T E N D E R S P E C I F I C A T I O N

NO: BHE/PW/PUR/MANUT-CVL (Levelling & Grading)/1446

Leveling, Grading and Road Work up to Water Bound Macadam Level including Excavation, Backfilling, filling with borrowed soil and/or Morrum, disposal of unserviceable earth and all associated works, complete as per specification of entire Plant Area.

AT

4x270 MW BHADRADRI TPS, MANUGURU

TELANGANA STATE

TECHNICAL BID- VOLUME- I E

CONSISTS OF:

a. **Volume- II B –Section-D General Technical Specification**
b. **Section C Technical Specification.**

Bharat Heavy Electricals Limited
(*A Government of India Undertaking*)
Power Sector - Western Region
345-Kingsway, Nagpur-440001

VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-999-600-C025

SECTION - D

GENERAL TECHNICAL SPECIFICATION

SITE LEVELING AND GRADING

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

GENERAL TECHNICAL SPECIFICATION FOR SITE LEVELLING AND GRADING

1.00 GENERAL

This specification cover the works to be carried out for **"Site Levelling and Grading Works including Slope Protection"** etc for the entire plant and associated areas. The specified formation level(s) shall be achieved either by excavation or by raising with controlled fill with excavated/borrowed earth as the case may be.

2.00 SCOPE

2.01 The scope include all works involved in levelling the site to the lines, grades, cross sections and dimensions as shown on the approved drawings and/or as directed by the engineer including site clearance, setting out, earth work in excavation, stacking, loading, transportation, unloading, dewatering, drainage, filling, watering, compaction, turfing on slopes (if required), lighting, disposal of residual/surplus earth etc. It also include supplying and providing all labour, materials, supervision, services, equipments, tools and plants, testing and all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work etc.

2.02 All tools and plants, equipments and machineries to be used in this work shall be of standard quality and manufactured by reputed concerns conforming to Indian Standard (IS) codes or equivalent thereof.

2.03 Work to be provided by the Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision, services including as required under statutory labour regulations, materials, equipments, tools and plants, approaches, transportation etc required for the completion of the work.

b) Preparation and submission of detailed scheme of all operations required for executing the work (material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.

2.04 Work to be provided by others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.05 Codes and Standards

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) codes unless specified otherwise.

IS: 1200 Methods of measurement of building and civil engineering works, Part-1: Earthwork

IS: 2720 Method of test for soils (Relevant parts)

IS: 3764 Excavation work- Code of safety

IS: 4081 Safety code for blasting and related drilling operations

IS: 4701 Code of practice for earthwork on canals

IS: 6922 Criteria for safety and design of structures subject to underground blasts

In case of conflict between this specification and those (IS codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by the specification or/and by the IS codes, any other standard practice as may be specified by the engineer shall be followed.

2.06 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

3.00 MATERIALS

All materials required for the work shall be of best variety and approved by the engineer.

3.01 Materials for Excavation

For the purpose of identifying the various strata met during the course of excavation, the following classification is to be followed.

a) Soil

It include all type of soil including laterite, moorum etc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall under **clause** 3.01 (b) and (c) etc.

b) Soft Rock

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.

c) Hard Rock

It includes the rocks, which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

3.02 Materials for Filling

Any coarse grained or fine grained low plastic soil free from vegetation, roots, shingle, salts, organic matters, sod and any other harmful chemicals shall be used for filling. The contractor shall test the fill material to establish its suitability and submit the results to the engineer for approval. Fill material shall be got approved by the engineer. The following type of materials shall not be used for filling.

a)Materials from swamps, marshes and bogs
b)Expansive clays
c)Peat, logs, sod and perishable materials
d)Materials susceptible to combustion
e)Any material or industrial and domestic produce which will adversely affect other materials of work
f)Materials from prohibited areas

The earth available by cutting the high grounds within the project site and the materials (if) available from the road excavation or any other excavation under the same contract shall be used for filling depending upon its suitability as fill material. Filling with excavated rock (in the project site) shall be done only with

the written permission of the engineer in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as for as possible and the mixture shall then be used for filling. In case the earth required for filling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. He shall obtain and submit the necessary clearances/permissions from the concerned authorities to the engineer for the borrow areas/materials acquired.

4.00 QUALITY CONTROL

All works shall conform to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Filling	(a) On quality of fill material (b) On moisture content of fill material (c) On degree of compaction achieved

5.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of approaches, dewatering (if any), drainage and compaction etc within 15 days of award of the contract to the engineer for approval.

5.01 Site Clearance

Before the commencement of earthwork, the entire area of cutting and filling shall be cleared of all trees, stumps, bushes, grasses, vegetation etc with their roots, fences, logs, rubbish, water, slush etc. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below the existing ground level or 300mm below the formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm

layers (loose thickness) and compacted unless otherwise directed by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed off to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timbers, fire woods etc shall be the property of owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

5.02 Setting Out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for the ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. The contractor shall take spot levels of the area (with respect to the bench mark/ available source as provided by the engineer) to be excavated or to be filled at an interval of not more than 10m or as directed by the engineer before starting any earth work and shall be submitted to the engineer for prior approval.

5.03 Excavation

Levelling by excavation shall be carried out where the existing ground levels are higher than the specified formation level. Excavation shall include removal of all materials whatever nature as may be and whether wet or dry shall be carried out exactly in accordance with the line, levels, grades and curves shown on the approved drawings and/or as directed by the engineer. All excavations shall be done to the minimum dimensions as required. The contractor shall obtain prior approval of the engineer for the method he proposes to adopt for excavation in different types of strata including dimensions, side slopes and dewatering if any, stacking or disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. **Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.**

The rough excavation may be carried up to a maximum depth of 150mm above the final formation level. The balance shall be excavated with special care and the final surface shall be compacted by rolling with 6 passes of 8 to 10 tonne

roller. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The contractor shall be paid for the extra excavation and filling at the appropriate items of work.

If the excavation is done to a depth greater than that shown on the drawing or as directed by the engineer due to the contractor's fault, the excess depth shall be filled up to the required level with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer at the own risk and cost of the contractor.

Suitable slope in cutting as per the requirements and as directed by the engineer shall be adopted to withhold the face of earth. The contractor shall be held responsible for any damage to any part of the work caused by the collapse of the side of excavations.

5.03.01 Excavation in Hard Rock

Excavation in hard rock shall normally be done with blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces.

5.03.02 Blasting

a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to

transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well-ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.

Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful

* not to put their feet on the clean floor unless the magazine shoes on.

* not to touch the magazine shoes on ground outside the clean floor.

* not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.
The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be

present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

5.03.04 Restrictions on Blasting

a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
e) The last blast shall not be more than 0.50 m in depth.
f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

5.04 Sorting of Excavated Materials

The excavated material shall be carefully sorted for use in filling the areas in the project site by removing roots, grasses, organic matters and other objectionable materials and be sorted out into different types of materials for use and as directed by the engineer. The excavated material which is not considered fit for filling purpose shall be immediately removed and disposed at such a place and in such a manner as will be directed by the engineer. The material found unusable should be got approved by the engineer before actually disposing it off. The useful materials that cannot be used directly shall be heaped in separate area as stock piles. Stockpiles shall be of regular size as for as possible for ease of measurement. The materials heaped shall be utilised as and when required and as directed by the engineer. The cost of complete item of earthwork includes the cost of rehandling of the materials and temporarily heaped and reused.

5.05 Disposal of Surplus/ Waste Materials

Surplus and other waste materials shall be removed and disposed of from the construction site to the area demarcated by the engineer. No material shall be wasted unless approved by the engineer.

5.06 Earth Work in Filling

Levelling by raising with controlled fill of approved excavated/borrowed earth shall be carried out where the existing ground levels are lower than the specified formation level. After clearing site as per clause 5.01, the original ground shall be compacted by rolling subject to a minimum 6 passes of 8 to 10 tonne roller. The approved earth/fill material shall then be spread in horizontal layers not exceeding 300mm in compacted thickness. Each layer shall be watered and thoroughly compacted with proper moisture content and such equipments as may be required to obtain a minimum of 95% of its maximum dry density as determined by standard Proctor's test as per IS: 2720 part-VII or 85% of relative density as per IS:2720 part-XIV as specified. Moisture content of the fill material shall be controlled near optimum moisture content during compaction

The fill material shall be tested for its optimum moisture content and maximum dry density as per IS: 2720, part-VII. Moisture content shall be checked at the source of supply in accordance with IS:2720 part- II and if found less than that required for proper compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case, water shall be sprinkled directly from the hose line or from the truck-mounted water tank etc making due allowance for evaporation losses and the fill material be thoroughly mixed by means of harrows, rotary mixers or by any other suitable approved method until the layer is uniformly wet. **Flooding shall not be permitted for watering purpose under any circumstances.** If the material delivered is too wet, it shall then be dried by aeration and exposure to the sun till the moisture content is suitable for compaction. Should circumstances arise owing to wet weather the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended. Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the layers before compaction. For each of the above tests on the fill material, one sample for every 10,000cu.m shall be tested. Additional samples shall be tested whenever there is a change of source or type of material.

Before start of filling, the contractor shall submit the engineer his proposal for the methodology to be adopted for compaction. The compaction equipments as approved by the engineer shall only be employed to compact the different type materials encountered during construction. If directed by the engineer, the contractor shall demonstrate the efficacy of the plant he intends to use by carrying out compaction trials. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

The compacted layer shall be tested for its dry density as per IS:2720**,** part-XXVIII or XXIX as directed by the engineer. Samples shall be taken at the rate

of one sample for every 10,000sq.m area of each compacted layer. In addition random checks shall be carried out in compacted layers by means of Proctor needle penetration test. Contractor shall submit all the test results to the engineer immediately after completion of the tests. A sample shall be deemed to have passed the test when the dry density of the compacted fill is equal to or more than 95% of its maximum dry density. When field density measurements reveal any soft areas in the fills, further compaction shall be carried out as directed by the engineer. If in spite of that, the specified compaction is not achieved, the material in the soft areas shall be replaced with approved material compacted to the density requirements and satisfaction of the engineer.

Subsequent layers shall be placed only after the finished layer has been tested and accepted by the engineer.

Where the filling is to be done across low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

5.07 Dewatering and Drainage

It shall be ensured that the area to be excavated/filled shall be free from water. The contractor shall remove the water (if any) by pumping or by any other means as approved by the engineer. At all times, the surface of cutting/filling during execution shall be maintained at such a cross fall as will shed water and prevent ponding. All existing drains/channels (if any) in the work area shall be suitably diverted by the contractor before taking up any excavation or filling. These diversions shall be such that it shall ensure effective disposal of water without any accumulation or flooding within the project site and in adjoining areas.

5.08 Finishing Operations

Finishing operation shall include the work of shaping and dressing the excavated/filled ground to the required grades, levels, lines, side slopes, cross-sections and dimensions as shown on the approved drawings or as directed by the engineer.

5.09 Turfing

Turfing shall be provided at the slopes and other locations as shown on the drawings or as directed by the engineer. The turf shall be of approved quality of grass. The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds or other undesirable matter. The grass on the sod shall have a length of approximately 50mm and the sod shall be free of any

debris. Thickness of the sod shall be as uniform as possible with 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that all the dense root system of the grasses are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than about 300mm x 250mm size but not so large so that it is convenient to handle and transport without damage.

The area to be sodded shall be previously constructed to the required slope and cross section. Prior to placing the sods, the slopes shall be **roughned** and wetted in order to have a satisfactory bond. The strips of sod shall be laid in close contact with each other and be tamped firmly in place so as to fill and close the joints between them. The turfing so laid shall be well watered and protected until final acceptance.

5.10 Approaches

The contractor shall provide proper approaches for workmen and inspection.

5.11 Lighting

Full scale lighting are to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the edges of excavations and fills.

6.00 RATES AND MEASUREMENTS

6.01 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding sections in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

a) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

SECTION - D

SUB-SECTION – D16

ROADS AND DRAINAGE

C 0 N T E N T

Road And Drainage

1.00.00 Scope

The scope include all works required for the construction of road including construction of embankment, sub-base course, base course, tack coat, bituminous macadam, wearing course, liquid seal coat, shoulder and all incidental items of work specified or not shown but reasonably implied or necessary for the completion of the work etc.

The scope also include all works required for the construction of drainage including construction of road side drains, RCC culverts, pipe culverts, drainage pipes, manholes and all other incidental items necessary for the completion of the work etc.

1.01.00 Works To Be Provided By The Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

a) Construction of roads including providing all materials, labour, supervision, services, equipments, tools and plants, transportation etc all required for the completion of the work.

b) Submission of detailed scheme of all operations required for executing the work (e.g. material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out tests whenever required by the engineer to assess the quality of work and submission of the test results to the engineer after completion of the same etc.

1.02.00 Work To Be Provided By Others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

1.03.00 Conformity With Designs

The contractor shall carryout the work as per the construction drawings, specification and as directed by the engineer.

1.04.00 Materials To Be Used

All materials required for the work shall be the best commercial variety and as approved by the engineer.

2.00.00 Codes and Standards

All works under this specification shall conform to the latest revision and/or replacement of the following or any other IRC/IS Codes and Standard Practices unless specified otherwise.

a) Specification for road and bridge works of Ministry of Shipping & Transport (Road Wing) Published by the IRC

b) IRC: 19 - Standard specification and code of practice for Water bound Macadam

c) IRC :SP 11 - Hand Book of Quality Control for Construction of Roads and Runways

d) IS:456 - Indian Standard Code of Practice for Plain and Reinforced Concrete.

e) IS:2212 - Code of Practice for Brick work

f) IS: 783 - Code of Practice for Laying of Concrete Pipes

g) IS: 1201 - Methods of testing tar and bituminous materials to 1220

h) IS: 73 - Specification for paving bitumen

i) IS: 215 - Specification for Road tar

j) IS: 216 - Coal tar pitch

k) IS: 217 - Specification for cut-back bitumen

l) IS: 454 - Specification for cut-back bitumen from waxy crude

m) IS: 1834 - Specification for hot applied sealing compound for joint in concrete

n) IS: 1838 - Specification for performed fillers for expansion joints in concrete, non extruding and resilient type

Part I Bitumen impregnated fibre

Part II CNSL Aldehyde resin and coconut pith

o) IS : 334 - Glossary of terms relating to bitumen and tar

p) IS: 1077 - Common burnt clay building bricks.

q) IS : 3117 - Specification for bitumen emulsion roads (anionic type).

r) Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by the specification/Indian Standard Code of practices, any other standard practice as may be specified by the engineer shall be followed.

2.01.00 Quality Control

The Contractor shall establish and maintain quality control for all materials, procedures, workmanship and equipments used. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings, specification and as directed by the engineer. Permitted tolerances for road works are described hereinafter.

a) Horizontal Alignment

Horizontal alignment shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 25mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of the pavement shall be ± 40mm.

b) Longitudinal Profile

The finished levels of the sub-grade and different pavement courses as constructed shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the engineer and shall not exceed the tolerances as mentioned below.

Sub-grade ± 25 mm

Sub-base ± 20 mm

Base course ± 15 mm

Wearing course ± 10 mm

Tolerance in wearing course shall not be permitted in conjunction with the positive tolerance on base course if the thickness of the wearing course is thereby reduced by more than 6 mm.

c) Surface Regularity of Sub-grade and Pavement Courses

The surface regularity of the completed sub-base, base course and wearing surfaces in the longitudinal and transverse directions shall be within the

tolerances indicated in Table - I. The longitudinal profile shall be checked with a 3m long straight edge at the middle of each traffic lane along a line parallel to the centre of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10m.

TABLE –I

PERMITTED TOLERANCE OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sl. No.	Type of Construction	Longitudinal profile with 3m straight edge					Cross Profile
		Maximum permissible Undulation (mm)	Maximum number of undulations permitted in any 300m length with undulation exceeding (mm)				Maximum permissible variation from specified profile under camber template (mm)
			18	12	10	6	
1	2	3	4	5	6	7	8
1.	Earthen sub-grade	25	30	-	-	-	15
2.	Granular sub-base	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50 mm and 40-63 mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.	Surface dressing** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam	12	-	-	20	-	8
6.	Open graded premix carpet, mix seal Surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20***	6
8.	Semi-dense carpet	10	-	-	-	20***	6
9.	Asphaltic Concrete	8	-	-	-	10***	4

Notes:

1. ** For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

2. *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Engineer. However this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3.00.00 Execution

3.01.00 Setting Out

Within 15 days of the award of contract, the contractor shall prepare and submit to the Engineer, detailed drawings/schemes of embankment filling and excavation works as proposed to be executed by him showing the dimensions as per construction drawings and specification adding his proposals of drainage and dewatering of pits, watering and compacting the embankment fill etc. On receiving the approval from the Engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the contractor shall proceed with the work. It should be noted that this checking by the Engineer prior to the start of the work will in no way absolve the contractor of his responsibility of carrying out the work to true lines and levels as per the approved drawings. If any errors are noticed in the Contractor's work at any stage, the same shall be rectified by the contractor at his own risk and cost. Profiles of the embankment made by Bamboo, earth or other convenient materials and strings shall be set up at suitable intervals for the guidance of the workmen.

3.02.00 Clearing and Grubbing etc

Before commencement of earthwork, the surface area of ground to be occupied shall be cleared of all fences, trees, logs, stumps, bush, vegetation, rubbish, slush etc. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below ground level or 300mm below formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the Engineer. The trees shall be cut into suitable pieces as instructed by the Engineer. Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to the approved disposal areas as may be specified. Useful materials, saleable timbers, firewood, etc shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.03.00 Filling in Embankment

3.03.01 General

The material used for constructing the embankment shall be earth, moorum, gravel or a mixture of the above or any other material approved by the Engineer. The material shall be free from lumps & clods, boulders and rock pieces, roots and vegetation, harmful salts and chemicals, organic materials, loose silts, fine sands and expansive clays in order to provide a stable embankment. The filling and compaction operation should be such that the best available materials are saved for the top portion and will result in an acceptable and uniform gradation of material and provide impermeability and stability to the embankment when compacted. The size of the coarse material in the mixture of earth shall ordinarily not exceed 75mm. However, the Engineer may at his discretion permit the use of material coarser than the specified if he is satisfied that the same will not present any difficulty as regard to the placement and compaction of the fill material are concerned. Ordinarily, only the materials satisfying the density requirements as given below in Table-II shall be employed for embankment construction.

