



**TITLE: - 2 X 660 MW KHARGONE SUPER
THERMAL POWER PROJECT.
SPECIFICATIONS FOR CIVIL,
STRUCTURAL, ARCHITECTURAL &
BUILDING SERVICE WORKS**

SPECIFICATION NO.

VOLUME

SECTION :

REV.NO. 00

SHEET

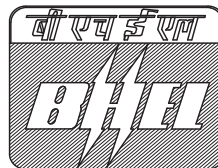
KHARGONE SUPER THERMAL POWER PROJECT

2 X 660 MW

**TECHNICAL SPECIFICATIONS
(MAKE UP WATER PIPE LINE)**

CIVIL , STRUCTURAL & ARCHITECTURAL WORKS

FOR MAKE UP WATER PIPE LINE



Bharat Heavy Electricals Limited

Project Engineering Management

Power Sector, PPEI BUILDING

SECTOR 16A, NOIDA-201301



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SHEET

PREAMBLE

Standard technical details as indicated in specification shall be agreed upon between BHEL & Bidder.

Technical requirements are stipulated in this Volume which comprises of

Section C : This section indicates the technical requirements specific to the contract not covered in Section D

Section D : This section comprises of general technical specification(s)

Annexures I : Topographic survey detail of Main Plant

Annexures II : Preliminary topographic survey detail of make up water pipe line (12 sheets)

Annexures III : Typical detail of make up water pipe line crossings

The requirements mentioned in the Section C shall prevail and govern in case of conflict between the same and the corresponding requirements mentioned in the Section D in the specification.



**TITLE: - 2X660 MW KHARGONE SUPER
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SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME

SECTION : D

REV.NO. 01

SHEET

SECTION D

TECHNICAL SPECIFICATION(S)



**TITLE: - 2X660 MW KHARGONE SUPER
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SPECIFICATIONS FOR CIVIL,
STRUCTURAL, ARCHITECTURAL &
BUILDING SERVICE WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME

SECTION : D

REV.NO. 01

SHEET

TABLE OF CONTENTS

D1	EARTHWORK IN EXCAVATION AND BACKFILLING
D2	CEMENT CONCRETE (PLAIN & REINFORCED)
D3	FORMWORK
D4	FABRICATION OF STRUCTURAL STEEL
D5	ERECTION OF STRUCTURAL STEEL WORK
D6	ROAD AND DRAINAGE
D7	MASONRY AND ALLIED WORKS
D8	FINISH TO MASONRY AND CONCRETE
D9	FLOOR FINISH AND ALLIED WORKS

DELETED

D22	ANTI-TERMITE TREATMENT
D23	SITE LEVELING AND GRADING
D24	BORED CAST-IN-SITU RCC PILES



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D1
REV.NO.	01
SHEET	1 OF 18

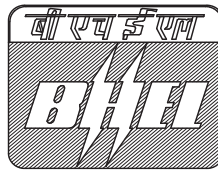
**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

SECTION - D

GENERAL TECHNICAL SPECIFICATION

EARTHWORK IN EXCAVATION AND BACKFILLING



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



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
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SPECIFICATION NO. PE-TS-K13-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D1
REV.NO. 01
SHEET 2 OF 18

TABLE OF CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.0.0	SCOPE	3
2.0.0	GENERAL	3
3.0.0	EXECUTION	5
4.0.0	TESTING AND ACCEPTANCE CRITERIA	17
5.0.0	INFORMATION TO BE SUBMITTED	18



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D1

REV.NO. 01

SHEET 3 OF 18

**TECHNICAL SPECIFICATION
FOR
EARTHWORK IN EXCAVATION AND BACKFILLING**

1.0.0 SCOPE

This specification covers excavation in all types of soil, soft and decomposed rock not requiring blasting and rocks requiring blasting, shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. relevant to structures and locations covered under the scope of this contract.

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

- a) Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.
- b) Prepare and submit working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering, including drains and outfall for drainage, space for temporary stacking of spoils, disposal area, fencing, etc. and all other details as may be required by the Engineer.
- c) To carry out sampling and testing and submit to the Engineer, results of soil compaction tests whenever required by the Engineer to assess the degree of compaction.
- d) Construction, maintenance and removal after completion of magazine of proper capacity as well as design for storing of explosives required for blasting work to be carried out under the scope of this tender including procurement of necessary licenses from proper authorities.

2.2.0 Work to be provided for by others

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

2.3.0 Codes and Standards

All works under this specification, unless specified otherwise, shall conform to the latest revision and/or replacement of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D1

REV.NO. 01

SHEET 4 OF 18

of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed :-

IS:1200 (Part-I)	Method of Measurement of Building and Civil Engineering work; Part - I Earthwork.
IS:2720 (Part-II)	Determination of Moisture Content
IS:2720 (Part-VII)	Determination of Moisture content / Dry Relation using Light Compaction.
IS:2720 (Part-xiv)	Determination of Density Index (Relative Density) of cohesionless soils.
IS:2720 (Part-xxix)	Determination of Dry Density , in place, by core cutter method.
IS:2720 (Part- xxviii)	Determination of Dry Density of soils, in place, by sand replacement methods.
IS:3764	Safety code for Excavation work.
IS:4081	Blasting and Related Drilling Operations
IS:4701	Earthwork on canals

2.4.0 Conformity with Designs

The Contractor is to carry out the work as per the drawings issued to him and/or Contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.5.0 Materials to be used

2.5.1 General

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

2.5.2 Borrow Material

Borrow material required for back-filling shall be excavated from approved locations and levels, and shall consist of material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand free from harmful and deleterious material from approved quarries, shall be used as fill material.



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D1
REV.NO. 01	
SHEET 5	OF 18

2.6.0 Quality Control

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work :

- a) Lines, Levels and Grades :
- i) Periodic surveys
 - ii) Establishment of markers, boards etc.
- b) Back-filling :
- i) Checking the quality of fill material
 - ii) Checking moisture content of the backfill
 - iii) Checking the degree of compaction

2.7.0 Information regarding site conditions

Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and / or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.0.0 EXECUTION

3.1.0 Setting Out

The Contractor will prepare and submit to the Engineer, detailed drawings of the excavation work as proposed to be executed by him showing the dimensions as per drawings and specification adding his Proposals of slopes, shorings, approaches, dewatering sumps, berms, etc. On receiving the approval from the Engineer with modifications and corrections, if necessary, the Contractor will 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 fixed at intervals prescribed by the Engineer and checked by the Engineer and certified by him after which the Contractor will proceed with the work. Engineer shall be provided with necessary men, material and instructions for such checking. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines and levels and grades as per drawing and subsequent corrections, if necessary, in case any errors are noticed in the Contractor's work at any stage.



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D1

REV.NO. 01

SHEET 6 OF 18

3.2.0 Initial Levels

Initial levels of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements.

All records of levels, measurements etc. and also any drawing, cross section etc. made therefrom, shall be jointly signed by the authorised representative of the contractor and the Engineer before the commencement of work and they shall form the basis of all payments in future.

3.3.0 Clearing and Grubbing, etc.

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and levelled up. Trees upto 300mm girth shall be uprooted. Trees above 300 mm girth to be cut, shall be approved by the Engineer and then marked. Felling of trees shall include taking out roots upto 600 mm below ground level or 150 mm below formation level whichever is lower. After the tree is cut and roots taken out the pot-holes formed shall be filled with good earth in 250 mm layers and consolidated unless directed by the Engineer otherwise. The trees shall be cut in 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 approved disposal areas as may be specified. Ash shall be spread or removed. Useful materials, saleable timber, 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.

3.4.0 Classification

All earthwork shall be classified under the following categories :

No distinction will be made whether the material is dry or wet.

a) **Ordinary Soil**

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

b) **Hard Soil**



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D1

REV.NO. 01

SHEET 7 OF 18

This shall include :

- i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;
- ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;
- iii) soling of roads, paths, etc., and hard core ;
- iv) macadam surfaces such as water bound, and bitumen/tar bound;
- v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;
- vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and
- vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

c) Soft and Decomposed Rock

This shall include :

- i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;
- ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;
- iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin ; and
- iv) any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

d) Hard Rock (requiring blasting)

This shall include :

- i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required ;



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D1

REV.NO. 01

SHEET 8 OF 18

- ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and
- iii) boulders requiring blasting.
- e) Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (d) but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

3.5.0 Excavation for Foundations and Trenches

3.5.1 General

All excavations shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor, in each individual case, for the method he proposes to adopt for the excavations including dimension, side slopes, shoring, dewatering, 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.

All excavation in open cuts shall be made true to line, slopes and grades shown on the drawing or directed by the Engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders projecting out of the excavated surfaces shall be removed, if in the opinion of the Engineer they are likely to be a hindrance to the workers.

Method of excavation shall be in every case subject to the approval of the Engineer and the Contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works.

The Contractor shall have full responsibility of the stability of the excavation and safety of the workmen. If any slip occurs, the Contractor shall remove all slipped material from the excavated pit.

All loose boulders, semi-detached rocks, not directly in excavation but so close to the area to be excavated as to be liable, in the opinion of the Engineer, to fall or otherwise endanger the workmen, equipment of the work, etc., shall be stripped off and removed away from the areas of excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion which was originally sound and safe. Any materials not requiring removal as contemplated in the work, but which, in the opinion of the Engineer, is later to become loose or unstable shall also be promptly and satisfactorily removed as directed by the Engineer.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D1

REV.NO. 01

SHEET 9 OF 18

The rough excavation may be carried upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Engineer.

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Engineer, due to the Contractor's fault, the excess depth shall be filled up to the required level (with cement concrete not leaner than 1:4:8 ordinary concrete or richer) as directed by the Engineer in each individual case.

In formation of rock requiring blasting, those overcuts which are unavoidable will be made up by ordinary cement concrete 1:2:4. All excavated materials such as hard rock, boulders, bricks, dismantled concrete blocks, etc. shall be stacked separately as directed by the Engineer and shall be the property of the Owner.

**3.5.2 Excavation in Ordinary Soil, Hard Soil
and Soft and Decomposed Rock**

The excavation in ordinary soil, hard soil, soft and decomposed rock will be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work will be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work will be checked by the Engineer thoroughly and the balance work will be carried out carefully to avoid any over-excavation. On completion, the work will be finally checked and approved by the Engineer. In certain cases, where deterioration of the ground, upheaval, slips, etc. are expected, the Engineer may order to suspend the work at any stage and instruct the Contractor to carry out the balance work just before the foundation work of the structure can be started.

3.5.3 Excavation in Hard Rock

In case where excavation, both in ordinary soil and hard rock, are involved, the ordinary soil comprising of soft, hard and dense soils (including laterite formations) and rock including weathered rocks, lateritic rocks, etc. which can be excavated without blasting, shall be completely stripped off. Further work in hard rock shall be resumed after clearance from the Engineer.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres, steel mesh anchored to the lower edge of



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D1

REV.NO. 01

SHEET 10 OF 18

excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiselling, wedging or any other approved method.

3.5.4 Blasting

3.5.4.1 General

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Contractor shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superseded by the above rules.

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.

3.5.4.2 Storage of Explosive

Storage of explosives shall be governed by the current Explosive Rules, Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The mezzanine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.

Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annexe adjoining the magazine provided that their number does not exceed 25,000 and that the annexe is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detonators in such annexe and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine. Explosive in open cases are not to 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 destroyed.

Artificial light is not to be allowed in any magazine. No smoking shall be allowed within 100 m of a magazine.



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D1

REV.NO. 01

SHEET 11 OF 18

Magazine shoes without nails shall be used while entering the magazine.

The mallets, levers, wedges etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any duststorm or thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

3.5.4.3 Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to 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 a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.5.4.4 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 the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging operations shall be carried out by or under the personal supervision of the shotfirer. Wrappings shall never be removed from explosive cartridges. Only



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D1

REV.NO. 01

SHEET 12 OF 18

wooden rods shall be used for loading and stemming shotholes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

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 shotfiring 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 and to keep the lead wires short circuited until ready to fire. Any kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shotholes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

All connections shall be made by the authorised shotfirer himself. The shotfiring cable shall not be dragged along the ground to avoid possible damage to the insulation. The shotfiring cable shall be tested for continuity and possible short circuiting before it is used each time.

The shotfirer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the Engineer.

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 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encircled by red flags.

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

When blasting is conducted in the neighbourhood of roads, structures, buildings etc. controlled blasting has to be carried out by drilling shallow shotholes and filling the same with light charge of explosives.



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001			
VOLUME - II B			
SECTION - D		SUB-SECTION - D1	
REV.NO.	01		
SHEET	13	OF	18

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.5.5 Disposal

The excavated spoils will be disposed of in any or all the following manners :

- a) By using it for backfilling straightway.
- b) By stacking it temporarily for use in backfilling at a later date during execution of the Contract.
- c)
 - i) By either spreading, Or
 - ii) spreading and compacting at designated filling areas and / or disposal areas.
- d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in backfilling by some other agency.

3.5.6 Disposal of Surplus

All surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Engineer.

All good and sound rock excavated from the pits and all assorted materials of dismantled structures shall be the property of the Owner.

3.5.7 Protection

The Engineer shall be notified by the Contractor as soon as the excavation is expected to be completed within a day so that it may be inspected by him at the earliest. Immediately after approval of the Engineer, the excavation must be covered up in the shortest possible time. But, in no case the excavation shall be covered up or worked on before approval and measurement by the Engineer. Excavated material shall be placed beyond 1.5 metres from the edge of the pit or trench or half the depth of the pit or trench whichever is more or further away if directed by the Engineer.

Excavation shall not be carried out below the foundation level of structure close by until required precautions have been taken.

Adequate fencing is to be made enclosing the excavation.

The Contractor shall protect all under-ground services exposed by excavation. The Contractor shall also divert all surface drains, etc. affected by the excavation to maintain the working area neat and clean.

3.5.8 Dealing with Surface Water



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D1

REV.NO. 01

SHEET 14 OF 18

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems to drain surface water from working areas.

3.5.9 Dewatering

All excavations shall be kept free of water and slush. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer any water inclusive of rain water and subsoil water accumulated in excavation and keep the trench dewatered until the construction of foundation structure and backfilling are complete in all respects. (except where such dewatering would need installation of well points or deep wells for which separate payment will be made) Sumps made for dewatering must be kept clear of the foundations. Method of pumping shall be approved by the Engineer but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping.

3.5.10 Timber Shoring

Timber Shoring made out of approved quality of timber shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench and the type of timbering shall be determined by the Engineer. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.5.10.1 Close Timbering

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 250 x 40 mm sections as directed by the Engineer. The boards shall generally be placed in position vertically in pairs, one board on each side of cutting, and shall be kept apart by horizontal walers of strong wood at maximum 1.2 metres spacings, cross strutted with ballies or as directed by the Engineer. The length of the bally struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical walers, which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D1

REV.NO. 01

SHEET 15 OF 18

into the ground. No portion of the vertical side of the trench or pit shall remain exposed, so that the earth is not liable to slip out.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.5.10.2 Open Timbering

In the case of open timbering, the entire surface of the side of trench pit is not required to be covered. The vertical board of minimum 250 mm width and minimum 40 mm depth shall be spaced sufficiently apart to leave unsupported strips of maximum 500 mm average width. The detailed arrangement, sizes of the timber and the distances apart shall be subject to the approval of the Engineer. In all other respects, specification for close timbering shall apply to open timbering.

3.6.0 Treatment of Slips

The Contractor will take all precaution to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond the control of the Contractor, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Contractor will be cleared and back-filled later by him.

3.7.0 Back-filling

3.7.1 General

The material used for backfilling shall consist of material, approved by the Engineer obtained directly from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits from selected areas designated by the Engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials, etc.

In certain locations, the Engineer may direct sand fillings. The sand should be clean, well graded and be of quality normally acceptable for use in concrete.

3.7.2 Filling and Compaction in Pits and Trenches around Structures

As soon as the work in foundations has been accepted and measured, the spaces around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings, etc., and filled with earth in layers not exceeding 250 mm in loose thickness each layer being watered, rammed and properly compacted to achieve a dry density of not less than



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D1

REV.NO. 01

SHEET 16 OF 18

90% of proctor's dry density at optimum moisture content as per IS-2720 (Part-VII) where backfilling with cohesive soil and sandy silt containing high percentage of silt. For back filling with sand having little or no silt, each layer shall be compacted to a relative density of 75% as per IS-2720 part XIV. Earth shall be rammed with approved mechanised compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and levelled to proper profile as shown in the drawing and as desired by the Engineer.

