

SECTION 8: CIVIL WORKS

8.1 GENERAL

The civil works to be provided by the Contractor, in accordance with the Specification, shall include the design & construction of all the items required, in each of the converter stations, including site and general services; buildings; foundations; structures; noise, fire and blast walls etc. The supply of steel and cement required for the civil works shall also be in the scope of the Contractor.

All civil works shall satisfy the requirements specified in other Sections of this Specification and as detailed below. They shall be designed to the required service conditions/loads as specified elsewhere in this Specification and implied as per national/international Standards.

All civil works shall be carried out as per applicable Indian Laws, Standards and Codes. The Contractor shall furnish all design, drawings, labour, tools, equipment, materials, temporary works, constructional plant, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the Works in accordance with approved drawings, specifications and directions of the Employer.

All the Works shall be carried out according to the design/drawings to be developed by the Contractor, and approved by the Employer. For all buildings, structures, foundations etc. necessary layout and details shall be developed by the Contractor keeping in view the functional requirement of the plant and facilities and providing enough space and access for operation, use and maintenance. Certain minimum requirements are indicated in this Specification for guidance purpose only; however, the Contractor shall provide according to the complete requirements.

All quality standards, fabrication and erection check lists, welding standards and other technical requirements as covered in the Specification shall be strictly adhered to by the Contractor.

8.2 CIVIL WORKS DESIGN BASIS

8.2.1 GENERAL

The Contractor shall design and construct all civil works to meet the requirements of the Specification and to be suitable for the intended use at the specified locations. In particular the Contractor shall be responsible for obtaining all data not specifically detailed herein which is required to ensure compliance with the Specification.

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The foundations and structures shall be designed to ensure that relative movement over the specified life of the installation does not result in stresses in any part of the Works which exceed the maximum design levels.

A design intent memorandum (DIM) to the effect shall be submitted by the Contractor for the Employer's specific approval giving details regarding his assumed data, loading for all civil design.

Any variation in design data shall not constitute a valid reason for any additional cost & shall not affect the terms & condition of the Contract. No extra payment what so ever, shall be paid to the Contractor on account of any variation in soil properties/conditions.

8.2.2 GEOTECHNICAL INVESTIGATION

Levelled site shall be handed over to the Contractor. The finished ground level shall be the finished formation level furnished by the Employer. The compaction of finish formation shall be approx 95% on proctor scale. In case it is found to be lower, then the Contractor shall redo the job without any additional cost to the Employer. The Contractor shall perform a detailed soil investigation to arrive at sufficiently accurate, general as well as specific information about the soil profile and the necessary soil parameters of the Site in order that the foundation of the various structures can be designed and constructed 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 utilised for civil structures design.

8.2.3 SCOPE OF WORK

This specification covers all the work required for detailed soil investigation and preparation of a detailed report. The work shall include mobilisation of necessary equipment, 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 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

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- viii) In case of foundation in rocky strata, type of foundation and recommendation regarding rock anchoring etc. should also be given.

8.3 SITE PREPARATION

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 give all help 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.

8.3.1 SCOPE

This clause covers the design and execution of the work for site preparation, such as clearing of the site, the supply and compaction of fill material, excavation and compaction of backfill for foundation, road construction, drainage, trenches and final topping by stone (broken hard stone).

8.3.2 GENERAL

- .1 The Contractor shall develop the site area to meet the requirement of the intended purpose. The site preparation shall conform to the requirements of relevant sections of this specification or as per stipulations of standard specifications.
- .2 If fill material is required, the fill material shall be suitable for the above requirement. The fill shall be such a material and the site so designed as to prevent the erosion by wind and water of material from its final compacted position or the in-situ position of undisturbed soil.
- .3 Backfill material around foundations or other works shall be suitable for the purpose for which it is used and compacted to the density described under Compaction. Excavated material not suitable or not required for backfill shall be disposed off in areas as directed by Employer upto a maximum lead of 2 km.

8.3.3 EXCAVATION AND BACKFILL

- .1 Excavation and backfill for foundations shall be in accordance with the relevant code.
- .2 Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom

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of the excavation level during excavation, concreting and backfilling.

- .3 When embankments are to be constructed on slopes of 15% or greater, benches or steps with horizontal and vertical faces shall be cut in the original slope prior to placement of embankment material. Vertical faces shall measure not more than 1 m in height.
- .4 Embankments adjacent to abutments, culverts, retaining walls and similar structures shall be constructed by compacting the material in successive uniform horizontal layers (not exceeding 15 cm in thickness). (of Loose material before compaction). Each layer shall be compacted as required by means of mechanical tampers approved by the Employer. Rocks larger than 10 cm in any direction shall not be placed in embankment adjacent to structures.
- .5 Earth embankments of roadways and site areas adjacent to buildings shall be placed in successive uniform horizontal layers not exceeding 20 cm in thickness in loose stage measurement and compacted to the full width specified. The upper surface of the embankment shall be shaped so as to provide complete drainage of surface water at all times.

8.3.4 COMPACTION

- .1 The density to which fill materials shall be compacted shall be as per relevant IS and as per direction of Employer. All compacted sand filling shall be confined as far as practicable. Backfilled earth shall be compacted to minimum 95% of the Standard Proctor's density at OMC. The sub grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor's density at OMC. Cohesion less material sub grade shall be compacted to 70% relative density (minimum).
- .2 At all times unfinished construction shall have adequate drainage. Upon completion of the road's surface course, adjacent shoulders shall be given a final shaping, true alignment and grade.
- .3 Each layer of earth embankment when compacted shall be as close to optimum moisture content as practicable. Embankment material which does not contain sufficient moisture to obtain proper compaction shall be wetted. If the material contains any excess moisture, then it shall be allowed to dry before rolling. The rolling shall begin at the edges overlapping half the width of the roller each time and progress to the centre of the road or

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towards the building as applicable. Rolling shall also be required on rock-fills. No compaction shall be carried out in rainy weather.

8.3.5 ANTIWEED TREATMENT & STONE SPREADING

8.3.5.1 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 along with cement concrete layer shall be done in the areas of the switchyard under present scope of work within fenced area. Outside the fenced area where no equipment is envisaged, the Employer may carryout landscaping in those areas. Landscaping shall not be in the Contractors scope.

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.