Table - II

Density Requirements of Embankment Materials

Sl. No.	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part - VII)
1.	Embankment upto 3m height	Not less than 1.44 gm/cc
2.	Embankment exceeding 3m height and embankment of any height subject to long period of inundation	Not less than 1.52 gm/cc
3.	Top 0.5m of the embankment below sub-base and shoulders (where earth shoulders are specified)	Not less than 1.65 gm/cc

Expansive clays exhibiting marked swell and shrinkage properties shall not be used for embankment construction.

The material for embankment construction shall be obtained from approved sources with preference given to the materials available from nearby road excavation or any other excavation under the same contract.

3.03.02 Setting Out

After the site clearance, the work shall be set out true to lines, curves, slopes, grades and sections as shown on the approved drawings or as directed by the Engineer. The contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboo, stones, lime, mortar, concrete etc required in connection with the setting out of the works and establishment of the bench marks. The limits of the embankment shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. To ensure the safety, the pegs should normally be fixed about 500mm away from the actual limits of the fill and to be painted in a distinct colour. The centreline of the embankment shall be pegged at regular intervals of 25/30m and at all skews/curves. The actual profile of the embankment shall be made at every third centreline peg with bamboo posts and strings. Preferably prototype profiles developed with wooden planks need to be fixed at every 200m and at the intersection points at curves. The profile shall be about 3m long.

3.03.03 Stripping and Storing top soil

The construction of the earthen embankment by filling shall conform to the dimensions, slopes and other details shown in the approved drawings. Before commencement of the embankment construction, the surface area of ground to be occupied after clearing and grubbing shall be stripped off to a minimum depth of 150mm or more as directed by the Engineer in order to remove all perishable material and any soil which may become unstable on saturation or may interfere with the development or proper bonding between the foundation and embankment. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. In localities where most of the available embankment fill materials are not conducive to plant growth or when so directed by the Engineer, the top soil shall be stripped to specified depths not exceeding 150mm.

3.03.04 Compacting Original Ground

In all cases, the original ground after stripping shall be compacted by rolling with a minimum of six passes of 8-10 tonne roller and as directed by the Engineer. Where the height of the proposed embankment is less than 0.5m and the original ground does not already have a relative compaction of atleast 95 percent, the same shall be loosened upto a depth of 0.5m and filled in layers not exceeding 250mm in loose thickness and each layer shall be watered and compacted to 100% maximum dry density of the fill material determined in accordance with IS:2720, Part-VII. However, before relaying and compacting the loosened material, the surface below this level shall be suitably compacted as directed by the Engineer with a minimum of six passes of a 8 - 10 tonne roller.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced with approved materials

suitably compacted. Embankment work shall not proceed until the foundation soil of the embankment is inspected by the Engineer and approved.

3.03.05 Filling

The embankment material shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness. Successive layers of embankment shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down hereunder. Moisture content of the fill material shall be checked at the source of supply and if found less than that specified for compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case water shall be sprinkled directly from a hose line or from a truck mounted water tank and flooding shall not be permitted under any circumstances. After adding required amount of water, the soil shall be processed by means of harrows, rotary mixers or by any other approved methods until the layer is uniformly wet.

If the material delivered to the road bed is too wet, it shall be dried by aeration and exposure to the sun till the moisture content is acceptable for compaction. Should circumstances arise where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended.

Moisture content of each layer shall be checked in accordance with IS:2720, Part-II and unless otherwise specified shall be so maintained making due allowance for evaporation losses that during compaction, the moisture content shall be in the range of 1 percent above to 2 percent below the optimum moisture content as determined in accordance with IS:2720, Part-VII.

Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5m portion of the embankment below sub-base.

Hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.

Where the embankment is to be constructed across a low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer to a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

3.03.06 Compaction

Compaction equipment approved by the Engineer shall only be employed for construction. If directed by the Engineer, the Contractor shall demonstrate the efficiency of the plant he intends to use by carrying out compaction trials.

Each layer shall be thoroughly compacted to the density as specified in Table-III. Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer.

Table - III

Compaction Requirements For Embankment

Sl. No.	Type of work/material	Field dry density as a percentage of maximum laboratory dry density as per IS : 2720, Part-VII
1.	Top 0.5m portion of embankment below sub-base and shoulders	Not less than 100
2.	Other portions of embankment	Not less than 95

When density measurement reveal any soft area in the embankment, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft area shall be removed and replaced with approved material, compacted to the density requirements and satisfaction of the Engineer.

3.03.07 Drainage

The surface of the embankment at all times during construction shall be maintained at such a cross fall as will shed water and prevent ponding.

3.03.08 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders, road bed and side slopes to conform the alignment, levels, cross sections and dimensions as shown on the drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and merge the embankment with the adjacent terrain.

3.04.00 Turfing With Sods

3.04.01 General

This work shall consist of furnishing and laying of live sod of perennial turf forming grass on embankment slopes, shoulders or other locations as shown

on the drawings or as directed by the Engineer. Unless otherwise specified the work shall be taken up following the construction of embankment provided the season is favourable for establishment of the sod.

3.04.02 Materials

The sod shall consist of dense, well rooted growth of permanent and desirable grasses, indigenous to the locality where it is to be used and shall be practically free from weeds or other undesirable matter. At the time the sod is cut, the grass shall have a length of approximately 50mm and the sod shall be free from any debris.

Thickness of the sod shall be as uniform as possible with some 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that practically all the dense root system of the grass are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than 250mm x 300mm in size but not so large so that it is convenient to handle and transport without damage. During wet weather the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather it shall be watered before lifting to ensure its vitality and prevent dropping of soil during handling.

3.04.03 Placing The Sods

The area to be sodded shall be previously constructed to the required slope and cross section. Soil on the area shall be loosened, freed from all stones larger than 50mm size, sticks, stumps and any other undesirable foreign matter etc and brought to a reasonably granular texture to a depth not less than 25mm for receiving the sod. Following soil preparation, fertilizer and ground limestone when specified shall be spread uniformly. After spreading, the materials shall be incorporated in the soil by discing or other means. The prepared sod bed shall be moistened if not already sufficiently moist and the sod shall be placed thereon within approximately 24 hours after the same has been cut. Each sod strip shall be laid in close contact with each other and shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil. At points where water may flow over the sod, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth shall be placed over it followed by thorough compaction.

3.04.04 Staking the Sods

Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods and to be almost flushed with them.

3.04.05 Top Dressing

After the sods have been laid in position, the surface shall be cleaned of loose sod, excess soil and other foreign materials. Thereafter a thin layer of top soil shall be scattered over the top dressed surface and the area shall be thoroughly moistened by sprinkling water.

3.04.06 Watering and Maintenance

The turfing so laid shall be well watered and protected until final acceptance. Watering shall be done in such a way that no erosion or damage to the sodded areas/embankment occur. The Contractor shall erect necessary warning signs and barriers, repair or replace the sods which are failing to show uniform growth of grass or damaged by his operation and shall maintain the sod at his own cost until final acceptance.

3.05.00 Shoulder Construction

3.05.01 Description

This work shall consist of constructing shoulder on either side of the pavement in accordance with the requirements of this specification and in conformity with the lines, grades and cross sections shown on the approved drawings and as directed by the Engineer.

3.05.02 Materials

Shoulder shall be made of selected earth or granular material as specified conforming to relevant IRC standards.

3.05.03 Construction Operations

Except in the case of bituminous pavements, the shoulders shall be constructed in advance to the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and the area enclosed between the shoulders shall be cleaned of all spilled material before proceeding with the construction of the pavement layer.

In the case of bituminous pavements, shoulder shall be constructed only after the pavement courses have been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed without any damage to the pavement and the area so affected shall be thoroughly cleaned. During all

stages of shoulder construction, the required crossfall shall be maintained to drain off surface water.

3.06.00 Kerb

3.06.01 Material

Kerb if required for the construction of footpath shall consist of precast concrete blocks with concrete grade of M-20. The blocks shall be of 100mm thick and of suitable length. The depth of blocks unless otherwise mentioned elsewhere shall be 375mm considering 225mm height of footpath above the road level.

3.06.02 Laying

The kerb shall be laid by cutting trenches of 150mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the kerbs shall be in plumb and the gap between the block shall not be more than 10mm.The gap shall be filled with cement mortar as specified.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.07.00 Sub-base (Granular Sub-base)

3.07.01 Description

This work shall consist of laying and compacting well graded material on the prepared sub-grade in accordance with the specification. The material shall be laid in one or more layers as shown on the drawings and shall conform to the lines, grades and cross sections shown on the drawings and as directed by the Engineer.

3.07.02 Materials

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kankar etc or combinations thereof depending upon the grading required. The mixed materials shall be free from organic or other deleterious constituents and conform to one of the three grading given in Table - IV below.

Table - IV

Grading for Granular Sub-base Material

Sieve designation	Percent by weight passing the sieve		
	Grading 1		
80 mm 63 mm 4.75 mm 75 micron	100 90 - 100 35 - 70 0 - 20	100 90 - 100 40 - 90 0 - 25	100 90 - 100 50 - 100 0 - 30
Minimum CBR value for the fraction of material passing 20 mm sieve.	30 %	25%	20%

Note : The materials passing 425micron sieve for all the three gradings when tested according to IS : 2720, Part V shall have liquid limit and plasticity index not more than 25 percent and 6 percent respectively.

3.07.03 Physical Requirements

The fraction of materials passing 20 mm sieve shall give a CBR value as specified in Table – IV when tested in accordance with IS : 2720, Part XVI after preparing the samples at maximum dry density and optimum moisture content corresponding to IS : 2720, Part VII and soaking the same in water for 4 days.

3.07.04 Spreading and Compacting

Immediately prior to laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetations and other extraneous matter, lightly sprinkled with water if necessary and rolled with one pass of 8 - 10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of each layer after compaction shall not exceed 150mm.

Moisture content of the loose material shall be checked in accordance with IS : 2720, Part II and shall be suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it shall be from 1 percent above to 2 percent below the optimum moisture content. While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be done with 8 to 10 tonne smooth wheeled rollers or with any other approved plant. Rolling shall commence from the edges and progress towards the centre longitudinally except that on super elevated portions it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent shall be corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 100% of the maximum dry density of the material determined as per IS : 2720, Part VII. The surface of any layer of material on completion of compaction shall be well closed free from movement under compaction plant and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and recompacted.

3.08.00 Water Bound Macadam Sub-base/Base Course

3.08.01 Description

Water bound macadam shall consist of clean crushed aggregates mechanically interlocked by rolling and bonded together with screenings, binding material wherever necessary and water laid on the prepared sub-grade or sub-base as the case may be and finished in accordance with the specification and in conformity with the lines, grades and cross-sections shown on the approved drawings.

3.08.02 Materials

a) Coarse Aggregates - General Requirements

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table - V.

Table - V

Physical Requirements of Coarse Aggregates for water Bound Macadam

Sl.No.	Type of Construction	Test	Test method	Requirements
1.	Sub-base	Los Angeles Abrasion Value * or Aggregate Impact Value	IS : 2386 (Part IV) IS : 2386 (Part IV) or IS : 5640**	50 percent maximum 40 percent maximum
2.	Base	a) Loss Angeles Abrasion value* or Aggregate Impact Value	IS : 2386 (Part IV) IS : 2386 (Part IV) or IS : 5640 **	50 percent maximum 40 percent maximum
		b) Flakiness Index ***	IS : 2386 (Part I)	15 percent maximum

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

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

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

b) Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other objectionable matters.

c) Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table – VI. However the use of Grading No.1 shall be restricted to sub-base courses only.

Table - VI
Grading Requirements of Coarse Aggregates

Grading No.	Size range	Sieve designation	Percent by weight passing the sieve
1.	90mm to 40 mm	100 mm 80 mm 63 mm 40 mm 20 mm	100 65 - 85 25 - 60 0 - 15 0 - 5
2.	63 mm to 40 mm	80 mm 63 mm 50 mm 40 mm 20 mm	100 90 - 100 35 - 70 0 - 15 0 - 5
3.	50 mm to 20 mm	63 mm 50 mm 40 mm 20 mm 10 mm	100 95 - 100 35 - 70 0 - 10 0 - 5

d) Screenings

Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregates. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the grading set forth in Table-VII. Screenings of Type A in Table-VII shall be used with coarse aggregates of Grading No.1 in Table-VI. Screenings of Type-A or B shall be used with coarse aggregates of Grading No.2. Type-B screenings shall be used with coarse aggregates of Grading No. 3.

Table - VII
Gradings For Screenings

Grading classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm	12.5 mm 10.0 mm 4.75 mm 150 micron	100 90 - 100 10 - 30 0 - 8
B	10 mm	10 mm 4.75 mm 150 micron	100 85 - 100 10 - 30

e) Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value of less than 6 as determined in accordance with IS : 2720,Part V. Application of binding material may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.08.03 Construction Operations

a) The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50mm x 50mm furrows shall be cut at an angle of 45 degrees to the centre line of the road at 1m intervals in the latter before laying the coarse aggregates.

b) Inverted Choke

If water bound macadam is to be laid directly over the sub-grade without any other intervening pavement course, a 25mm course of screenings (Grading B) shall be spread on the prepared sub-grade before application of the coarse aggregates is taken up.

c) Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly over the prepared surface in such quantities that the thickness of each compacted layer is limited to 100mm for Grading No.1 and 75 - 100mm for Grading No. 2 and 3.

The spreading shall be done from stockpiles along the side of the roadway or directly from the vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over permitted.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The coarse aggregate shall not normally be spread more than 3 days in advance of the subsequent construction operations.

d) Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or tandem or Vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road. Each pass of the roller shall uniformly overlap not less than one half the width of the track made in the preceding pass.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wavelike motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities found shall be corrected by loosening the surface, adding or removing necessary amount of aggregates and rerolled until the entire surface conform to the desired camber and grade. In no case shall the use of screenings be permitted to make up the depressions.

e) Application of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreader or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregates.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms or hand brooms or with both. In no

case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids in the coarse aggregates.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

f) Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to seep the wet screenings into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional screenings applied as necessary until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set to its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excess quantity of water during construction.

g) Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application the surface shall be copiously sprinkled with water and the resulting slurry shall be swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling the voids form a wave ahead of the wheels of the moving roller.

h) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer shall have the discretion to stop hauling traffic from using the complete water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.09.00 Tack Coat

3.09.01 Description

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

3.09.02 Materials

The binder used for tack coat shall be bitumen of a suitable grade as approved by the Engineer and conforming to IS-73, IS-217 or IS-454 as applicable or any other approved cutback.

3.09.03 Construction Operations

a) Preparation of Base

The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous materials before the application of the binder.

b) Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight run bitumen shall be 5 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers.

The tack coat shall be applied just ahead of the oncoming bituminous construction.

3.10.00 Bituminous Macadam Binder Course

3.10.01 Description

This work shall consist of construction in a single course of 50mm/75mm thickness of compacted crushed aggregates premixed with a bituminous binder laid immediately after mixing on a base prepared previously in accordance with the specification and in conformity with the lines, grades and cross sections shown on the approved drawings.

3.10.02 Materials

a) Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS : 73.

b) Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, fairly cubical

shape and free of disintegrated pieces, organic and other deleterious matter and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table - VIII.

Table - VIII

Physical Requirements of Aggregates For Bituminous Macadam

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	35 percent maximum
2.	Aggregate Impact Value *	IS : 2386 (Part IV)	30 percent maximum
3.	Flakiness Index	IS : 2386 (Part I)	35 percent maximum
4.	Stripping Value	IS : 6241 (Part IV)	25 percent maximum
5.	Water Absorption	IS : 2386 (Part III)	2 percent maximum

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

The Aggregates for bituminous macadam for different thickness shall conform to the grading A or B given in Table IX or X.

Table-IX

Aggregates Grading For 75mm Compacted Thickness Of Bituminous Macadam

Sieve Designation	ent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90 - 100	
40 mm	35 - 65	100
25 mm	20 - 40	70 - 100
20 mm	-	50 - 80

12.5 mm	5 - 20	-
4.75 mm	-	10 - 30
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

Table-X

Aggregates Grading For 50mm Compacted Thickness Of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	ng B
50 mm	100	
40 mm	90 - 100	
25 mm	50 - 80	100
20 mm	-	70 -100
12.5 mm	10 - 30	-
10 mm	-	35 - 60
4.75 mm	-	15 - 35
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

c) Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate grading- A and B respectively unless directed otherwise by the Engineer.

The quantity of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

d) Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. Variation in binder content upto ± 0.3 percent by weight of total mix shall however be permissible for individual specimens taken for quality control tests.

3.10.03 Construction Operations

a) Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

b) Preparation of Base

The base on which the bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as shown on drawings and as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free from dust and foreign matter.

c) Tack Coat

A tack coat shall be applied over the base.

d) Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix. The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg. C and to that of aggregates shall be in the range 125 Deg. - 150 Deg. C provided the temperature difference between the binder and the aggregate at no time exceeds 25 Deg. C. Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly. The mixture shall be transported from the mixing plant to the point of use in a suitable vehicle. The vehicle employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

e) Spreading

After mixing, the mix shall be spread immediately by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However in restricted locations and in narrow widths where the available plants cannot operate in the opinion of the Engineer may permit manual laying of the mix.

The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg. C.

In multilayer construction, the longitudinal joint in one layer shall offset that into the layer below by about 150mm. However, the joint in the topmost layer shall be at the centre line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

f) Rolling

After spreading of mix, rolling shall be done with 8 to 10 tonne power rollers or other approved plant. Rolling should start as soon as possible after the material has been spread. Rolling shall be done with care to avoid any undulation in the pavement surface.

Rolling on the longitudinal joint shall be done immediately after the paving operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except on superelevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface and no mix pick up on the roller wheels. The second or intermediate rolling shall follow the break down rolling as closely as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh materials. The rolling shall then be continued till the entire surface has been rolled to compaction and there is no crushing of aggregates and till all the roller marks are eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rolling operation shall be completed in every respect before the temperature of the mix fall below 80 Deg. C.