Since the degree of compaction depends on the moisture content of the soil, a close watch should be kept on it and corrections done to optimise the moisture content.

3.7.3 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered and compacted as stated under clause no. 3.7.2 with approved compaction machine or manually, if specifically permitted by the Engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slope intended to be given to the floor.

3.7.4 Filling in Trenches for Water Pipes and Drains

Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling. The types of bedding & pipe surround material shall be as specified in the drawings .

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed.

Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed and compacted taking care that no damage is caused to the pipe below. Filling of trenches shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

In case of excavation of trenches in rock, the filling upto a depth of 300 mm or the diameter of the pipe whichever is more, above the crown of pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash according to the availability at site. The remaining filling shall be done with rock filling of boulders of size not exceeding 150 mm mixed with fine material as available to fill up the voids, watered, rammed and compacted.



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D1

REV.NO. 01

SHEET 17 OF 18

3.7.5 Filling in Disposal Area

Surplus material from excavation which is not required for backfilling will be disposed of in designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250 mm thick when loose and compacted with the help of compacting equipment. In wide areas rollers will be employed and compaction done to the satisfaction of the Engineer at the optimum moisture content which shall be checked and controlled by the Contractor.

In certain cases the Engineer may direct disposal without compaction which can be done by tipping the spoils from a high bench neatly maintaining always a proper level and grade of the bench.

3.8.0 Approaches and Fencing

The Contractor should provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the excavated pits should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the Project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.9.0 Lighting

Full scale area lighting is 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 corners of the excavated pit and the edges of the fill.

4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 Excavation

On completion of excavation, the dimensions of the pits will be checked as per the drawings after the pits are completely dewatered the work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by placing ordinary concrete of 1:4:8 proportion and/or richer and/or by compacted earth, as directed by the Engineer. The choice of grade of concrete will be a matter of unfettered discretion of the Engineer. Over excavation of the sides will be made good by the Contractor while carrying out the back-filling. The excavation work will be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.2.0 Back-filling

The degree of compaction shall be sufficient to achieve a dry density of not less than 90% of proctor's dry density at optimum moisture content as



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION AND
BACKFILLING**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D1
REV.NO. 01	
SHEET 18	OF 18

per IS-2720 (Part - VII) or a relative density of 75% as per IS-2720 (Part-XIV) as applicable depending on the nature of back filling material as stated in clause no. 3.7.2 of this specification. The work of back-filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

5.0.0 INFORMATION TO BE SUBMITTED

5.1.0 With Tender

Details of Equipment proposed to be used for excavation, back-filling and compaction have to be submitted along with the tender.

5.2.0 After Award

After award of the Contract the successful tenderer shall submit the following for approval and adoption :

- a) The Contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation of the various foundations and the time required for back-filling and compaction after completing the foundation for structures.

The programme should show how the excavation and back-filling quantities will be balanced, minimising temporary stacking of spoils. It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with the progress of foundations without attracting any claims from the Contractor. The initial programme being submitted by the Contractor should have sufficient flexibility to take care of such reasonable variations.

- b) The Contractor shall submit drawings showing details of slopes, shorings, approaches, sump pits, dewatering lines, fencing etc. for approval of the Engineer for adoption.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001			
VOLUME - II B			
SECTION - D		SUB-SECTION - D2	
REV.NO.	01		
SHEET	1	OF	31

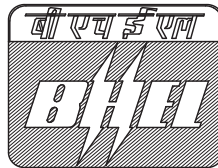
VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-K13-600-C001

SECTION - D

GENERAL TECHNICAL SPECIFICATION

CEMENT CONCRETE (PLAIN & REINFORCED)



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



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D2
REV.NO. 01
SHEET 2 OF 31

TABLE OF CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.0	SCOPE	3
2.0	GENERAL	3
3.0	INSTALLATION	13
4.0	SAMPLING AND TESTING	14
5.0	ACCEPTANCE CRITERIA	16
6.0	LIST OF I.S. CODES AND STANDARDS FOR REFERENCE	17



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 3 OF 31

**TECHNICAL SPECIFICATION
FOR
CEMENT CONCRETE (PLAIN & REINFORCED)**

1.0 SCOPE

1.1 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

1.2 This specification shall also apply to the extent it has been referred to or applicable with the special requirements of structures covered in SCOPE of IS:456.

1.3 IS:456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate IS Code, specifications and/or replacement by any International Code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference.

2.0 GENERAL

2.1 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following :-

- a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.
- b) Except where it is excluded from the Scope of Contract, Contractor shall prepare progressively and submit for approval detailed drawings and Bar Bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.
- c) Design and prepare working drawings of formworks, scaffolds, supports, etc. and submit for approval.
- d) Submit for approval shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.
- e) Submit for approval detailed drawings of supports, templates, hangers, etc. required for installation of various embedments like



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 4 OF 31

inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

- f) Submit for approval detailed schemes of all operations required for executing the work, e.g. Material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.
- g) Design and submit for approval concrete mix designs required to be adopted on the job.
- h) Furnish samples and submit for approval results of tests of various properties of the following :
 - i) The various ingredients of concrete
 - ii) Concrete
 - iii) Embedments
 - iv) Joint seals
- i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.
- j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved proforma for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.2 Work by Others

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

2.3 Information to be submitted by the Tenderer

2.3.1 With Tender

The following technical information are required with the tender :

- a) Source and arrangement of processing of aggregates proposed to be adopted.
- b) Type of plant and equipment proposed to be used.
- c) Names of firms, if any, with which association is sought for to execute the special items of work in the contract.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001			
VOLUME - II B			
SECTION - D		SUB-SECTION - D2	
REV.NO.	01		
SHEET	5	OF	31

- d) Types of formwork proposed to be used.

2.3.2

After Award

The following information and data including samples where necessary, shall be submitted by the Contractor progressively during the execution of the contract.

a) **Programme of Execution and Requirement of Materials**

The Contractor will submit a Master Programme for completion of the work giving monthwise requirements of materials for the procurement.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day to day programme of every month is to be submitted by the Contractor before the end of the previous month.

b) **Samples**

Samples of the following materials and any other materials proposed to be used, shall be submitted as directed by the Engineer, in sufficient quantities for approval. Approved samples will be preserved by the Engineer for future reference. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities :

- i) Coarse and fine aggregates.
- ii) Admixtures.
- iii) Plywood for Formwork.
- iv) Embedded and anchorage materials as may be desired by the Engineer.
- v) Joint sealing strips and other waterproofing materials.
- vi) Joint filling compounds.
- vii) Foundation quality Rubber Pads.

c) **Design Mix**



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 6 OF 31

Design mix as per Clauses 2.1 (g) & 3.4 of this specification giving proportions of the ingredients, sources of aggregates and cement, along with accompanying test results of trial mixes as per relevant I.S., is to be submitted to the Engineer for his approval before it can be used on the works.

d) **Detail Drawings and Bar Bending Schedules**

Detailed working drawings and Bar Bending Schedules in accordance with Clause 2.1(b) and 3.16.1 of this specification.

e) **Detailed Drawings and Designs of Formworks to be used**

Detailed design data and drawings of standard formworks to be used as per clause 2.1 (c).

f) **Detailed Drawings for Templates & Temporary Supports for Embedments**

As per Clause 2.1 (e).

g) **Mill Test Reports for Cement & Reinforcing Steel**

h) **Inspection Reports**

Inspection Reports in respect of Formwork and Reinforcement and any other item of work as may be desired by the Engineer in accordance with Clause 2.4 of this specification.

i) **Test Reports**

Reports of tests of various materials and concrete as required under Clause 4.0 : SAMPLING & TESTING of this specification.

j) **Any other data which may be required as per this specification.**

2.4

Conformity with Design

The Contractor will prepare check lists in approved proforma which will be called 'Pour Cards'. These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the Engineer will give written permission on the same 'Pour Card' allowing the Contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. These sheets, termed as 'Progress Cards', will be prepared by the Contractor on approved proforma. The Pour Cards along with accompaniments will be



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 7 OF 31

handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.5 Materials to be used

2.5.1 General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless stated otherwise and be of best approved quality.

2.5.2 Cement

Generally cement shall be 33 grade ordinary Portland Cement conforming to IS-269 . In special cases any of the following type of cement may be permitted or directed to be used with prior approval by the Engineer :

- a) 43 Grade ordinary Portland Cement conforming to IS-8112
- b) 53 Grade ordinary Portland Cement conforming to IS-12269
- c) Rapid hardening Portland Cement conforming to IS-8041
- d) Portland slag cement conforming to IS-455
- e) Portland Pozzolona Cement (flyash based) Conforming to IS- 1489 (Part -1)
- f) Portland pozzolona Cement (calcined clay based) conforming to IS-1489 (Part-2)
- g) Hydrophobic Cement conforming to IS-8043
- h) Low heat Portland Cement conforming to IS : 12600
- i) Sulphate Resisting Portland Cement conforming to IS-12330

2.5.3 Aggregates

Aggregates shall be natural or crushed gravel or crushed rock and free from deleterious material. It shall comply with the requirements of IS-383. All fine and coarse aggregate shall be tested for susceptibility to Alkali Silicate reaction in a laboratory approved by the Engineer.

a) Coarse Aggregate



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 8 OF 31

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries and conforming to IS:383 will be allowed to be used on the works. Aggregates shall be washed to make it free from deleterious materials, if necessary.

The grading of coarse aggregates by sieve analysis shall be as per IS:383. If by the analysis the deficiency of a particular grain size is found, which could affect the density of the concrete, the Engineer may ask the contractor to avoid such quantities of aggregate of the particular size or and such quantity of aggregate of any particular size to achieve the required grading as per IS:383.

b) Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS:383 is termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used on works.

In certain cases there may be two types of sand, one very fine and the other very coarse. In such cases, the two types shall be combined to meet the requirements of a particular zone of IS:383. In all cases, the preferred zone is Zone - II.

In certain cases crushed stone sand may be added to natural sand in order to achieve the required grading. Crushed stone sand alone may be used only with the approval of the Engineer.

2.5.4 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts or other impurities. Normally potable water is found to be suitable. Generally, IS:3550 will be followed for routine tests. Acceptance test for water shall be as per IS:3025, and Table-1 of IS:456.

In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by compressive strength and initial setting time tests as per method of tests in accordance with the requirements of IS-516 & IS- 4031 respectively. The PH value of water shall generally be not less than 6.

2.5.5 Admixture

Only admixture of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures which may be necessary to satisfy the concrete mix and the design requirement shall be as per the following I.S. Standards :

IS : 2645 - Integral cement water proofing compound



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 9 OF 31

IS : 9103 - Indian standard specification for Admixtures for Concrete or equivalent American Codes (ASTM C494 and ASTM C260) or British Codes (BS 5075 , Part 1 to 3) and may be one of the following :

a) Accelerating admixtures :

- Set accelerating admixtures like "Sigunit Powder" or "Sigunit LN10" .

b) Retarding admixtures :

- Modified ligno sulphonate based set retarding concrete admixture like , "Plastiment R".

c) Water reducing admixtures :

- Modified sulphonated melamine formaldehyde based water reducing concrete admixture like, "Sikament" .

d) Air entraining admixtures :

- Modified ligno sulphonate based air entraining concrete admixture like "FLOMO AEP " or surface - active agents like "Sika AER".

e) **Water proofing admixtures**

- Modified ligno-sulphonate based waterproofing admixture like "Plastocrete Super".

However, the Contractor shall furnish following technical information about the admixtures (alongwith the manufacturer's Catalogue) which he is planning to use in different areas within the scope of work for the approval of the Engineer :

- Type of admixture
- Mix proportion & mode of application in concrete/mortar
- Manufacturer's specification & necessary quality assurance certificates (mainly on chloride & sulphate content , PH value infra red analysis & solid content.)

2.5.6 **Reinforcement**

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars shall be of tested quality.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 10 OF 31

2.6.0 Storage of Materials

2.6.1 General

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and Storage of materials shall conform to IS:4082.

2.6.2 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated ware-houses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

Different types of cement shall be clearly marked with the Type and different types of cement shall not be intermixed.

2.6.3 Aggregates

Aggregates shall be stored on planks or steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulk-heads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

2.6.4 Reinforcement

Reinforcing steel shall be stored consignment-wise and sizewise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease and distortions. If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.7 Quality Control



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 11 OF 31

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same.

The quality control operation shall include but not be limited to the following items of work :

a) Admixture : Type, quantity, physical and chemical properties that affect strength, workability and durability of concrete.

For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits

b) Aggregate : Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.

c) Water : Impurities tests.

d) Cement : Tests to satisfy relevant IS Specifications (only association with Owner's tests, if the supply is made by Owner).

e) Formwork : Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.

f) Reinforcement : Shapes, dimensions, length of plices, clearances, ties and supports. Quality and requirement of welded splices.

Material tests or certificates to satisfy relevant IS Specification (If Contractor's supply).

g) Grades of concrete : Usage and mix design, testing of all properties.

h) Batching & Mixing : Types and capacity of plant, concrete mixers and transportation equipment.

i) Joints : Locations of joints, water stops and filler materials. Dimension of joints, quality and shape of joint material and splices.

j) Embedded and Anchorage Items : Material, shape, location, setting.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 12 OF 31

- k) Placing : Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
- l) Compaction : Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
- m) Setting of base & Beaming plates : Lines, elevations and bedding mortar.
- n) Concrete Finishes : Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
- o) Curing : Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.0 **INSTALLATION**

All installation requirements shall be in accordance with IS:456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Engineer.

3.1 **Washing and Screening of Aggregates**

Washing and Screening of coarse aggregate shall be carried out to remove fines, dirt or other deleterious materials.

Washing of fine aggregate shall not be allowed, Fine aggregates shall be screened only to remove dirt or other deleterious materials.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 13 OF 31

However, all washing & screening of aggregates shall be carried out by approved means to ensure compliance with the aggregate specification.

3.2 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete.

Admixtures may be permitted to be used in accordance with IS:456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or other satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.3 Grades of Concrete

Structural concrete shall be of M30 grade and for other part of the work shall be as shown on the drawing as per grade classification of IS-456. In case of liquid retaining structures, IS:3370 will be followed.

3.4 Proportioning and Works Control

3.4.1 General

Proportioning of ingredients of concrete shall be made by any of the two following methods as directed by the Engineer.

- a) With preliminary tests by designing the concrete mix. Such concrete shall be called 'Design Mix Concrete'.
- b) without preliminary tests adopting nominal concrete mix. Such concrete shall be called 'Nominal Mix Concrete'.

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades permitted in accordance with IS:456, may be used if shown on drawings or approved by the Engineer. In all cases the proportioning of ingredients and works control shall be in accordance with IS:456 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.4.2 Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations :



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001			
VOLUME - II B			
SECTION - D		SUB-SECTION - D2	
REV.NO.	01		
SHEET	14	OF	31

- a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.
- b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.
- c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.
- d) Chemical admixtures may be used to modify the rate of hardening, to improve workability (maintaining low water - cement ratio) or as an aid to control concrete quality.
- e) The finished concrete should have adequate durability in all conditions, to withstand satisfactorily the weather and other destructive agencies which it is expected to be subjected to in actual service.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete by the Engineer. The Contractor will strictly abide by the same in his design of concrete mix installation. Notwithstanding anything mentioned in various tables given in IS:456 giving specific values and degrees of workability for different condition of concrete placing, minimum cement content and maximum water-cement ratio for concrete exposed to sulphate attack and for concrete to ensure durability under different condition of exposure, strength requirement for different grades of concrete, proportion for nominal mix concrete, values given in the tables in IS:456, shall be followed.

Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D2
REV.NO. 01
SHEET 15 OF 31

TABLE - I

STRENGTH REQUIREMENT OF CONCRETE

Specified Characteristic Compressive Grade of concrete strength of 15 cm Cubes at 28 days conducted in accordance with IS:516 (All values in N/Sq.mm)

M - 10	10
M - 15	15
M - 20	20
M - 25	25
M - 30	30
M - 35	35
M - 40	40

Note -1: Nominal mix concrete of proportions 1:4:8 or 1:3:6 may be used as lean concrete for simple foundations for masonry walls , below the reinforced concrete foundations and mass filling . These mixes need not be designed.