- .1 The material to be used for stone filling/site surfacing shall be uncrushed/crushed/broken stone 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

Amendment II SI No 173

~~"One Test" shall be conducted for every 500 cu.m.~~

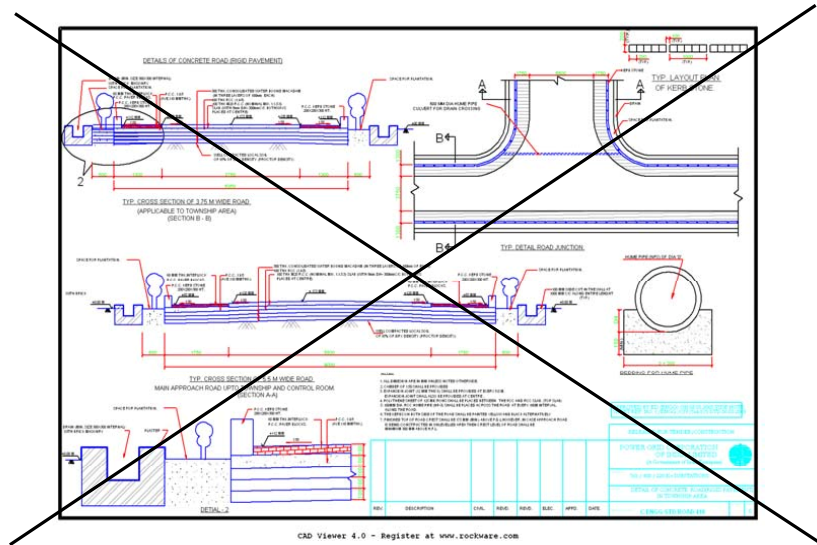
"One sieve analysis test" shall be conducted for every 500 cu.m

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).

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8.4 FOUNDATIONS AND OTHER RCC CONSTRUCTIONS

8.4.1 GENERAL

Amendment III SI No 96 (Add)

- .1 Work covered under this Clause comprises the design, supply and construction of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, drains, jacking pad, pulling block, fencing, boundary wall, control cubicles, bus supports, transformers, reactors, marshalling kiosks, auxiliary equipments & systems, buildings, tanks, rail tracks or for any other equipment or service and any other foundation/RCC construction required to complete the work. This clause is as well applicable to the other RCC constructions.

PPC (ordinary Portland cement) shall not be used for RCC works

Amendment II SI No 178

- .2 ~~Concrete shall conform to the requirements mentioned in CPWD specification and all the tests shall be conducted as mentioned in Standard field quality plan appended with the specification.~~

~~A minimum grade of M20 concrete shall be used for all structural/load bearing members. Nominal mix by volume 1:1.5:3 (1cement: 1.5 coarse sand: 3stone aggregate 20mm nominal size) shall be used for all RCC works. Higher grades of concrete can be allowed if Contractor carries out mix design and installs a batching plant or arranges the concrete from a approved ready mix concrete supplier.~~

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Reinforced Concrete shall conform to the requirements mentioned in IS 456 (latest version).

A minimum grade of M 25 concrete shall be used for all structural/load bearing members for all RCC works in the terminal stations. Only weigh batching shall be allowed for design mix concretes.

ADD:

All the tests shall be conducted as mentioned in the IS 456 for design mix concretes and will supersede the relevant sections of Standard field quality plan appended with the specification. In case of repeater stations where the concrete volume is very small nominal mix conforming to CPWD specification may be used.

Amendment II SI No 179

- ~~.3 Where the site is inclined, the foundation height shall be adjusted to maintain the exact level of the top of structures to compensate such slopes.~~

Amendment II SI No 180

- ~~.4 The switchyard foundations plinth and building plinth shall be minimum 300 mm and 500 mm above finished ground level respectively.~~

The switchyard foundations plinth and building plinth shall be minimum 300 mm and 750 mm above finished ground level respectively

- .5 Minimum 75 mm thick lean concrete 1:4:8 (1 cement : 4 coarse sand : 8 stone aggregate 40mm nominal size) shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction.

Amendment II SI No 181

- ~~.6 Concrete made with ordinary Portland cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering. Portland pozzolone / slag cement can be used, however 53 grade cement shall be used with specific approval of Employer.~~

Concrete made with Portland Pozzolana or slag cements cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering. In case of encountering of aggressive soils and sub soil water OPC/PPC Sulphate resisting cement shall be used for foundations as per the provisions of IS 456

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maximum GWT. Intermediate dividing piers of such enclosure shall be designed considering water in one pump sump only and the other pump sump being empty e.g. for maintenance.

- .19 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. Foundation settlements shall, in no case, exceed the permissible limits specified in relevant Indian Standard Specification.

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

For the foundations of rotating machines, detailed static and dynamic analysis shall be done. A fatigue factor of at least 2.0 shall be considered for dynamic forces. Minimum reinforcement shall be governed by IS-2974 as well as IS-456. RCC design shall be done by working stress method.

For the foundations supporting minor equipments weighing less than one ton or if the mass of the rotating parts is less than one-hundredth of the mass of the foundation, dynamic analysis is not must. However, if such minor equipment is to be supported on building structures, floors etc. suitable vibration isolation shall be provided by means of springs, neoprene pads etc. and such vibration isolation system shall be designed suitably.

- .21 All other foundations shall be designed in accordance with the provisions of the relevant parts IS-2911 and IS-456.
- .22 The gantry/tower foundations shall be designed for factor of safety of 2.2 for normal and broken wire condition and 1.65 for combined short circuit and broken wire condition.
- .23 Minimum two piles shall be provided in any pile group.

Amendment II SI No 184

Add

24. Equipment foundations shall be designed for a factor of safety of 2.2 for normal and 1.65 for short circuit condition

8.4.3 ADMIXTURES & ADDITIVES

- .1 Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer.

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Admixtures shall be delivered in suitably labelled containers to enable identification.

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- .2 Admixtures in concrete shall conform to IS-9103. The water proofing cement additives shall conform to IS-2645. Concrete Admixtures/Additives shall be approved by the Employer.
- .3 The Contractor shall use an approved neutralized vinsol resin or air-entraining agent in concrete. The Air-entraining agent shall be supplied and batched as a solution with a solid content not exceeding 15% by weight with suitable, stable and consistent pH. Air- entraining requirements shall be in accordance with CP 100 Part I.
- .4 The Contractor can propose and the Employer, at his discretion, may approve the use of a water-reducing set retarding admixture in some of the concrete. The use of such an admixture shall not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid overcoming unusual circumstances and placing conditions.
- .5 The water-reducing set-retarding admixture shall be an approved brand of ligno-sulphonate type admixture.
- .6 The water proofing cement additives shall be used only after approval of the Employer.

8.4.4 HOT WEATHER REQUIREMENTS

- .1 During hot weather all necessary precautions, as per relevant Codes, shall be taken to avoid premature stiffening of the fresh mix and to reduce water absorption and evaporation losses and when the temperature of the surrounding air is higher than 30°C. The following shall apply unless otherwise approved by the Employer:
 - a) The formwork shall be continuously sprayed with cold water in advance of concreting and excess water shall be removed from inside the forms immediately prior to placement of concrete.
 - b) The reinforcement and the formwork (if metal forms are used), shall be protected from the effects of hot winds and direct sunlight.
 - c) Suitable barriers shall be provided to protect the freshly placed concrete from wind until the concrete is sufficiently hard to allow it to be covered according to (e) below.

