4. 20/40mm stone aggregate	Grading	IS 383, IS 2386 and POWERGRID Speci. The grading shall be as per single sized nominal size	Contractor (POWERGRID accepted lab)	1 sample per lot of 500 Cubic Meter or part thereof from each source for each size.	100% review of test report	Site Engineer
		5. Compacted thickness of 20/40mm stone layers as applicable	Physical	POWERGRID spec & approved drawings	Contractor	100%	Random	Site Engineer
S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
					Agency	Extent		
9	Road (WBM layers)							
		1. Alignment & Level	Physical check	Power grid spec & approved drawings	Contractor	100%	100%	Site In charge



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	Material	A. Coarse Aggregates	1. Source approval	Source with materials meeting POWERGRID Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the test results of Joint samples tested in POWERGRID accepted lab	To review the proposal based on the documents	Site In charge
			2. Physical tests	As per document at Annexure-7 of this FQP	Samples to be taken jointly and tested in POWERGRID approved lab	One sample per lot of 200 cum or part thereof per source	100% review of lab test results	Site In charge
		B) Stone Screening						
			1. Source approval	Source with materials meeting POWERGRID Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the test results of Joint samples tested in POWERGRID accepted lab	To review the proposal based on the documents	Site In charge
			2. Grading	As per document at Annexure-7 of this FQP	Samples to be taken jointly and tested in POWERGRID accepted lab	One sample per lot of 200 cum or part thereof	100% review of lab test results	Site In charge
S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
					Agency	Extent		
		C) Binding Material	Plasticity index	As per document at Annexure-7 of this FQP	Contractor	One sample per lot of 25 cum or part thereof	100% review of lab test results	Site In charge
		D) Laying of sub base Course	Physical check	As per CPWD spec clause 17.7.2	Contractor	100%	Random	Site Engr



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		E) Laying of base Course	Physical check	As per CPWD spec clause 17.8.1	Contractor	100%	Random	Site Engr
10	Drain	Alignment and invert level	Physical	POWERGRID spec and approved drawing	Contractor	100%	Random	Site Engr





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### ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR CEMENT

ORDINARY PORTLAND CEMENT					
S. No.	Name of the test	Ordinary Portland Cement 33 grade as per IS 269	Ordinary Portland Cement 43 grade as per IS 8112	Ordinary Portland Cement 53 grade as per IS 12269	Remarks
a)	Physical tests				To be conducted in Appd. Lab
(i)	Fineness	Specific surface area shall not be less than 225 sq.m. per Kg. or 2250 Cm <sup>2</sup> /gm.	Specific surface area shall not be less than 225 sq.m. per Kg or 2250 Cm <sup>2</sup> /gm.	Specific surface area shall not be less than 225 sq.m. per Kg or 2250 Cm <sup>2</sup> /gm.	Blaine's air permeability method as per IS 4031 (Part-2)
(ii)	Compressive strength	72 ± 1 hour : Not less than 16 Mpa (16 N/mm <sup>2</sup> )  168 ± 2 hour : Not less than 22 Mpa (22 N/mm <sup>2</sup> )  672 ± 4 hour : Not less than 33 Mpa (33 N/mm <sup>2</sup> )	72 ± 1 hour : Not less than 23 Mpa ( 23 N/mm <sup>2</sup> )  168 ± 2 hour : Not less than 33Mpa ( 33 N/mm <sup>2</sup> )  672 ± 4 hour : Not less than 43 Mpa ( 43 N/mm <sup>2</sup> )	72 ± 1 hour : Not less than 27Mpa (27 N/mm <sup>2</sup> )  168 ± 1 hour : Not less than 37Mpa ( 37 N/mm <sup>2</sup> )  672 ± 1 hour : Not less than 53 Mpa ( 53 N/mm <sup>2</sup> )	As per IS 4031 (Part-6)
(iii)	Initial & Final setting time	Initial setting time : Not less than 30 minutes  Final setting time : Not more than 600 minutes	Initial setting time : Not less than 30 minutes  Final setting time : Not more than 600 minutes	Initial setting time : Not less than 30 minutes  Final setting time : Not more than 600 minutes	As per IS 4031 (Part-5)  -do-
(iv)	Soundness	Unaerated cement shall not have an expansion of more than 10mm when tested by Le Chatlier and 0.8% by Autoclave test.	Unaerated cement shall not have an expansion of more than 10mm when tested by Le Chatlier and 0.8% by Autoclave test	Unaerated cement shall not have an expansion of more than 10mm when tested by Le Chatlier and 0.8% by Autoclave test.	Le Chatlier and Autoclave test as per IS 4031 (Part-3)