TABLE - II

**MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE
DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT
VALUES OF WATER - CEMENT RATIO**

(FOR GUIDANCE)

CEMENT/TOTAL AGGREGATE RATIOS

WORKABILITY	WATER/CEMENT/RATIO	RATIO BY WEIGHT OF CEMENT OF GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT OF CRUSHED STONE AGGREGATE	
		20 mm size	38 mm size	20 mm size	38 mm size
Very low	0.4	01:04.8	01:05.3	01:04.5	01:05.0
Slump	0.5	01:07.2	01:07.7	01:06.5	01:07.4
0-25 mm	0.6	01:09.4	1:10	01:07.8	01:09.6
	0.7	1:10	1:12	01:08.7	01:10.6
Low	0.4	01:03.9	01:04.5	01:03.5	01:04.0
Slump	0.5	01:05.5	01:06.7	01:05.0	01:05.5
25-50 mm	0.6	01:06.8	01:07.4	01:06.3	01:07.0
	0.7	01:08.0	01:08.5	01:07.4	01:08.0



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D2
REV.NO. 01
SHEET 16 OF 31

Medium	0.4	01:03.5	01:03.8	01:03.1	01:03.6
Slump	0.5	01:04.8	01:05.7	01:04.2	01:05.0
50-100 mm	0.6	01:06.0	01:07.3	01:05.2	01:06.2
High	0.4	01:03.2	01:03.5	01:02.9	01:03.3
Slump	0.5	01:04.4	01:05.2	01:03.9	01:04.6
100-175 mm	0.6	01:05.4	01:06.7	01:04.7	01:05.7
	0.7	01:06.2	01:07.4	01:05.5	01:06.5

NOTE : 1 - Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Engineer.

NOTE : 2 - It should be noted that such high aggregate cement ratios will be required for concretes of very low slump and high water- cement ratios which may be required to be used in mass concrete work only.

NOTE : 3 - The above figures are for guidance only, the actual cement/aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

3.5 **Strength Requirements**

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland slag cement is used, shall be as per Table-2 of IS:456. All other relevant clauses of IS:456 shall also apply.

3.6 **Minimum Cement Content**

The minimum cement content for each grade of concrete shall be as per Table-5 of IS : 456.

3.7 **Water-Cement Ratio**

The choice of water-cement ratio in designing a concrete mix will depend on -

- The requirement of strength.
- The requirement of durability.

3.7.1 **Strength Requirement**

In case of 'Design Mix Concrete', the water-cement ratio of such value as to give acceptable test results as per IS:456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001			
VOLUME - II B			
SECTION - D		SUB-SECTION - D2	
REV.NO.	01		
SHEET	17	OF	31

Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, proportions for different grades of concrete is specified in Table-9 of IS:456 and no tests are necessary. The acceptance test criteria for nominal mix concrete shall be as per IS:456.

3.7.2 Durability Requirement

Table-5 of IS:456 gives the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration. Whenever the water-cement ratio dictated by durability consideration is lower than that required from strength criterion, the former shall be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer / super-plasticizer. However the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer. It will be preferable to use Melamine based plasticizer.

3.8 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below :



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 18 OF 31

TABLE - III
LIMITS OF CONSISTENCY

Degree of workability	Slump in mm with Standard Cone as per IS:1199		Use for which concrete is suitable.
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipment, roads and like.
Low	25	50	Uncongested wide and shallow R.C.C. structures.
Medium	50	100	Deep but wide R.C.C. structures with congestion or reinforcement and inserts.
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

(NOTE : Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer)

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS:1199.

3.9

Size of Coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer :-

Very narrow space	- 12 mm
Reinforced concrete except foundation	- 20 mm
Ordinary Plain concrete and Reinforced concrete foundations	- 40 mm
Mass concrete	- 80 mm
Mass concrete in very large structure	- 150 mm



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)**

SPECIFICATION NO. PE-TS-K13-600-C001			
VOLUME - II B			
SECTION - D		SUB-SECTION - D2	
REV.NO.	01		
SHEET	19	OF	31

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles :

150 mm to 80 mm, 80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.10

Mixing of Concrete

Concrete shall always be mixed in mechanical mixer unless specifically approved by the Engineer for concrete to be used in unimportant out of the way locations in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS:4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances specified in IS:1791 will be allowed to be employed.

Ingredients for design mix concrete shall be measured by weight. For small jobs portable swing weigh Bachers conforming to IS:2722 may be used.

Batching plant conforming to IS:4925 shall be used for large jobs. The accuracy of the measuring equipment shall be within + 2% of the quantity of Cement , water or total aggregates being measured and within + 5% of the quantity of any admixture being used . The batching equipment shall be fitted with an accurate mechanism for weighing separately the cement, fine



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)**

SPECIFICATION NO. PE-TS-K13-600-C001			
VOLUME - II B			
SECTION - D		SUB-SECTION - D2	
REV.NO.	01		
SHEET	20	OF	31

aggregate and coarse aggregate. Water may be measured by volume or by weight. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy shall be checked periodically.

Mechanical / electrical control shall be provided on the mixing equipment to ensure the batch cannot be discharged until approved mixing time has elapsed and the entire batch shall be discharged before the mixer is recharged.

Where admixtures are employed, separate containers & measuring devices shall be used.

For minor concreting works, batching by volume according to specific weight may be permitted by the Engineer. In that case the whole bags of cement shall be used and gauge boxes used for measuring aggregates.

When hand mixing is permitted by the Engineer, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch.

3.11 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, in spite of all precautions, segregation does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers which will reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in the relevant I.S. Code for any particular aspect of work, any other standard Code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces :

- a) Earth foundation



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 21 OF 31

- b) Rock foundation
- c) Formwork
- d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. All excavated areas for foundations, ring beams, plinths, pile caps etc. shall be rammed & consolidated properly before blinding with nominal mix plain concrete, as per drawing and / or direction of the Engineer and shall be allowed to cure prior to setting out steel fixing, shuttering and concrete pouring for the main structural element.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed and cement slurry will be spread thoroughly on the rock foundation or construction joint just prior to placement of concrete. The cost of application of such cement slurry and mortar will be deemed to be included.

After concrete has been placed, it shall be spread, if necessary and thoroughly compacted by approved mechanical vibration to maximum subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice. In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS:4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS:2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures,



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001			
VOLUME - II B			
SECTION - D		SUB-SECTION - D2	
REV.NO.	01		
SHEET	22	OF	31

reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

The size of the concrete pours must be carefully considered prior to commencement to ensure the structural elements are poured in on continuous shift to avoid cold joints.

Slabs, beams and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Moulding, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation therefrom shall be set right by the Contractor as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13 Construction Joints and Cold Joints

3.13.1 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete at certain predetermined stages. These joints will be formed in a manner specified in the drawings/ Instruction. Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 23 OF 31

embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12. For water retaining structures and leak-proof buildings suitable approved water bars will be installed at the construction joints.

Where the location of the joints are not specified, it will be in accordance with the following :

- a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.
- b) Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and within the middle third of the span.
- c) A joint in a suspended floor slab shall be vertical and within the middle third of the span and at right angles to the principal reinforcement.
- d) Feather-edges in concrete shall be avoided while forming a joint.
- e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.
- f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be sub-mitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.2 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it :

- a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systemetically vibrated.
- b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 24 OF 31

shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

- c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise inspite of extensive vibration, the joint will be left to harden for at least 12 - 24 hrs. It will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14 Repairs, Finishes and Treatment of Concrete surfaces

3.14.1 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods. All concrete work shall be inspected by the Contractor immediately after the forms are removed and he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations :

- a) Sack rubbing with mortar and stoning with carborundum stone.
- b) Cutting away the defective concrete to the required depth and shape.
- c) Cleaning of reinforcement and embedments. It may be necessary to provide an anti-corrosive coating on the inforcement.
- d) Roughening by sand blasting or chipping.
- e) Installing additional reinforcement/welded mesh fabric.
- f) Dry packing with stiff mortar.
- g) Plastering, guniting, shotcreting etc.
- h) Placing and compacting concrete in the void left bycutting out defective concrete.
- i) Groting with a cement sand slurry of 1:1 mix.
- j) Repairing with a suitable mortar either cement or resin modified mortar.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 25 OF 31

- k) Polymer modified patching and adhesive repair mortar for beams & columns.

3.14.2 Finishing Unformed Surface

A few typical and common cases of treatment of concrete surface are cited below :

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No overtrowelling, to obtain a very smooth surface, shall be done as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling by hand or by rotary power float is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples and trowel marks. A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beams, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15 Protection and Curing of concrete



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 26 OF 31

Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, polythene sheet, hessian, canvas or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor.

If permitted by the Engineer, curing compound like "ANTISOLE (WP)" may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water sheen from concrete surface.

It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case any lapse on the part of the Contractor is noticed by the Engineer, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and entirely at the discretion of the Engineer.

3.16

Reinforcement

Mild steel round bars, cold twisted and deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc., will be



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 27 OF 31

used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS:9077, as shown on the drawing or as directed by the Engineer.

3.16.1 Bar Bending Schedules

The Contractor shall submit to the Engineer for approval Bar Bending Schedules with working drawings in triplicate, showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, within one month of receipt of the Letter of Intent or of the receipt of the relevant design drawings, whichever is later. Upon receipt of the Engineer's final approval of the Bar Bending Schedule and drawings, the Contractor shall submit 6 (six) prints of the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the Contract.

3.16.2 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.3 Cutting & Bending of Reinforcement

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS:2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding to the approved Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars above 16 mm diameter shall be bent by machine producing a gradual and even motion. Bars of 16 mm or below may be bent by hand. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat(not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

Reinforcing bars, whether high yield or mild steel shall be cut using either hand held shears, guillotines or foot operated pneumatic cutters. Cutting bars using cold chisels may be allowed by the Engineer at exceptional cases.

3.16.4 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 28 OF 31

mild steel chairs and/or concrete spacer blocks irrespective of whether such supports are payable or not. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire. Tack welding of bars should not be done unless permitted by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.5 Welding

Normal bond laps in reinforcement may be placed by lap or butt welding reinforcement bars, if asked by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS:2751 and IS:456. Welded mesh fabrics conforming to IS:1566 may also be used if specified in the Schedule of Items and Drawings.

3.16.6 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS:456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position do not have to bear extra load and get disturbed.

The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17 Cold Weather Concreting

When conditions are such that any operation of concreting may be expected to be done at 5 Deg.C atmospheric temperature or below the work shall conform to the requirement of Clause 14 of IS:456 and IS:7861. (Part. II).



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 29 OF 31

3.18 Hot Weather Concreting

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS:7861 (Part-I) and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 40 Deg.C while placing. Positive temperature control by precooling, postcooling or any other method, if required, will be specified.

3.19 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of clause 14 of IS:456.

3.20 Form Work

3.20.1 General

Formwork shall conform to the shape, grade, lines, levels and dimension as shown on the drawings. The contractor shall prepare design & working drawings for formwork & temporary support system for important structures and get them approved by the Engineer prior to commencement of actual work.

Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centering shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rekers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete as a liquid as well as the working load, in case the Contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used. Alternatively, except in case of water retaining structures through rods and the tie bolts shall be sleeved with PVC conduits to allow retraction of the ties on removal of the shutters. Where required, the annulus of the conduits will be filled with expanding mortar to seal the void. Bolts passing



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 30 OF 31

completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion- resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so. All floor and beam centering shall be crowned not less than 8 mm in all directions for every 5 metres span. Unless specifically described on the drawings or elsewhere to the contrary, bevelled forms 25 mm by 25 mm shall be fixed in the form-work at all corners to provide chamfering of the finished concrete edges. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.2 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes, brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil based shutter release agent like "Separol/Sika form oil/ Siparol Concentrate" before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.3 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork. Removing any props or reproping shall not be done except with the specific



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
CEMENT CONCRETE (PLAIN &
REINFORCED)

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D2

REV.NO. 01

SHEET 31 OF 31

approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

The design of formwork shall take into account all vertical and lateral loads that the forms will carry or be subjected to during the construction process. Besides weight and pressures of reinforced concrete and weight of the forms themselves, the design shall consider loading due to unsymmetrical placement of concrete ; impact from dumping of concrete ; movement of men and construction equipment ; wind action and any other imposed load during construction. The contractor shall assess the magnitude of vertical live load to be taken for design of formwork duly considering his method, sequence and rate of pour of concrete. However, minimum design vertical live load to be considered shall be 750 kg/sqm excluding weight of concrete.

3.20.4 **Inspection of Forms**

Casting of Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.5 **Removal of Forms**

Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if he so desires. The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed therefrom and have this record checked and countersigned by the Engineer regularly.

The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him. The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

Forms for various types of structural components shall not be removed before the minimum periods specified herein and the removal after the minimum periods shall also be subject to the approval of the Engineer in each case.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D3
REV.NO.	01
SHEET	1 OF 21

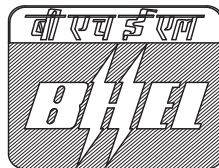
**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

SECTION - D

GENERAL TECHNICAL SPECIFICATION

FORMWORK



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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 2 OF 21

TABLE - IV

SCHEDULE OF REMOVAL OF FORM

Part of Structure	Ordinary Portland Cement Concrete				Rapid Hardening Portland Cement Concrete			
	Temperature Deg.C				Temperature Deg.C			
	Above 40 Deg.C				Above 40 Deg.C			
	20 Deg. 5 Deg. 5 Deg.				20 Deg. 5 Deg. 5 Deg.			
	Days	Days	Days	Days	Days	Days	Days	Days
a) Columns & Walls	2	1	1	Do not remove forms until site cured test specimen develop at least 50% of the specified 28 days strength	1	1	1	Do not remove forms until site cured test specimen develop at least 50% of the specified 28 days strength
b) Beam sides	3	2	3		2	1	1	
c) Slabs, 125 mm	10	7	8		7	4	5	
d) Slabs over 125 mm thick and soffit of minor beams	18	14	16		12	8	9	
e) Soffit of main beams	24	21	22		14	10	12	

Wherever exposed surfaces of concrete can be effectively sealed to prevent loss of water, the periods specified for temperature above 40 Deg.C can be reduced to those of the temperature range of 20 Deg.C to 40 Deg.C subject to approval of the Engineer.

Construction joints in beams, if required to be provided, will be located within the middle third of span according to clause 3.13.1(b) of this specification. In such cases, however, entire span of beam shall have to be kept supported by formwork till its removal for the portion of beam, cast at a later date, is due and so approved by the Engineer.

If any type of cement other than ordinary portland cement and Rapid hardening portland cement is used the time of removal of forms shall be revised as approved by the Engineer such that the strength of this cement at the time of removal of forms match with strength of portland cement at



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 3 OF 21

the time of removal of form as mentioned above . This has to be supported by regular tests.

3.20.6

Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this Specification or drawings or directed by the Engineer :

For

- a) Sectional dimension - ± 5 mm
- b) Plumb - 1 in 1000 of height
- c) Levels - ± 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface and should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.7

Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.8

Classification

Generally, the 'ordinary' class formwork shall be used unless otherwise directed by the Engineer :

- a) Ordinary : These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.
- b) Plywood : These shall be used in exposed surfaces, where a specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 4 OF 21

by the Engineer. He may also permit utilisation of used plywood for the 'ordinary' class, if it is still in good condition.

- c) Ornamental: These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

- 3.22** Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and Other misc. Embedded Fixtures. The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as directed and secure the same as may be required. The materials, if required to be supplied by the Contractor, shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to be painted with one coat of approved anti-corrosive paint and/or bituminous paint. If welding is to be done subsequently on the exposed surface of embedded material the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer. Items to be embedded.

- a) Inserts, hangers, anchors, frames around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.
- b) Anchor bolts and plates for machinery, equipment and for structural steel work.
- c) Steel structurals to be left embedded for future extension, special connection etc.

- d) Lugs or plugs for door and window frames occurring in concrete work.

- e) Flashing and jointing in concrete work.