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- d) The concrete when placed shall be maintained at a temperature of less than 30 degree C by the use of chilled mixing water or by spraying the aggregate with cold water.
- e) The concrete shall be mixed, transported, placed and consolidated, as rapidly as possible and shall then be covered with an impervious membrane or wet Hessian until moist curing beings.
- .2 Curing compounds shall not be used as an alternative to the requirements of Clause 8.4.3.
- .3 During hot weather (atmospheric temperature above 40 deg C) or cold weather (atmospheric temperature at & below 5 deg C) the concreting shall be done as per the procedure set out in IS-7861 (Part I & II).

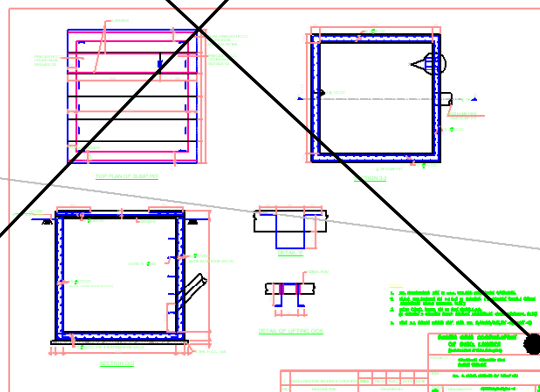
~~8.5 CABLE & PIPE TRENCHES~~

~~Amendment II SI No 185 (Add)~~

- ~~.1 RCC trenches and pre-cast removable concrete covers (with lifting arrangement) shall be designed to withstand *surcharge* loads of 1000 kg/m² from maintenance trucks and a concentrated load of 200 kg at mid span of cover. Cable trenches shall also be designed with water pressure along with earth pressure.~~

~~Amendment II, SI No 186~~

- ~~.2 Trenches shall be of reinforced cement concrete, having minimum ~~M-20~~ grade ~~M-25~~ grade of concrete. The standard / typical trench drawing is indicated below:~~



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surface.

iii) Posts shall be set in 1:2:4 Plain Cement Concrete block of minimum 0.40x0.40x1.2m depth. 75mm thick plain cement concrete 1:4:8 shall be provided below concrete blocks. Posts shall be braced and held in plumb position and true alignment and elevation until concrete has set.

iv) Fence fabric shall not be installed until concrete has been cured for a minimum of 7 days.

—Amendment II SI No 191

v) ~~Fence fabric panel shall be fixed to the post by 4 nos. MS flat each of 50x6, 75 long through 2 nos. of bolts (12 diameters) on each flat.~~

Fence fabric panel shall be fixed to the post by 4 nos. GI flat each of 50x6, 75 long through 2 nos. of bolts (12 diameters) on each flat.

Amendment II SI No 192

vi) ~~The painting pattern of fence panels shall be decided by Engineer in charge.~~

e) Gate

i) The gate shall be made of medium duty M.S. pipe conforming to relevant I.S. 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. Other details shall be as shown in the drawing.

ii) The gates shall be fabricated with welded joints to achieve rigid connections. The gate frames shall be painted with one coat of approved steel primer and two coats of synthetic enamel paint.

iii) The gates shall be provided with suitable locking arrangement.

iv) The main gate shall be 5.0m wide and shall be of double leaf type (as shown in the drawing). Next to the main gate, a man gate (1.25m wide single leaf) shall also be provided.

v) The main gate shall be motorised .

vi) Gate shall be installed in location as shown in approved G.A. drawing.

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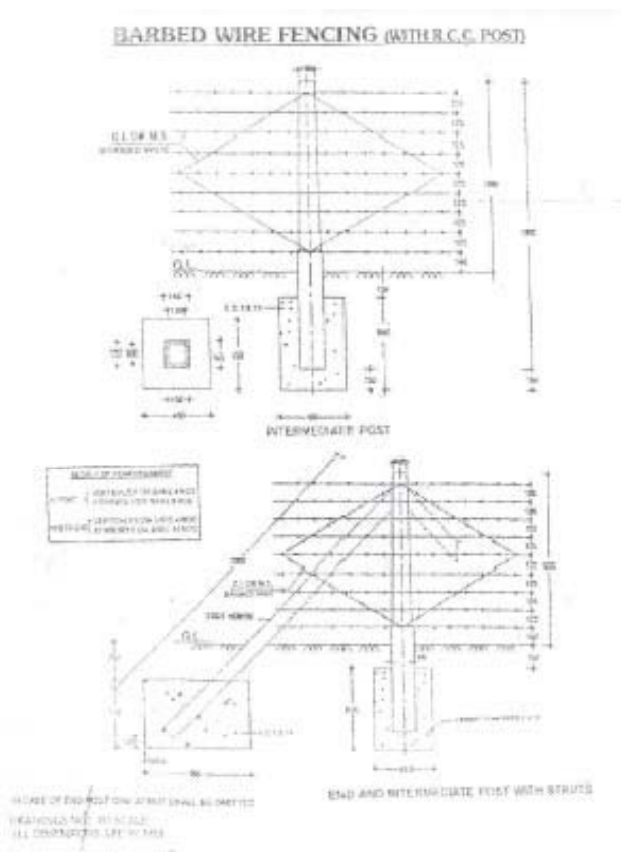
f) Electrode station fencing:

Amendment II SI No 193

The fence shall be 1.2 m high comprising of 1.8 m RCC standard posts, with wooden plugs or 6 mm bar nibs, placed every 3 m apart embedded in cement concrete blocks. Every 15th post, last but one end post and corner post shall be struttled on both sides and end post on one side only. ~~There shall be nine parallel horizontal lines of barbed wire~~

There shall be nine parallel horizontal lines of galvanized barbed wire

9.38 kg per 100 metres (minimum) between the two posts fitted and fixed with GI staples on wooden plugs or GI binding wire tied to 6 mm bar nibs. In addition to horizontal lines, two diagonals shall also be provided between the posts. The RCC posts and fencing shall be provided as per the enclosed drawing.



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8.10.6 BUILDING STORM WATER DRAINAGE

The building design shall provide for the collection of storm water from the roofs. This water shall be drained to the main drainage system of the station.

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

All drains inside the buildings shall have minimum 40 mm thick grating covers and in areas where heavy equipment loads would be coming, pre-cast RCC covers shall be provided in place of steel grating.

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

8.11 MISCELLANEOUS GENERAL REQUIREMENTS

Amendment II SI No 202

1. ~~Dense concrete with controlled water cement ratio preferably 0.45 shall be used~~

Dense concrete with controlled water cement ratio preferably 0.45 (As per IS 456) shall be used for all underground concrete structures such as pump-house, tanks, water retaining structures, cable and pipe trenches etc. for achieving water-tightness.