Rollers shall not stand on the newly laid material as it may lead to undue deformation. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

The bituminous macadam shall be provided with a final surfacing without any delay. If there is to be any delay the course shall be covered by seal coat before allowing any traffic over it.

3.11.00 Open Graded Premix Carpet

3.11.01 Description

This work shall consist of laying and compacting open graded carpet of specified thickness in a single course of suitable small sized aggregates premixed with bituminous binder on a previously prepared base to form wearing course in accordance with the specification.

3.11.02 Materials

a) Binder

The binder shall be bitumen of a suitable grade, as approved by the Engineer and satisfying the requirements of IS: 73, 217, 454 or any other approved cutback as applicable.

b) Aggregates

The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, vegetable and any other deleterious matter etc. They shall preferably be hydrophobic type.

The aggregates shall satisfy the quality requirements set forth in Table VIII except that the Flakiness Index shall be limited to a maximum of 30.

c) Proportioning of Materials

The materials shall be proportioned in the ratio of its thickness based upon quantities given in Table XI.

Table - XI

Quantity of Materials Required For 10 Sq. M of Road Surface For 20mm Thick Open Graded Premix Carpet

Aggregates for Carpet		
i)	Stone Chippings - 12mm size ; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
ii)	Stone Chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
	Total	0. 27 Cu.m
Binder for premixing (quantities in terms of straight run bitumen)		
i)	For 0. 18 Cu.m of 12 mm size stone	9.5 Kg

Chippings at 52 Kg per Cu.m

ii) For 0.09 Cu. M of 10mm size stone Chippings at 56 Kg per Cu.m 5.1 Kg

Total 14.6 Kg

3.11.03 Construction Operation

a) Weather and Seasonal Limitations

Open graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg. C or below.

b) Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with the drawing, specification and as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matters with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

c) Tack Coat

A tack coat complying with clause 3.09.00 shall be applied over the base preparatory to laying of the carpet. However application of tack coat shall not be necessary when the laying of carpet follows soon after laying the bituminous course.

d) Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.

The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer in boilers of suitable design avoiding local overheating and ensuring a continuous supply.

The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified.

The mixing of binder with chipping shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

e) Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material has been laid rolling shall be commenced with 6 to 8 tonne power rollers preferably with smooth wheel tandem type or with any other approved plant. Rolling shall begin at the edges and progress toward the centre longitudinally except on the superelevated portions where it shall progress from the lower to upper edge parallel to the centre line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks have been eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose. Rollers shall not stand on newly laid material as it may lead to undue deformations.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of approved binder before the new mix is placed against it.

f) Seal Coat

A seal coat conforming to clause 3.12.00 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.12.00 Seal Coat

3.12.01 Description

This work shall consist of application of a seal coat as specified for sealing the voids in the bituminous surface laid to the specified levels, grade and camber.

Type A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

3.12.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as directed by the Engineer and conforming to the requirements of IS : 73, 217 or 454 as applicable or any other approved cutback.

The quantity of binder to be adopted in terms of straight run bitumen shall be 9.8 Kg and 6.8 Kg per 10 square metre area for Type A and Type B seal coat respectively.

b) Stone Chippings for Type A Seal Coat

The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matters etc. Stone chippings shall be of 6mm size defined as 100 percent passing through 10mm sieve and retained on 2.36mm sieve. The quantity used for spreading shall be 0.09 cu.m per 10 sq.m area. The chippings shall satisfy the quality requirements spelled out in Table- VIII except that the upper limit for flakiness Index shall be 30.

c) Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.

3.12.03 Construction Operations

a) Preparation of Base

The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat, the surface shall be cleaned free of any dust or other extraneous matters.

b) Construction of Type- A Seal Coat

The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or due to any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state shall be spread uniformly on the surface preferably by means of a mechanical grittier or otherwise manually so as to cover the surface completely. If necessary the surface shall be broomed to ensure uniform spread of chippings.

Immediately after the application of the cover material, the entire surface shall be rolled with a 8 - 10 tonne smooth wheeled roller. Rolling shall commence at the edges and progress towards the centre except in superelevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up the irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present a uniform closed surface.

c) Construction of Type-B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.

The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before the same are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued till the latter is thoroughly coated with the former.

The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed.

As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6 - 8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.12.04 Opening to Traffic

In case of Type-B Seal coat, traffic may be allowed soon after the final rolling when the premixed materials are cooled down to the surrounding temperature. However in case of Type- A seal coat, the traffic shall not be permitted until the following day.

3.13.00 Repair of Existing Water Bound Macadam Surfaces

Pot holes or patches and ruts in the water bound macadam base or surface course which is to be surface treated shall be repaired by removing all loose materials by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under.

Pot holes, patches and ruts shall be drained of water and cut to regular shape with vertical sides and then be filled either with i) Coarse aggregate and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer etc or ii) premixed material

conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer.

3.14.00 Road Side Drains

3.14.01 Drains

The road side drains shall be made in sizes and slopes as shown on approved drawings. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts outside the plant area as per drawings and instructions of the Engineer.

The excavated spoils other than that required for backfilling shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for the drains shall be as per drawing. Lining of drains may be of bricks or cement concrete blocks of M15 grade concrete as shown on approved drawing or as directed by the Engineer. If shown on approved drawing, drains may be of R.C.C. construction with necessary slopes.

3.15.00 Culverts

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the drawings and instructions of the Engineer after clearing the site etc. As per the specification of earthwork, backfilling in layers with watering and compaction shall be done after the construction of foundations. The construction of culverts shall be done true to the lines and levels as shown on the drawings. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed as applicable.

3.16.00 Pipe Culverts and Drainage Pipes

3.16.01 Materials

The drainage pipes shall be made of R.C.C and shall be either class NP-2 or NP-3 as shown on the approved drawings.

Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP4 or of RDSO class for railway as shown in the drawing. All pipes shall meet the requirements of IS : 458 and shall be procured from approved manufacturers with collars as per manufacturer's specification. The tenderer shall specifically mention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland Cement as per IS : 269.

Aggregates shall be as per IS : 383. Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller.

Fine aggregates for concrete shall be as per IS : 383.

3.16.02 Laying of Pipes

Laying of concrete pipes shall correspond to IS : 783 and as per the specification given below.

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings and as directed by the Engineer. When trenching is involved, its width on either side of the pipe shall not be less than 150mm and not more than one third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water etc as required shall be done by the Contractor.

Side slips if there be any shall be removed by the Contractor. After laying of the pipes are completed, backfilling of the trenches shall be done as per the specification of earth work to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area as instructed by the Engineer.

When bedrock or boulder stratum is encountered during excavation, the excavation shall be taken down to at least 200mm below the bottom of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented materials, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur and shall be done as per the specification of earth work.

When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm.

Laying of pipes shall start from the outlet and proceed towards inlet.

All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care not to damage them. Under no circumstances the pipes shall be dropped into the trench or on supports from the height.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS : 783 having a projection ratio not greater than 0.70. The pipe shall be carefully laid on bedding made up of fine granular materials in an earth foundation; the bedding shall be carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height and in which the fill material is thoroughly compacted in

layers not exceeding 150mm in depth around the pipe for the remainder of the pipe laid in trench.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M15. The shape and dimension of the cradle shall be as indicated on the drawing or as directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete is set.

c) The drop walls shall be made with first class brickwork in 1:4 cement mortar.

d) The pipe culverts shall be made with proper care with respect to the invert of the pipe, gradient if any etc as specified on drawings and as instructed by the Engineer.

e) Where R.C.C pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and the balance height of the block shall be concreted subsequently.

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part cement and 2 part of clean sand with only enough water for workability. Procedure of jointing shall be as per IS : 783.

3.16.03 Relation With Water Supply Pipeline

Unless specifically cleared by the Engineer, under no circumstances shall the drainage pipes be allowed to come close to water supply pipelines.

3.17.00 Manholes and Inspection Chambers

The maximum distance between the manholes shall be 30m unless specifically permitted otherwise. In addition, at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between the manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water tight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connection to existing pipelines shall be through a manhole.

Manholes shall be provided with standard covers usually of C.I. or as directed by the Engineer. The cover shall be closely fitted so as to prevent gases from coming out.

4.00.00 Testing And Acceptance Criteria

All testing as mentioned in the specification and as mentioned in Clause No. 900 of the "Specification for Roads and Bridge Works, 1983" published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per the direction of the Engineer.

SECTION - D

SUB-SECTION – D17

FABRICATION OF STRUCTURAL STEEL WORK

6.02 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS:1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numericals shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in cutting shall be computed from these levels in cubic meter.

c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rocks so arrived shall be taken as soil.

e) For earth work in filling, the actual measurements of fill shall be calculated by taking levels of the original ground before start of the work but after site clearance and after compaction of fills. The quantity of earth work in filling shall be computed from these levels in cubic meter.

f) For turfing, the measurement shall be made on the finished work in square meter.

TELANGANA STATE ELECTRICITY CORPORATION LIMITED (TSGENCO)
4X270MW BHADRADRI TPS

TECHNICAL SPECIFICATIONS
(EXCEPT CHIMNEY)

CIVIL STRUCTURAL & ARCHITECTURAL WORKS

PE-TS-411-600-C001
SECTION C

Bharat Heavy Electricals Limited
Project Engineering Management
Power Sector, PPEI BUILDING
SECTOR 16A, NOIDA-201301

CONTENTS

1.0 GENERAL

1.1 SCOPE

The scope includes civil, structural and architectural works of the following areas/structures/buildings.

- Topographical Survey
- Geo-Technical Investigation
- Leveling and Grading
- Power House including AC Plant & MCC control building
- Mill and Bunker Bay including bunkers
- Foundation for TG, Mills, ESP, FD/ID/PA Fans, Boiler & Boiler auxiliary foundations, Duct supporting column foundations and miscellaneous equipments.
- Transformer Yard including transformer foundation, fire barrier wall etc.
- Chimney
- Raw water reservoir and Raw water pump house
- Clarified water cum Fire water reservoir
- ESP Control Building
- FO System including fuel oil pump house, LDO/HFO tank foundation and dyke area.
- CW System including fore-bay basin, CW-duct, CW-pump house including maintenance bay and electrical annex.
- Fire Station Building.
- Main Plant Paving
- Service Building
- Canteen Building
- Admin building and gate Complex
- Permanent Store building
- DM Plant including DM regeneration, DM plant building, DMW Storage Tank foundation and paving etc.

- CW Treatment Building
- Compressor Building
- Chlorination Building
- Pipe and Cable Rack
- ETP Sumps.
- Chemical dosing.
- Watch Towers
- Rain Water Harvesting pits
- Plant Road and drains.
- Sanitary Sewer including inspection pits, manholes and foundation for skid mounting plant.
- Civil works for Complete Plant Water System
- Weigh Bridge
- DG Building

1.1.1 The criteria furnished in this document shall govern the design of Civil, Structural and Architectural works of buildings, structures and yard facilities related to the proposed project, indicated in Section 1.1 only.

This document covers the general description of structural framing system, applicable design codes and standards, specific design criteria, design loads and combinations, design methodology and characteristics of construction materials to be adopted for the structures indicated above.

1.2 SITE INFORMATION

1.2.1 Site Location

The plant site is located at 10 km from Manuguru town and 20 km from Manuguru railway station and nearest airport is Vijaywada which is about 220km from site.

1.2.2 Grade level

Finished Graded Level (FGL) for entire plant area shall be at least 1 m above HFL. However FGL will be finalized after topographical/contour survey data considering minimum levelling and grading works.

1.2.3 Soil Condition and Ground Water Level & HFL

Type of foundation, depth, safe bearing capacity etc., shall be as per the approved Geotechnical report. HFL of the plot is at RL (+) 65.465 m (based on area boundary survey drawing manuguru TPP- Boundary-4000-1).

1.2.4 Seismic Location

The project site lies in zone III as defined in IS: 1893 (Part 1)-2002. All the structures shall be designed complying with the requirements specified in IS: 1893 (Part-1) -2002 and (Part-4) - 2005.

1.2.5 Wind Pressure

Wind force on structures has been considered as per the provisions of IS: 875 (Part-3) - 1987. The basic wind speed of 44 m/sec at a height of 10m above the ground level and wind assumed to blow in any direction and the most unfavorable condition shall be considered for design.

1.2.6 Reference Level

All elevations shall be marked with reference to Finished Ground Floor elevation of Power House building as EL (±) 0.000m.

In the Boiler, ESP and Chimney Area, paving top shall be at EL(-)0.20 m and main road levels in Boiler Area shall be EL(-)0.20 m.

Transformer yard paving top shall be EL(-)0.10 m .

2.0 REFERENCES, CODES AND STANDARDS

Structural design shall be developed on the basis of the standard codes and documents listed below.

All designs shall generally be prepared in accordance with Bureau of Indian Standards (BIS) codes of practice unless specified elsewhere.

2.1 BIS CODES AND REFERENCES

The analysis, design and construction for structural and civil works shall be in accordance with the BIS codes/standards or equivalent International codes.

2.1.1 EARTHWORK

IS: 1498	Classification and identification of soils for General Engineering Purposes.

2.1.2 LOADS

IS: 875	Code of Practice for design loads (other than earthquake) for buildings and structures (All parts)
IS: 1911	Schedule of Unit Weights of building materials
IS: 1893	Criteria for earthquake resistant design of structure (All parts)

2.1.3 FOUNDATIONS AND SOIL ENGINEERING

IS: 1080	Code of Practice for design and construction of shallow foundations on soils (other than raft, ring and shell)
IS: 1904	Code of Practice for design and construction of foundations in soils (General requirements)
IS: 2911	Code of Practice for design and construction of pile foundations (All parts)
IS: 2950	Code of Practice for design and construction of raft foundations
IS: 2974	Code of Practice for design and construction of machine foundations (All parts)
IS: 8009	Code of Practice for calculation of settlement of foundations (All parts)
IS: 9556	Code of Practice for design and construction of diaphragm walls
IS: 11089	Code of Practice for design and construction of ring foundation
IS: 13301	Guidelines for vibration isolation for machine foundations.

2.1.4 REINFORCED CEMENT CONCRETE

IS: 383	Specification for Coarse and fine aggregate from natural sources for concrete

IS: 432	Specification for Mild steel and Medium tensile steel bars
IS: 455	Specification for Portland Slag Cement
IS: 456	Code of Practice for plain and reinforced concrete
IS: 458	Specification for pre cast concrete pipes
IS: 1443	Code of practice for laying and finishing of cement concrete flooring tiles
IS: 1566	Specification for Hard drawn wire fabric for concrete reinforcement.
IS: 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement.
IS: 1834	Hot applied sealing compounds for joints in concrete
IS: 2502	Code of Practice for bending and fixing of bars for concrete reinforcement
IS: 3370	Code of Practice for concrete structures for storage of liquids (All parts)
IS: 3414	Code of Practice for design and installation of joints in buildings
IS: 3935	Code of Practice for composite construction
IS: 4326	Code of Practice for earthquake resistant design and construction of buildings.
IS: 4948	Welded steel wire fabrics for general use
IS: 4995	Criteria for design of reinforced concrete bins for storage of granular and powdery materials (All parts)
IS: 5525	Recommendation for detailing of reinforcement in reinforced concrete works
IS: 8112	Specification for 43 grade Ordinary Portland cement
IS: 12269	Specification for 53 grade Ordinary Portland cement

IS:11384	Code of Practice for composite construction in structural steel and concrete
IS:11682	Criteria for design of RCC staging for Overhead water tanks
IS:13920	Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces.
BS: 8007	British Standard Code of practice for design of concrete structures for retaining aqueous liquid.

2.1.5 STRUCTURAL STEEL

IS: 800-1984	Code of Practice for general construction in steel
IS: 806	Code of Practice for use of steel tubes in general building construction
IS: 808	Dimensions for hot rolled steel beam, column channel and angle section
IS: 813	Scheme of symbols for welding
IS: 816	Code of Practice for use of metal arc welding for general construction in mild steel
IS: 919	Recommendations for limits and fits for engineering.
IS: 1024	Code of Practice for use of welding in bridges and structures subjected to Dynamic loading
IS: 1161	Steel tubes for structural purposes
IS: 1239	Mild steel tubes, tubular and other wrought steel fittings (all parts)
IS: 1363	Black hexagonal bolts, nuts and locknuts (dia 6 to 39 mm) and black hexagon screws (dia 6 to 24 mm) [All parts]
IS: 1364	Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm). [all parts]
IS: 1365	Slotted counter sunk head screws (dia range 1.6 to 20 mm).
IS: 1730	Dimensions for steel plate, sheet and strip for

structural and general engineering purpose.

IS: 2016	Plain Washers
IS: 2062	Structural steel (fusion welding quality)
IS: 3502	Specification for steel chequered plates
IS: 3589	Seamless or electrically welded steel pipes for water, gas and sewage.
IS: 3613	Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels.
IS: 4000	Code of Practice for High strength bolts in steel structures
IS: 4759	Hot dip zinc coatings on structural steel and other allied products
IS: 4923	Hollow Steel sections for structural use
IS: 7215	Tolerances for fabrication of steel structures
IS: 7280	Base-wire electrodes for sub-merged arc welding of structural steels
IS: 8500	Structural steel - micro alloyed (medium and high strength qualities).
IS: 8640	Recommendations for dimensional parameters for industrial building
IS: 9178	Criteria for design of steel bins for storage of bulk material (Al parts).
IS: 12843	Tolerances for erection of steel structures

2.1.6 MASONRY

IS: 1077	Specification for Common Burnt Clay Building Bricks .
IS: 1905	Code of Practice for structural use of unreinforced masonry
IS: 2185	Specification for Concrete Masonry units (All parts)
IS: 2212	Code of Practice for brickwork

IS: 2185	Concrete Masonry units (All parts - Hollow & Solid concrete blocks)
IS: 4860	Specification for Acid Resistant Bricks
IS: 12894	Specification for Pulverized Fuel Ash (Fly Ash) Lime Bricks

2.1.7 DOORS, WINDOWS AND VENTILATORS

IS: 1038	Steel doors, windows and ventilators
IS: 1361	Steel windows for industrial buildings
IS: 1948	Aluminium doors windows and ventilators
IS: 1949	Aluminium windows for industrial building
IS: 2835	Transparent sheet glass for glazing and framing purposes
IS: 3103	Code of practice for Industrial ventilation.
IS: 3548	Code of practice for glazing in buildings
IS: 3614	Specification for Fire check doors.
IS: 4351	Specification for Steel door frames.
IS: 6248	Metal rolling shutters and rolling grills.