- f) Any misc. embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23 Expansion and Isolation Joints



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 5 OF 21

3.23.1

General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.2

Bitumen Board/Expanded Polystyrene Board

a) **Bitumen Board**

Bitumen impregnated fibre board of approved manufacturer as per IS:1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) **Expanded Polystyrene Boards**

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.3

Joint Sealing Strips

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure.

The sealing strips will be non-metallic like rubber or P.V.C.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 6 OF 21

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanised.

Non - metallic sealing strips will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features :

- i) Plain
- ii) Central bulb
- iii) Dumb-bell or flattened ends
- iv) Ribbed and Corrugated Wings
- v) V shaped

As these types of seals can be easily handled in very large lengths, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer.

The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

a) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings of items and/or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer :

Specific Gravity : 1.1 to 1.15

Shore Hardness : 65A to 75A

Tensile Strength : 25 - 30 N/Sq.mm



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 7 OF 21

Maximum Safe
Continuous
Temperature : 75 Deg.C

Ultimate Elongation : Not less than 350%

b) P.V.C. Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly :

Specific Gravity : 1.3 to 1.35

Shore Hardness : 60A to 80A

Tensile Strength : 10 - 15 N/Sq.mm

Maximum Safe
Continuous
Temperature : 70 Deg.C

Ultimate Elongation : Not less than 275%

3.23.4 Joint Sealing Compound

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS:1834.

Alternatively, when directed, the expansion Joints may be filled with joint sealing compound like "Sikalastic" or approved equivalent and shall be applied as per manufacturer's specification.

3.23.5 Isolation Joints



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 8 OF 21

Strong and tough alkathene or PVC sheet about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.6 Rubber Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Engineer. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stonechips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If desired by the Engineer, admixtures like Aluminium powder, 'Ironite' etc. may have to be added with the grout in proportions to be decided by the Engineer. Admixture, if directed to be added, will be measured and paid separately.

Alternatively non-shrink, free flow, cementitious grout like "Sikagrout 214/Ankor NSG" or approved equivalent specifically selected for the type of equipment to be located (vibrating, static etc.) may also be used for grouting as per manufacturer's specification with necessary approval of the Engineer.

3.25 Precast Concrete

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose.

This yard shall be dry, properly levelled and having a hard and even as well as well drained surface to prevent excessive uneven settlement due to softening of soil during casting & curing. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 9 OF 21

will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 10 (Ten) days of curing and can be removed for erection after 28 (twenty eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal and must be rigid enough to prevent distortion during placing and compaction of the concrete.

Other than normal curing by applying water through spray nozzles or perforated hose curing by high pressure steam, steam vapour or other accepted processes may also be employed to accelerate the hardening of the concrete and to reduce the curing time.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

All members shall be indelibly marked with a unique identification mark on a surface which will not be permanently exposed to show on which production line they were manufactured, their type, the class of concrete, the data of casting and if they are of a symmetrical section the face which will be uppermost when the member is in its correct position after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as directed by the Engineer. If centerings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement : sand mortar where called for in the drawings.

3.26 Waterproofing of Concrete Structure

3.26.1 General

Waterproofing of concrete structures shall be done by either suitable extraneous treatments like applying waterproofing paints like "Sikatop Seal" fixing bitumen felts etc. or internally by suitable design of the concrete mix, addition of suitable admixtures conforming to IS:2645 and equivalent American or British codes in the concrete or mortar at the time of mixing and/or installing water bars at the joints.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001		
VOLUME - II B		
SECTION - D	SUB-SECTION - D3	
REV.NO.	01	
SHEET	10	OF 21

The design, material and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.2

Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be rubber or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint should be provided as per clause 3.13.1 with or without water bar / Seal as shown on the drawing. In case of water bars being used at the construction joint, fixing of the same has to be done carefully so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods :

Method 1 : A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting in case of walls. The above bonding agent will be mixed with water which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two component epoxy resin bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days :

Compressive strength	-	55 to 60 N /Sq. mm
Flexural Strength	-	25 to 30 N /Sq. mm.
Tensile strength	-	15 N Sq. mm (approx)
Bonding strength to concrete	-	3 N / Sq. mm (approx)
Bonding strength to steel	-	20 N / Sq. mm (approx)

The whole operation shall be done as per manufacturer's specification. The contractor shall provide manufacturer's supervision.

Method 2 : One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 11 OF 21

waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 Kg/Sq cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision.

3.26.3

Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar / plaster shall conform to relevant IS code. The admixture shall not cause decrease of strength of concrete / plaster at any stage and it is free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5 %

The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement but a lower dosage will always be preferred.

The product shall be stored in strong moisture proof packings.

However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water resistant concrete admixture shall be used to provide a waterproof concrete around 410 Kg/ Cm.m a melamine based super plasticizer will be preferable.

a) In concrete : The approved admixture shall be based on modified lignosulphonate like "Plastocrete - N/Super" or approved equivalent. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor to supervise the work, if desired by the Engineer.

b) In Plaster : The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture like "Noleak CP/Sika Latex" or approved equivalent and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 12 OF 21

3.26.4 Bituminous or Tar Coating on External Surface

The surface to be waterproofed shall be rendered absolutely dry, clean and dust free. The surface shall be sand papered, cleaned and completely coated with hot coal tar pitch of approved manufacturer and quality as per IS:216 (not heated above 375 Deg.F) using not less than 2 Kg. per Sq.M. or with hot asphalt i.e., bitumen according to IS:73 (not heated above 400 Deg.F) using not less than 1.5 kg. per Sq.M. When the first coat has completely dried up and approved by the Engineer, the second coat shall be applied in the same manner using not less than 1.25 Kg. per Sq.M. in case of coal tar and 1 Kg. per Sq.M. in case of asphalt. Immediately after application of the second coat and before it is dried up, sand shall be spread on the surface to cover it completely. Sufficient time shall be allowed after spreading of sand before backfilling is done in order to allow the final coat to dry up completely. In place of hot application by coal tar / asphalt the coating of the outside surfaces of walls may be carried out using a ready to use liquid, bituminous emulsion/rubber protective coating of approved manufacturer.

3.26.5 Protective Coating on Inside Surface

Two coats of cement based to components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/ floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.6 Bitumen Felt : Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS:1322, and the workmanship to IS:1609. The bitumen felt shall be hessian base and/or fibre base as specified in Drawing/Schedule of Items. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor.

The Contractor shall execute this work in direct collaboration with one of the well known specialised approved by the Engineer.

Cleaning the surface, keeping it dry, providing necessary corner fillets and cement rendering and cutting chases, etc. shall be included in the rate for this item. If any protective brickwork on/against concrete sub-bases or walls are required, these will be paid extra under suitable items in the contract. A 20 (twenty) years' guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this item of work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.7 Polyethelene Films : Application in Walls or base of Structures



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 13 OF 21

Waterproof treatment shall be applied as outlined and as per sequence given hereunder :

- i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6
- ii) apply hot bitumen 80/100 grade (IS:73-1961) at the rate of 1.0 Kg/Sq.m minimum
- iii) lay black polyethelene film 250 micron (IS:2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethelene film to be heat sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a celophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another celophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat sealing, the celophane tape is to be removed and the joints are to be tested for leaks.

- iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen.
- v) Lay hot bitument 80/100 grade (IS:73-1961) at 1.0 Kg/Sq.m minimum.
- vi) Lay 250 micron polyethelene film as second layer similar to (iii) above.
- vii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.
- viii) Apply hot bitumen (straight run grade) to IS:73-1961 at 1.0 Kg/Sq.m dusted with fine sand.
- ix) Protecting with a layer of 75 mm plain cement concrete M-100, or a layer of brick laid in cement mortar 1:6. In case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27 Protective coating on Concrete Surface

3.27.1 On Foundation

The outside faces of foundation of important structures will be protected from adverse effect of soil/ underground water, if shown on drawing or instructed by the Engineer , by using bitumen emulsion protective coating of approved manufacturer.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 14 OF 21

3.28 Waterproofing by Pressure /Chemical Grouting

Where required, waterproofing for underground concrete structure shall be done by injecting high polymer based non- shrink waterproof grouting compound through nozzle under pressure as per manufacturer's recommendation. The pressure during injection shall not be less than 2.5 kg/Sq.cum and the thickness of epoxy resinous emulsion waterproof paint (to be applied on the external surface of walls/slabs) shall not be less than 700 microns.

4.0 SAMPLING AND TESTING

4.1 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.2 Cement

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths. Soundness Tests may also be required to be carried out if required by the Engineer. The tests shall be carried out free of charge by the Owner if cement is supplied by him. In case the Contractor is directed to arrange for the supply of cement as per the terms and conditions of the Contract the tests shall be carried out by him. In case due to any circumstances, the agency of supply is changed in the middle of the Contract, the party who bore the original contractual obligation will carry on with the test, free of charge to the other, till the end of the job. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Owner, Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the Owner or the Contractor. These tests are of great importance as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.3 Aggregates

The Contractor shall carry out any or all the tests aggregates as may be required by the Engineer in accordance with IS:2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.4 Water



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001			
VOLUME - II B			
SECTION - D		SUB-SECTION - D3	
REV.NO.	01		
SHEET	15	OF	21

Sampling and Testing of water being used for concrete works as per IS:3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The final acceptance criteria in case of doubt will be as per IS:3025 & IS:456.

4.5 Admixture

4.5.1 Air Entraining Agents (A.E.A)

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor by carrying out sufficiently large number of tests. After then, at regular intervals and whenever directed by the Engineer, the Contractor will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.5.2 Other Admixtures

Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the Contractor.

4.6 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS:516 and IS:1199 the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS:516.

Sampling procedure, frequency of sampling and test specimen shall conform to Clause 14 of IS:456.

To control the consistency of concrete from every mixing plant, slump tests and/or compacting factor tests in accordance with IS:1199 and as mentioned in Clause 3.6 of this Specification shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference.

The acceptance criteria of concrete shall be in accordance with Clause 15 of IS:456.

Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures, etc. wasted in the dismantled portion shall be made. In the course of dismantling, if any damage is done to the



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 16 OF 21

embedded items or adjacent structures, the same shall be made good to the satisfaction of the Engineer.

5.0 ACCEPTANCE CRITERIA

5.1 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to clause 16 of IS:456.

5.2 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to Clause 16 of IS:456.

5.3 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to Clause 17 of IS:456.

5.4 Load Test

Load tests of structural members may be required by the Engineer, when the strength of test specimen results fall below the required strength, as per 'Load Test on Parts of Structures', Clause 17.6 of IS:456. If load testing is decided by the Engineer, the member under consideration shall be subjected to a test load equal to 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of 24 (twenty four) hours before removal. The detailed procedure of the test is to be decided by the Engineer. Load tests shall not be made until the structure is at least 56 days old.

If the member shows evident failure, such changes as are necessary to make the structure adequately strong shall be made by the Contractor. Alternatively, if permitted under Statutory Regulations and at the discretion of the Engineer, the structure under test or a portion thereof may be retained as such without any modification by derating its load bearing capacity, provided the design criteria allows such derating.

A reinforced concrete beam, floor or roof shall be deemed to have passed the test if the maximum deflection at the end of 24 hours does not exceed the deflection given in Clause 17.6 of IS:456.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good by the Contractor to the satisfaction of the Engineer.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 17 OF 21

6.0

LIST OF I.S. CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian Standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed :-

- IS : 73 - Indian Standard Specification for Paving Bitumen
- IS : 216 - Indian Standard Specification for Coal Tar Pitch
- IS : 269 - Indian Standard Specification for 33 grade Ordinary Portland Cement
- IS : 383 - Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
- IS : 432 - Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement - Part 1 & 2
- IS : 455 - Indian Standard Specification for Portland Slag Cement
- IS : 456 - Indian Standard Code of Practice for Plain and Reinforced Concrete
- IS : 457 - Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures
- IS : 516 - Indian Standard Specification for Methods of Test for Strength of Concrete
- IS : 737 - Indian standard specification for wrought Aluminium and Aluminium Alloy sheet and strip for general Engineering purpose. IS : 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete
- IS : 1200 - Indian Standard Specification for Method of (Part-II) Measurement Cement Concrete Works.
- IS : 1200 - Indian Standard Specification for Method of (Part-V) Measurement of Formwork
- IS : 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 18 OF 21

- IS : 1489 - Indian Standard Specification for Portland - Pozzolona Cement - Part 1 & 2
- IS : 1566 - Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.
- IS : 1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts
- IS : 1786 - Indian Standard Specification for high strength deformed Bars & wires for Concrete Reinforcement
- IS : 1791 - Indian Standard Specification for Batch Type Concrete Mixers
- IS : 1834 - Indian standard specification for hot applied sealing compound for joint in concrete.
- IS : 2062 - Steel for general structural purpose.
- IS : 2185 - Indian Standard Specification for Hollow and solid / solid light wt. Cement Concrete Blocks - Part - 1 & 2
- IS : 2210 - Indian Standard Specification for Design of Reinforced Concrete Shell Structures and Folded Plates
- IS : 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII
- IS : 2430 - Indian standard specification for method of sampling of Aggregate for concrete.
- IS : 2502 - Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
- IS : 2505 - Indian Standard Specification for Concrete Vibrators Immersion Type
- IS : 2506 - Indian Standard Specification for Screed Board Concrete Vibrators
- IS : 2514 - Indian Standard Specification for Concrete Vibrating Tables
- IS : 2645 - Integral Cement water proofing compound
- IS : 2722 - Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)
- IS : 2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 19 OF 21

- | | | |
|-----------|---|--|
| IS : 2770 | - | Indian Standard Specification for Method of Testing Bond in Reinforced Concrete. Part - 1 : Pull out Test |
| IS : 3025 | - | Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water & waste water - art - 1 to 37 |
| IS : 3201 | - | Indian Standard Specification for Design and Construction of Precast Concrete Trusses and purlins. |
| IS : 3370 | - | Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids Part 1 to 4 |
| IS : 3384 | - | Indian standard specification for / Bitumen primer for use in waterproofing and Danp proofing |
| IS : 3414 | - | Code of practice for Design and Installation of joints in Buildings |
| IS : 3550 | - | Indian Standard Specification for Method of Test for Routine Control for Water used in Industry |
| IS : 3558 | - | Code of Practice for use of Immersion Vibrators for Consolidating Concrete |
| IS : 3696 | - | Safety Code for Part-1 : Scaffolding and Part 2: Ladders |
| IS : 3812 | - | Indian Standard Specification for Fly Ash for Use as Pozzolone & Admixture |
| IS : 4031 | - | Indian Standard Specification for Method of Tests for Hydraulic Cement - Part - 1 to 14 |
| IS : 4082 | - | Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site |
| IS : 4090 | - | Indian Standard Specification for Design of Reinforced Concrete Archs |
| IS : 4634 | - | Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixers |
| IS : 4656 | - | Indian Standard Specification for Form Vibrators for Concrete |
| IS : 4925 | - | Indian Standard Specification for Concrete Batching and Mixing Plant |
| IS : 4926 | - | Indian Standard Specification for Ready Mixed Concrete |



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001			
VOLUME - II B			
SECTION - D		SUB-SECTION - D3	
REV.NO.	01		
SHEET	20	OF	21

- IS : 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work
- IS : 4991 - Indian Standard Specification for Blast Resistant Design of Structure for Explosion above ground
- IS : 4995 - Indian Standard Specification for Design (Part-I of Reinforced Concrete Bins for the Storage & II) of Granular and Powdery Materials
- IS : 4998 - Indian Standard Specification for Design of (Part - I) Reinforced Concrete Chimneys
- IS : 5512 - Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials
- IS : 5513 - Indian Standard Specification for Vicat Apparatus
- IS : 5515 - Indian Standard Specification for Compaction Factor Apparatus
- IS : 5751 - Indian Standard Specification for Precast Concrete Coping Blocks
- IS : 5816 - Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders
- IS : 5891 - Indian Standard Specification for Hand Operated Concrete Mixers
- IS : 6452 - Indian Standard Specification for High Alumina Cement for Structural Use
- IS : 6909 - Indian Standard Specification for Supersulphated Cement
- IS : 6923 - Indian Standard Specification for Method of Test for performance of Screed Board Concrete Vibrators
- IS : 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures
- IS : 7242 - Indian Standard Specification for Concrete Spreaders
- IS : 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete
- IS : 7251 - Indian Standard Specification for Concrete Finishers
- IS : 7320 - Indian Standard Specification for Concrete Slump Test Apparatus



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FORMWORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D3

REV.NO. 01

SHEET 21 OF 21

- IS : 7861 - Indian Standard Specification for (Part-I Recommended Practice for hot and cold & II) Weather Concreting
- IS : 7969 - Safety Code for Storage and Handling of Building Materials
- IS : 8041 - Indian Standard Specification for Rapid Hardening Portland cement
- IS : 8043 - Indian standard specification for hydrophobic cement
- IS : 8112 - Indian Standard Specification for 43 grade Ordinary Portland Cement
- IS : 8142 - Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance
- IS : 8989 - Safety Code for Erection of Concrete Framed Structures
- IS : 9013 - Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated - cured Concrete Test Specimens
- IS : 9077 - Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction
- IS : 9103 - Indian Standard Specification for Admixtures for Concrete.
- IS : 9417 - Recommendation for welding cold worked bars for reinforced concrete construction
- IS : 10262 - Recommended Guideline for concrete Mix Design
- IS : 12269 - Indian standard specification for 53 grade ordinary portland cement
- IS : 12330 - Indian standard specification for sulphate resisting portland cement
- IS : 12600 - Indian standard specification for low heat portland cement



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001		
VOLUME - II B		
SECTION - D	SUB-SECTION - D4	
REV.NO.	01	
SHEET	1	OF 26

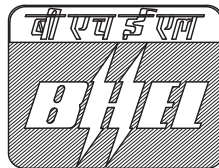
**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

SECTION - D

GENERAL TECHNICAL SPECIFICATION

FABRICATION OF STRUCTURAL STEELWROK



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

TABLE OF CONTENTS



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D4
REV.NO. 01
SHEET 2 OF 26

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.0.0	SCOPE	3
2.0.0	GENERAL	3
3.0.0	WORKMANSHIP	13
4.0.0	INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY	21
5.0.0	INFORMATION TO BE SUBMITTED	25



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 3 OF 26

**TECHNICAL SPECIFICATION
FOR
FABRICATION OF STRUCTURAL STEELWORK**

1.00 SCOPE

This specification covers supply of all raw steel materials, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork in general covered under the scope of the contract. However, for any special structures such as rail & road bridges, steel chimney, tanks, transmission towers, furnace structures, etc., the relevant Indian Standard or IRC specification and Codes of Practices shall be given due consideration over & above this specification.