Amendment II SI No 203

~~For all civil works covered under this specification, nominal mix by volume batching as per CPWD specification is intended.~~

For all civil works covered under this specification design mix concrete is intended in conformity to IS 456. However, in case of repeater station work where, nominal mix by volume batching as per CPWD specification is intended. The relationship of grade of concrete and ratio of ingredients shall be as below:

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S.No.	Mix	Cement	Sand	Coarse Aggregate (As per IS 383)
1.	M10	1	3	6
2.	M15	1	2	4
3.	M20	1	1.5	3

Amendment II SI No 204

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

The material specification, workmanship and acceptance criteria shall be as per the provisions of IS 456:2000 In case of nominal mixes relevant clauses of CPWD specifications shall be adopted. Approved Field Quality Plan shall be followed for adherence to quality norms.

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2. All joints including construction and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 6 mm and minimum width shall be 230 mm.

In case the Contractor can demonstrate for adopting a suitable construction technique to avoid seepage of ground water, then the PVC water stops need not be used as specified above.

3. All steel sections and fabricated structures which are required to be transported on sea shall be provided with anti-corrosive paint to take care of sea worthiness.
4. All mild steel parts used in the water retaining structure shall be hot double dip galvanized. The minimum coating of the zinc shall be 750 gm/sq.m. for galvanized structures and shall comply with IS-2629 and IS-2633. Galvanizing shall be checked and tested in accordance with IS-2629. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS-3416.
5. A screed of concrete layers not less than 100 mm thick and of grade not weaker than M10 shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structures.
6. Bricks having minimum 75 kg/m² compressive strength can only be used for masonry work.
7. Monorails, monorail girders and fixtures shall be provided, wherever required.
8. Doors and windows on external walls of buildings (other than areas provided with insulated metal cladding) shall be provided with RCC sun-shade over the openings with 300 mm projection. Projection of sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings.
9. All stairs shall have a maximum riser height of 150 mm and a minimum tread width of 250 mm. Minimum clear width of stairs shall be 1500 mm.

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10. Angles with lugs shall be provided for edge protection all round cut outs/openings in floor slab, edges of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes supporting covers, supporting edges of pre-cast covers including cable trench covers and any other place where breakage of corners of concrete is expected.
11. Anti- termite treatment shall be done as per CPWD specification.
12. Hand railing minimum 1200 mm high shall be provided around all floor/roof openings, projections/balconies, walkways, platforms, steel stairs etc. All handrails and ladder pipes shall be 32 mm nominal bore MS pipes (medium class) and shall be galvanized (medium-class as per IS-277). All rungs for ladder shall also be galvanized as per IS-277 medium class.

Stairs within the service building shall be provided with 50mm dia stainless steel hand rail and, 20 mm dia stainless steel balustrades with suitable flats.

Amendment III SI No. 101

13. ~~All shuttering material used shall be of wood only.~~
All centering and shuttering materials used shall be of steel only. However, for sides of footings, beams and columns, densified wood may be used.
14. 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.

8.12 STATUTORY RULES

1. The Contractor shall comply with all the applicable statutory rules pertaining to Factories Act, Fire Safety Rules of Tariff Advisory Committee, and Water Act for pollution control etc.
2. Provisions for fire proof doors, number of staircases, fire separation wall, lath plastering on structural members (in fire prone areas) etc. shall be made according to the recommendations of Tariff Advisory Committee.
3. Statutory clearance and norms of State Pollution Control Board

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shall be followed as per Water Act for effluent quality from plant.

4. Requirement of sulphate resistant cement (SRC) for sub-structural works shall be decided in accordance with the Indian

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Standards based on the findings of the detailed soil investigation to be carried out by the Bidder/ Contractor.

5. Foundation system adopted by the Contractor shall ensure that relative settlement shall be as per provisions in IS-1904 and other Indian Standards.
6. All water retaining structures designed as un-cracked section shall also be tested for water tightness at full water level as per clause no. 10 of IS-3370 (Part-I).
7. Construction joints at the following locations shall be provided
 - a) At the meeting points of the columns and the raft.
 - b) At the points of contra flexure in the columns.

Additional reinforcements and shear keys shall be provided at the construction joints.

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

In case of water leakage in the above structures, Injection grouting shall be applied for repairing the leakage.

PGCIL Field Quality Plan

(Pages 1 to 20)

POWERGRID CORPORATION OF INDIA LIMITED

(Quality Assurance & Inspection Deptt.)

STANDARD FIELD QUALITY PLAN FOR SWITCHYARD CIVIL WORKS

Section : FOUNDATION MATERIALS

Sl. No.	Component/Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norm	Testing Agency	Remarks	Check
1.	CHECKING OF FOUNDATION MATERIALS					
A)	CEMENT					
i)	Fineness	One sample per lot of 100 MT or part thereof from each source for MTCs and one sample per lot of 200 MT or part thereof from each source for site testing	IS:456, IS:269	Manufacturer/ POWERGRID approved lab	Review of manufacturers test certificates (MTCs) and laboratory test results by POWERGRID	B
ii)	Compressive Strength		IS:8112, IS:12269			
iii)	Initial & final setting time		IS:1489 & POWERGRID specification			
iv)	Soundness					
v)	Heat of Hydration for low heat cement (Not applicable for OPC & PPC)					
vi)	Chemical Composition of Cement	One sample per lot of 100 MT or part thereof from each source for MTCs	IS:456, IS:269 IS:8112, IS:12269 IS:1489 & POWERGRID specification	Manufacturer	Review of manufacturers test certificates by POWERGRID	B
B)	COARSE AGGREGATES					
i)	Determination of Partical size (Sieve Analysis)	One sample per lot of 100 cubic meter or part thereof from each source for each size	IS:383, IS:2386 and POWERGRID specification	POWERGRID approved lab. However, Moisture content test for design mix concrete shall be done on all days of concreting at site.	Each source to be approved by POWERGRID Review and acceptance of test result by POWERGRID.	B
ii)	Flakiness Index					
iii)	Crushing Value					
iv)	Specific Gravity*					
v)	Bulk Density*					
vi)	Absorption Value*					
vii)	Moisture Content*					
viii)	Soundness of Aggregate**					
ix)	Presence of deleterious materials					
	* Applicable Design concretes only	** Applicable to concrete work subject to frost action				

POWERGRID CORPORATION OF INDIA LIMITED

(Quality Assurance & Inspection Deptt.)