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S. No.	Name of the test	Ordinary Portland Cement 33 grade as per IS 269	Ordinary Portland Cement 43 grade as per IS 8112	Ordinary Portland Cement 53 grade as per IS 12269	Remarks
b)	Chemical composition tests				Review of MTC only
		a) Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.66 to 1.02	a) Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.66 to 1.02	a) Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.80 to 1.02%	
		b) Ratio of percentage of alumina to that of iron oxide Minimum 0.66%	a) Ratio of percentage of alumina to that of iron oxide Minimum 0.66	a) Ratio of percentage of alumina to that of iron oxide Minimum 0.66%	
		c) Insoluble residue, percentage by mass Max. 4.00%	c) Insoluble residue, percentage by mass Max. 2.00%	c) Insoluble residue, percentage by mass Max. 2.00%	
		d) Magnesia percentage by mass Max. 6%	d) Magnesia percentage by mass Max. 6%	d) Magnesia percentage by mass Max. 6%	
		e) Total sulphur content calculated as sulphuric anhydride (SO <sub>3</sub> ), percentage by mass not more than 2.5 and 3.0 when tri-calcium aluminate percent by mass is 5 or less and greater than 5 respectively.	e) Total sulphur content calculated as sulphuric anhydride (SO <sub>3</sub> ), percentage by mass not more than 2.5 and 3.0 when tri-calcium aluminate percent by mass is 5 or less and greater than 5 respectively.	e) Total sulphur content calculated as sulphuric anhydride (SO <sub>3</sub> ), percentage by mass not more than 2.5 and 3.0 when tri-calcium aluminate percent by mass is 5 or less and greater than 5 respectively.	
		f) Total loss on ignition shall not be more than 5 percent	f) Total loss on ignition shall not be more than 5 percent	f) Total loss on ignition shall not be more than 5 percent	





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S. No.	Name of the test				Remarks
2.	POZZOLANA PORTLAND CEMENT AS PER IS 1489				
a)	Physical tests	i) Fineness	Specific surface area shall not be less than 300 sq.m. per Kg. or 3000 Cm <sup>2</sup> /gm		
		ii) Compressive strength	a) 72 ± 1 hour : Not less than 16 Mpa (16 N/mm <sup>2</sup> ) b) 168 ± 2 hour : Not less than 22 Mpa (22 N/mm <sup>2</sup> ) c) 672 ± 4 hour : Not less than 33 Mpa (33 N/mm <sup>2</sup> )		
		iii) Initial & Final setting time	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes		
		iv) Soundness	Un-aerated cement shall not have an expansion of more than 10mm Le Chatlier test and 0.8% by Autoclave test as per IS 4031 (Part-3)		
b)	Chemical composition tests				
		a) Magnesia percentage by mass Max. 6%			Review of MTCC only
		b) Insoluble material, percentage by mass $x + 4 (100-x)/100$ where x is the declared % of pozzolana in the PPC			-do-
		c) Total sulphur content calculated as sulphuric anhydride (SO <sub>3</sub> ), percentage by mass not more than 3.0			-do-
		Total loss on ignition shall not be more than 5 percent			



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### ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR REINFORCEMENT STEEL AS PER IS 1786-1985 Edition-4.3 (2004-12)

S. No.	Name of the test	Fe 415	Fe 500
i)	<b>Chemical analysis test</b>		
	Carbon	0.30 Percent Maximum	0.30 Percent Maximum
	Sulphur	0.060 Percent Maximum	0.055 Percent Maximum
	Phosphorus	0.060 Percent Maximum	0.055 Percent Maximum
	Sulphur & Phosphorus	0.11 Percent Maximum	0.105 Percent Maximum
ii)	<b>Physical tests</b>		
	a) Tensile Strength Minimum	10% more than actual 0.2% proof stress but not less than 485 N/Sq.mm.	8 % more than actual 0.2% proof stress but not less than 545 N/Sq.mm
	b) 0.2% of proof stress/Yield stress Minimum, N/mm <sup>2</sup>	415	500
	c) Elongation percent , Minimum	14.5	12
iii)	<b>Bend &amp; Rebend tests</b>	Pass	Pass