2.1.8 ROOF AND FLOORING

IS: 809	Rubber flooring materials for general purposes
IS: 1195	Bitumen mastic for flooring
IS: 1237	Cement concrete flooring tiles

2.1.9 WATER PROOFING

IS: 1322	Bitumen felts for waterproofing and damp proofing
IS: 1346	Code of practice for waterproofing of roofs with bitumen felts
IS: 3067	Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings.

2.1.10 WATER SUPPLY, DRAINAGE AND SEWERAGE

IS: 1172	Code of basic requirements for water supply, drainage and sanitation
IS: 1742	Code of practice for building drainage
IS: 2065	Code of practice for water supply in buildings
IS: 5329	Code of practice for sanitary pipe work above ground for buildings
IS: 12251	Code of practice for Drainage of Building Basement

2.1.11 MISCELLANEOUS

SP-6	Handbook for Structural Engineers (all parts)
SP-7	National Building Code of India
SP-16	Design Aids for reinforced concrete to IS: 456-1978
SP-20	Handbook on masonry design and construction
SP-22	Explanatory handbook on codes on earthquake engineering (IS 1893-1975 and IS: 4326-1976)
SP-24	Explanatory handbook on Indian Standard code of Practice for plain and reinforced concrete (IS: 456 -1978)
SP-25	Handbook on causes and prevention of cracks in buildings
SP-32	Handbook on functional requirements of industrial buildings
SP-34	Handbook of concrete reinforcement and detailing (SCIP)
SP-35	Handbook on Water Supply and Drainage
SP-38	Handbook on Typified designs for structures with Steel roof trusses (With & without cranes)
SP-40	Handbook on Structures with Steel Portal frames (without cranes)

SP-47	Handbook on Structures with Steel Lattice Portal frames (without cranes)
SP-64	Explanatory handbook on IS Code of Practice for Deisgn loads (other than earthquake) for buildings and structures (Part 3 – wind load IS 875 – Part 3 – 1987)
IRC: 15	Code of Practice for construction of concrete roads
IRC: 19	Standard specification and Code of Practice for Water Bound Macadem
IRC: 36	Recommended Practice for the Construction of Earth Embankments for Road Works
IRC: 37	Guidelines for the design of flexible pavements
IRC: 101	Guidelines for design of continuously reinforced Concrete pavement with elastic joints
IRC: SP - 042	Guidelines on Road drainage

3.0 LOADS AND LOAD COMBINATIONS

All structures will be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, steam piping (static and dynamic) and other piping loads, wind loads, seismic loads, temperature loads and any other loading condition which can occur during the design life of the facility.

3.1 DEAD LOADS (DL)

Dead loads consist of the weights of the structure complete with floors, roof, finishes, fixtures, partitions, wall panels, etc.

3.1.1 The following unit weight of material shall be considered for computation of loads. Loads given in IS: 875 (part-I) shall be made use of for material not listed below.

Materials	**Unit weight**
Plain cement concrete	24 kN/m^3
Reinforced cement concrete	25 kN /m^3
Structural steel	78.5 kN /m^3
Brick work	19 kN /m^3
Cement plaster	21 kN /m^3
Floor Finish	24 kN /m^3
Coal	12 kN /m^3
Fly Ash	16 kN /m^3
Bottom Ash	16 kN /m^3

:

3.1.2 Following will be considered for evaluation of dead loads:

02

- Load of RCC slab wherever concrete floors are provided
- Floor finish of 40/50 mm laid over RCC Slab
- Other area flooring will consist of removable electro forged grating/ chequered plate.
- Beams & Columns as per actual size
- Wall cladding loads.
- Self-weight of supporting structure/facilities

3.2 IMPOSED LOADS (IL)

The loads considered as imposed loads are live loads, dust loads, minor equipment loads, cable trays, small pipe racks / hangers (not exceeding 2.5 kN/m^2), erection loads, operation / maintenance loads and loads produced by personnel, movable equipment and other items placed on the structure, but not permanently attached to it. Imposed loads for design at various floors in different areas will generally be considered as given below.

Imposed/Live loads will consist of uniform live loads and equipment live loads. Uniform live loads are assumed unit loads which are sufficient to provide for movable and transitory loads, such as the weight of people, portable equipment and tools, equipment, or parts which may be moved over or placed on floors during maintenance operations. These uniform live loads will not be considered on floor areas which will be permanently covered with equipment. In the absence of equipment load, the predefined LL to be considered for whole area for the design of foundation, column & mainframe beams. The floor beams may be designed for the equipment load.

Equipment live loads are calculated based upon the actual weight and size of the equipment and parts to be placed on floors during dismantling and maintenance or to be temporarily placed on or moved over floor during installation. Floors and supporting members, which are subject to heavy equipment loads, will be designed on the basis of the weight of the equipment or specifically defined loads and the erection loads wherever required. Each member in the floor which may carry these loads will be designed for the heaviest piece or pieces of equipment arranged in the most critical position. These loads will also be compared with the superimposed loads given below. Higher of the two will be adopted for analysis and design.

Steam Piping Load: The loads superimposed on structure by piping hangers and at the restraint points will be considered. However, pipe dynamic forces at hanger location / restraint points will not be considered to act simultaneously, in that direction with seismic forces.

Roads

Design of roads shall be in accordance with Indian Road Congress standard IRC 37.

Road culverts and its allied structures including R.C.C. Pipe Crossings & Road Crossing of Trenches shall be designed for Class `AA' loading (wheeled and tracked both) and to be checked for Class `A' loading as per IRC standards.

3.3 WIND LOAD

Wind loading will be in accordance with Indian Standard Code IS:875 (Part 3) for a basic wind speed of 44 m/sec. upto a height of 10 metres above mean ground level. Terrain Category-2 shall be considered for all structures.

Risk coefficient (k1) shall be considered as 1.07 for all structures

3.4 SEISMIC LOADS

The lateral forces will be established in accordance with the recommendations of IS:1893-1984 of Indian Code of practice. The site falls in Zone- III as identified in the map in IS:1893-2002. Analysis and design of structures shall be carried out accordingly taking into consideration the factors related to soil characteristics and importance of the structure together with the basic seismic co-efficient as per provision of Indian code.

Importance factor and response reduction factor shall be taken as per IS:1893(part I & IV).

Response spectrum method shall be used for seismic analysis as per IS : 1893 .

3.5 EARTH PRESSURE LOADS

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable). However, for design of substructure of pump house, cold water basin of cooling water and underground liquid storage tanks earth pressure at rest shall be considered.

In addition to earth pressure and ground water pressure, etc., surcharge load shall also be considered for the design of all underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure. Intensity of Surcharge Load shall be as described elsewhere in this specification.

3.6 TEMPERATURE LOADS

The effect of temperature loads shall be considered for design of structural frames. For temperature loading calculation the temperature variation shall be considered as 2/3rd of the difference in the mean of the daily maximum ambient temperature during the hottest month of the year (0C) and mean of the daily minimum ambient temperature during the coldest month of the year (0C). The structure shall be designed to withstand stresses due to 50% of the total temperature variation. Expansion and contraction due to changes of temperature of materials of structure

shall be considered and adequate provision shall be made for the effects produced as per provision in the relevant IS codes.

Mean Daily minimum ambient temperature during coldest month of the year = 11.5° C

Mean Daily maximum ambient temperature during hottest month of the year = 45.1° C

3.7 EQUIPMENT LOAD

i) Loadings (both static and dynamic) of major equipments, including boiler, turbine-generator, boiler feed pumps, feed water heaters, de-aerator, PA, FD & ID fans, Coal Mill obtained from the manufacturer's certified drawings of the specified equipment to be furnished. Where design of structures supporting minor equipment other than those included above has to proceed, the loadings will be estimated from similar jobs or catalog data.

ii) All equipment, tank and piping design loadings will include Hydraulic Testing loads.

iii) Air and gas duct loadings will include weight of insulation, duct attachments, dust accumulation loads, seismic, wind and other loads as applicable.

iv) Crane girders and supporting columns will be designed for vertical and horizontal forces (including impact forces) as developed from the crane weights and wheel loads. Unless otherwise specified, the vertical and horizontal loadings will conform to the applicable sections of the IS specifications.

v) Weight of equipments, ducts, tanks, pipes, conduits etc. supported by structure shall include maximum possible loading conditions i.e. flooded material contents and associated impacts, test loadings, anchorage and constraint effects.

vi) All structural components shall be designed to accommodate anticipated concentrated loads which will or may be applied during the life of the plant.

Where both concentrated and uniform loads cannot act simultaneously, the structure or component shall be analyzed for both conditions of loading and shall be designed for most critical condition.

viii) Lay down areas in the Turbine Hall shall be investigated for concentrated loads resulting from equipment components to be stored during erection and maintenance operation. Where live load allowance is inadequate to permit

storing of such equipment components, the design live load shall be increased to permit such use or the area shall be restricted by identifying lay down areas for specific components, each area to be identified by permanent marking.

3.8 CRANE, MONORAIL AND ELEVATOR LOADS

Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vendor data. All lifting beams, monorails shall have design loads increased for impact factor. Vertical impact force and surge force in lateral and longitudinal direction shall be taken as per following.

3.8.1 Crane loads

i) For vertical force, an impact factor of 25% of the maximum crane wheel load.

ii) A lateral crane surge of 10% of the weight of the trolley plus the lifted load applied at the top of each rail..

iii) A longitudinal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail in the longitudinal direction.

3.8.2 Monorail loads

i) Impact factor of 10% of lifted load hoist for rail and support design

ii) Impact factor of 25% of the lifted load for electrical hoist for rail and support design

3.8.3 Elevator loads

i) 100% of the lifted load plus the equipment weight for the elevator support beams.

3.9 Load Combinations

While designing consideration shall be given to the following load combinations :

i) DL + LL
ii) DL + LL + PL + Equip (+/-) TL
iii) DL + LL + PL + Equip + Cb + CtLA(+/-) CS (+/-) TL
iv) DL + LL + PL + Equip + Cb + CtLB(+/-)CS (+/-) TL
v) 0.9DL(+/-)EL (for DL only) (+/-) TL
vi) 0.9DL (+/-) WL1 (+/-) TL
vii) 0.9DL (+/-)WL2 (+/-)TL
viii) DL +* LL + PL + Equip + Cb + Ct(+/-) EL (+/-)TL(* Appropriate portion of LL which is considered for working out EL shall only be taken)
ix) DL + LL + PL + Equip + Cb + CtL1(+/-) (CS1+WL1(+/-)TL
x) DL + LL + PL + Equip + Cb + CtL1(+/-) (CS1+WL2) (+/-)TL

Where the above loads are :

DL = Dead load of structures, floors, walls etc.
LL = General live load on floors
PL = Pipe Load
Equip = Equipment loads
Cb = Crane Bridge
Ct = Crane trolley positioned at middle of bridge
CtLA = Crane trolley + Load near one row
CtLB = Crane trolley + Load near other row
CtL1 = Crane trolley + Half load lifted at centre of bridge
CS = Crane surge for full load
CS1 = Crane surge for half load lifted
WL1 = Wind load from left to right
WL2 = Wind load from right to left
EL = Earthquake load
TL = Temperature load

Appropriate allowable increase in permissible stresses as per IS codes, may be taken only under normal loads along with wind and seismic conditions. However, members which are designed primarily to resist wind, no increase in wind permissible stresses will be permitted.Applicable load factors to be used for design of RCC structures by Limit State Method as per IS:456.

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3.10 LOAD COMBINATIONS FOR UNDERGROUND STRUCTURES

Following loading conditions shall be considered in addition to the loading from superstructure for the design of sub structure of pump house, channels, sumps, tanks, reservoirs, trenches and other underground structures.
Only liquid pressure from inside and no earth pressure and ground water pressure and surcharge pressure from outside (applicable only to the structures which are liable to be filled with water or any other liquid).
Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

Base slab of the pump house shall be designed for the condition of different combinations of pump sumps being empty during maintenance stages with ground water table up to the finished grade level. Intermediate dividing piers of pump sumps and partition walls in channel shall be designed considering water on one side only and the other side being emptied for maintenance.
Design shall also be checked against buoyancy due to ground water during construction and operation stage. Minimum factor of safety as per IS:3370 against buoyancy shall be ensured considering empty condition ignoring superimposed loads.

3.11 SPECIAL STRUCTURES

The following densities shall be considered for design of coal bunkers:

a) For volume calculations : 8.0 kN/cum
b) For Structural design : 12.0 kN/cum

Coal bunker shall be designed as per criteria specified in IS:9178 (Part I&II)

4.0 DESIGN METHODOLOGY

Wind and seismic forces shall not be considered to act simultaneously.
For the design of main plant structures during seismic condition, the Deaerator Feed

Water Tank shall be considered full up to operating level. However, for other load

combinations, Deaerator Feed Water Tank in flooded condition shall be considered.
`Lifted Load' of crane shall not be considered during seismic condition.
For design of all underground structures/foundations, ground water table shall be considered at the Finished Ground Level..

In Turbine Bay, horizontal wind girders between A-row and B-row columns must be provided below Mezzanine and Operating floor at gable ends to transmit wind load from gable columns.

PTFE bearing shall be provided where horizontal loads not to be transferred.
For calculation of seismic load, equipment load shall be considered as Dead Load.

Gratings / chequered plates shall not be considered as restraining members for compression flange of beams/girders. Diaphragm action shall also be not considered in design. Adequate horizontal bracings to be provided.

4.1 REINFORCED CONCRETE STRUCTURES

4.1.1 GENERAL

Reinforced concrete structures will be moment resisting frames along both longitudinal & transverse directions. The suspended slab will be considered as continuous over secondary beam and will not form part of the framing system. RCC structures/members will be designed as per the provisions of IS: 456 using limit state method, unless use of working stress method is specifically mentioned elsewhere in this document.

Design strength of materials and design loads shall be calculated using appropriate partial safety factors over characteristic strength and characteristic loads as per IS: 456.

Mix design concrete will be used for all areas other than lean concrete work and plain cement concrete work where nominal/volume mix may be permitted.

Water retaining RCC Structures will be designed in accordance to IS: 3370 (Code of practice for concrete structures for the storage of liquids) by Working Stress Method.

The grade of concrete for various structures shall be as follows;

- Mass concrete filling M7.5

- PCC below T G Foundations, Fan foundations and all vibratory foundations / Screed concrete M10
- PCC below Paving(general) incl plinth protection M10
- RCC in grade slabs M25
- Boiler area paving M20
- RCC for Super Structure works in structural Steel buildings / Trench slab and wall M25
- RCC in foundations/ Water retaining Structures M25
- RCC for Super Structure works in RCC building M25
- RCC for T G raft, Mill, BFP & fan foundations M30
- Precast RCC Trench Covers M25
- Encasement of Base plate/Steel columns/ Wall beams M20
- RCC for TG top deck and columns M35
- Drain/cable trench M25

Minimum cement content, maximum water cement ratio and minimum grade of concrete shall be considered as per IS: 456-2000 for structures not mentioned above.

Minimum cover to reinforcement shall be as per Table 16 of IS: 456-2000 for mild exposure condition. Minimum fire rating of 2 hours shall be considered where fire hazard is expected and accordingly minimum cover shall be increased if required to meet the requirements as per Table 16A of IS:456-2000.

MATERIALS 02

Cement: Ordinary Portland cement (Grade 53) of approved manufacturer conforming to IS: 12269 and Ordinary Portland Cement (Grade 43) conforming to IS 8112 will preferably be used. However other types of cement such as Portland slag cement conforming to IS: 455 & Portland pozzolana cement confirming to IS: 1489 may also be used except for in TG Foundation top deck and sub-structures including foundation raft, major machine foundation like PA/FD/ID FANS, MILLS,BFP etc where OPC grade 53/43 shall necessarily be used.

Reinforcing Steel: Reinforcing steel will be TMT bars of grade Fe-500 conforming to IS: 1786.

Aggregates: Coarse aggregate for concrete will be chemically inert, hard, strong

durable against weathering, of limited porosity, and free from deleterious materials. It will be properly graded. Coarse aggregates will be either crushed gravel or stone. Aggregates will meet the requirement of IS: 383.

Admixtures: Plasticizers-cum-retarder type admixture will generally be added to concrete for promoting workability in addition to retard setting time for mass concreting work.

Water: Water used for cement concrete, mortar, plaster, grout curing, washing of coarse aggregates, soaking of bricks etc. will be clean and free from oil, acids, alkalis, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure.

The following minimum thickness of the structural elements shall be followed:

- Suspended floor / slab / walkways / canopy slabs, etc 50 mm
- Ground floor slab (non-suspended) 150 mm
- Water Retaining slabs / walls 200 mm
- Cable / pipe trenches / underground pits /
- Launder walls and base slab 100 mm
- All footings (including raft foundations) 300 mm
- Parapets 125 mm
- Sunshades at edge 75 mm
- Pre cast louvers / fins 50 mm
- Pre cast trench cover slabs / floor slabs / louvers 75 mm
- Paving 100 mm
- Basement walls and base slab 200 mm
- Silo / bin walls 200 mm
- Underground reservoir
- Below ground water table 200 mm
- Above ground water table 150 mm

Minimum heights for pedestals for steel columns shall be as follows:

i) Top of pedestals for building structures will be kept at a lower level so that column base plate together with gussets and stiffeners remain below finished floor level

(FFL). The column bases as well as column section shall be encased in concrete

above FFL as per following:

a) Open area : 300mm above paved level
b) Covered area : 150mm above FFL

ii) Stairs and ladder pedestal will be kept 200mm above the FFL

iii) Pedestals to steel columns for equipment structures:

a) Equipment in open area : as required (minimum 300 mm)
b) Equipment in covered area : as required (minimum 150 mm)
c) Structures and equipment : as per vendors data supplied by vendor subject to min as specified above

4.1.2 FOUNDATION AND UNDERGROUND STRUCTURES

4.1.2.1 Foundation for all main plant structure i.e. Power House Building, Boiler, ESP, Mill and Bunker Bay, Transformer Foundations, Air compressor, and other auxiliary buildings shall be decided based on loading arrangement, load intensity and soil strata. Design of foundation at various levels shall be dependent upon the safe bearing capacity at that level and on the basis of recommendation furnished in the Geotechnical Investigation report.