C)	FINE AGGREGATE					
i)	Gradation/Determination of Particle size (Sieve Analysis)	One sample per lot of 100 cubic meter or part thereof from each source	IS:383,IS:2386,IS:456 and POWERGRID specification	POWERGRID approved lab. However Moisture content test for design mix concrete shall be done on all days of concreting at site.	Each source to be approved by POWERGRID Review and acceptance of test result by POWERGRID.	B
ii)	Specific Gravity and density					
iii)	Moisture content					
iv)	Absorption Value					
v)	Bulking					
vi)	Silt Content Test					
vii)	Presence of deleterious materials					
D)	BRICKS					
i)	Dimensional tolerance	As per enclosed Annexure-II	CPWD & POWERGRID specification	POWERGRID approved Lab.	Approved by POWERGRID	B
ii)	Compressible Strength					
iii)	Water Absorption					
iv)	Efflorescence					
E)	WATER					
i)	Cleanliness (Visual Check)	Random	IS:456, IS:3025 and POWERGRID specification. The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalies, organic materials, or other deleterious materials	Contractor	Each source to be approved by POWERGRID	B
ii)	Chemical and physical properties of water for checking its suitability for construction purposes	One sample per source	IS:456, IS:3025 and POWERGRID specification	Contractor/ POWERGRID Approved Lab	Approved by POWERGRID	B
	*Applicable to design mix concretes only					

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Sl. No.	Component/Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norm	Testing Agency	Remarks	Check
1.	REINFORCEMENT STEEL					
i)	Identification & size	Random	IS:432, IS:1139, IS:1786 & POWER GRID specification	Contractor	Approved by POWERGRID	B
ii)	Chemical Analysis Test	One sample per heat	IS:432, IS:1139, IS:1786 POWERGRID specification	Manufacturer	Review of manufacturers test certificates by POWERGRID	B
iii) iv) v)	Tensile Test Yield stress/proof stress Percentage Elongation	One sample per lot of 40 MT or part thereof for each size of steel conforming to IS: 1139 and 5 MT or part thereof for HDS wire for each size of steel as per IS: 432. For steel as per IS:1786 under 10mm 1 sample for each 25 MT or part thereof. 20 mm-16 mm 1 sample for each 35 MT or part thereof. Over 16mm 1 sample for each 45 MT or part thereof	IS:432, IS:1139, IS:1786 POWER GRID specification	Manufacturers/ POWERGRID approved lab	Review of manufacturers test certificates as well as lab test results by POWERGRID	B
vi)	Bend/Rebend Test	One sample per lot of 20 MT or part thereof for each size of steel as per IS:432, IS:1139. For steel as per IS:1786 under 10mm-16mm 1 sample for each 25MT or part thereof 10 mm-16mm 1 sample for each 45 MT or part thereof.	IS:432, IS:1139, IS:1786 POWER GRID specification	Manufacturers/ POWERGRID	Review of manufacturers test certificates as well as lab test results by POWERGRID	B
vii)	Reverse Bend Test for HDS wire	One sample per lot of 5 MT or part thereof for each size	IS:432 POWER GRID specification	Manufacturer/ POWERGRID approved lab	Review of manufacturers test certificates as well as lab test result by POWERGRID	B

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Section : FOUNDATION

Sl. No.	Component/Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norm	Testing Agency	Remarks	Check
C.	STRUCTURAL STEEL USED IN CABLE TRENCHES & FOUNDATIONS					
i)	Dimensional Check	Random	POWERGRID Specification & approved drawing	Contractor	Checklist to be prepared and signed jointly	B
ii)	Visual Check for damages, rusting, Pitting etc.	100%	POWERGRID Specification & approved drawing	Contractor	Checklist to be prepared and signed jointly	C
iii)	Visual Check for welding, defects, primer, coating and painting/galvanizing as applicable	Random	POWERGRID specification & approved drawings	Contractor	Checklist to be prepared and signed jointly	C
iv)	Physical properties of structural steel	1 sample per lot of 40 MT or part thereof for tensile tests and 1 sample per lot of 20 MT or part thereof for bend test for each size.	IS:2062, POWERGRID specification & approved drawings	Manufacturer/ POWER GRID Approved lab	Review of Mfgs. Test certificates as well as lab test results by POWERGRID	B

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Sl. No.	Component/Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norm	Testing Agency	Remarks	Check
2.	GANTRY/EQUIPMENT FOUNDATION/ CABLE TRENCH					
A.	BEFORE EXCAVATION					
i)	Checking of pegs condition as per line and alignment	100% on each location	IS:4091, IS:3764 & POWERGRID approved drawings/specification	Contractor	Approval by POWERGRID	C
ii)	Checking of pit making as per drawing & RL	100% on each location	IS:4091, IS:3764 & POWERGRID approved drawings/specification	Contractor	Approval by POWERGRID	C
B.	EXCAVATION					
i)	Dimensional conformity	Each location	IS:4091, IS:3764 & POWERGRID approved drawings/specification	Contractor	Approval by POWERGRID (JMC/MB)	B
ii)	Verticality/slopes & Squareness of each pit	Each location	IS:4091, IS:3764 & POWERGRID approved drawings/specification	Contractor	Checklist to be prepared and signed jointly	B
iii)	Verification of classification of foundation wherever applicable	Each location	IS:4091, IS:3764 & POWERGRID approved drawings/specification	Joint inspection by POWER GRID and contractor	Approval by POWERGRID	B
C.	FOUNDATION BOLTS/METALLIC INSERTS					
i)	Check for proper	100%	POWERGRID	Contractor	Checklist to be	C

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	identification foundation bolts w.r.t type of foundation		specification & approved drgs.		prepared and signed jointly	
ii)	Visual check for mechanical damage and galvanising/ painting if applicable for metallic insert	100%	POWERGRID specification & approved drgs.	Contractor	Checklist to be prepared and signed jointly	C
iii)	Alignment & Level	100%	POWERGRID specification & approved drgs.	Contractor	Checklist to be prepared and signed jointly	B
iv)	Grouting/Underpinning of foundation base plate	100%	POWERGRID specification & approved drgs.	Contractor	Checklist to be prepared and signed jointly	C
D.	P.C.C. Padding	For all locations	IS:456 and POWERGRID approved foundation drawings & specification	Joint inspection by POWER GRID and contractor	Approval by POWERGRID	B
E.	SHUTTERING(Form work)					
i)	Check for materials, breakage or damage	100%	IS:456, POWERGRID specification/ approved drawings	Joint inspection by POWER GRID and contractor	Approval by POWERGRID	C
ii)	Check for plumb, alignment parallelism, squareness and equidistance from stub	100% casting	IS:456, POWERGRID specification/ approved drawings	Joint inspection by POWER GRID and contractor	Approval by POWERGRID	B
iii)	Dimensional check	100% before casting	IS:456, POWERGRID specification/ approved drawings	Joint inspection by POWER GRID and contractor	Approval by POWERGRID	B
iv)	Check for level & height	100% before casting	POWERGRID specification/ approved drawings	Joint inspection by POWER GRID and contractor	Approval by POWERGRID	B
v)	Check for rigidity of	100%	POWERGRID	Joint	Approval by	B