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### ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR COARSE AGGREGATES AS PER IS 383

3.	<b>Coarse Aggregates</b>										
i)	<b>Physical Tests</b>										
	a) Determination of particles size	a. IS Sieve Designation	%age passing for Single-Sized Aggregate of nominal size					Percentage Passing for grades Aggregate of nominal size			
			40 mm	20 mm	16 mm	12.5 mm	10 mm	40 mm	20 mm	16 mm	12.5 mm
		63 mm	100	-	-	-	-	-	-	-	-
		40 mm	85 to 100	100	-	-	-	95 to 100	100	-	-
		20 mm	0 to 20	85 to 100	100	-	-	30 to 70	95 to 100	100	100
		16 mm	-	-	85 to 100	100	-	-	-	90-100	-
		12.5 mm	-	-	-	85 to 100	100	-	-	-	90 to 100
		10 mm	0 to 5	0 to 20	0 to 30	0 to 45	85 to 100	10 to 35	25 to 55	30 to 70	40 to 85
		4.75 mm	-	0 to 5	0 to 5	0 to 10	0 to 20	0 to 5	0 to 10	0 to 10	0 to 10
		2.36 mm	-	-	-	-	0 to 5	-	-	-	-
	b. Flakiness index	Not to exceed 25%									
	c. Crushing Value	Not to exceed 45%									
	d. Presence of deleterious material	Total presence of deleterious materials not to exceed 5%									
	e. Hardness	Abrasion value not more than 40%, Impact value not more than 30%									
	f. Soundness test (for concrete work subject to frost action)	12% when tested with sodium sulphate and 18% when tested with magnesium sulphate									





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### ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR FINE AGGREGATES AS PER IS 383

<b>4.</b>	<b>Fine aggregates</b>				
i)	Physical Tests	IS Sieve Designation	Percentage passing for graded aggregate of nominal size		
a)	Determination of particle size		F.A. Zone I	F.A. Zone II	F.A. Zone III
		10 mm	100	100	100
		4.75 mm	90-100	90-100	90-100
		2.36 mm	60-95	75-100	85-100
		1.18 mm	30-70	55-90	75-100
		600 microns	15-34	35-59	60-79
		300 microns	5 to 20	8 to 30	12 to 40
		150 microns	0-10	0-10	0-10
b)	Silt content		Not to exceed 8%	Not to exceed 8%	Not to exceed 8%
c)	Presence of deleterious material	Total presence of deleterious materials shall not exceed 5%			
d)	Soundness Applicable to concrete work subject to frost action	12% when tested with sodium sulphate and 15% when tested with magnesium sulphate			



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### ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR CONCRETE WORK

1)	Concrete	a) Workability	Slump shall be recorded by slump cone method and it shall be between 25-75 mm. depending upon workability requirement as per IS 456.
		b) Compressive strength	For Design mix as per IS:456 for Grade M20 or above For nominal (volumetric) concrete mixes compressive strength for 1:1.5:3 (Cement : Fine aggregates : Coarse aggregates) concrete 28 days strength shall be min 265Kg/cm <sup>2</sup> and for 1:2:4 (Cement: Fine Aggregate: Coarse aggregate) nominal mix concrete 28 days strength shall be min 210Kg/cm <sup>2</sup> .

**Notes :**

- 1) All Design Mix concrete shall be as per IS: 456.
- 2) ACCEPTANCE CRITERIA BASED ON 28 DAYS COMPRESSIVE STRENGTHS FOR DESIGN MIX CONCRETE: AS PER Table-11 of IS:456 as given below:

Specified Grade	Mean of the Group of 4 Non-Overlapping consecutive test results in N/sq mm	Individual Test Results in N/sq mm
M 20 or above	Shall be greater than or equal to $f_{ck} + 0.825 \times \text{established standard deviation (rounded off to nearest 0.5 N/sq mm)}^*$ Or $F_{ck} + 3 \text{ N/sq mm, whichever is greater}$	$\geq f_{ck} - 3 \text{ N/sq mm}$