Foundations will be designed for the most critical combinations of forces and moments, resulting from all possible combinations of the various loading from the structural system. No major foundations will rest on filled up ground. The effect of water table will be considered and the foundation will be checked for overturning for minimum and maximum vertical loads. The foundation sections will be sized and reinforced adequately for bending moments and shear stresses.

4.1.2.2 All foundations including machine/equipment foundations will be of RCC block/frame foundations as the case may be. All foundations will be designed in accordance with relevant parts of IS: 2974 and IS: 456 by limit state method. Raft foundation will be designed as per IS: 2950.

4.1.2.3 For design of Foundations and underground structures including trenches etc., ground water level shall be considered up to the finished grade level.

4.1.2.4 **Stability** : The following minimum safety factors for stability checks of foundations shall be used:

1. Overturning 1.4
2. Sliding 1.4
3. Uplift
   a) Normal loading 1.4
   b) Hydrostatic forces 1..2

Where dead load provides restoring forces, only 0.9 times dead load shall be considered. Imposed loads shall be considered as the restoring force.

4.1.2.5 Minimum cover to Foundation Bolts

Minimum distance from the centerline of foundation/anchor bolt to the edge of pedestal shall be maximum of the following:

Clear distance from the edge of base plate/base frames to the outer edge of the pedestal shall be minimum 50mm.
Clear distance from the face of pocket to the outer edge of pedestal shall be 75mm.
Clear distance from the edge of sleeve of anchor plate to the edge of pedestal shall be 75mm.

4.1.2.6 Permissible settlement of Foundation

For open foundations, the permissible settlement and differential settlement shall be governed by IS: 1904 and IS: 8009. However, total settlement will be restricted to the following.

a) Foundations for main power house columns, Boiler, Mills, bunker, TP's : 25mm
b) Foundation for other structures including ESP with Isolated/strip footing of width up to 6.0M : 40mm
c) Foundation for other structures with Footings greater than 6.0M (raft) : 75 mm

4.1.2.7 Levelling and grading: Each layer of filling shall be watered and thoroughly compacted with proper moisture content and such equipment's as may

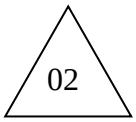
be required to obtain a minimum of 95% of its maximum dry density as determined by standard Proctor's test as per IS: 2720 part-VII or 85% of relative density as per IS:2720 part-XIV as specified. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

4.1.2.8 **Backfilling:** Backfilling around foundation and bottom of pipes, thrust blocks etc shall be carried out with approved material in layers not exceeding 30 cm thickness and each layer shall be compacted to 90% standard proctor density for cohesive soil and to 75% of relative density for non-cohesive soils**.**

4.1.3 TANK FOUNDATIONS

The Storage tanks/Day tanks will be resting on hydraulically compacted clear river sand, in layers of 500 mm maximum thickness, topped with 150 thk PCC. PCC layer will be topped with 50 thk. Anti-corrosive asphalt layer, which in turn is topped with 50 thk. Premix carpet. The entire sand fill along with toppings will be confined within a RCC ring beam of appropriate design.

4.1.4 MACHINE FOUNDATIONS



This section outlines the design philosophy and construction aspects of foundations for the following equipments;

- ✓ ID/FD/PA/SEAL AIR Fan Foundations & TG Foundation
- ✓ Boiler Feed pump foundations,
- ✓ Bowl Mill foundations and
- ✓ Miscellaneous Machine foundations.

4.1.4.1 For the foundations of TG & Fans (ID, FD, PA & Seal Air etc.), Boiler feed pump, Bowl Mill, detailed static and dynamic analysis will be performed. The static analysis will include operating conditions load cases and abnormal loads like, maximum unbalance and seismic forces. Unbalanced loads for normal operating condition as given by machine manufacturers or as specified in IS: 2974 whichever is more conservative shall be used. Vibration isolation system shall not be provided in any of rotating foundation except for ID fan foundation

4.1.4.2 The dynamic analysis will consist of free vibration analysis and forced vibration analysis. Frequency separation criteria and amplitude criteria as laid down in IS: 2974 and/or DIN 4024 and/or VDI 2056 or as required by the machine manufacturer will be satisfied. RCC design will be done by working stress method for all machine foundations as per IS: 2974. Minimum reinforcement will be governed by the requirements specified in IS: 2974 as well as IS: 456.

4.1.4.3

All block foundation supporting rotating equipments and resting on soil will be designed using the elastic half space theory and/or Barkan's method. The mass of the RCC block will not be less than 2.5 times the mass of the machine. Dynamic analysis will be carried out to calculate natural frequencies in all the modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down in the relevant codes and/or by machine manufacturer will be satisfied. Minimum reinforcement will be governed by the requirements specified in IS: 2974 and IS: 456.

4.1.4.4 The analysis and design of machine foundations will be carried out to ensure the following.

- Compliance with the manufacturer's requirements.
- No resonance phenomenon of a disturbing nature to machine operation should exist at the normal running speed.
- Calculations to be performed for dynamic as well as static cases for reinforced concrete block type pedestals.

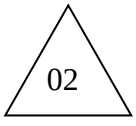
4.1.4.5 Bowl mills shall be supported on conventional block type R.C.C foundations. All machine foundation shall be separated from adjoining building / foundations. Isolation joints shall be given all round to isolate the machine foundation from the grade slab..

4.1.4.6 **Foundation Sizing:** The outline plan dimensions of foundations as given by the machine supplier will be adopted. The height of foundation will be selected after taking into consideration soil strata and operating level of the machine. The eccentricity of common CG of machine and foundation with respect to the centroid of base area should not exceed 5% of the corresponding base dimensions of foundation.

4.1.4.7 For other types of machines, most suitable type of foundations will be provided. For the foundations supporting minor equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary.
Foundation for pumps, and minor rotating equipment etc., are usually in the form of solid block foundations, resting on the ground or on a floor of the building.

At such machine supports, floor may be thickened and extra reinforcement provided. Rubber or neoprene pads under some of these machines to reduce transmission of vibrations to the supporting floor shall be provided if required.

4.1.5 LIQUID RETAININING STRUCTURES



RCC water retaining structure like storage tanks, reservoirs, etc., shall be leak proof and designed as un-cracked section with limiting steel stresses in accordance with IS: 3370 ([Part I to IV) by working stress method.

Water channels and substructure of pump houses shall be designed as cracked section with limiting crack width to 0.1mm and limiting steel stresses as per IS: 3370 (Part I to IV) by working stress method for concrete face away from water/liquid. For faces in contact with water/liquid the structure shall be designed as uncracked section in accordance with IS:3370 (part 1 to IV) by working stress method.

All water retaining/ storage structures shall be designed assuming liquid upto the height of wall irrespective of provision of any over flow arrangement. Pressure relieving devices may be used and 50% release in water uplift pressure through pressure release valves may be considered in design. In all liquid structures, PVC water bars shall be provided at each construction/ expansion joint. The sequence of construction shall also be specified on drawings showing construction joints.

Screed layer of concrete grade M10 and of minimum 100 mm thickness shall be provided below all water retaining structures.

All underground water retaining/conveying system structures shall have platiciser cum waterproofing cement additives conforming to IS:9103. In addition, limits on permeability as given in IS:2545 shall also be met with. The concrete surface of these structures in contact with soil shall be provided with minimum two coats of bituminous painting of grade 85/25 conforming to IS:702 @ 1.7 kg/sqm (minimum) for water / damp proofing. Storm water drains shall not be provided with bituminous paint and weep holes also shall not be provided in storm water drains.

4.1.6 **Raw Water Reservoir:** The capacity of raw water reservoir shall be for 7 days with minimum capacity of 6.00 Lakhs cu.m. Shape, size and detail of the same shall be as per approved drawings. The reservoir shall be provided with a free board as per requirements of IS: 10635, but in no case, the same shall not be less than 1000 mm. The reservoir shall have two compartments with separate inlet and outlet arrangement. The reservoir embankment shall be made in earthwork with side slopes 1V : 2H (minimum). The reservoir embankment shall be designed and constructed as an earthen dyke founded on natural ground with proper foundation. The entire area, top soil shall be increased to the required level as per actual conditions to totally removal of all vegetation, organic
matters, roots, soft spots etc. Required slush removal sump, provision for deep sump shall be provided in the pumping suction to ensure the pumping head. Also, a suitable

02

spillway arrangement shall be provided to take care of any heavy storm event. The bund shall have adequate width on top to form the road for vehicle movement with minimum width as 4.0 m. bituminous road shall be constructed as per IRC.On the down stream slope of the embankment, turfing shall be provided with a provision of Toe drain. The bund with impervious geo-membrane (LDPE 500 micron thick) layer on water contain face including base. 150 mm thick sand blanket is recommended below the geo-membrane bottom as a cushion. The reservoir shall be provided with 50 mm thick precast concrete tiles of M20 grade concrete over LDPE film / sand planked lining. The protective layer over LDPE shall be provided over entire bed and side slopes. Material to be used for bund construction shall be as per IS: 1498. Top layer of reservoir basin sub grade shall be compacted to at least 95% of Standard Proctor density by vibro compaction equipment or by any other suitable equipment

4.2 STEEL STRUCTURES

4.2.1 MATERIALS

Structural Steel: Structural steel will be straight sound, free from twists, cracks, flow, laminations and all other defects. Structural steel shall confirm to IS:2062 for rolled members or plates. Structural steel shall conform to Grade A of IS 2062 for rolled steel members or plates up to 20mm thickness. For plates from 20mm to 40mm thickness steel conforming to Grade BR (killed and rolling normalized) of IS 2062. For plates above 40mm thickness steel conforming to Grade BR (killed and furnace normalised) of IS 2062.

Material: Structural steel shapes, plates, and appurtenances for general use will conform to Indian Standards IS: 800 with minimum yield strength of 250 MPa. Connection bolts will confirm to relevant IS codes.

Steel Grating: All indoor gratings shall be electro forged type and outdoor gratings shall be welded type. Minimum thickness of grating shall be 40mm for indoor installation and 32mm for outdoor installation. The opening size shall not be more than 30mm x 100mm. The minimum thickness of the main bearing bar shall be 4mm. All gratings shall be hot dip galvanized @ 610 gm/sqm.

02

Guard rail /Handrail: For powerhouse building upto operating floor + half landing, main stair & lobby shall have 40mm diameter stainless steel railing with minimum 3mm thick SS posts & decorative minimum 3mm thick seamlessly joined SS handrails. Stainless steel pipe handrail in shall be of approved design to meet the functional requirement as

well as very good aesthetic appearance. For any other RCC stairs of non-plant buildings 20mm square MS bar post with suitable MS flat and anodized aluminium handrails are to be provided. For any other floor of power house building, plant & non plant buildings unless otherwise indicated in the specification the post and handrails of stairs, railing, etc will be 32mm nominal bore GI pipes of medium grade conforming to IS: 1161 / IS 1239.

Chequered Plate: Chequered plate shall conform to IS: 3502 and shall be minimum 6 mm thickness over plane. Steel for chequered plates shall conform to Grade 'A' of IS: 2062.

Stainless Steel: Stainless steel liner in the Coal Bunkers will be 4.00 mm thick & of grade AISI – 304, Finish Grade 2B (Cold Rolled, Annealed & Pickled and Skin passed) will be provided on the inner faces, Hoppers and mouth of the Hoppers, without allowing any projections in coal flow path. while coal bunker will be made of MS plate.

4.2.2 FRAMING

All steel framed structures shall be either "rigid frame" or "simple space frames" or a combination of two.

Lateral forces shall be resisted by stiff jointed moment connections in rigid frame. The column bases shall generally be fixed to concrete foundation pedestal by providing moment resistant base detail.
Simple space frame design utilizes single-span beam systems, vertical diagonal bracing at main column lines and horizontal bracing at the roof and major floor levels. Most of the plants' steel buildings shall be designed as simple space frame structures.
The turbine building design shall be a combination of rigid frame in transverse direction and simple frame in longitudinal direction.
Pipe rack shall consist of rigid main frame in transverse direction spaced longitudinally as required. In longitudinal direction, pipe rack shall be divided into sections of suitable length with an anchor bay. The main transverse frames shall be connected with longitudinal beams which will transmit horizontal forces to braced anchor bays. The pipe and cable rack bridge structure shall be adequately rigid to carry the forces from pipelines at anchor points without undue deflection so that pipelines are really anchored at the anchor points.

Concrete floors shall be considered to provide continuous lateral support to the top (compression) flange of the support beams. Suitable shear connectors shall be welded

to the top of the top flange of all secondary beams to ensure the lateral support.. Grating/chequered plate floor shall neither be considered to provide lateral support to the top flange of supporting beams nor to provide a shear diaphragm. Adequate lateral support and horizontal bracing shall be provided as required.

Floors for vibrating machines of all kind together with supporting framework shall be adequately braced in both horizontal and vertical planes. Floors or structure supporting mechanical equipment shall be designed to minimize vibration, avoid resonance and maintain alignment and level.

Columns shall be designed to support the load combination which produces the maximum stress ratio. Exterior columns shall be designed to resist wind moments between braced elevations as appropriate. Columns shall also be designed to resist moments caused by discontinuous vertical bracing work points.

4.2.3 CONNECTIONS

Shop connections will be by welding, preferably by submerged arc welding. Field connections for light members such as purlins, girt and inaccessible beams, will be done by MS bolts with nuts. All other connections will be designed with welding / high strength friction grips bolts, as necessary.

IS: 816 and IS: 9595 shall be followed for welding of structures.
Connection of vertical bracings with connecting members and diagonal truss members shall be designed for full tensile capacity of the bracings.

Size of fillet weld for flange to web connection for built up column section will be as follows:

Full shear capacity for box section.

80% of full shear capacity or actual shear (if indicated in drawings) or 0.5 times of the web thickness whichever is more for I section. Weld will be double fillet.

All welds will be continuous. The minimum size of fillet weld will be as per relevant IS code.

Shear connections shall be designed for 75% of section strength for rolled sections

and 80% of section strength for built up section or rolled section with cover plates.

Design shear force should be more than actual shear.

Moment connections between beam and column will be designed for 100% of moment capacity of the beam section.

All butt welds shall be full penetration butt welds.

Connection of base plate & gusset members with the columns will be done considering that total load gets transferred through weld.

All splicing work shall be of full strength. Shop splicing for all sections other than rolled sections shall be carried out by full penetration butt welds. Shop splicing of all rolled sections shall be carried out using web and flange cover plate.
Following connections will be provided during erection :

1.) Welded Connection

- Connection of secondary beam to main beam
- Connection of bracing to column
- Connection of bracing to longitudinal tie beam
- Connection of longitudinal tie beam to column
- Connection of spandrel beam to column
- Connection of other secondary structures

2.) HSFG Connection (Grade 8.8 bolts)

- Splicing of column/transverse frame beam/ longitudinal tie beam
- Connection of Crane Girder to column
- Connection between crane girders
- Other major connections

3.) Bearing Type Connection (HT bolts Grade 8.8)

- All removable type connections
- M.S. bolts (Grade 4.6)

Purlins, stairs, wall beams etc

4.2.4 DESIGN

The design of steel structures will be done by linear elastic method as per the provision of IS: 800-1984. Individual members of the frames will be designed for load combinations for moment, axial force, shear force and torsion. Wind and seismic loads will not be considered to act simultaneously in transverse or longitudinal direction as per IS 1893-2002. The gable end columns of Power House building will be designed for wind and axial loads considering base as fixed and restraints provided by wind girder at operating floor and roof levels. The secondary beams will be designed as simply supported beams between the main beams of frames. The secondary beams supporting various RCC slabs without cut outs/openings will be designed as composite beam with channel type shear connectors and will be designed as per the provisions in IS: 11384 for composite construction.

All buildings/structures shall be framed structure. Basic consideration for structural framing shall be stability, rigidity, building uses, ease of fabrication / erection and overall economy. Additional bracings / moment connections shall be used to assure stability of structures. Structure shall be designed such that the surface of all parts shall be accessible for inspection, cleaning, painting and maintenance.

Crane gantry girders shall be single web plate girder of welded construction with bearing and intermediate stiffeners. Crane girder shall be designed as simply supported and of single span length. Chequered plate shall be used for gantry girder walkway flooring. For lifting / monorails beams ISMB sections shall be preferred and the bottom flange of all beams shall be checked separately for distortion and reinforced / braced suitably if required.

Base plate shall be fixed on foundation pedestal with grouting. For large base plates necessary grout holes shall be provided for escape of air. All anchor bolts for fixing steel columns to foundation shall be embedded in foundation during concreting itself..

4.2.5 PERMISSIBLE DEFLECTIONS

The permissible deflections of various steel members under normal loading conditions shall be as specified below. For calculation of deflections in structures and individual members, dynamic effects shall not be considered unless specified otherwise. Also, no increase in deflection limits shall be allowed when wind or seismic load are acting concurrent with normal loading conditions.

4.2.5.1 Vertical Deflection

For beams supporting dynamic equipment	Span / 500
For beams supporting floors / masonry	Span / 325
For beams supporting pipes (pipe racks)	Span / 400
Purlins and side runners supporting sheets	Span / 250
For grating and chequered plates	Span / 250 subject to a maximum of 6 mm

For crane gantries or any member subjected to dynamic loads, the maximum deflection under dead load and live load excluding impact shall not exceed the following values:

For manually operated cranes & monorails	Span / 500
For electric overhead cranes.	
Upto 50 t capacity	Span / 750
Over 50 t capacity	Span / 1000

4.2.5.2 Horizontal Deflection

The permissible horizontal deflections shall be as given below unless specified otherwise.