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	frame/tightness		specification/ approved drawings	inspection by POWER GRID and contractor	POWERGRID	
vi)	Cleaning and oiling	100%	POWERGRID specification/ approved drawings	Joint inspection by POWER GRID and contractor	Approval by POWERGRID	B
vii)	Diagonal bracing if required as per drawings/site conditions	100%	POWERGRID specification/ approved drawings	Joint inspection by POWER GRID and contractor	Approval by POWERGRID	C
viii)	Checking of joints to avoid undue loss of cement slurry	100%	POWERGRID specification/ approved drawings	Joint inspection by POWER GRID and contractor	Approval by POWERGRID	C
E.	PLACEMENT OF REINFORCEMENT STEEL					
i)	Check the steel bars for rust, cracks, surface flaws, laminates etc. (Visual check)	100%	IS:456 and POWERGRID specification/ approved drawings	Joint inspection by POWER GRID and contractor	Approval by POWERGRID	C
ii)	Check as per the bar bending schedule before placement of concrete	For all locations	IS:456,IS:2502 and POWERGRID specification/ approved drawings	Joint inspection by POWER GRID and contractor	Approval by POWERGRID (Pour Card)	B
iii)	Check cutting tolerance for bars as per check list/drawings. Check whether all the bent bars and lap lengths are as per approved bar bending schedule	For all locations	IS:456,IS:2502 and POWERGRID specification/ approved drawings	Joint inspection by POWER GRID and contractor	Approval by POWERGRID (Pour Card)	B
iv)	Check whether all joints & crossing of bars are tied properly	100%	IS:456 and POWERGRID specification/	Joint inspection by POWER	Approval by POWERGRID	C

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	with right guage & annealed wire as per specification		approved drawings	GRID and contractor		
v)	Check for proper cover distance spacing of bars, spacers, & chairs after the reinforcement cage has been put inside the formwork	100%	IS:456 and POWERGRID specification/ approved drawings	Joint inspection by POWER GRID and contractor	Approval by POWERGRID	C
vi)	Check whether lapping of bars are tied properly with right gauge and annealed wire as per specification	100%	IS:456 and POWERGRID specification/ approved drawings	Joint inspection by POWER GRID and contractor	Approval by POWERGRID	B
G.	PILE FOUNDATION (Additional Tests)					
i)	Check of centre line of pile group	Each pile group	IS:2911 & POWERGRID approved pile foundation drawings/specification	Joint inspection by POWER GRID and contractor	Checklist to be prepared and signed jointly	B
ii)	Check pile location	Each pile	IS:2911 & POWERGRID approved pile foundation drawings/specification	Joint inspection by POWER GRID and contractor	Checklist to be prepared and signed jointly	B
iii)	Temporary casing tube & permanent liner also check thickness of liner material (if applicable)	Each pile	IS:2911 & POWERGRID approved pile foundation drawings/specification	Joint inspection by POWER GRID and contractor	Verticality of the tube to be checked	B
iv)	Bentonite slurry (if applicable)	Each pile	IS:2911 & POWERGRID approved pile foundation drawings/specification	Joint inspection by POWER GRID and contractor	Records to be kept by POWERGRID for specific gravity of slurry	B
v)	Pile depth, level, size	Each pile	IS:2911 &	Joint	Approved by	B

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	and alignment		POWERGRID approved pile foundation drawings/specification	inspection by POWER GRID and contractor	POWERGRID	
vi)	Chipping of pile head	Each pile	IS:2911 & POWERGRID approved pile foundation drawings/specification	Joint inspection by POWER GRID and contractor	Before concreting pile cap, pile head to be chipped off for concreting	B
vii)	Standard Penetrator Test	As per Powergrid BOQ/Specification	IS:2911 & POWERGRID approved pile foundation drawings/specification	Joint inspection by POWER GRID and contractor	Records to be kept by POWERGRID	B
viii)	Pile load testing	As per Powergrid BOQ/Specification IS:2911	IS:2911 & POWERGRID approved pile foundation drawings/specification	Joint inspection by POWER GRID and contractor	Records to be kept by POWERGRID Approval by POWERGRID	B
ix)	Anchor bolts if applicable					
a)	Level, centre to centre distance of bolts	100% on each location	POWERGRID approved pile foundation drawings/specification	Joint inspection by POWER GRID and contractor	Checklist to be prepared and signed jointly	B
b)	Visual check for galvanising	100% on each location	POWERGRID approved pile foundation drawings/specification	Joint inspection by POWER GRID and contractor	Checklist to be prepared and signed jointly	B
3.	CONCRETING					
A)	APPROVAL OF MIX DESIGN	Each Mix.	IS:456 & POWERGRID approved drawings and specifications	POWER GRID Approved by lab	Approval by POWERGRID	A
B)	BATCHING,MIX-	100%	IS:456 &	Joint	Approval by	B

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	ING & PLACING OF CONCRETE AND COMPACTING		POWERGRID approved drawings and specifications	inspection by POWER GRID and contractor	POWERGRID	
C)	FIXING OF CHIMNEY COLUMN Check for Width/length squareness, parallelism & equidistance from stub	100%	IS:456 & POWERGRID approved drawings and specifications	Joint inspection by POWER GRID and contractor	Approval by POWERGRID	C
D)	PLACING CONCRETE, AND COMPACTING	100%	IS:456 & POWERGRID approved drawings and specifications	Joint inspection by POWER GRID and contractor	Min. gap between boxes and reinforcement bars should be maintained Approval by POWERGRID	B
E)	CONCRETE TESTING					
i)	Slump test	One sample per foundation	IS:456,IS:516, IS:1199 and POWERGRID Specification	Contractor	Approval by POWERGRID	B
ii)	Check for quantities for cement, fine aggregate, coarse aggregate and water while batching	100% on all locations	IS:456,IS:516, IS:1199 and POWERGRID Specification	Contractor	Checklist to be prepared and signed jointly	B

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Sl. No.	Component/Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norm	Testing Agency	Remarks	Check
F)	CONCRETE CUBE TESTING					
i)	Compressive Strength	One sample for every 20 Cum of concreting or part thereof for each days concreting (one sample consists of min. 3 test cubes for 28 days strength).	IS:1199,IS:456, IS:516 and POWERGRID Specification	POWERGRID Approved lab	Approval by POWERGRID Cubes must be tested within a week after 28 days curing period and test results should be approved.	A
G)	CHECK FINISHING, DIMENSIONAL CONFORMITY AND WORKMANSHIP BEFORE & AFTER BOX REMOVAL	100%	IS:456,IS:516, IS:1199 and POWERGRID Specification	Contractor	Approval by POWERGRID	B
4.	BACKFILLING					
i)	Check for thickness of Layer & watering	100%	POWERGRID Specification and approved drawings	Contractor	Approval by POWERGRID	C
ii)	Visual check for correction/ramming	100%	POWERGRID Specification and approved drawings	Contractor	Approval by POWERGRID	C
iii)	Compaction test (Percentage of max. dry density)	Gantry Foundation-2 samples for each pit. Equipment	POWERGRID specification	POWERGRID approved lab	Review of lab test results by POWERGRID Elevation for testing to be	B