2.00 GENERAL

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following :

- a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on contractor's design drawings approved by the Owner / Consultants.
- b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.
- c) To submit design calculations for joints and connections developed by the contractor along with detailed fabrication drawings.
- d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary bolts, nuts, washers, tie rods and welding electrodes for field connections. The field connection materials supplied by the contractor shall be in adequate quantity to avoid delay in erection.
- e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.
- f) Suitably mark, bundle and pack for transport all fabricated materials.
- g) Prepare and furnish detailed Bill of Materials, Drawing Office Despatch lists, Bolt List and any other list of bought out items



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 4 OF 26

required in connection with the fabrication and erection of the structural steelwork.

- h) Insure, load and transport all fabricated steelwork field connection materials to site.

2.2.0 Work by others

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

2.3.0 Codes and standards

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard Specification, any other standard practice, as may be specified by the Engineer shall be followed:-

LIST OF I.S. CODES - RELEVANT TO FABRICATION OF STRUCTURAL STEEL WORK

IS Codes	Description
IS : 800 -	Code of practice for general construction in steel.
IS : 801 -	Code of practice for use of cold formed light gauge steel structural members in general building construction.
IS : 806 -	Code of practice for use of steel tubes in general building construction.
IS : 808 -	Dimensions for rolled steel beams, channels and angle sections.
IS : 812 -	Glossary of terms relating to welding & cutting of metals.
IS : 813 -	Scheme of symbols for welding.
IS : 814 -	Covered electrodes for metal arc welding of carbon and carbon manganese steel.
IS : 815 -	Classification coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D4
REV.NO.	01
SHEET	5 OF 26

- IS : 816 - Code of practice for use of metal arc welding for general construction in mild steel.
- IS : 817 - Code of practice for training & testing metal arc welders.
- IS : 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations.
- IS : 819 - Code of practice for resistance spot welding for light assemblies in mild steel.
- IS : 822 - Code of practice for inspection of welds.
- IS : 919 - Recommendations for limits and fits for engineering.
(Part - 1&2)
- IS : 1161 - Steel Tubes for structural purposes.
- IS : 1182 - Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates.
- IS : 1200 - Method of measurement of steel work and iron work
(Part - 8)
- IS : 1239 - Mild steel tubes, tubulars and other wrought steel fittings
(Part - 1&2)
- IS : 1363 - Hexagon head bolts, screws and nuts of product grade C.
(Part - 1 to 3)
- IS : 1364 - Hexagon head bolts, screws and nuts of product grade A & B.
(Part - 1 to 5)
- IS : 1365 - Slotted counter sunk head screws (dia. 1.6 to 20 mm)
- IS : 1367 - Technical supply conditions for threaded steel fasteners.
(Part - 1 to 18)
- IS : 1608 - Method for tensile testing of steel products.
- IS : 1730 - Dimensions for steel plate, sheet and strip for structural and general engineering purposes.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D4
REV.NO.	01
SHEET	6 OF 26

- IS : 1852 - Rolling and cutting tolerances for hot-rolled steel product.
- IS : 1977 - Structural steel (Ordinary quality)
- IS : 2016 - Plain washer
- IS : 2062 - Steel for general structural purposes.
- IS : 2629 - Recommended practice for hot-dip galvanising of iron and steel.
- IS : 2633 - Method for testing uniformity of coating on zinc coated articles.
- IS : 3644 - Code of practice for ultrasonic pulse echo testing by contact and immersion method.
- IS : 3757 - High Strength Structural Bolt
- IS : 4000 - High strength bolts in steel structure
- IS : 4759 - Specifications for hot-dip zinc coatings on structural steel and other allied products.
- IS : 4923 - Hollow steel sections for structural use.
- IS : 5334 - Code of practice for magnetic particle flaw detection of weld.
- IS : 5369 - General requirements for plain washers and lock washer.
- IS : 6005 - Code of practice for phosphating of iron and steel.
- IS : 6649 - Specification for hardened and tempered washers for high strength structural bolts and nuts.
- IS : 6623 - Specification for high strength structural nuts.
- IS : 7215 - Tolerances for fabrication of steel structures.
- IS : 7280 - Bare wire electrode for submerged arc welding.
- IS : 8500 - Structural steel micro alloyed (medium & high strength quality).
- IS : 8629 - Code of practice for protection of iron and (Part - I to III) steel structures from atmospheric corrosion.
- IS : 9595 - Recommendation for metal arc welding of carbon manganese steels.

PAINTING



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 7 OF 26

- IS : 117 - Specification for ready mixed paint, brushing, finishing, exterior, semi-gloss, for general purposes.
- IS : 128 - Specification for ready mixed paint, brushing, finishing, semi-gloss for general purposes, black.
- IS : 1477 - Code of practice for painting of ferrons metal (Part - I & II) in building.
- IS : 2074 - Ready mixed paint, air-drying red-oxide zinc chrome priming.
- IS : 2339 - Specification for aluminium paints for general purposes in dual container.
- IS : 2932 - Specification for enamel, synthetic exterior type - I.
- IS : 2933 - Specification for enamel, synthetic exterior type - II.

2.4.0 Conformity with Designs

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.5.0 Materials to be used

2.5.1 General

All steel materials shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates of materials supplied by the contractor in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tonnes or less of any particular section.

The arc welding electrodes shall conform to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 8 OF 26

container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and ampereage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.5.2 Steel

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable :

- 1) IS : 801 - Cold formed light gauge steel structural member.
- 2) IS : 806 - Steel tubes in general building construction.
- 3) IS : 1161 - Steel tubes for structural purpose.
- 4) IS : 1977 - Structural steel (Ordinary quality)
St-42-0
- 5) IS : 2062 - Steel for general structural purpose
- 6) IS : 8500 - Structural steel-microalloyed (Ordinary & high strength quality)

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.5.3 Electrodes

All electrodes to be used under the Contract shall comply with any of the following Indian Standard Specifications as may be applicable :

- 1) IS : 814 - Covered electrodes for metal arc welding structural steel
- 2) IS : 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
- 3) IS : 7280 - Base wire electrode for submerged arc welding.

2.5.4 Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS:1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

- a) Mild Steel : All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 9 OF 26

than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 /A, where 'A' is the cross sectional area of the test specimen : -

1) IS:1367 - Technical supply conditions for threaded fasteners.

2) IS:1608 - Method for tensile testing of steel other than sheet, strip, wire and tube.

b) High
Tensile
Steel :

The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS:1367 or as approved by the Engineer.

2.5.5 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract :

- 1) IS : 1977 - Structural steel (Ordinary Quality) St-42-0
- 2) IS : 2062 - Steel for general structural purpose
- 3) IS : 8500 - Structural steel - microalloyed (medium & high strength quality)
- 4) IS : 6623 - High Strength Structural Nuts
- 5) IS : 6649 - Hardened and tempered washers for high strength structural bolts & nuts.

2.5.6 Paints

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS:2074 - Ready mixed Paint, Air Drying, Red Oxide - Zinc Chromate Priming.

In highly corrosive environment other type of primer such as epoxy resin based zinc rich primer (such as blast steel EZ1 of Shalimer Paints Ltd., may be necessary.

2.6.0 Storage of Material

2.6.1 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed. The Contractor shall maintain upto date



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D4
REV.NO.	01
SHEET	10 OF 26

accounts in respect of receipt, use and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.6.2 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground sectionwise and lengthwise so that they can be easily inspected, measured and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.6.3 Electrodes

The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.6.4 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length and quality.

2.6.5 Paints

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.7.0 Quality Control

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 11 OF 26

The quality control procedure shall cover but not be limited to the following items of work :

- 1) Steel : Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
- 2) Bolts, Nuts & Washers : Manufacturer's certificate, dimension checks, material testing.
- 3) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.
- 4) Welders : Qualifying Tests
- 5) Welding sets : Performance Tests
- 6) Welds : Inspection, X-ray, Ultrasonic tests
- 7) Paints : Manufacturer's certificate, physical inspection reports
- 8) Galvanizing : Tests in accordance with IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.8.0 Standard dimensions, forms and weights

The dimensions, forms, weights and tolerances of all rolled shapes bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.9.0 Shop Drawings

The Contractor shall submit to the Engineer the Schedule of Fabrication and delivery of structural steelwork for approval. He shall start to submit progressively for approval the shop drawings based on the approved Design Drawings and before proceeding with the fabrication work, shall get the said shop drawings approved in accordance with the contract.

The sequence of submission of shop drawings for approval shall match with the approved fabrication and delivery schedule. The approval for the shop drawings will be accorded only towards the general conformity with the design requirements as well as specification and will ensure the correctness



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 12 OF 26

of general arrangement for centreline dimensions and levels, Section sizes, and adequacy of connections including splice joints as to the no. of bolts, weld length, size of gusset/end plates.

The correctness of all other details like cutting lengths, matching of holes, notch dimensions, match markings, bill of materials, bolt list etc. will be entirely the contractor's responsibility. The approval of the drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The shop drawings shall include but not be limited to the following :-

- a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.
- b) Dimensional drawings of base plates, foundation bolt location etc.
- c) Details of all connections with supporting calculations.
- d) Comparison sheets to show that the proposed alternative section, if any, are as strong as the original sections shown on the Design Drawings.
- e) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.
- f) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

The shop drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with the provisions of this Specification. Shop drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Shop drawings shall give complete information necessary for fabrication of various components of the steelwork, including the location, type, size and extent of welds. These shall also clearly distinguish between shop and field bolts and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately.

Notes on the shop drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked-up stresses and distortion.

Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification --IS:813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall pay for any alterations of the work due to any discrepancies, errors or omissions on the drawings or



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 13 OF 26

other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.0.0 WORKMANSHIP

3.1.0 Fabrication

3.1.1 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS:800 - Code of Practice for use of Structural Steel in General Building Construction and other relevant Indian Standards.

3.1.2 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification IS:1852 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600 Deg. C.

3.1.3 Cutting

Cutting shall be effected by shearing, cropping or sawing. Use of a mechanically controlled gas cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges. Occasional notches or gauges not more than 4 mm deep will be permitted. Gouges greater than 4 mm, that remain from cutting, shall be removed by grinding. All re-entrant corners shall be shaped notch-free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.1.4 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 14 OF 26

3.1.5 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats shall be not more than 3 mm at each end, but where, for practical reasons, greater clearance is necessary, suitably designed cleatings shall be provided.

3.2.0 Bolted construction

3.2.1 Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of H8 as specified in IS:919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for bolts shall not be formed by gas cutting process.

3.2.2 Assembly

Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted nor otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if directed by the Engineer.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 15 OF 26

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer, one spring washer or lock-nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.3.0 Welded Construction

3.3.1 General

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS:817.

3.3.2 Preparation of Material

Surface to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas-cutting shall, wherever practicable, be done by a mechanically guided torch.

3.3.3 Assembling

Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2 Deg.).

The work shall be positioned for flat welding whenever practicable.

3.3.4 Welding Sequence

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph. When required by the Engineer, welded



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 16 OF 26

3.3.5

assemblies shall be stress relieved by heat treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

Welding technique

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the Contract.

To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.3.6

Temperature

No welding shall normally be done on parent material at a temperature below (-) 5 Deg.C. However, if welding is to be undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5 Deg. C and 0 Deg. C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is handwarm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20 Deg. C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.3.7

Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.3.8

Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 17 OF 26

capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.4.0 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.2 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc., after welding together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 2.0 mm.

3.5.0 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut from material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face. To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3.6.0 Lacing bars

The ends of lacing bars shall be neat and free from burrs.

3.7.0 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.8.0 Bearing Plates

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.9.0 Architectural Clearances

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.10.0 Shop connections

- a) All shop connections shall be welded as specified on the Drawings.
- b) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the Contractor will have to make the desired changes.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 18 OF 26

3.11.0 Castings

Steel castings shall be annealed

3.12.0 Shop erection

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before despatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchangeability.

3.13.0 Shop painting

3.13.1 General

Unless otherwise specified, steelwork which will be concealed by interior building finish need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other mechanical cleaning methods to remove loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by through sweeping with a fibre brush.

After completion of the precleaning, the metal surface shall immediately be painted with red oxide zinc chromate primer conforming to IS : 2074.

In highly corrosive environment, all steelwork shall be given a coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned by sand blasting to SA 2/1/2 grade minimum. The shop paint shall be epoxy resin based zinc rich primer such as Blast Steel EZ1 of Shalimer Paint Limited.

3.13.2 Inaccessible parts

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.13.3 Contact surfaces



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 19 OF 26

Contact surface shall be cleaned in accordance with Sub-clause 3.13.1 before assembly.

3.13.4 Finished surfaces

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.13.5 Surfaces adjacent to field welds

Unless otherwise provided for, surfaces within 50 mm of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.14.0 Galvanizing

3.14.1 General

Structural steelwork for switchyard or other structures as may be specified in the Contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS : 2629 - Recommended practice for Hot-Dip Galvanising of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.14.2 Surface Preparation

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, dirt, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.14.3 Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 20 OF 26

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after having been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport and handling. Damages, if occur, shall be made good in accordance with the provisions of this Specification or as directed by the Engineer.

4.0.0 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.1.0 Inspection

Unless specified otherwise, inspection to all work shall be made by the Engineer or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract.

The Contractor shall guarantee compliance with the provisions of this Specification.

4.2.0 Testing and Acceptance Criteria



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 21 OF 26

4.2.1 General

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost, unless otherwise specified in the Contract. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.2.2 Steel

All steel supplied by the Contractor shall conform to the relevant Indian Standards. Except otherwise mentioned in the Contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T. or less of any particular section for tests to conform to relevant Indian Standards.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance.

4.2.3 Testing Criteria for checking Lamination in raw steel plates

All raw steel plate of thickness more than 20 mm supplied by the contractor shall be checked against lamination before procurement & prior to commencement of fabrication work in the following ways as directed by the Engineer.