Single storey building	Height / 325
Pipe rack columns	Height / 200
Open structures	Height / 200
Crane gantry girder due to surge	Span/2000 limited to maximum of 15mm
Building main columns at crane raillevel due to action of crane surge load only	Height/2500 limited to 10 mm
Open gantry columns at crane rail level due to action of crane surge load only	Height/4000 limited to 10 mm

Provisions of IS: 800-1984 and relevant IS Code shall be followed for limiting deflections of structural elements not listed above.

4.2.6 MINIMUM THICKNESS & SIZES OF ELEMENTS

4.2.6.1 Minimum Thickness

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to significantly corrosive environment shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgment in each instance.

a) Trusses, purlins, girts and bracing	6 mm
b) Columns and beams	8 mm
c) Gussets	8 mm
d) Stiffeners	8 mm
e) Base plates	10 mm & above
f) Chequered plates	6 mm o/p & above
g) Grating Flats	3 mm for secondary bars and 6 mm for main / edge bars
h) Minimum thickness of structural members other than gratings and chequered plates directly exposed to weather and inaccessible for painting and maintenance	8 mm

4.2.6.2 **Minimum Sizes:** The flange width of purlins for those supporting roof sheeting and wall cladding shall not be less than 50 mm. Width of steel rolled section connected to other member shall be at at least 50mm. The depth of beams for platform of all structures shall not be less than 125 mm.

4.2.7 SLENDERNESS RATIO

The Slenderness ratio of main members in tension, compression or bending shall be in accordance with IS: 800.

4.2.8 PAINTING

All structural steel should be painted with 2 coats of zinc phosphate primer and finished with Synthetic enamel paint of approved make and colour.

All steel structure shall receive two primer coats and two finish coats of painting. First coat of primer shall be given after fabrication, before dispatch to site for erection, after surface preparation as described below. The second coat of primer shall be applied after erection and final alignment of erected structures. Two finish coats shall be applied after the second primer coat.

Steel surface which is to be painted shall be cleaned of dust and grease and heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be abrasive blasted to Sa-2½ finish as per SIS 05-5900. Primer paint shall be inorganic Zinc phosphate of approved brand. Dry film thickness of each primer coat shall be 25 microns minimum.

Providing and applying two coats of synthetic enamel paint with minimum 50 micron total dry film thickness (DFT) of approved make and shade to achieve an even shade over steel sections already having primer coats and keeping overall DFT with primer not less than 110 microns.

4.2.9 REQUIREMENTS FOR SPECIFIC STRUCTURES

4.2.9.1 Coal bunkers

Design of the bunkers shall be as per IS: 9178. Plates shall be cut to the maximum width to reduce the number of horizontal joints. Vertical joints shall be staggered. All vertical joints above bunker supporting zones and both vertical and horizontal joint below the zone shall be inspected by radiography to ensure quality. Trial assembly of the bunker including hopper shall be made at least for one bunker before commencing regular fabrication of the bunkers..

Stainless steel liner in the coal Bunkers will be 4.0 mm thick & of grade SS: 409M, Finish Grade 2B (Cold Rolled, Annealed & Pickled and Skin passed) will be provided on the inner faces of entire inclined portion of Hoppers and mouth of the Hoppers, without allowing any projections in coal flow path. The suitable electrodes' classification as per AWS will be as followed for welding of stainless steel to stainless steel & for welding of stainless steel to mild steel.

The coal pressure distribution in the bunker walls and hopper will be calculated as per the guideline laid in IS: 9178.

4.3 DESIGN PHILOSPHY

4.3.1 POWER HOUSE STRUCTURE (TURBO GENERATOR / DEAERATOR BAY)

The Main Power House structure will be moment resisting frame in the transverse direction and will have fixed base. The structure will be braced in longitudinal direction. In the longitudinal direction, the structure will be continuous for the total length of one unit of the power house. Adopting twin columns between the two units of Power house buildings, expansion gap shall be provided.

Columns inside TG bay (auxiliary structures around TG) will be fixed at base and have shear connection with beams supporting R.C.C floor at operating floor level & mezzanine floor level. Beams in transverse direction will have connection with TG bay main columns.

Analysis of Main Frame of the Main Power House: The structural steel main frame will be analyzed as space frame with fixed base. The frame will be subjected to dead load, live load, crane load, equipment load, wind load and seismic load. Structural analysis will be carried out for the different load combinations as specified elsewhere. For the main frame subjected to seismic load, the analysis will be carried out using the response spectrum method using at least five modes of vibration as per IS: 1893-2002.
The structural steel main frame in the longitudinal direction will be analyzed and designed as braced structure with all the applied external forces resisted through axial tension or compression.
Individual members of the frames shall be designed for various load combinations for moment, axial force, shear force and torsion. The gable end columns shall be designed for wind and axial loads considering base as fixed and restraints provided by the wind girder at operating floor and roof girder levels. The secondary beams shall be designed as simply supported beams between the main beams of frames.

4.3.2 Electrical Bay

The electrical bay will consist of areas for the cable spreader, switchgear floor, Control Room floor and MCC Floor. It will be supported on structural steel frame work with moment connection in transverse direction and bracings in longitudinal direction.

4.3.3 PIPE AND CABLE RACKS AND PIPE PEDESTALS

Pipe and Cable racks will be latticed steel structure on RCC foundations decided on the basis of Geotechnical Investigation Report. At road crossings the minimum height clearance will be 8 m.

The racks shall generally be designed as braced in the transverse direction below the bottom most rack level and rigid above the level since bracing will interfere with pipe / cables. Longitudinal direction they are braced generally in the centre of an expansion unit. Expansion joint shall be provided whenever there is a change in direction and where length of the rack exceeds 150 meters. Access ladder shall be provided at suitable locations. Where so specified 600 mm wide chequered plate platform will be provided in the cable rack portion for maintenance purpose.

4.3.4 MILL AND BUNKER BAY

The framing shall be of structural steel. This shall be designed as a moment connected framing in the transverse direction and braced in the longitudinal direction. These structures primarily support coal bunkers, coal feeders and tripper arrangement to feed coal into the coal bunker. The structure shall be designed to have a Moment connection at the base of the frame.

4.4 DRAINAGE AND SEWERAGE

4.4.1 SURFACE DRAINAGE

All the paved and unpaved areas will be adequately drained. The paved areas will be sloped towards the nearest drains with a slope of 1 in 100. The surface drainage from uncontaminated areas will be connected to the nearest storm water drains through rectangular drains. Contaminated area surface drainage will be connected through a separate network. Run off coefficient for paved and unpaved areas will be taken as 0.9 and 0.6 respectively.

4.4.2 STORM WATER DRAINAGE SYSTEM

A network of open rectangular or pipe drain will be constructed for efficient discharge of storm water. The drains shall be constructed of RCC. Minimum clear width of the drains shall be 300mm and minimum depth of drain shall be 300mm. NP3 class pipe culverts will be provided under road and railway crossings.

For pipe drains, concrete pipes of class NP2 will be used. However, for road and rail crossing, concrete pipes of class NP3 will be used. Manholes will be provided at 30m intervals along the length, at connection points and at every change of alignment, gradient or diameter of pipeline. Hume pipe of 150mm diameter shall be provided below each road at every 50m and of 600mm diameter at every 300mm and also at all turnings for maintenance purpose. The runoff collected by the above drains will be suitably discharged at a suitable location at plant boundary.

The plant storm water drainage will be designed taking into account the finished grade levels of the plant and invert levels of existing drains(if any), area drainage pattern within and outside plant area, intensity of rainfall @50mm/hr considering heaviest fall in 24 hrs(As per climatological table furnished by customer). The slope shall not be milder than 1 in 1000 and maximum velocity in open drain shall be limited to 1.8 m/s. However a self-cleansing velocity of 0.6m/s shall be ensured.

Drains inside the building will have minimum 40mm thick grating covers. In areas where heavy equipment loads would be coming, pre-cast RCC covers will be provided in place of steel grating.

Open RCC rectangular section shall be provided for all drains.. In areas where vehicular loads would be coming, pre-cast RCC covers of suitable thickness without perforations and designed for the vehicular loading will be provided.

In the buildings suitable arrangement for draining out water collected from equipment blow downs, leakages, floor washings, fire fighting etc. will be provided for each floor with suitable floor drains. Water from roof surface shall be removed by a system of Roof Drain Heads, rainwater down comers and necessary fixtures. The roof of power house shall be provided with a slope of 1

in 100 in one direction in A-B bay and sloping towards A - row.

Garland drains of minimum 300 mm wide shall be provided all around the buildings to lead away roof drainage to the plant drainage system. Plinth protection shall be provided between the building wall and drains with appropriate slope.

Minimum earth cover of 450mm shall be provided over drainage pipes in paved areas.

4.4.3 PLANT EFFLUENT DRAINAGE (OILY WASTE/PROCESS WASTE DRAINAGE)

The oily / process waste shall be collected and drained through a separate sewer system consisting of cast iron pipes in the paved area and concrete pipe class NP2 in other area. Manholes shall be provided at junctions of pipes.

The minimum dia of pipe shall be 150 mm for C.I pipe and 300 mm for concrete pipes. The pipes shall be adequately sloped and shall carry the flow to Neutralising pit / oil water separator / guard pond of effluent treatment plant as the case may be.

4.4.4 SEWAGE DISPOSAL

All buildings with toilets shall be connected to the sewage treatment plant with a proper sewage disposal network.
Pipe connecting toilet facilities to manholes shall be pipes of,cast iron in paved area whereas in other area hume pipes shall be provided, of minimum size 100 mm dia. Pipes connecting various manholes in the power block area shall be having a minimum dia of 150 mm.
Sewers shall have such slope as to ensure effective discharge. Manholes shall be provided along the sewers at 30 m intervals, at junctions and at changes of gradient or alignment.

4.4.5 BUILDINGS - WATER SUPPLY SYSTEM

Roof water tanks of adequate capacity, depending on the number of users for 12 hours requirement will be provided on the roof of buildings as required. Polyethylene water storage tank conforming to IS: 12701 will be used. The tanks will be complete with fittings including float valve, stop cock etc.
Galvanized MS pipe of medium class conforming to IS: 1239 will be used for internal piping works for potable water supply.

4.5 CABLE TRENCHES

The slab and walls of cable trenches shall be constructed using concrete grade M25 and pre-cast removable RCC cover (with lifting arrangement) will be

constructed using concrete grade M25. Each precast removable RCC cover shall not weigh more than 75 kg and shall be provided with lifting hooks. Proper drainage of trenches shall be provided.

The cable trench walls will be designed for the following loads:

1. Triangular earth pressure + Uniform surcharge pressure of 15kN/m^2.
2. Cable trench covers will be designed for self-weight of top slab and concentrated load of 200 Kg at center of span on each panel.
3. Cable trench crossing the road/rails will be designed for class AA loading of IRC/relevant IS code and should be checked for transformer loading. Lifting hooks will be provided in the pre-cast covers.
4. Cable trenches will be blocked at the ends if required with RCC walls.

Trenches located inside the building will be covered with removable chequered plate covers.

Where the cable trench connects to a building, R.C.C duct banks with PVC / HDPE conduits for running cables will be provided. There conduits shall be sealed with fire resistant sealing compound after cables are laid to prevent ingress of water into the building and to avoid spreading of fire.

4.6 PAVING / GRADE SLAB

RCC Grade Slab / Boiler area paving : Minimum 150 mm thick (with minimum reinforcement of 8 dia (HYSD) @ 300 c/c both ways top & bottom) over an underbed as specified herein will be provided for areas mentioned below. Underbed will consist of preparation and consolidation of sub-grade to the required level, laying of stone soling of 230mm compacted thickness with 63mm and down aggregate with interstices filled with selected sand followed by 75mm thick M10 PCC

Area between main plant building and ESP, ID, FD fan will be provided with paving. This paving will have regular configuration with boundaries of the block extending minimum 2 m from the outermost face of the equipment/structures.

1. For Ground floor of all buildings - Grade slab shall be provided
2. Two meter wide corridor along the entire width of TG & Deaerator bay at both the gable ends - Paving shall be provided
3. Complete Transformer yard area between A-row of main power house and

fencing of transformer yard – Paving shall be provided.

4.7 **ROAD & DRAIN** 02

The main road to the Power Plant shall originate from the main approach road. The main road shall be 12M wide(carriage way width 10M) with 1M wide shoulder on either side to accommodate large trucks movement .The 10M wide road shall be provided upto service building from the main gate.

Other roads may be of double lane of 7.5M wide (carriage way width) and single lane of 3.75M wide with 1M wide shoulder on either side for both, depending on the location.

Branch roads may be of single lane and 3.75 meter wide with 1meter wide berm on either side.

The minimum recommended road section is as follows :

Sub-base : Sub base shall consist of stones of 150 mm maximum size in two layers compacted to a thickness of 230 mm.

Base : Base shall have a thickness of 225 mm consisting of 3 layers of 75 mm each (compacted thickness).

Topping : The bituminous surfacing shall consist of wearing course of premix carpet 20 mm thick (with seal coat on top) over binder course of 55 mm thick Bituminous Macadam.

Initially only water bound macadam surface shall be constructed and after completion of bitumen topping shall be carried out .

All roads should designed in accordance with IRC 37-2001.

DRAINAGE

Open RCC rectangular drains shall be provided for storm water. The thickness of sides & bottom shall be minimum 100 mm or as per design considerations whichever is higher. RCC culverts shall be provided for road and rail crossing. Drains shall be provided on both sides of the roads except patrol road where drains will be only one side.
Inside surface of the drain will have smooth neat cement finish over with screed

concrete. Invert of the drain shall be decided in such a way that the water can easily be discharged to the recommended nearest outfall outside the plant boundary. The minimum slope of the drain shall be 1:1000 longitudinally to take care of the silting problems. It is recommended to maintain the maximum velocity within 1.2 m/sec..

4.8 FENCING

4.8.1 Minimum 2.4m high fencing above toe wall shall be provided around transformer yard. Other areas where fencing is necessary it shall comprise of PVC coated galvanised chain linked fencing of minimum 8 gauge (including PVC coating) with barbed wire for remaining height shall be provided for areas as per safety requirements.

4.8.2 Access in fencing wherever required shall be with steel gates

4.9 Plinth Protection

All buildings will be provided with 1000 mm wide and 75mm thick reinforced cement concrete M25 paving all around on the outside. The plinth protection will be laid over prepared sub-grade and base formed with 100 mm thick compacted sand bed with broken bricks, or rubble laid to a thickness of 75 mm. RCC drains by the side of plinth protection for catering the storm water from roofs and adjacent area will be provided.

4.10 Grouting/Encasement

Grout shall be flow able, and no shrinkable kind. Grouting shall be done with Conbextra GPX-2 of `Fosroc' or equivalent for Equipment foundations and Conbextra GP-1 or equivalent for all structural column bases. For pipe-supports grouting shall be done with 1:1:2 cement-sand - 6mm down stone chips

4.11 Damp Proofing

Damp proof course in a thickness of 40mm and consisting of cement concrete 1:1.5:3 with minimum of 2% admixture of approved water proofing compound shall be provided at plinth level for masonry walls in super structure.

4.9 Watch Tower

Watch tower shall be provided at the change of alignment of boundary wall and the inter distance of 500 mtr (approx.).

5.0 BRIEF DESCRIPTION OF STRUCTURES IN POWER PLANT

5.1 POWER HOUSE BUILDING

Main power house framing is of structural steel. Columns and framing beams are of built-up section. Main power house comprises of Turbo Generator bay and Electrical bay.

Turbo-Generator Bay: Roof in turbo-generator bay (A-B bay) will be with cast-in-situ RCC slab laid over metal decking sheet as a permanent shuttering.

Other Areas: Casting of RCC roof slab will be done with the provision of removable shuttering.

Flooring: The floor slab will be designed as cast-in-situ RCC slabs with removable shuttering unless mentioned elsewhere. The minimum thickness of RCC slabs will be 150mm. Floor finish of 40mm thickness will be provided over the RCC slab. Type of floor finish will be as per the functional requirements of different areas and facilities. Floor finish that will preferably be adopted for important areas will be as per Finish schedule described elsewhere. TG bay will have RCC floors at finished floor levels (FFL) at EL+8.500 and EL +13.500.

For Fire barrier wall, RCC fire barrier wall shall be provided for the transformer in front of power house. Brick partition walls will be 115mm thick. Bricks shall be burnt clay bricks or fly ash bricks of class designation 7.5 conforming to IS 12894 having 75 kg/Sqcm compressive strength shall be used for brick work. Metal cladding shall be of prefabricated, prepainted and insulated metal sheet of Luxalon or equivalent.

5..2 Roof Water Proofing Treatment: The gradient for the roof of Turbine bay will be provided either in steel structure or by use of screed concrete of M10 grade. Water proofing treatment shall be laid over 100mm thick foam concrete insulation over permanent 0.8mm thick metal decking plate. Minimum 15mm thick cement mortar (1:4) will be provided on top to achieve smooth surface. Roof water proofing treatment will be provided over this by providing extra heavy duty four layers of Hessian based bitumen felt and five layers of bitumen paint

finish. Wearing course consisting of 25mm thick plain cement concrete of grade M15 (1:2:4) with graded aggregate of 12.5mm size cast in panels of maximum size 1.2mx1.2m and reinforced with 0.56 mm dia. galvanized chicken wire mesh and sealing of joints (in grooves of 6mm X 6mm) using silicon /elastomeric compound will be provided over bitumen paint.

Roof waterproofing in all other areas will have 75mm thick foam concrete over conventional RCC slab with extra heavy duty nine layers of bitumen felt over which 20mm thick pressed pre-cast concrete tiles on 15mm thick cement sand (1:4) under bed shall be laid.

Rain water down comers shall be GI pipes conforming to IS: 1239 for Power house building. Rain water down take pipes shall be provided one per bay near each column location on both A and C row for Power House building.