\* Established value of standard deviation shall be determined based on Note of Table-11 of IS:456

- 3) ACCEPTANCE CRITERIA BASED ON 28 DAYS COMPRESSIVE STRENGTHS FOR NOMINAL MIX CONCRETE:
  - a) On the basis of mandatory lab test result, in case of actual average compressive strength being less than specified strength but up to 70% of specified strength, concrete may be accepted and the rate payable shall be in the same proportion as the actual average compressive strength bears to specified compressive strength..
  - b) If the actual average strength of accepted sample is less than 70% of specified strength, the Engineer-in-charge shall reject the defective portion of work represented by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall be taken at the risk and cost of contractor. If, however, the Engineer-in-charge so desires, he may order additional tests to be carried out to ascertain if the structure can be retained. All the charges in connection with these additional tests shall be borne by the Contractor.
  - c) 53 Grade cement shall be used after obtaining specific approval of the Engineer in charge.
  - d) Portland slag cement conforming to IS: 455 may be used after obtaining specific approval of the Engineer In charge.



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### SAMPLING PLAN FOR BRICK-WORK

Scale of sampling and permissible number of defectives for visual and dimensional characteristics.

No of Bricks in the lot	For characteristics specified for individual bricks		For Dimensional characteristics for group of 20 bricks- No of bricks to be selected
	No of bricks to be selected	Permissible no of defective in the sample.	
(1)	(2)	(3)	(4)
2001-10000	20	1	40
10001-35000	32	2	60
35001-50000	50	3	80

Note : In case the lot contains 2000 or less bricks the sampling shall be as per decision of the Engineer – in- charge.

Scale of sampling for physical characteristics

Lot size	Sampling size for compressive strength water absorption and efflorescence	Permissible No of defectives for efflorescence
(1)	(2)	(3)
2001-10000	5	0
10001-35000	10	0
35001-50000	15	1





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### ACCEPTABLE CRITERIA FOR BRICK WORK

1) Dimensional Tolerances: The dimensions of modular/ Non modular bricks when tested shall be within the following limits per 20 bricks.

S.No	DESCRIPTION	MODULAR BRICKS	NON-MODULAR BRICKS
1	LENGTH	372 to 388 cm (380 ± 8 cm)	432 to 468 cm (450 ± 18)
2	WIDTH	176 to 184 cm (180 ± 4 cm)	213 to 231 cm (222 ± 9)
3	HEIGHT	176 to 184 cm (180 ± 4 cm)	134 to 146 cm (140 ± 6)

2) Compressive strength: the bricks shall have a minimum average compressive strength as specified in POWERGRID specification. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20% . in case compressive strength of any individual brick tested exceeds the upper limit specified for the corresponding class of bricks, the same shall be limited to upper limit of the class as specified for the purpose of calculating the average compressive strength.

3) Water absorption : The average water absorption of bricks shall not be more than 20% by weight.

4) Efflorescence : The rating of efflorescence of bricks shall not be more than moderate.



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### PHYSICAL, REQUIREMENT OF COARSE AGGREGATE

S.No.	Type of Constn.	Type of W.B.M	Test Method	Requirements
1.	Sub-base	Los Angeles Abrasion Value or Aggregate Impact value	IS:2386(Pt.IV) IS:2386 (Pt.IV) IS:5640***	60% max. * 50% max
2.	Base	a) Los Angeles Abrasion Value or Aggregate Impact value b) Flakiness Index	IS:2386(Pt.IV) IS:2386 (Pt.IV) IS:5640*** IS:2386 (Pt.I)	50% max. * 40% max ** 15% max
3.	Surface Course	a) Los Angeles Abrasion Value or Aggregate Impact value b) Flakiness Index	IS:2386(Pt.IV) IS:2386 (Pt.IV) IS:2386 (Pt.I)	40% max. 30% max 15% max
4	Binding Material	Plasticity index	IS :2720 (Pt V)	Less than 6

\* Aggregates may satisfy requirements of either of the two tests

\*\* The requirements of flakiness index shall be enforced only in case of crushed/broken stone and crushed slag.

\*\*\* Aggregates like brick metal, kankar and laterite which get softened in presence of water, shall be tested for impact value under wet conditions in accordance with IS:5640.