- a) Ultrasonic testing along the edge of specified points of the plates shall be carried out to delete lamination in the plates, if any.
- b) If the results of the tests in (a) are not satisfactory, the whole area of the plates shall be checked by ultrasonic testing at specified nodal points formed at equidistant grid locations. The spacing of the grids shall be determined from tests in (a) or as directed by the Engineer.

If the results of the above tests are not satisfactory, the plates shall not be taken up for fabrication work. Even after fabrication at shop, if the Engineer requires any ultrasonic testing to detect lamination of plates, the same shall be carried out by the Contractor. If the plates in the fabricated item is found to be laminated, the component will be rejected.

4.2.4 Welding

All electrodes shall be procured from reliable manufacturers with test certificates. The correct grade and size of electrode which has not deteriorated in storage shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tonnes of welded fabrication, the Engineer may ask for at least 1 (one) test-destructive or non-destructive including X-ray, ultrasonic test or similar. In the event of



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 22 OF 26

further tests as may be desired by the Engineer, if the results are found to be unsatisfactory; and if the test shows no defect. In cases of the test results showing deficiency, the Engineer shall have option to reject or instruct any remedial measures to be taken.

4.2.5 Bolts, nuts and washers

All bolts, nuts and washers shall be procured from reputed manufacturer approved by the Engineer and shall conform to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards.

4.2.6 Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.2.7 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.3.0 Tolerance

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS:1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures other than steel railway & road bridges, structures subjected to dynamic loading (like wind, seismic etc.) and thin walled construction (like box girders) shall be as specified in IS:7215 - Tolerances for Fabrication of Steel Structures.

4.4.0 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this Specification, the same shall be liable to rejection. No structure or part of the structure, once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check the test results obtained at the Contractor's works by independent tests at an approved laboratory and should the items, so tested, be found to be unsatisfactory.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue an acceptance certificate,



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 23 OF 26

upon receipt of which, the items will be shop painted, packed and despatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.5.0 Delivery of materials

4.5.1 General

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. the Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.5.2 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.5.3 Packing and Shipping

All projecting plates or edges and all ends of members of joints shall be stiffened, all straight members and plates, shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all bolts, nuts, washers, and small loose parts shall be packed separately in order to prevent damage or distortion during shipping.

Shipping shall be strictly in accordance with the sequence stipulated in the agreed programme. Payment may be held up for items sent in advance of the sequence till they could be erected. The Contractor shall include and provide for in his rates, the freight and other charges for despatching the materials to the worksite and also for securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All packings shall allow for easy removal and checking at site. Special precautions shall be taken against rusting, corrosion, breakage or damage otherwise of the materials. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following :-

- a) Name and address of the consignee



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001			
VOLUME - II B			
SECTION - D		SUB-SECTION - D4	
REV.NO.	01		
SHEET	24	OF	26

- b) Name and address of the consignor
- c) Gross weight of the package in tonnes and its dimensions
- d) Identification marks and/or number of the package
- e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially :

- a) Name of the Contractor
- b) Number and date of the Contract
- c) Name of the office placing the contract
- d) Nomenclature of stores
- e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each package shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above mentioned charges, the amount paid will be deducted from the progressive bills of the Contractor.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 25 OF 26

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.0.0 INFORMATION TO BE SUBMITTED

5.1.0 With Tender

The following information are required to be submitted with the Tender :

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

- 1) Preparation and approval of shop drawings
- 2) Procurement of materials
- 3) Fabrication and shipping of all anchor bolts
- 4) Fabrication and shipping of main steelwork
- 5) Fabrication and shipping of steelwork for bunkers. Tanks and/ or silos as applicable.
- 6) Fabrication and shipping of all other remaining steel work including miscellaneous steelwork
- 7) Final date of completion of all shipments

Time required for completion being one of the main criteria for selecting the successful bidder, it is desired that the bidder quotes the minimum time required by him for completing the work.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity and the capacity that will be available exclusively for this contract shall be submitted.

c) Matching Steel

A rough indication of the quantities and details of matching steel sections required to start the work shall be furnished.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FABRICATION OF STEEL WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D4

REV.NO. 01

SHEET 26 OF 26

5.2.0

After Award

After award of the Contract the successful Tenderer is to submit the following :

- a) Complete fabrication drawings, material lists, cutting lists, bolt lists, field welding schedules based on the design drawings in accordance with the approved schedule.
- b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day of each month, giving the upto date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.
- c) Results of any test as and when conducted and as required by the Engineer.
- d) Manufacturer's mill test report in respect of steel materials, bolts, nuts and electrodes as may be applicable.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D5
REV.NO.	01
SHEET	1 OF 17

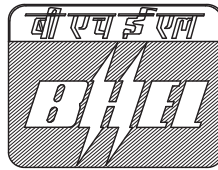
**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

SECTION - D

GENERAL TECHNICAL SPECIFICATION

ERECTION OF STRUCTURAL STEELWORK



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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D5
REV.NO. 01
SHEET 2 OF 17

TABLE OF CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.0.0	SCOPE	3
2.0.0	GENERAL	3
3.0.0	WORKMANSHIP	6
4.0.0	TESTING AND ACCEPTANCE CRITERIA	12
5.0.0	INFORMATION TO BE SUBMITTED	16



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D5
REV.NO.	01
SHEET	3 OF 17

**FOR
ERECTION OF STRUCTURAL STEELWORK**

1.0.0 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at Site and installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:-

- a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour and supervision required for the erection of the structural steelwork.
- b) Receiving, unloading, checking and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.
- c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.
- d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. any defect observed in the foundation shall be brought to the notice of the Engineer. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.
- e) Aligning, plumbing, levelling, bolting, welding and securely fixing the fabricated steel structures in accordance with the Drawings or as directed by the Engineer.
- f) Painting of the erected steel structures if required by the Contract.
- g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following :



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D5
REV.NO.	01
SHEET	4 OF 17

- i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.
- ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.
- iii) Reaming of holes for use of higher size bolt if required.
- iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication. Welding in place of bolting will be permitted only at the discretion of the Engineer.
- v) Refabrication of parts damaged beyond repair during transport and handling or Refabrication of parts which are incorrectly fabricated.
- vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.
- vii) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.
- viii) Carry out tests in accordance with this Specification if directed.

2.2.0 Work 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.

2.3.0 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:-

- IS-800 : Code of Practice for general construction in steel
IS-456 : Code of Practice for plain or reinforced concrete
IS-7205 : Safety Code for erection of Structural Steel work
IS-12843 : Tolerance for erection of Steel Structures

2.4.0 Conformity with designs

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the design criteria detailed in the approved erection drawings and/or other stated document. All work shall conform to the provisions of the relevant Indian Standard



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 01

SHEET 5 OF 17

Specifications and/or the instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specification and/or the instructions of the Engineer.

2.5.0 Material

2.5.1 General

The Contractor will check the quantity, quality and the sizes of the fabricated materials and verify the adequacy of the same in accordance with the Drawings and Specifications. The Contractor shall make good any deficiency, if detected, either by repair or with fresh material as may be directed by the Engineer.

All consumables like oxygen and acetylene gas, paints, fuels, lubricants, oil, grease, cement, sand, aggregates and any other material that may be required for the execution of the works in accordance with the contract will be supplied by the contractor for erection work and will be deemed to have been included in this rates.

2.5.2 Materials to conform to Indian Standards

All materials required to be supplied by the Contractor under this Contract shall conform to the relevant Indian Standard Specifications.

2.6.0 Storage of materials

2.6.1 General

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the Engineer shall be at liberty to get the materials removed by agency.

2.6.2 Yard

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other materials which will be delivered to him by the Owner according to the Contract. The yard shall have proper facilities like, drainage, lighting, suitable access for large cranes, trailers and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved programme of work. The Tenderer should visit the site prior to submission of his Tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor as directed by the Engineer.

2.6.3 Covered Store



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D5
REV.NO.	01
SHEET	6 OF 17

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built.

2.7.0 Quality Control

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the following items of work:-

- 1) Erection : Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.
- 2) Grouting : Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency and strength of grout.
- 3) Painting : Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

The Contractor shall salvage, collect and deliver all the packing materials to the Owner.

3.0.0 WORKMANSHIP

3.1.0 Erection

3.1.1 Plant and equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.1.2 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Erection shall arrange for most economical method and sequence available to him consistent with the Drawings and Specifications and such information as may be furnished to him prior to the execution of the Contract.

3.1.3 Temporary bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 01

SHEET 7 OF 17

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made.

The responsibility of the Contractor in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

3.1.4 Temporary floors for buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or by-laws of state, Municipal or other local authorities.

3.1.5 Setting out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. Concrete foundations, where required, shall be made by other agencies. Anchor bolts and other anchor steel shall be embedded by other agencies. The Contractor shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning. For heavy columns, etc. the Contractor shall set proper screed bars if desired by the Engineer, to maintain proper level.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance allowable under this Specification.

No permanent field connections by bolting or welding shall be carried out until proper alignment and plumbing has been attained.

3.1.6 Field bolting

All relevant portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following :

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 01

SHEET 8 OF 17

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) **Turn-of-nut method**

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into good contact with each other. "snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-1 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE - I

Bolts length not exceeding 8 x dia. or 200 mm	Bolt length exceeding 8x dia. or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation - 30 over or under.

Bolts may be installed without hardened washers when tightening is done by the turn-of-nut method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the nut match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) **Torque Wrench tightening**

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE - II. Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D5
REV.NO.	01
SHEET	9 OF 17

TABLE - II

Nominal Bolt Diameter (mm)	Torque to be applied (Kg.M) for bolt class 8.8 of IS : 1367
20	59.94
22	81.63
24	103.73

NOTE :

The above torque values are approximate for providing tensions of 14.7 MT for 20 mm dia., 18.2 MT for 22 mm dia; and 21.2 MT for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular torque wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.1.7 Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.1.8 Holes, cutting and fitting



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 01

SHEET 10 OF 17

No cutting of sections, flanges, webs, cleats, bolts, welds etc. shall be done unless specifically approved and/or instructed by the Engineer.

The erector shall not cut, drill or otherwise alter the work of other trades, or his own work to accommodate other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work.

3.2.0 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.3.0 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below :

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air-locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

Admixtures like aluminium powder, "ironite" may be required to be added to the grout to enhance certain desirable properties of the grout.

Alternatively, the grouting may be done with non-shrink high strength free flow cementitious grout (ready mixed) like "Sika grout - 214", or "Anchor NSG" or approved equivalent.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, levelled and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 01

SHEET 11 OF 17

3.4.0 Painting after erection

Field painting, if required to be done by the erection Contractor, shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. However, touch up paintings, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the erection Contractor to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in rainy or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field bolts, welds and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces which will be in contact after site assembling shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface which will be inaccessible after field assembly shall receive the full specified protective treatment before assembly. Bolts and fabricated steel members which are galvanized or otherwise treated and steel members to be encased in concrete shall not be painted.

The specification for paint and workmanship shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable to the project.

The number of coats and the shades to be used shall be as specified or as directed by the Engineer.

3.5.0 Stainless Steel Plate Lining in Bunker Hopper

The hopper portion of the coal bunkers shall be lined with stainless steel plates of 3 mm thickness. The stainless steel shall be of AISI-316 quality. The work includes supply, fabrication, welding and fixing of stainless steel lining plate to bunker M.S. plate as per drawing.

The stainless steel liner shall be fixed to the Bunker hopper by plug welding using special electrodes (such as, Inox-CW coding AWS-310-16 ISMBOS-311 or Inox-D2 coding AWSE-309-16, ISMB 04-311 manufactured by Advani Oerlikon Ltd). Such plug welding shall be done by drilling 21.5 mm dia. holes at 300 mm centre to centre both ways. The plug welding shall be ground flush with the lining plate.

3.6.0 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the Contractor shall remove all falsework, rubbish and all Temporary Works resulting in connection with the performance of his work.

3.7.0 Safety Measures during Erection



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D5
REV.NO.	01
SHEET	12 OF 17

The safety measures to workmen and supervisors during all types of erection work (e.g., use of lifting appliances, slingning, welding, gas cutting, etc.) should be taken as per IS : 7205. When any statutory provisions exist, the same shall be complied with in addition to the provisions contained in the above code.

4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good by the Contractor responsible, to the satisfaction of the Engineer.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following Sub-clauses 4.1.1, 4.1.2 and 4.1.3. The method of testing and application of loading shall be as approved by the Engineer.

4.1.1 Stiffness Test

In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 percent of the maximum increase in strain or deflection recorded during the second test.

4.1.2 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D5

REV.NO. 01

SHEET 13 OF 17

conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.1.3 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.1.4 Repair for subsequent test and use after strength tests

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.1.1. hereinbefore.

4.2.0 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steelwork applicable to this Project and as specified below :

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
Main columns	a) Shifting of column axis at foundation level with respect to building line	



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D5
REV.NO.	01
SHEET	14 OF 17

Component	Description	Variation Allowed
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and other member connection levels :	
	i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical
	ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for any 10M length measured between connection levels, but not more than ± 7.0 mm per 30 m length.
	c) For adjacent pairs of columns across the width of the building prior to placing of truss.	± 9 mm on true span.
	d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.	3 mm
Trusses	a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord.	1/1500 of the span or not greater than 10 mm whichever is the least.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001		
VOLUME - II B		
SECTION - D	SUB-SECTION - D5	
REV.NO.	01	
SHEET	15	OF 17

Crane Girders & Tracks	b) Lateral displacement of top chord at centre of span from vertical plane running through centre of supports.	1/250 of depth of truss or 20 mm whichever is the least.
	a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm
	b) Deviation to crane rail gauge	± 3.0 mm
	c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermit welding.	1.0 mm
	d) Deviation of crane rail axis from centre line of web.	± 3.5 mm

Component	Description	Variation Allowed
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Setting of Expansion gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.	
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II. For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ± 3.0 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10M section of height and not more than 7.0 mm per 30 M section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.3.0 **Acceptance**

Structures and members which have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.1.0, 4.1.1, 4.1.2, 4.1.3 and 4.1.4 and other applicable provisions of this Specification and are within the limits of tolerances specified in Sub-clause 4.2.0 and/or



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D5
REV.NO.	01
SHEET	16 OF 17

otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfilment of the provisions of this Contract.

5.0.0 INFORMATION TO BE SUBMITTED

5.1.0 Before Tender

Along with the Tenders the Tenderers will be required to submit the following information :

5.1.1 Tentative Programme

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to Site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

5.1.2 Constructional Plant and Equipment, Tools, Temporary Works & Manpower

A detailed list of all Constructional Plant & Equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.1.3 Erection yard

A site plan showing the layout and location of the erection yard proposed to be established by the Tenderer shall be attached with the Tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.2.0 After award of the Contract

After award of the contract, the Contractor shall submit the following :-

5.2.1 Detailed Programme

The Contractor shall submit a detailed erection programme for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required and an assessment of



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL STEEL
WORK**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D5
REV.NO.	01
SHEET	17 OF 17

required strength of various categories of workers in a proforma approved by the Engineer.

5.2.2

Fortnightly Progress Report

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.2.1 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 1 OF 36

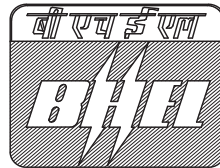
**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

SECTION - D

GENERAL TECHNICAL SPECIFICATION

ROAD AND DRAINAGE



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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 2 OF 36

C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	CODES AND STANDARDS	4
a.	EXECUTION	7
4.00.00	TESTING AND ACCEPTANCE CRITERIA	37
5.00.00	MEASUREMENT	37



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 3 OF 36

General Standard Technical Specification For 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 4 OF 36

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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001		
VOLUME	II B	
SECTION	D	SUB-SECTION – D6
REV.NO.	01	
SHEET	5	OF 36

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) IS : 1200 - Method of measurement of building and civil engineering work (Part-17)- Road work including airfield pavements
- s) 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 ± 25 mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of the pavement shall be ± 40 mm.

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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 6 OF 36

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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 7 OF 36

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 contractor at his own risk and cost shall rectify the same. Profiles of the embankment made with 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 8 OF 36

Before commencement of earthwork, the surface area of ground to be occupied shall be cleared of all fences, trees, logs, stumps, bushes, 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 work site 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 and 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.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 9 OF 36

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 skew/curves. The actual profile of the embankment shall be made at every third centre line 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.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 10 OF 36

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 materials 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 suitable for plant growth existing over the embankment foundation areas shall be stripped to specified depths not exceeding 150mm and stored for covering the embankment slopes where revegetation is desired.