5.3 MILL AND BUNKER BAY STRUCTURE

The framing shall be of structural steel. This shall be designed as a moment connected framing in the transverse direction and braced in the longitudinal direction. These structures primarily support coal bunkers, coal feeders and tripper arrangement to feed coal into the coal bunker

Mills are to be located on the ground floor. Mill foundations are to be designed as a dynamic block.

Mill maintenance platform is provided with chequered plate or gratings over steel framing with hand rails all-round. Feeder floor shall be of RCC supported on structural steel framework.

Tripper floor is provided immediately above the bunker. Tripper roof shall be of RCC supported on structural steel frame work. An RCC parapet or steel handrail shall be provided for the tripper roof. An access stair or ladder shall be provided from tripper floor to roof in each unit.

5.4 ESP CONTROL ROOM

This shall be a steel framed structure. The building houses cable vault, toilet, staircase, switch gear rooms, control rooms and AHU room. An auxiliary transformer yard with fencing and gate shall be provided adjoining to the building. Side cladding shall be of brick wall with wall in front of transformer yard made sufficiently thick to satisfy fire rating as per TAC regulations.

5.5 TRANSFORMER YARD

Transformer yard will be provided with foundations for transformers & other

equipment, cable trenches and fencing. The transformer yard will be provided with the chain link PVC coated galvanized chain link fencing of minimum 8 gauge supported by steel posts. Gravel will be filled in transformer oil and water collecting pits. The transformer yard area will be provided with RCC paving. Fire barrier wall will be provided between the adjacent transformers and fire wall will be provided in the adjacent buildings on the wall facing the transformers as per TAC requirements.

Transformer yard pit will be leveled to proper slopes for drainage towards sump. Sump will be connected to the nearest drainage system after passing through oil water separator.

The total transformer area shall be paved with 150 mm thick RCC paving over 230 mm thick rubble soling.

5.6 MISCELLANEOUS BUILDINGS/STRUCTURES

02

SL.No.	Building Name	Description
1.	Service Building	RCC structure with brick cladding. Total area of 4000 sqm (approx)
2.	Clarified water pump house	RCC sump with structural steel framework above FFL only superstructure with brick cladding with RCC roof over deck sheeting.
3.	CW pump house	RCC sump with structural steel framework, superstructure with brick cladding and RCC floor slabs and roof
4.	CW Treatment	Steel Shed
5.	ESP Control room	Steel structure frame with brick cladding RCC floor slabs and roof.
6.	Compressor house	Steel Building
7.	Chemical Lab	RCC structure with brick cladding.
9.	Fuel oil Pressurizing pump house	RCC structure with brick cladding.

11.	Administrative building	RCC structure with brick cladding. G+1 Structure of total area 2500 sqm.
12	Canteen	RCC structure with brick cladding. One floor of 40m x 18m (excluding corridor and portico). The main dining area shall have the arrangement to seat minimum 150 people at one time. In addition there shall be a separate executive dining area to accommodate about minimum 25 executive and separate dining area for women for 25 nos.
13	Fire Water Tank Foundations	RCC ring wall.
14	Fuel Oil Storage Tank Foundations	RCC ring wall.
15	Pipe and Cable Trestles	Structural Steel super structure with RCC foundation.
16.	Raw water pump house	Steel Structure
17.	Fire station	G+1 RCC structure with brick cladding.20m x 15m x 4.0m (ht) of each floor. Additional 2 Nos fire tender parking area
18	Permanent Store Building	RCC columns with brick cladding and steel truss roof. Area 30m x 15m-15 No.s
19	CW Treatment Building	Steel shed with side open
20	Security Building	RCC structure with brick cladding of 300 sqm floor area

21	Parking sheds	Parking sheds shall be provided as mentioned below apart from bus parking for 3No.

Parking Requirement

Sl. No.	Location	Car parking (No.s)	Two Wheeler Parking (No.s)
1	Administrative Building	5	50
2	Service Building	20	200
3	Canteen	10	100
4	Chemical lab	--	10
5	Security Building	2	20
6	Permanent store building	--	50
7	CW pump house	--	10
8	Ash Pump House area	2	20
9	Coal Handling area	2	20

6.0 GENERAL REQUIREMENT OF BUILDINGS

The design and construction of buildings, structures etc. shall take in to account the functional requirements for operation and maintenance of all equipment and its users. The following details indicted will generally apply for all buildings and structures.

6.1 ARCHITECTURAL CONCEPTS AND DETAILS

Architectural scheme components viz shape, form, colour, and basic materials for interior and exterior architecture, will generally conform to that described herein and match with local practice and surroundings.

6.2 ROOF ACCESS

For roofs more than 8m above grade or if major equipments are placed over the roof, shall have access from a proper staircase. Minimum 1000 mm wide access path with tiles shall be provided to approach equipment on roof. For other roofs cage ladder or staircase as appropriate shall be provided.

6.3 PLATFORMS AND WALKWAYS

6.3.1 Platforms shall be provided to all major equipment, not directly accessible from the floors, for maintenance. Platforms located close to each other shall be connected with walkways.

6.3.2 All steel platforms above grade level shall be constructed with kick plates at edge of the platform to prevent tools or materials from falling off.

6.3.3 Continuous walkway with hand rails shall be provided along the crane girder level in the TG building. Approach to EOT crane shall be ensured by Cage ladder or staircase.

6.4 STAIRS & LADDERS

6.4.1 STEEL STAIRS

All steel staircases shall normally have minimum clear width (back to back of stringer) of 1000 mm and minimum inclination with horizontal of 35.7 degree. However, in case of space restriction, minimum 250 mm wide treads of chequered plate/grating, with suitable nosing, and spaced equally so as to restrict the rise to maximum 200 mm .

6.4.2 STEEL LADDERS

Ladders shall be provided to platforms, walkways, instruments and equipments which do not require frequent access. Ladders shall preferably be vertical and its angle with vertical shall not exceed 50.
Ladders shall be of minimum 450 mm clear width with 20 mm dia. MS rungs spaced at 300 mm (maximum).
Ladders shall be provided with a safety cage wherever required starting at 2.5 m above the lower landing level.

6.4.3 RCC STAIRS

All stairs shall have riser of minimum 150 to 200 mm and a minimum tread of 250 mm. However, for administration building riser shall be limited to 150 mm tread width of 300 mm. Minimum width of stairs shall be 1200 mm generally. No staircase shall have more than 15 risers in one flight. Aluminium angle nosing with minimum 50 x 25 x 3 angle shall be provided for edge protection of RCC stairs.

6.5 VERTICAL HEAD ROOM

All accessible areas will be provided with a minimum clear headroom as follows,

unless otherwise specified.

1. Finished floor to ceiling (Buildings) : 3000 mm
2. Doors, walkways, platforms : 2100 mm
3. False ceiling to office areas/stairs : 2400 mm
4. Cat walkways above false ceiling : 1000 mm
5. Safety cage for cage ladders : 2500 mm
6. Access for forklift trucks : 2800 mm
7. Roads / railway crossings : 8000 mm
8. Cable and pipe racks (except road/rail crossing) : 3000 mm

6.6 GUARD RAIL / HAND RAILS

Guard rail will be a two-rail system with the top rail 1000 mm above the walkway/platform/floor surface and the intermediate rail 500 mm below the top rail. Guard rail post spacing will be proportioned to the length of the protected horizontal opening, but will not exceed 1500mm centre-to-centre of posts.

6.7 EDGE PROTECTION

Wherever possible around floor openings an RCC Kerb of 100 mm wide 150 mm high shall be provided. All concrete edges, where breakage of concrete corner is expected shall be provided with edge angles e.g. alround the cut-outs / openings in floor slab, edges of drains supporting grating covers, edges of manholes supporting covers and supporting edges of pre-cast covers etc.

6.8 ANCHOR BOLTS AND INSERT PLATES

Anchor bolts shall be designed for tension and shear, for embedded length of the anchor bolts and pipe sleeves. Shear and crushing strength of concrete shall also be checked. Increase in allowable stress for loading including seismic and wind loads shall not be permitted in design of anchor bolts.

Insert plats shall be designed / checked for shear and bending moment. All lugs shall be checked for tension. Bond strength of concrete shall be checked. Lugs using steel bars shall preferably be fillet welded to the plate to transfer full strength of the lug.

6.9 EXPANSION / CONSTRUCTION JOINTS

Expansion and construction joints shall be provided wherever required. All expansion and construction joints of water retaining structures in RCC shall be

made water tight using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops may be used for the base slabs 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 225 mm. At other joints these shall be 150 mm wide. Two part polysulphide sealant conforming to IS: 12118 shall be used for sealing of joints in contact with water. For other cases, bitumen sealing compound conforming to IS: 1834 can be used. Preformed bitumen impregnated fibre board conforming to IS: 1838 shall be used as joint filler.

6.10 BRICK MASONRY / STONE MASONRY

Walls will be non-load bearing in-filled panel of 230mm thick. For initial height upto 3.0 meters from ground level, walls will rest on grade beam. Internal walls and toilet walls will be 115mm thick. 115mm thick brick walls shall be provided with transomes and mullions where the length or height of wall exceeds 2 m.

Bricks shall be clay burnt bricks or fly ash bricks of class designation 7.5 and shall will be laid with cement mortar (1:6) for 230mm thick brick walls and (1:4) for 115 thick brick walls. IS:1905, IS:2212 and SP-20 will be followed for brick work design and construction. Minimum compressive strength of brick shall be 75 kg/Sqcm. Wall cladding loads along with the effects of wind, earthquake etc. will be considered in the design of beams supporting the walls.

6.11 WATER PROOFING & PAINTING OF UNDERGROUND STRUCTURES

All underground structures like basements, pump houses, water retaining structures shall have plasticizer cum waterproofing cement additives conforming to IS: 9103. In addition, limit on permeability as given in IS: 2545 shall also be met with.

6.12 Rolling Shutters: Rolling shutters as per IS:6248 with suitable operating arrangement (manual, mechanical and /or electric) according to size shall be provided in buildings to facilitate handling and transportation of equipment. The curtains of rolling shutter will be of interlocking scrolls made of hot rolled double dipped galvanized steel lath section of 18swg tested mild steel strips at 75mm rolling centers, locked with galvanized malleable iron clips. The bottom lath will be coupled to a locked plated fabricated from 3 mm thick galvanized steel plate and security riveted with stiffening angles.

7.0 FINISHES

7.1 Plastering

The exterior plaster on brick wall shall be 20 mm thick sand face plaster in CM

(1:6) and shall be laid in 2 courses. Interior face of all brick walls will have 12 mm thick cement sand plaster (1:6). 2mm thick plaster of paris punning to be provided over plaster to air conditioned areas.

7.2 DOORS, WINDOWS AND VENTILATORS

a) Generally hollow metal (steel) flush doors with pressed steel frame shall be provided for plant and utility areas.

b) Solid core factory made wooden flush doors in hard wood frame shall be used in interior office areas. Aluminium doors shall be provided in at entrances and important areas.

c) Rolling steel shutters shall be used where frequent use is not envisaged and large openings are required. Operation shall be manual/mechanical/electrical depending on the size of opening.

d) Special areas like control rooms and other special areas shall be provided with minimum 15 micron pre-coated i.e. colour anodised aluminium glazed partitions with air lock facilities having two sets of doors preferably double door system.

e) Minimum 2 hour Fire rated doors with panic bar shall be provided in cable spreader rooms and other areas having fire hazard and also to all fire exists as per TAC requirement.

f) Doors shall be provided at appropriate location to prevent dust ingress from outside.

g) Wooden panel doors shall be provided for toilet entrance and toilet internal doors shall be solid core PVC.

h) Weather stripping shall be provided to all outside doors as well as air conditioned areas and all other doors where dust-free environment is required.

In Powerhouse building, full glazed windows of sliding type ventilators in minimum 15 micron anodized aluminium window frame shall be provided with 4 to 6 mm thick (depending on the size of panel) clear float glass and 6 mm thick clear wired/laminated glass where required from safety point of view. For an operating floor of Power House, structural glazing may be considered as an important façade element.

In other areas aluminium windows with 4 mm thick clear float glass shall be provided. The window area shall be so decided so as to allow adequate natural ventilation and light.

Note: Glass thickness and member sizes of Aluminium Glazed doors and windows shall be designed by the manufacturer and to be submitted for approval before execution.

7.3 GLAZING

a) Glazing in Control room between A.C. and non-A.C. areas shall be insulating glass consisting of two 6 mm thick toughened float glass sheet hermetically sealed and separated by 12 mm gap for thermal insulation. Clear glass shall be provided where clear view is required. In other areas tinted glass may be provided.

b) 4 mm thick ground glass shall be provided for toilets.

c) Glazing between two A.C. areas shall be with 6 mm thick clear float glass.

d) All glazing shall be in aluminium frame having 15-micron colour anodised.

e) 6mm thick Wired / laminated glass shall be used for windows / ventilators at higher level for safety.

f) 24mm thick insulated double glazing having 6mm thick tinted heat-reflecting type float glass on outer side and 6mm thick clear float glass on inner side with 12mm air gap & hermetically sealed shall be mounted on 15 micron coloured anodised aluminium frame suitable for structural glazing system.

7.4 ACID ALKALI RESISTANT LINING

7.4.1 25mm thick acid and alkali proof tiles will be laid over acid and alkali proof epoxy mortar under bed shall be provided for Battery room, battery charger room, degasser area, chemical house floor etc. Similar tiles over chemical resistant silica based epoxy mortar shall be used as dadoing above floor level. Ceiling will be painted with chemical resistant epoxy paint.

7.5 FLOORING & FLOOR FINISHES

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7.5.1 The floor slabs will be designed as cast-in-situ RCC slabs with removable shuttering unless mentioned otherwise. The nominal thickness of RCC slabs will be 150 mm.

7.5.2 The nominal total thickness of floor finish will be 40/50 mm i.e. underbed & topping. The floor will be laid on already laid and matured concrete base.

7.5.3 The finished floor level of toilet areas shall be kept 12 mm below as that of the surrounding area. Toilet area slabs will be made water tight by suitable water proofing treatment.

7.5.4 Floor finishes will be as per Finish schedule of this specification

7.5.5 Skirting in general will be 150 mm high. Dado in toilets, will be upto 2.1m. height from finished floor level. Skirting and Dado will match with the floor finish.

7.6 FALSE CEILING

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Aluminium pre-painted/Powder coated false ceiling, either lineal panel system or aluminium tile/plank system for control rooms and other important areas, with suspension system as per manufacturer's details shall be used.

Areas like office space or where specified Mineral Fibre Based Acoustic Ceiling Board either Armstrong or similar to Armstrong in aluminium snap grid suspension system as per manufacturer's specification shall be provided. As an alternative Moisture & Fire Resistant Gypsum Board false ceiling system of Saint Gobain Gyproc India Ltd or similar manufacturer may be used.

Unimportant areas Calcium Silicate Board/Tiles false ceiling shall be of HILUX or AEROLITE or Fibre Cement Board of EVEREST Industries Ltd shall be used.

The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement. False ceiling shall be provided with 25 mm thick insulation of resin bonded mineral wool conforming to IS: 8183. Wherever under-deck insulation is required the insulation shall be 50 mm thick resin bonded rigid mineral wool / polystyrene block with protective aluminium foil lining.

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7.7 SCHEDULE OF FINISHES

7.7.1 **INTERIOR FINISH SCHEDULE FOR POWER HOUSE BUILDING**

BUILDING/ AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING
T.G. Hall Area	Overall 50mm thick flooring shall be finished with 18 mm thick polished Granite for unloading areas and walkways shall be demarcated with 75 mm wide and 18 mm thick Granite stone (black) on both sides of Granite finished walkways.	Granite tiles/10mm thick high polished decorated coloured background 1st quality digital series dual charged glazed tiles of size not less than 18"x12" shall be provided for inner faces of all four sides walls of operating floor TG hall and columns (by encasing structural steel columns along A-row and both gable ends with brick masonry for 3.0mts height above operating floor) up to bottom of window lintel level or 1.80mts height from operating floor level whichever is high and balance portion of brick wall shall be painted with two coats of plastic emulsion paint over primer and white cement putty. A row and gable end shall have double skin metal cladding system above brick masonry wall. Synthetic enamel paint up to 1.50mts	T.G. Hall – anti-corrosive paint to metal deck and all metal works. Acrylic Distemper on exposed plastered ceiling (without false ceiling). Aluminium panel pattern false ceiling for false ceiling areas

		height and acrylic emulsion paint for balance height for all other floors of STG building.	
Switchgear Room, MCC Room,	Electric insulated flexible PVC sheet as per IS: 15625-2006 to be laid over heavy duty IPS flooring. Overall thickness shall be 50mm. pattern.	Synthetic enamel paint upto 1.50mts height from floor level and balance portion with plastic emulsion paint over primer and white cement putty.	Acrylic Distemper
2 Control Rooms, Control Equipment Room, Computer Rooms, etc. Other than Main Control Room.	Non-skid, fully vitrified, 10 mm thick non-porous, homogenous, abrasion resistant, floor tiles similar to 'MARBONITE',FERRASTONE' of " BOSS Profile Ltd", "RESTILE",ENDURA" of H&R jonson (India) Pvt. Ltd,"Kajaria" profile Ltd",of minimum size minimum 600 mm x 600 mm x 9~10 mm of approved colour and shall be laid over concrete floor with laying compound strictly as per manufacturer's specification. Total thickness of the flooring shall be 50mm thick including the thickness of the tiles and under bed.	Vitrified tiles dadoing up to false ceiling level in UCB control room and annexure room shall be provided. Front portion of the UCB control room facade above glass panelling a suitable combination of Aluminium composite panel (ACP)/granular textured paint may be used. Columns, bracings or any other element within the room as the case may be shall be clad with polyester coated 3mm thick Aluminium Composite Panels (Aluminium thickness minimum 0.2mm) of approved make or composite panelling of approved pattern upto the false ceiling level.	Gypsum board plaster false ceiling for control room and annexure rooms. The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement.