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		and other foundation-20% at random			decided by POWERGRID	
5.	BRICK-WORK					
i)	Mortar mix/proportion	Random	IS:2250, POWERGRID Specification & CPWD Specification	Contractor	Approval by POWERGRID	B
ii)	Plumb & Alignment	Random	POWERGRID Specification & CPWD Specification	Contractor	Approval by POWERGRID	B
iii)	Joints	Random	POWERGRID Specification & CPWD Specification	Contractor	Approval by POWERGRID	B
6.	PLASTERING					
i)	Plastering thickness and evenness	Random	POWERGRID Specification & CPWD Specification	Contractor	Approval by POWERGRID	B
ii)	Mortar mix proportion	Random	POWERGRID Specification & CPWD Specification	Contractor	Approval by POWERGRID	B
7.	CURING FOR CONCRETE, MASONRY, PLASTERING ETC.	100% on all location	IS:5613 & POWERGRID Specification	Contractor	Approval by POWERGRID	C
8.	SWITCH YARD EARTHING					
i)	Check for dimension of earth mat rod	Random	POWERGRID Specification & drawings	Contractor	Approval by POWERGRID	B
ii)	Depth of excavation	Random	POWERGRID Specification & drawings	Contractor	Approval by POWERGRID	C
iii)	Check for weld joints and anti corrosive treatment	Random	POWERGRID Specification & drawings	Contractor	Approval by POWERGRID	B
iv)	Backfilling	100%	POWERGRID Specification & drawings	Contractor	Approval by POWERGRID	C
9.	SITE SURFACING					
i)	Levelling	100%	POWERGRID Specification and approved drawings	Contractor	Checklist to be prepared and signed jointly	C

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ii) a)	Soil Sterilisation Spraying of chemicals	100%	POWERGRID Specification and Manufacturers recommendations	Con tractor	Checklist to be prepared and signed jointly	B
iii)	Grading of 20/40mm Stone	1 sample per lot of 500 Cubic Metre or part thereof from each source for each size	IS: 383, IS: 2386 and POWERGRID Specification. The grading shall be as per single sized nominal size	Contractor/ POWERGRID Approved lab	Each source to be approved by POWERGRID Review and acceptance of test results by POWERGRID	B
iv)	Compacted thickness of 20/40 mm stone layers as applicable	Random	POWERGRID Specification and specification drawings	Contractor	Checklist to be prepared and signed jointly	B

Section: GENERAL GUIDELINES FOR IMPLEMENTATION

1. Details of categories of check codes A,B & C including accepting and deviation dispositioning authorities are indicated at Annexure-I.
2. POWERGRID specification shall mean POWERGRID technical specification, approved drawings data sheets and LOA provisions applicable for the specific contract.
3. Acceptance criteria and permissible limits for certain tests are indicated at Annexure-II. For balance tests, site to verify the same with respect to POWERGRID specification, relevant Indian Standards and/or prevalent code of practice.
4. It is clarified that the tests indicated at column 2 of this FQP i.e. against column “Component operation & Description of Test”, are only generally required to be conducted. However, POWERGRID reserves the right to carry-out any additional tests at any stage if the situation so warrants.
5. POWERGRID site representative shall witness all the tests conducted by the contractor as mentioned in the FQP. However, in case of tests conducted in the POWERGRID approved lab, it is preferred to witness the tests in the lab itself, if possible.
6. Head of GHQ shall approve testing laboratory before accepting the test results from the lab.
7. Head of GHQ shall approve the sources for cement , coarse aggregate, fine aggregate & water before actual utilization.
8. All the testing & measuring equipments used by the contractor for testing are required to be calibrated. A copy of valid calibration report shall be retained by POWERGRID as records.
9. Classification of foundations shall be approved by POWERGRID based on the Joint Inspection Report & soil investigation reports.
10. Curing of concrete work should be continued for minimum period of 10 days.

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11. ZONE-IV FINE AGGREGATE

11.1 Zone-IV fine aggregate shall be used for nominal mix. Reinforced cement concreting work.

11.2 Zone-IV fine aggregate shall be avoided for design mix reinforced cement concreting work unless tests have been done to ascertain the suitability of proposed with the prior approval POWERGRID site.

12. Bricks should be free from cracks, flaws and modules of free lime. They should have smooth rectangular faces with sharp corners and should be uniform in colour.

13. CEMENT

13.1 In case of cement is in the scope of the contractor, the same shall be procured from sources approved by POWERGRID site and got tested on sample basis for specified acceptance tests as specified in the FQP at a reputed Third Party Lab approved by POWERGRID site.

13.2 The samples of cement for site testing shall be taken within three weeks of the delivery and all the tests shall be commenced within one week of sampling. If the cement remains in store for a period of more than six months. All the site tests are required to be repeated before usage.

14. REINFORCEMENT STEEL & STRUCTURAL STEEL USED IN CABLE TRENCHES & FOUNDATIONS

14.1 In case supply of steel is in the scope of the contractor, the same shall be procured from the main producers i.e. SAIL, TISCO, IISCO or Rashtriya Ispat Nigam or the rerollers approved by main producers. The steel shall be got tested at site on sample basis for specified acceptance tests as specified in this FQP at a reputed Third Party Lab approved by POWERGRID site.

14.2 The results of the testing of cement and reinforcement steel referred in 13.1 and 14.1 above shall be got approved from POWERGRID site before cement and reinforcement steel are put to use. However, in exceptional cases due to exigencies of work. POWERGRID site may authorize the contractor to use Cement and Reinforcement Steel even before the test results are received. However, in all such cases, if the test results subsequently received are found to be not complying with the specified acceptance criteria, the contractor shall have to dismantle and recast all such foundations cast with such non-conforming materials at his own cost. Confirmation to this effect shall be obtained from the contractor by the Project authorities beforehand in all such cases.

15. The contractor shall submit welding procedure specification (WPS) including the type of electrode used for approval of POWERGRID site before starting the welding work.

16. Approval/acceptance of individual test results by POWERGRID in the course of execution of contract will not relieve the contractor of his contractual obligations and responsibilities, nor does it limit the Owner's right under the contract.

17. In case, requirement of special items like Super Sulphated Cement, Corrosive Resistant Reinforcement Steel (CRRS) etc. arise due to site conditions, the specific approval of POWERGRID may be obtained before using the same and all the tests as per relevant standards shall be carried out.

18. All the materials shall be stored by the contractor in a manner affording convenient access for identifications and inspection at all times. Storage of material shall be in accordance with IS: 4032 (Latest Edition).