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### GRADING REQUIREMENTS OF COARSE AGGREGATE FOR W.B.M

Grading No.	Size Range	Sieve designation	% by weight passing the sieve
1	90mm to 45mm (Suitable for sub base courses of compacted layer of not less than 90mm thickness).	125mm 90mm 63mm 45mm 22.4mm	100 90-100 25-60 0-15 0-5
2.	63mm to 45mm	90mm 63mm 53mm 45mm 22.4mm	100 90-100 25-75 0-15 0-5
3.	53mm to 22.4mm	63mm 53mm 45mm 22.4mm 11.2mm	100 95-100 65-90 0-10 0-5
4	Screening		
	A) 13.2 mm	13.2 mm 11.2 mm 5.6 mm 180 micron	100 95-100 15-35 0-10
	B) 11.2 mm	11.2 mm 5.6 mm 180 micron	100 90-100 15-35





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### Requirement of grading of broken Burnt Brick Coarse aggregate

IS Sieve Designation	Percent Passing
75 mm	100
37.5 mm	95-100
19.0 mm	45-75
4.75 mm	0-5

### General Notes :

- 1) This standard Field Quality Plan is not to limit the supervisory checks which are otherwise required to be carried out during execution of work as per drawings/Technical specifications etc.
- 2) All materials under supply contract should have Cat-A CIP before they are erected.
- 3) Contractor shall be responsible for implementing/documenting the SFQP. Documents shall be handed over by the contractor to POWERGRID after the completion of the work.
- 4) Project incharge means over all incharge of work. Site Incharge means incharge of the Site. Site Engr means incharge of the section.  
Site Engineer's responsibility may be allocated to Site JE, with the approval of Regional Head, only in such cases where, Site Engineer is not in position.
- 5) In case of deviation the approving authority will be one step above the officer designated for acceptance in this quality plan subject to minimum level of Site incharge.
- 6) Acceptance criteria and permissible limits for tests are indicated in the Annexures. However for further details/tests POWERGRID specification and relevant Indian standards shall be referred.
- 7) Tests as mentioned in this FQP shall generally be followed. However E.I.C. reserves the right to order additional tests wherever required necessary at the cost of the agency.
- 8) All counter checks/tests by POWERGRID shall be carried out by POWERGRID's officials' at least at the level of Site. Engr.
- 9) Main producer of reinforcement steel means SAIL, RINL, TATA STEEL, ISCO, JSPL, JSW etc. as listed in COV in POWERGRID web site. The authorized dealer means the dealer whose names are listed in the main producer's web site or certified by the main producers.
- 10) Though CTD bars (Fe 415 ) are specified for reinforcement steel, however TMT reinforcement steel are acceptable if the physical, chemical & Mechanical properties of TMT reinforcement meets the minimum requirement of CTD bars.



## STANDARDISED FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	08.01.2015
Validity	Till next revision

SFQP No.	DOC No.C/QA&I/SFQP/SCW
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- 11) Accepting Authority for testing Laboratory shall be Site in Charge.
- 12) Mobile testing Labs owned by the contractor may also be acceptable if their facilities meet the testing requirements and the testing equipments are properly calibrated subject to approval of project Incharge.
- 13) **READYMIX CONCRETE (RMC) IS ACCEPTABLE FOR USE. HOWEVER, SITE INCHARGE SHALL APPROVE THE SOURCE OF MATERIALS TO BE USED FOR RMC .The documentation to be maintained shall be as per IS 4926:2003 i.e i) Information to be supplied by the purchaser (clause 7)**  
 ii) Information to be supplied by the producer (clause 8)  
 iii) Sampling for concrete strength should be one set of 3 nos of cubes for every 20 cu.m or part thereof for each day of concreting and 28 days compressive strength shall be tested in line with IS:456.
- 14) Epoxy coating on reinforcement steel wherever required shall be done as per IS 13620.
- 15) Cement is to be used in the order it is delivered (ie. First in First Out). Cement bought to works shall not be more than 6 weeks old from the date of manufacture.in case the cement remains in storage for more than 3 months, the cement shall be retested before use and shall be rejected, if it fails to conform to any of the requirements given in the relevant Indian Standard. Cement shall be packed in bags and stored in accordance with the provisions in IS -4082.