3 All office areas, Conference Room and other important areas.	10/11 mm thick non-skid fully vitrified dual charged tiles of minimum size 600 mm x 600 mm similar to 'MARBONITE',FERRASTONE' of " BOSS Profile Ltd", "RESTILE",ENDURA" of H&R jonson (India) Pvt. Ltd,"Kajaria" profile Ltd", (overall 40 mm thick) laid in pattern with different colour of tiles.	Acrylic emulsion paint over white cement putty.	Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system. Acrylic emulsion paint over white cement putty in areas without false ceiling with necessary lighting arrangements for illumination shall be provided.
4 Access floor where required	Minimum 600 mm high false floor with adjustable metal supporting system and fire resistant floor panels finished with antistatic vinyl flooring and matching skirting		
5 Stairs & Lobby	Kota stone slab in general.	Coloured 6mm thick(min) ceramic tiles up to 1.50mts height and Acrylic emulsion Paint over white cement putty for balance height.	Acrylic Distemper Paint
Main Stair & Landing	Aranga White marble slab//makarana pink / Jaishalmir Yellow and Baroda green combination 25 mm thick (min.) with larger possible size to be approved by the owner.	Acrylic emulsion paint over white cement putty.	Acrylic emulsion paint over white cement putty.
Lift lobby	Aranga White marble slab/makarana pink / Jaishalmir yellow and Baroda green combination 25 mm thick (min.) with larger possible	Granite slab cladding	Aluminium plank panelled pattern false ceiling.

	size to be approved by the owner.		
6 Battery Room & Battery Charger Room, UPS Room	Minimum 20 mm thick acid and alkali resistant vitrified tiles “ENDURA” Or similar set in and jointed with epoxy mortar (overall 40 mm thick)	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height	Acid/Alkali resistant epoxy paint for balance height.
7 Chemical Feed Station	Minimum 20 mm thick acid and alkali resistant vitrified tiles “ENDURA” or similar Minimum 37mm thick Acid /Alkali resistant brick, set in and jointed with epoxy mortar (overall 40 mm thick) .	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height.	Acid/Alkali resistant epoxy paint for balance height.
8 AHU Rooms, Air Washer Rooms, Cable Spreader Rooms & all other service areas	50 mm thick heavy-duty cement concrete floor with metallic hardener.	Synthetic enamel paint up to 1.50mts height and acrylic emulsion paint for balance height over white cement	Acrylic Distemper Paint
9 Toilet and other wet areas	Minimum 10 mm thick non-skid vitrified tile of make ‘MARBONITE’,FERRASTONE’ of “ BOSS Profile Ltd”, “RESTILE”,ENDURA” of H&R jonson (India) Pvt. Ltd,”Kajaria” profile Ltd”,of minimum size 400 mm x 400 mm (overall 40 mm thick) with glazed ceramic tile of same make dado topped with 50 mm wide matching moulded ceramic trims. Dado height shall be full height starting from finish floor level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	Acrylic emulsion paint over white cement putty. Aluminium false ceiling where required.
10 Oil Spillage area	Non-skid self-leveling epoxy over IPS (overall 40 mm thick)	Epoxy paint.	Epoxy paint.
11 Electrical Switchgear Room, MCC Room, etc	Electric insulated flexible PVC sheet as per IS: 15625-2006 to be laid over heavy duty IPS flooring. Overall thickness	Synthetic enamel paint up to 1.50mts height and acrylic emulsion paint for	Acrylic Distemper

	shall be 40mm.	balance height over white cement putty.	
12 All other general areas except operating floor	Overall 50 mm thick heavy-duty concrete floor (IPS) with metallic hardener or 40mm thick steelcrete tiles finish.	Synthetic enamel paint up to 1.50mts height and acrylic emulsion paint for balance height over white cement putty.	Acrylic Distemper

7.7.2 Interior Finish Schedule For Auxiliary Plant Buildings

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1 Mill Building	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Metal cladding	Synthetic enamel paint
2 ESP Control Building	10 mm thick non-skid fully vitrified tiles of make “MARBONITE”,”FERRASTONE” of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern for Control room. Other areas 50mm thick heavy duty IPS flooring with metallic hardener. MCC & Switchgear rooms shall have flexible electric insulated PVC synthetic sheet finish over IPS.	Acrylic emulsion paint over white cement putty for control room and Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint over white cement putty for balance height for Other areas	Pre-coated aluminium panelled (600mmx600mm size) ceiling “Luxalon” or “INTERARCH” in air-conditioned areas. Acrylic Distemper paint in other areas.
3 Chemical House	Minimum 20 mm thick acid and alkali resistant vitrified tile “ENDURA” or Minimum 37mm thick Acid /Alkali resistant brick, set in and jointed with epoxy mortar (overall 50 mm thick) along with 2100 mm high dado of same tile having 20mm thickness. Where required, other areas with 50mm thick heavy duty flooring with	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height and Acid/Alkali resistant epoxy paint for balance height	Chemical resistant paint for acid & alkali resistant area and other areas with Acrylic Distemper paint.

	metallic hardener.	in acid & alkali prone area and rest with Acrylic emulsion paint paint	
4 Raw Water Pump House & Electrical Building	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper
5 HFO & LDO Forwarding Pump House	Self-levelling epoxy floor paint on oily areas and heavy duty IPS flooring with hardener in balance areas.	-Do-	Acrylic Distemper Paint
6 CW, ACW Pump House	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	-Do-	-Do-
7 CW, ACW Pump House	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	-Do-	-Do-
8 Misc. Pump Houses/ Fire Water Pump House/ Clarified water pump house	-Do-	-Do-	-Do-
9 DM plant			
a) Plant area	Minimum 20 mm thick acid and alkali resistant Vitrified tile of “ENDURA” or similar set in and jointed with epoxy mortar (overall 40mm thick).	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height and Acid/Alkali resistant epoxy paint for balance height in acid & alkali	Chemical resistant paint for acid & alkali resistant area.

		prone area and rest with Acrylic emulsion paint	
b) MCC Room	50 mm thick heavy duty cement concrete floor with metallic hardener or flexible electric insulated PVC synthetic sheet finish and matching skirting.	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper Paint
c) Control room and offices	10/11 mm thick non-skid fully vitrified tiles of make “MARBONITE minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern for Control room and offices.	Acrylic emulsion paint over white cement putty.	Gypsum Board / Clacium Silicate Board or tiles false ceiling with insulation on top.
d) Laboratories	Minimum 20 mm thick acid and alkali resistant tile set in and jointed with epoxy mortar (overall 40mm thick) along with 2100mm high dado of same tile.	Acid / Alkali resistant paint in acid & alkali prone area.	Acid / Alkali resistant paint in acid & alkali prone area.
e) Toilet	10 mm thick non-skid fully vitrified tiles of make “MARBONITE”FERRASTONE” of minimum size 400 mm x 400 mm (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be full height.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	Acrylic Distemper Paint
10 CW Chlorination Building	Minimum 20 mm thick acid and alkali resistant vitrified tile “ENDURA” or minimum 37mm thick Acid /Alkali resistant brick, set in	Chemical resistant paint in acid & alkali prone area and	Chemical resistant paint for acid & alkali resistant area

	and jointed with epoxy mortar (overall 50 mm thick) along with 2100 mm high dado of same tile having 20mm thickness. Where required, other areas with 50mm thick heavy duty flooring with metallic hardener.	rest with Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint over white cement putty for balance height	and other areas with Acrylic Distemper paint.
11 CW Chemical Treatment Building	-Do-	-Do-	
12 Condensate Transfer Pump House	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint for balance height	Acrylic Distemper

7.7.3 Interior Finish Schedule For Non Plant Buildings

02

1 Service building/Administrative building			
a) Entrry cum reception lounge, VIP lounge, Main meeting/ conference room	Suitable and approved combination shed of marble slab and strips shall be used	Two coats of Acrylic Emulsion paint of approved colour shall be applied over a coat of approved primer on the masonry surface prepared with white cement putty.	Aluminium panelled (600x600mm size) acoustic false ceiling with glass wool insulation on top similar to LUXALON of Hunter Douglas or “INTERARCH” having approved colour with stove enamel finish, integrated

			with light fixtures, HVAC grills and other ceiling mounted accessories, complete in all respect with metal suspension system, trims, profiles etc.
b) Other floors/ office area etc.	10/11 mm thick non-skid fully vitrified tiles of make "MARBONITE","FERRASTONE","Kajaria" of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern with matching shirting of same make	- Do -	Gypsum board or Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system false ceiling of approved make as per specification
c) For staircase and Corridors	Steps – risers & tread, stair skirting, corridor floor should be combination of Aranga white marble and Abu green marble. Wall cladding of Elevator Lobby shall be of polished granite slab of light grey shed or colour as approved by the owner.	Two coats of Acrylic Emulsion paint of approved colour shall be applied over a coat of approved primer on the masonry surface	Acrylic Distemper paint colour super white.

		prepared with white cement putty.	
d) Toilet & pantry	Minimum 10 mm thick non-skid vitrified tile, of minimum size 400 mm x 400 mm (overall 40 mm thick) with glazed ceramic tile of same make dado topped with 50 mm wide matching moulded ceramic trims. Dado shall be 100 mm higher than lintel level starting from finish floor level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	False ceiling shall be perforated aluminium stove enamel finished panels of size 600x600mm
e) AHU room, store Generator room, Electrical room, Etc:	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting.	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper paint
2 Canteen Building			
a) Kitchen, Dining hall etc.	10/11 mm thick non-skid fully vitrified tiles of make “MARBONITE”,FERRASTONE”	1st quality coloured	Acrylic Distemper

	of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic tiles. Dado shall be full height for Kitchen and 1500mm. high for other areas. All counter for Kitchen and service areas shall have Polished Granite slab over RCC slab or Kadapa stone	glazed tiles of minimum 6/7 mm thickness up to 1.20mts height and balance height with Acrylic emulsion paint over primer and white cement putty	paint over white cement putty. Airconditioned areas shall have Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system false ceiling of approved make as per specification
b) Other areas	Kota stone flooring and skirting	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper paint
c) Toilet & wash areas	10/11 mm thick non-skid fully vitrified tiles of make “MARBONITE”,”FERRASTONE” of minimum size 400 mm x 400 mm over IPS floor (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level	Acrylic Distemper paint

		starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	
3 Permanent Store & Inflammable Store Building	50 mm thick heavy-duty cement concrete floor with metallic hardener and matching skirting. For office areas & AC stores vitrified tiles shall be used.	Acrylic emulsion paint with white cement putty for office & AC store areas and Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height for other areas	Acrylic Distemper paint over white cement putty. Offices and Airconditioned areas shall have Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system false ceiling of approved make as per specification
4 Main Gate Complex	Overall 40 mm thick Kota stone slab flooring	Acrylic emulsion paint over white cement putty	Acrylic emulsion paint over white cement putty
5 Weigh Bridge	10/11 mm thick non-skid fully vitrified tiles	Synthetic	Acrylic

Control room	of make “MARBONITE”,”FERRASTONE” of size 600 mm x 600 mm (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims	enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Distemper paint
7 Fire Station			
a) Office area, Toilet, Stores, Training room, Kitchen / Dining area, Dormitory,	"10/11 mm thick non-skid fully vitrified tiles of make “MARBONITE”,FERRASTONE” of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern for office, dormitory area with 150 high matching skirting with 5 mm thick glazed ceramic tile dado of approved make topped with 50 mm wide matching ceramic trims 2200mm. High."	Acrylic emulsion pain	Acrylic emulsion paint
b) Fire tender parking area and equipment store	50mm thick heavy duty IPS flooring with metallic hardener with matching skirting. or Paving with 65/70 mm thick pressed interlocking precast blocks	Cement paint and for equipment store Acrylic Distemper all be used	Parking area cement paint and for equipment store Acrylic Distemper shall be used.
8 Watch Tower	IPS flooring with Cement Skirting	Acrylic Distemper, Epoxy paint over exposed steel structure.	Acrylic Distemper, Epoxy paint over exposed steel structure.
9 Car & Scooter parking shed and Cycle parking shed	Mimimum 50mm thick coloured and polished interlocking concrete tiles with pattern as approved by the owner, set on sand bed over PCC underbed. Parking		Polycarbonate roof sheeting over RCC framed

	near Administrative block shall have vitrified tiles suitable for parking.		structure.

7.7.4 EXTERIOR AND GENERAL FINISH SCHEDULE

7.8 Cladding for Power house:

Providing and fixing of double skin insulated wall cladding system comprising of profiled external sheet manufactured out of 0.55mm TCT (Total Coated Thickness) permanently colour coated zincalume steel (150 gsm. zinc – aluminium alloy coating total of both sides as per AS 1397: 1993) having 300 Mpa yield strength. The colour coating shall comprise of SMP / super polyester XRW (as per AS/NZS – 2728: 1997 category 3). The inner sheeting shall be 0.50mm/0.6mm TCT of SMP / super polyester XRW (as per AS/NZS – 2728: 1997 category 3) coated zincalume steel 150 gsm. (Zinc – aluminium alloy coating mass total of both sides as per AS 1397:1993) having 550 Mpa yield strength or 180gsm galvanised of 240 mpa. The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side. The external sheet shall have 500mm cover width, 47mm high crests at 250mm centres with special male / female side laps and anti-siphoning feature to prevent leakage. The inner sheet shall have 980mm cover width 28mm high crests at 195mm centres with special male / female side laps and anti-siphoning features to prevent leakages. The inner sheet shall be fixed to the structure by means of self drilling fasteners no. 12-24 x 25 mm conforms to AS: 3566 Class-3 long at valley. Sub-girts of size 50mm x 50mm x 50mm manufactured out of 16G GI (1.6mm GI) ‘Z’ shape would be fixed the inner sheeting on face side at runner locations and outer sheeting shall be fixed with the help of concealed compatible interlocking clips and wafer head zinc coated self drilling fasteners / screws 4.2 x 25mm long on to the sub-girts. The clips

shall be concealed and no fasteners are to penetrate the external sheeting. An insulation of 50mm thick Rockwool insulation (Rockloyd-300) of density 48KG/M3 conforming to IS:8183 shall be provided and fixed to the inner sheet and between the two sheets as per the specification. Wherever single skin metal cladding shall be used over brickwork, the material shall be same as the outer skin of insulated metal cladding system.

Approved make: LLOYD Insulations (India) Ltd, Tata Blue Scope Steel, CRIL, Metecno or similar approved.

7.9 The epoxy systems

On the prepared substrate, one coat of a solvent free, resin based dispersion, Primer shall be applied. Density of the primer is around 1kg/lt and the mixing ratio of two components, Comp A and B : 1:2.5 by weight Over the primed surface, epoxy modified cementitious self _levelling floor topping shall be laid maintaining the thickness of 2mm. The mixing ratio of three component Comp.A :Comp.B: Comp.C: 1:2.5:17 by weight, compressive strength at 30ºC approx. 45N/mm² after 28days, the mortar density is around 2.2 kg/lt.

Priming should be done again with a primer of two component product, comp. A: comp. B: 4:1 (By weight). Prior to mixing of these two components, only comp. A shall be stirred mechanically. When all of part B is added to part A, the mix is to be stirred for 3 minutes until a smooth consistency is achieved. Finally, after drying of the primer, two coats of high-build, slightly thixotropic, chemical resistant epoxy protective coating shall be applied as the top coat. Minimum 2 coats are required. This is two component products, comp. A: comp. B: 3:1 (by weight). The mixed density is 1.5kg/lt at 270 C. The system shall be allowed for curing for 3 days.

Approved Make : Sika India (P) Ltd., BASF or similar approved.

7.10 Anti corrosive paint shall be Specification in short: Self Priming, Single Pack, Elastomeric (450% elongation), thermoplastic, fire retardant, Coating skin

tensile strength 18 to 21 kg. Per sq. Cm. Antifungal, antibacterial, anticorrosive, nontoxic graft Co-polymer coating of Meta Chem Paints & Adhesive Pvt. Ltd or similar approved.

7.11 False Ceiling : Aluminium pre-painted false ceiling, either lineal panel system or aluminium tile/plank system

Approved make: LUXALON by Hunter Dauglas, LLOYD, Armstrong, INTERARCH or similar approved.

In other air-conditioned areas 12.5 mm Gypsum board/Mineral fibreboard /Calcium Silicate Board / Fibre Cement Board ceiling with aluminium grid will be used.

Approved make: Saint Gobain Gyproc India Ltd, Armstrong, AMF, Everest, HILUX, Aerolite or similar approved.

7.12 For T.G. Hall (operating floor) Granite / Kota stone flooring finish will be as follows:

Minimum 18~20 mm thick polished Granite/ Kota stone slab or 600x600 mm tiles to be used over minimum 30 mm thick under-bed. Stones shall be hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of + 5 mm in dimensions and + 2 mm in thickness will be allowed. During laying the slabs the edges of the slab shall be buttered with slurry of cement, mixed with pigment matching the colour of the stone slabs. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. Per. Sq.m. water sprinkled on to it and finished by buffing with felt or Hessian bobs.

7.13 For battery room, battery charger room, chemical laboratories, chlorination room etc., the areas handling corrosive liquids, overall 40 mm thick Acid and Alkali resistant vitrified tiles flooring with 20mm thick tiles with silica based epoxy mortar shall be used. Acid and Alkali resistant vitrified tiles with silica based epoxy mortar up to 2.1M height from finished floor level shall be used as dado. Acid and Alkali resistant paint shall be applied up to the ceiling level above Acid and Alkali resistant tiles dado. Ceiling shall also be painted with Acid & Alkali resistant paint.

Approved Make :	ENDURA of Jhonson, Chemstone of BOSS Profiles Ltd, RESTILE Ceramics Ltd. or similar approved.
Paints :	ICI, ASIAN Paints, Berger or similar approved

7.14

All areas of toilet, including W.C and urinal shall have vitrified ceramic tiles floor. Dado shall be of glazed tiles of minimum 5/6 mm thickness up to 100 mm higher than lintel level starting from finish floor level.

Approved Make :	Ferrastone/Hardstone of BOSS Profiles Ltd, RESTILE Ceramics Ltd. , Marbonite, Kajaria, Nitco, Endura of H R Jonson, or similar approved.

7.15 For MCC and Switchgear rooms flexible electric insulated PVC synthetic sheet as per IS: 15652 2006 of Suntex Insulatic Pvt Ltd or similar shall be applied.