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ANNEXURE-I

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ACCEPTING AND DEVIATION DISPOSITIONG AUTHORITIES FOR DIFFERENT CATEGORIES OF CHECKS AS ENVISAGED IN FIELD QUALITY PLANT

CATE GORY	TYPE OF CHECK	100% CHECKING/WITNESSING BY	COUNTER CHECK/SURVEI LLANCE CHECK BY	ACCEPTING AUTHORITY, IF TEST RESULTS ARE WITHIN PERMISSIBLE LIMITS	DEVIATION DISPOSITIONING AUTHORITY
'A'	CRITI- CAL	EXECUTING DEPTT. PLUS FQA REPRESN-TATIVE GHQ	FQA REPRESN TATIVE AND RHQ/DHQ REPRESN TATIVE	HEAD OF DHQ	HEAD OF RHQ IN CONSULTATION WITH CQA, IF REQUIRED.
'B'	MAJOR	EXECUTING DEPTT.	DHQ- REPRESENTATI VE	HEAD OF GHQ	HEAD OF DHQ
'C'	MINOR	CONTRACTORS REPRESENTATIVE	EXECUTING DEPTT.	MINIMUM E4 LEVEL EXECUTING OF SUB- STATION/TL	HEAD OF GHQ

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ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR FOUNDATION MATERIALS AND CONCRETE

A) CEMENT

S. No.	Description of the tests	33 Grade OPC as per IS:269	43 Grade cement as per IS:8112	PPC as per IS:1489	Low Heat cement
1.	Fineness (min.)	225 m ² /kg	225 m ² /kg	300 m ² /kg	225 m ² /kg
2.	Compressive strength (min.) 72 ± 1 hours 168 ± 2 hours 672 ± 4 hours	160 kgf/cm ² 220 kgf/cm ² -	23 MPa 33 MPa 43 MPa	16 MPa 22 MPa 33 MPa	100 Kgf/cm ² 160 Kgf/cm ² 350 Kgf/cm ²
3.	Initial setting time (min.)	30 minutes	30 minutes.	30 minutes	30 minutes
4.	Final setting time (max.)	600 minutes	600 minutes	600 minutes.	600 minutes.
5.	Soundness (Le Chatelier Method)	Maximum 10 mm expansion	Maximum 10 mm expansion	Maximum 10 mm expansion	Maximum 10 mm expansion
6.	Heat of Hydration (max.)	-	-	-	Max. 65 cal/gm for 7 days & max. 75 cal./gm for 28 days
7.	Chemical composition	As per IS	As per IS	As per IS	As per IS

B) COARSE AGGREGATE :

(i) Sieve Analysis

IS SIEVE DESIGNATION	PERCENTAGE PASSING FOR GRADED AGGREGATE OF NOMINAL SIZE		PERCENTAGE PASSING FOR SINGLE SIZED AGGREGATE OF NOMINAL SIZE	
	40 mm	20 mm	40 mm	20 mm
63 mm	-	-	100	-
40 mm	95 to 100	100	85 – 100	100
20 mm	30 to 70	95 to 100	0 – 20	85 - 100
10 mm	10 to 35	25 to 55	0 – 5	0 - 20
4.75 mm	0 to 5	0 to 10	-	0 - 5

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- (ii) Flakiness Index Not to exceed 25%
- (iii) Crushing value Not to exceed 45%
- (iv) Soundness of aggregate applicable for concrete works subject to frost action Loss of weight after 5 cycle not to exceed 12% when tested with Sodium sulphate and 18% when tested with magnesium sulphate
- (v) Deleterious material Not to exceed 5% of the weight of aggregate when tested as per IS:2386 Part – II (1963)

(C) FINE AGGREGATE

- (i) Sieve Analysis Shall confirm to Zone-I, Zone-II or Zone-III

IS Sieve designation	Grading Zone-I	Percentage Grading Zone-II	Passing for Grading Zone-III	Grading Zone-IV
10 mm	100	100	100	100
4.75 mm	90 - 100	90 - 100	90 - 100	90 - 100
2.36 mm	60 - 95	75 - 100	85 - 100	95 - 100
1.18 mm	30 - 70	55 - 90	75 - 100	90 - 100
600 Micron	15 - 34	35 - 59	60 - 79	80 - 100
300 Micron	15 - 20	8 - 30	12 - 40	15 - 50
150 Micron	0 - 10	0 - 10	0 - 10	0 - 15

- (ii) For guidance of adjusting sand in mix of concrete, the following table may be used.

Moisture Content %	building % by volume
2	15
3	20
4	25
5	30

- (iii) Silt Content Test: Shall not exceed 8% when tested as per test procedure specified in appendix-D of chapter 3 of 1991-92 CPWD Specification.
- (iv) Deleterious Materials: Total deleterious material shall not be more than 5% by weight.

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(D) REINFORCEMENT STEEL: As per relevant Indian Standards.

(E) CONCRETE CUBE TEST

For nominal (volumetric) concrete mixes, compressive strength for 1:1½:3 (cement : sand : coarse aggregate) concrete shall be 265 kg/cm² for 28 days and for 1:2:4 nominal mix, it shall be 210Kg/cm².

(F) ACCEPTANCE CRITERIA BASED ON 28 DAYS COMPRESSIVE STRENGTH FOR NOMINAL MIX CONCRETE

- (a) The average of the strength of three specimen be accepted as the compressive strength of the concrete, provided the strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.
- (b) If the actual average strength of accepted sample exceeds specified strength by more than 30%, the Engineer-in-charge, if he so desires, may further investigate the matter. However, if the strength of any individual cube exceeds more than 30% of specified strength, it will be restricted to 30% only for computation of strength.
- (c) If the actual average strength of accepted sample is equal to or higher than specified strength upto 30%, then strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.
- (d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted at reduced rate at the discretion of Engineer-in-Charge.
- (e) 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 contract. 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.

(G) ACCEPTANCE CRITERIA FOR DESIGN MIX CONCRETE SHALL BE AS PER IS:456.

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ANNEXURE-2

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(H) SAMPLING PLAN FOR BRICK WORK

- i) 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.

- ii) 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

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

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(I) ACCEPTANCE CRITERIA FOR BRICK-WORK

- (i) Dimensional tolerances: The dimensions of modular bricks when tested shall be within the following limits per 20 bricks.

Length 372 to 388 cm (380 ± 8 cm)

Width 176 to 184 cm ($180 \pm$ cm)

Height 176 to 184 cm (180 ± 4 cm) for 90 mm high bricks

- (ii) In case of non-modular bricks, %age tolerance will be +/- 2% for group of 20 numbers of class 10 bricks and +/- 4% for other class of bricks.

- (iii) 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.

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

- (v) Efflorescence: The rating of efflorescence of bricks shall not be more than moderate.