3.03.04 Compacting Original Ground

In all cases, the original ground after stripping shall be compacted by rolling with a minimum 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 of Standard Proctor density (maximum dry density), 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 six passes of 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 11 OF 36

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 method 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.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 12 OF 36

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 measurements 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 and 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 the 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 live sod of perennial turf forming grass on embankment slopes, shoulders or other locations as



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001		
VOLUME	II B	
SECTION	D	SUB-SECTION – D6
REV.NO.	01	
SHEET	13	OF 36

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 and other undesirable matters. 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 about 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 to 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 in the area shall be loosened, freed from all stones larger than 50mm size, sticks, stumps and any other undesirable foreign matters etc and brought to a reasonably granular texture to a depth not less than 25mm for receiving the sod.

Where required, top soil shall be spread over the slopes. Prior to placing the top soil, the slopes shall be roughened and wetted in order to have a satisfactory bond. The depth of top soil (to be spread) shall be 75mm.

Following soil preparation and top soiling (if required), 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 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.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 14 OF 36

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 any 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 15 OF 36

edges of shoulders shall be trimmed vertical and the area enclosed between the shoulders shall be cleaned of all spilled materials 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 16 OF 36

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 and 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	Grading 2	Grading 3
80 mm	100	100	100
63 mm	90 - 100	90 - 100	90 - 100
4.75 mm	35 - 70	40 - 90	50 - 100
75 micron	0 - 20	0 - 25	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 20mm 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 matters, 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 17 OF 36

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 on super elevated portions where 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 materials. 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 18 OF 36

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 b) Flakiness Index ***	IS : 2386 (Part IV) IS : 2386 (Part IV) or IS : 5640 ** IS : 2386 (Part I)	50 percent maximum 40 percent maximum 15 percent maximum

* Aggregates shall 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 19 OF 36

The coarse aggregates shall conform to one of the gradings given in Table – VI. However the use of Grading-1 shall be restricted to sub-base courses only.

**Table - VI
Grading Requirements of Coarse Aggregates**

Grading	Size range	Sieve designation	Percent by weight passing the sieve
1.	90mm to 40 mm	100 mm	100
		80 mm	65 - 85
		63 mm	25 - 60
		40 mm	0 - 15
		20 mm	0 - 5
2.	63 mm to 40 mm	80 mm	100
		63 mm	90 - 100
		50 mm	35 - 70
		40 mm	0 - 15
		20 mm	0 - 5
3.	50 mm to 20 mm	63 mm	100
		50 mm	95 - 100
		40 mm	35 - 70
		20 mm	0 - 10
		10 mm	0 - 5

d) Screenings

Screenings to fill the 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-1 in Table-VI. Screenings of Type-A or B shall be used with coarse aggregates of Grading-2. Screenings of Type-B shall be used with coarse aggregates of Grading-3.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 20 OF 36

**Table - VII
Grading For Screenings**

Grading classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm	12.5 mm	100
		10.0 mm	90 - 100
		4.75 mm	10 - 30
		150 micron	0 - 8
B	10 mm	10 mm	100
		4.75 mm	85 - 100
		150 micron	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 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 any dust and other extraneous materials. 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 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-1 and 75 - 100mm for Grading-2 and 3. The spreading



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 21 OF 36

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 aggregates 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 aggregates as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregates as spread shall be of uniform gradation with no pockets of fine material. The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operation.

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 with 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 22 OF 36

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 of the coarse aggregates.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of 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 aggregates are 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001		
VOLUME	II B	
SECTION	D	SUB-SECTION – D6
REV.NO.	01	
SHEET	23	OF 36

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 is 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 24 OF 36

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 in shape and free from any 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 Grading- A or B as given in Table-IX or X as the case may be.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 25 OF 36

**Table-IX
Aggregates Grading For 75mm Compacted Thickness Of Bituminous
Macadam**

Sieve Designation	Percent 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	Grading 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 26 OF 36

The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. A 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 the drawings and as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free of any 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 27 OF 36

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 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, the rolling shall be done with 8 to 10 tonne power roller or with any other approved plant. Rolling should start as soon as the materials are 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 early 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 on the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 28 OF 36

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 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 as per the quantities given in Table-XI for 20mm thick open graded premix carpet.

Table - XI



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 29 OF 36

**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	<u>0.27 Cu.m</u>

Binder for premixing (quantities in terms of straight run bitumen)

i)	For 0.18 Cu.m of 12 mm size stone Chippings at 52 Kg per Cu.m	9.5 Kg
ii)	For 0.09 Cu. M of 10mm size stone Chippings at 56 Kg per Cu.m	5.1 Kg
	Total	<u>14.6 Kg</u>

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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 30 OF 36

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 are 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 31 OF 36

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.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 32 OF 36

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 from 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 an 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 33 OF 36

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 any water and cut to regular shape with vertical sides and then be filled either with i) coarse aggregates and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer etc or with 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 the 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 the 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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 34 OF 36

as instructed by the Engineer. The lining for drains shall be as per the drawings. Lining of drains may be of bricks or cement concrete blocks of specified grade as shown on the approved drawing or as directed by the Engineer. If shown on approved drawing, drains shall 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 described in the “Specification for Earthwork in Excavation and Backfilling”, 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 RDSO class for railways 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. Coarse 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.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME II B

SECTION D SUB-SECTION – D6

REV.NO. 01

SHEET 35 OF 36

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 “Specification for Earthwork in Excavation and Backfilling” 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 for Earthwork in Excavation and Backfilling”. 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 to avoid any damage. Under no circumstances the pipes shall be dropped into the trench or on supports from heights.

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 M-15. 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 the drawings and as instructed by the Engineer.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ROAD AND DRAINAGE**

SPECIFICATION NO. PE-TS-K13-600-C001		
VOLUME	II B	
SECTION	D	SUB-SECTION – D6
REV.NO.	01	
SHEET	36	OF 36

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 of 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 a smooth flow. Connection to the 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.

5.00.00 MEASUREMENT

Method of measurement shall be as per the latest version of IS:1200, Part-17 and as directed by the Engineer.



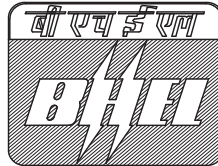
**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
MASONRY AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001		
VOLUME - II B		
SECTION - D	SUB-SECTION - D7	
REV.NO.	01	
SHEET	1	OF 7

**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS
SPECIFICATION NO. PE-TS-K13-600-C001**

**SECTION - D
*GENERAL TECHNICAL SPECIFICATION***

MASONRY & ALLIED WORKS



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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
MASONRY AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D7
REV.NO. 01
SHEET 2 OF 7

TABLE OF CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	I.S. CODES	7



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
MASONRY AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D7
REV.NO.	01
SHEET	3 OF 7

**TECHNICAL SPECIFICATION
FOR
MASONRY & ALLIED WORKS**

1.0.0 SCOPE

This specification covers furnishing, installation, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied works for use in structures and locations covered under the scope of the Contract.

2.0.0 INSTALLATION

2.1.0 Soling

2.1.1 Brick Soling

The ground shall be dressed, consolidated by ramming or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

2.1.2 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling as shown as the drawings. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

2.2.0 Brick Edging

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
MASONRY AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D7

REV.NO. 01

SHEET 4 OF 7

2.3.0 Masonry

2.3.1 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

2.3.2 Mortar

Mix for mortar shall be specified in the Schedule of Items.

When lime is used hydrated lime shall be mixed with water to form a putty and stored with care to prevent evaporation for at least 24 hours before use. Quick lime shall be slaked with enough water to make a cream, passed through a No. 10 seive and stored avoiding evaporation for seven days before use.

Lime putty and sand in proper proportion shall be mixed on a water-tight platform with necessary addition of water and thoroughly ground in a mortar mill. This mix shall be transferred to a mechanical mix, required quantity of cement added and the content mixed for at least 3 minutes. Mixtures of lime putty and sand may be stored avoiding drying out. For cement sand mortar cement and sand in requisite proportions shall be mixed dry in a mechanical mixer and then water added and mixed further. Minimum quantity of water shall be added to achieve working consistency.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement. No mortar which has stood for more than half an hour shall be used.

2.3.3 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
MASONRY AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D7

REV.NO. 01

SHEET 5 OF 7

2.3.4 Exposed Brickwork

Brickwork in superstructures which is not covered by plaster shall be as shown on drawing and executed by specially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule and string. All brick-work shall be cleaned at the end of days work. If face bricks are specified in the drawings, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

2.3.5 Reinforced Brickworks

Reinforcements shall be as specified in the drawings. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be laped with dowels if left in R.C. columns or welded to steel stanchions.

2.3.6 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

2.3.7 Exposed Stonework

Stonework which is to be kept exposed shall be as shown on drawing or described in the Schedule of Items. It shall be executed by specially skilled mason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or instructions. A sample wall, 10 sq.m. in area shall be built and approved by the Engineer and all works shall match with this sample.

2.3.8 Composite Masonry

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
MASONRY AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D7

REV.NO. 01

SHEET 6 OF 7

2.3.9 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard water proof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

2.3.10 Mouldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with carborandum stone.

2.3.11 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

2.3.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

2.3.13 Encasing of Structural Steel

This shall be done by building masonry work round flanges, webs etc. and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer. The minimum lap in chicken wire mesh shall be 50 mm.

2.4.0 Damp Proof Course

Unless otherwise specified Damp-proof course shall be 40 mm or as per schedule thick 'artificial stone' in proportion 1:1-1/2:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

2.5.0 Damp Proof Membrane



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
MASONRY AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D7
REV.NO.	01
SHEET	7 OF 7

Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS:1609. The number of courses shall be as mentioned. Sequence of work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.0.0

I.S. CODES

Some of the important relevant codes for this section are :

- IS:1127 : Recommendations for dimensions and workmanship of natural building stones for masonry work.
- IS:1597 : Code of Practice for Construction of stone Masonry.
- IS:1609 : Code of Practice for laying Damp-proof treatment using bitumen felts.
- IS:2212 : Code of Practice for Brickwork.
- IS:2250 : Code of Practice for preparation and use of Masonry Mortar.
- IS:5134 : Bitumen Impregnated Paper & Board.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FINISH TO MASONRY AND
CONCRETE**

SPECIFICATION NO. PE-TS-K13-600-C001		
VOLUME - II B		
SECTION - D	SUB-SECTION - D8	
REV.NO.	01	
SHEET	1	OF 8

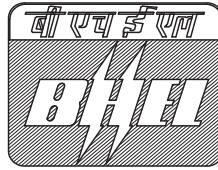
**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS**

SPECIFICATION NO. PE-TS-K13-600-C008

SECTION - D

GENERAL TECHNICAL SPECIFICATION

FINISH TO MASONRY & CONCRETE



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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FINISH TO MASONRY AND
CONCRETE**

SPECIFICATION NO. PE-TS-K13-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D8
REV.NO. 01
SHEET 2 OF 8

TABLE OF CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.0.0	SCOPE	3
2.0.0	INSTALLATION	3
3.0.0	ACCEPTANCE CRITERIA	8
4.0.0	I.S. CODES	8



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FINISH TO MASONRY AND
CONCRETE**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D8
REV.NO.	01
SHEET	3 OF 8

**TECHNICAL SPECIFICATION
FOR
FINISH TO MASONRY & CONCRETE**

1.0.0 SCOPE

This Specification covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment. Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimise damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.0.0 INSTALLATION

2.1.0 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be brushed down with stiff wire brush to remove all loose dust from joints and thoroughly washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval or the Engineer shall be taken as to the acceptability of the base.

2.2.0 Plastering

2.2.1 Mortar

Mortar for plastering shall be as specified in the drawings.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FINISH TO MASONRY AND
CONCRETE**

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D8
REV.NO.	01
SHEET	4 OF 8

For lime gauged plaster, lime putty or hydrated lime and sand in the required proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall then be transferred to a mechanical mixer to which the required quantity of cement is added and mixed for at least 3 minutes.

No plaster which has stood for more than half an hour shall be used; plaster that shows tendency to become dry before this time, shall have water added to it.

2.2.2 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats - a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat, the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.2.3 Finish

Generally, the standard finish shall be used unless otherwise shown on drawing or directed by the Engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the Engineer regarding the texture, colour and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough. Otherwise the interior plaster shall generally be



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FINISH TO MASONRY AND
CONCRETE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D8

REV.NO. 01

SHEET 5 OF 8

finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.2.2 but using coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the top coat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS:2114 latest edition. Samples of colouring material shall be submitted to the Engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.2.2. While the mortar is still plastic small pebbles or crushed stone of size generally from 10 mm to 20 mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) Rough-Cast Finish

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 mm as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) Scraped Finish

Ordinary plaster as described under Clause 2.2.2 after being levelled and allowed to stiffen for a few hours, shall be scraped



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FINISH TO MASONRY AND
CONCRETE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D8

REV.NO. 01

SHEET 6 OF 8

with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

g) Textured Finish

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 2.2.2. Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

2.2.4 Curing

All plastered surfaces after laying, shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.3.0 Pointing to Masonry

All joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finished with suitable tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.4.0 Plaster with Metal Lath

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 BG thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two layers.

The mortar for plastering shall consist of 1 part cement, 1/2 part lime and 4 parts sand by volume, or 1 part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.2.1. The application, finish etc. shall be as specified under relevant clause above. A 2 mm Plaster of Paris punning



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FINISH TO MASONRY AND
CONCRETE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D8

REV.NO. 01

SHEET 7 OF 8

shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.5.0 Lime Punning

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punning shall be applied by skilled workman and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.6.0 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. area and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.7.0 Stone Facing

Stone facing where specified shall be done as shown on design drawings and approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawing for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable noncorrodable anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanised (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer. The completed surface shall be neat, or uniform texture and acceptable to the Engineer.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FINISH TO MASONRY AND
CONCRETE**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D8

REV.NO. 01

SHEET 8 OF 8

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

3.0.0

ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as shown on drawings.

4.0.0

I.S. CODES

Important relevant code for this Section :

- a) IS:1661 : Code of practice for cement and cement-lime plaster finish on walls & ceilings.
- b) IS:4101 : Code of practice for external facings and veneers.

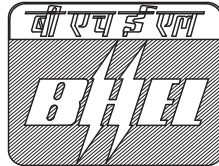


**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001		
VOLUME - II B		
SECTION - D	SUB-SECTION - D9	
REV.NO.	01	
SHEET	1	OF 22

**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS
SPECIFICATION NO. PE-TS-K13-600-C009**

**SECTION - D
GENERAL TECHNICAL SPECIFICATION
FLOOR FINISHES AND ALLIED WORKS**



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



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D9
REV.NO. 01
SHEET 2 OF 22

TABLE OF CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.0.0	SCOPE	3
2.0.0	INSTALLATION	4
3.0.0	ACCEPTANCE CRITERIA	21
4.0.0	I.S. CODES	22



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 3 OF 22

**TECHNICAL SPECIFICATION
FOR
FLOOR FINISHES AND ALLIED WORKS**

1.0.0 SCOPE

This specification covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes and allied items of work as listed below :

a) In Situ Finishes

- i) Integral finish to concrete base
- ii) Red Oxide of Iron finish
- iii) Terrazzo finish
- iv) Granolithic finish
- v) Patent Stone
- vi) Metallic Hardener like "Ironite" finish
- vii) Mastic Asphalt finish
- viii) Chemical Resistant finish

b) Tiled Finishes

- i) Terrazzo tile
- ii) Chequered tile
- iii) Glazed tile
- iv) Tesse rae (Mosaic etc.)
- v) Chemical Resistant
- vi) Rubber, Vinyl etc.
- vii) Stone Slab

1.0.1 Base

The base to receive the finish is covered under other relevant specifications.

1.0.2 Sequence



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 4 OF 22

Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damage whatsoever till handing over.

2.0.0 INSTALLATION

2.0.1 Special Materials

Basic materials are covered under Specification "Properties Storage and Handling of Common Building Materials". Special materials required for individual finishing items are specified under respective items. In general, all such materials shall be as per relevant I.S. Codes where available. In all cases these materials shall be of the best quality available indigenously, unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialised manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

2.0.2 Workmanship

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.

2.0.3 Preparation of the Base Surface

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirt, grease etc. with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification under individual item.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 5 OF 22

The surface shall be done dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.1.0 In Situ Finishes

2.1.1 Integral Finish To Concrete Base

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and levelled but the concrete is still 'green' a thick slurry made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations.

This finish shall be as thin as possible by using 2.2 kg. of cement per Sq. M. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after laying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings. the marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.1.2 Red Oxide of iron Finish

It shall consist of an underbed and a topping over already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall (not less than 10 mm) while the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finishes. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 2 parts coarse sand and 4 parts 10 mm down graded stone chips by volume.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 6 OF 22

For vertical and similar surfaces the mix shall consist of 1 part cement to 3 parts coarse sand by volume.

ii) **Topping**

For the topping cement, screened through a fine mesh and red oxide of iron pigment powder similarly screened shall be dry mixed thoroughly in right proportions to produce the desired colour when laid. The mix shall then be prepared with 1 part cement (mixed with pigment) and 3 parts coarse sand volume. The whole quantity required for each visible area shall be prepared in one batch to ensure uniform colour.

c) **Laying**

The underbed shall be laid in panels of mixing area 5 Sq.M. each and no side shall be more than 2.5 along. For outdoor locations the maximum area shall be 2.0 Sq.M. The forms for the panels shall have perfectly aligned edges to the full depth of the total thickness of finish. If specified aluminium or glass dividing strips shall be used.

The panels shall be laid in alternate bays or in chequered board pattern. No panel shall be cast in contact with another already laid until the contraction of the latter has taken place. The underbed shall be laid, compacted, levelled and brought to proper grade with a screed or float. The topping shall be placed after about 24 hours while the underbed is still somewhat 'green' but firm enough to receive the topping. The surface of the underbed shall be roughened for better bonding. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water to achieve a compact dense mass fully bonded with the underbed. The topping shall then be levelled up by trowelling and finished smooth with a slurry made with already prepared cement and pigment mixture. About 2.0 Kg. of the mixture shall be consumed/per Sq.M. for horizontal surface, and 1.0 Kg. for vertical surface. The surface shall be cured for seven days by keeping it moist.

d) **Polishing**

About 36 hours after laying when the surface has hardened sufficiently it shall be polished with polishing stone till a smooth shiny surface to the satisfaction of the Engineer, is achieved. The finish shall be washed and cleaned just before handing over.

2.1.3

Terrazo Finish : In Situ



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 7 OF 22

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) **Thickness**

Unless otherwise specified the total thickness of the finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall be not less than 10 mm. While the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project cut 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) **Mix**

i) **Underbed**

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 1.1/2 parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) **Topping**

The mix for the topping shall be composed of cement, colour pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or grey or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1.1/2 parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from white marble and shall be finer than IS Sieve No. : 30. The size of marble chips may be between 1 mm to 20 mm.

Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 8 OF 22

c) Laying

The underbed shall be laid in panels. The panels shall not be more than 5 sq.m in area of which no side shall be more than 2.5 M long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat "green" but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.

d) Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) Grinding and Polishing

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.60) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get smooth surface without any pinhole. The grinding shall be done by a suitable machine. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no.60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no.: 120). The surface shall be cleaned with water, dried and covered with soil free, clean sawdust if directed by the Engineer. The final



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 9 OF 22

polishing shall be positioned till before handing over if desired by the Engineer. 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. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy but not slippery.

2.1.4 Granolithic Finish

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) Thickness

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) Mix

The mix shall consist of 1 part cement : 1 part coarse sand : 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) Laying of Monolithic Topping

The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully "green" the topping shall be laid evenly to proper thickness and grade. If considered necessary the surface of the base shall be roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly to secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips.

For large areas the laying shall be in panels of maximum 25 Sq.M area. The panels shall be laid in chequered board pattern.

d) Laying of Topping Separately on Hardened Base

The base concrete shall be prepared as stated in clause 2.0.3 and a slurry of neat cement applied just prior to laying the granolithic



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 10 OF 22

concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

e) **Curing**

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or ponding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) **Grinding**

If grinding is specified, it shall start only after the finish has fully set. Clause 2.1.3 (c) shall be followed. However, the ultimate polish required shall be decided upon by the Engineer.

g) **Finishing**

Where specified, sodium silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as specified. The concentration and method of application of the solutions shall be as specified in IS : 5491.

2.1.5

Patent Stone

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) **Thickness**

The patent stone finish shall have thickness as stipulated under clause 2.1.2 (a) except that the topping shall be 6 mm thick.

b) **Mix**

i) **Underbed**

The mix shall be as stipulated under clause 2.1.3(b).

ii) **Topping**

The mix for the topping shall consist of 1 part cement and 1 part fine sand by volume.

c) **Laying**

The Patent Stone finish, including the underbed shall be laid in alternate bays or in chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has already taken place.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 11 OF 22

The maximum area of each panel shall be 3 Sq.M of which no side shall be more than 2 M long.

A cement grout shall be applied and worked into the surface to receive the finish, the underbed then laid, compacted and levelled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond.

The topping shall trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.

2.1.6 Metallic Hardener Like "Ironite" Finish

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is "Green".

a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) Material

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials. When desired by the engineer, actual samples shall be tested.

c) Mix

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) Laying

The concrete floor shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The forms, if any shall remain sufficiently projecting to take the finish.

The surface shall be roughened by wire brush as soon as possible.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 12 OF 22

The finish shall be laid while the concrete underbed is still very "green" within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigorously and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished \smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.1.7

Mastic Asphalt Finish

This is a one layer treatment on concrete or brick base.

a) **Thickness**

The thickness shall be as specified in the drawing

b) **Materials**

Bitumen shall be industrial bitumen of the grades 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75-micron IS Sieve.

Fine aggregate shall be crushed and graded natural lime stone or other hard-work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick & 10 mm chips for thicker finish.

c) **Composition**

Bitumen mastic shall conform to IS: 1195 and shall be either brought to site in blocks weighing about 25Kg. or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205°C.

d) **Laying**

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 13 OF 22

The mastic shall be laid in suitable panels of about 15 Sq.M in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.1.8 Chemical Resistant in Situ Finish

Chemical resistant in situ finish shall be as epoxy resin with suitable filler material over a primer or called for in the Schedule of Items. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence.

The Contractor shall get it done by a specialised manufacturer, get guarantee of performance from the organisation and pass it on to the Owner in addition to his own guarantee.

2.2.0 Tiled Finish

These shall include finish tiles, stone slabs and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.2.1 Terrazzo Tile Finish

The finish will consist of manufacture terrazzo tile and an underbed.

a) Thickness

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) Tiles : Terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.

Each tile shall bear on its back permanent and legible trade mark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the thickness + 3 mm. Face of the tile shall be plane, free from pin holes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 14 OF 22

The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary grey cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.1.3 (b).

The tile shall be cured at the shop for at least 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) **Mix : Underbed**

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty : 1 part surkhi : 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

d) **Laying**

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 15 OF 22

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.1.3 (c) may be used for dividing the work into suitable panels.

e) **Grinding and Polishing**

Procedure shall be same as Clause 2.1.3 (c) 2. Grinding shall not commence earlier than 14 days after laying of tiles.

2.2.2 **Chequered Tile Finish**

The finish shall consist of manufactured grey or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) **Thickness**

Thickness shall be same as in clause 2.2.1 (a).

b) **Tiles : Chequered**

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm c/c, Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.2.1 (b) except that these may have the topping in terrazzo or plain grey cement or colour pigment added to cement as specified.

c) **Underbed**

As per clause 2.2.1 (c).

d) **Laying**

As per clause 2.2.1 (d).

e) **Grinding and Polishing**

As per clause 2.2.1 (e) except that the tiles shall be ground and polished by hand after laying taking special care in polishing the grooves properly and uniformly.

2.2.3 **Glazed Tiles Finish**

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 16 OF 22

a) **Thickness**

The total thickness shall be between 20 mm and 25 mm including the underbed. The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

b) **Tiles : Glazed**

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 10 mm thick unless otherwise specified. The tolerance shall be ± 1.5 mm for length and breadth and ± 0.5 mm for thickness specials like internal and external angles, beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in extures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawlings, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

c) **Mix : Underbed**

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.

d) **Laying**

Same as clause 2.2.1 (d).

e) **Finishing**

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully and wiped with soft cloth to prevent scratching before handing over.

2.2.4 **Tesserae Finish (Mosaic etc.)**

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 17 OF 22

a) **Thickness**

The total thickness including the underbed shall be between 16 mm and 25 mm.

b) **Tesserae Finish**

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass or similar hard wearing, strong and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

c) **Mix : Underbed**

Same as clause 2.2.3 (c)

d) **Laying**

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.2.3 (d) shall generally be followed. However, instead of grey cement the slurry shall be made with white cement to fix the panels. The paper mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

2.2.5

Chemical Resistant Tiled Finish

This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) **Tiles**

The chemical resistant tiles as detailed in the Schedule of items shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical described in the Schedule of Items. The tiles shall have straight edges, uniform thickness, plain surface, uniform non-fading colour and textures.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 18 OF 22

Glazed tiles if permitted to act as chemical resistant finish shall be considered under clause 2.2.3.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/cm². The surface shall be abrasion resistant and durable.

b) **Laying**

The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.2.6 **Rubber, Vinyl or Vinyl Asbestos Tiles Finish**

This shall include various types of tiles manufactured from rubber, vinyl, etc. set with a adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) **Thickness**

The thickness of the tiles shall be mentioned in the Schedule or in drawing.

b) **Tiles**

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be $\pm 1.5\text{mm}$.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trade mark, the thickness, sizes, batch number and date of manufacturer.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 19 OF 22

c) **Mix : Underbed**

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty : 1 part cement : 4 parts coarse sand mixed with just sufficient water to make it workable.

d) **Laying**

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) **Finishing**

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried and polished with an approved type of polish just before handing over.

2.2.7

Stone Slab Finish : Marble, Stone and Similar Fine Grained Stone

a) **Thickness**

The underbed shall be minimum 12 mm and average 20 mm thick. The slabs may be 25 mm, 30 mm or 40 mm thick as specified.

b) **Stone Slab**



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 20 OF 22

The stone slabs shall be made from selected stock which are hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, 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. Unless specified the slabs shall be minimum 300 mm x 300 mm.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) **Mix : Underbed**

Same as clause 2.2.1 (c).

d) **Laying**

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed clean before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, a thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, grey/white/mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) **Polishing, Finishing**

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 2.2.1 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.2.8

**Stone Slab Finish : Sand Stone and
Similar Coarse Grained Stone Finish**



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D9

REV.NO. 01

SHEET 21 OF 22

Generally clause 2.2.7 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiseled or fine chiseled as specified. Tolerance may be allowed upto ± 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiseling the unevenness shall be limited to ± 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement.

3.0.0

ACCEPTANCE CRITERIA

The finish shall be checked specially for :

- a) Level, Slope, Plumb as the case may be
- b) Pattern and Symmetry
- c) Alignment of joints, dividing strip etc.
- d) Colour, texture
- e) Surface finish
- f) Thickness of joints
- g) Details at edges, junctions etc.
- h) Performance
- i) Precautions specified for durability

4.0.0

I.S. CODES

Important relevant codes for this section :

- IS : 777 : Glazed earthenware tiles
- IS : 1196 : Code of practice for laying bitumen mastic flooring
- IS : 1197 : Code of practice for laying of rubber floors
- IS : 1237 : Cement concrete flooring tiles
- IS : 1443 : Code of practice for laying and finishing of cement concrete flooring tiles
- IS : 2114 : Code of practice for laying in situ terrazzo floor



**TITLE: -2X660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
FLOOR FINISHES AND ALLIED
WORKS**

SPECIFICATION NO. PE-TS-999-600-C001			
VOLUME - II B			
SECTION - D		SUB-SECTION - D9	
REV.NO.	01		
SHEET	22	OF	22

- IS : 3461 : PVC asbestos floor tiles
- IS : 4860 : Specification for acid resistant bricks
- IS : 5518 : Code of practice for laying of flexible PVC Sheet and tile flooring.
- IS : 5491 : Code of practice for laying in situ granolithic floor topping.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ANTI-TERMITE TREATMENT

SPECIFICATION NO. PE-TS-K13-600-C001		
VOLUME - II B		
SECTION - D	SUB-SECTION - D22	
REV.NO.	01	
SHEET	1	OF 5

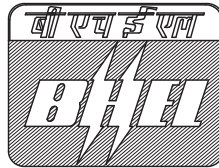
VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-K13-600-C001

SECTION - D

GENERAL TECHNICAL SPECIFICATION

ANTI-TERMITE TREATMENT



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



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ANTI-TERMITE TREATMENT

SPECIFICATION NO. PE-TS-K13-600-C001
VOLUME - II B
SECTION - D | SUB-SECTION - D22
REV.NO. 01
SHEET 2 OF 5

TABLE OF CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	SCOPE	3
2.00.00	EXECUTION	3
3.00.00	ACCEPTANCE CRITERIA	4
4.00.00	RATES	5
5.00.00	METHOD OF MEASUREMENT	5
6.00.00	I.S. CODES	5



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ANTI-TERMITE TREATMENT

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D22

REV.NO. 01

SHEET 3 OF 5

**TECHNICAL SPECIFICATION
FOR
ANTI-TERMITE TREATMENT**

1.00.00 SCOPE

The scope of work is to set up a chemical barrier against attack by subterranean termites while the building is under construction.

2.00.00 EXECUTION

2.01.00 General

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

2.02.00 Chemicals and Rate of Application

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals	Concentration by Weight, Percentage
Chlorpyrifos Emulsifiable (IS 8944 - 1978)	: 1.0
Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978)	: 0.5
Chlordane Emulsifiable Concentrate (IS: 2682 - 1984)	: 1.0

2.02.01 Treatment of Column Pits, Wall Trenches and Basement Excavations

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (upto a height of about 300 mm) for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M² of surface area. Backfills around columns, walls etc. shall be



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ANTI-TERMITE TREATMENT

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D22

REV.NO. 01

SHEET 4 OF 5

treated at the rate of 7.5 litres / M² of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.

2.02.02 Treatment of Top Surface of Plinth Filling

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M² of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

2.02.03 Treatment of Soil Surrounding Pipes, Wastes and Conduits

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

2.02.04 Treatment of Expansion Joints

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.02.05 Treatment at Junction of the Wall and the Floor

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.

A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

3.00.00 ACCEPTANCE CRITERIA

The Contractor shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period.

4.00.00 RATES



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
ANTI-TERMITE TREATMENT

SPECIFICATION NO. PE-TS-K13-600-C001	
VOLUME - II B	
SECTION - D	SUB-SECTION - D22
REV.NO.	01
SHEET	5 OF 5

Rates shall be of complete work per unit area as stated in the Schedule.

5.00.00

METHOD OF MEASUREMENT

Complete work of anti-termite treatment shall be measured for plinth area treated.

This includes treatment, to foundations, walls, trenches, basements, plinth, burried pipes, conduits etc. The extended portions of foundation and like beyond plinth limit shall be the part of complete work.

6.00.00

I.S. CODE

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 1981 : Code of Practice of Anti-Termite Measures in Buildings
Pre-constructional chemical treatment measures.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 1 OF 16

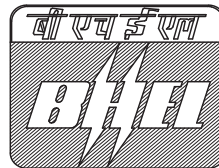
VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-K13-600-C001

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



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 2 OF 16

C O N T E N T

CLAUSE NO	DESCRIPTION	SHEET NO
1.00.00	GENERAL	3
2.00.00	SCOPE	3
3.00.00	MATERIALS	4
4.00.00	QUALITY CONTROL	6
5.00.00	EXECUTION	6
6.00.00	RATES AND MEASUREMENTS	15



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 3 OF 16

**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.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 4 OF 16

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.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 5 OF 16

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



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 6 OF 16

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 far 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



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 7 OF 16

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



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 8 OF 16

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



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 9 OF 16

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.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 10 OF 16

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



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 11 OF 16

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



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 12 OF 16

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 far 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



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 13 OF 16

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



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 14 OF 16

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



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 15 OF 16

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.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
SITELEVELING AND GRADING

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME IIB

SECTION D | SUB-SECTION – D23

REV.NO. 01

SHEET 16 OF 16

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.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

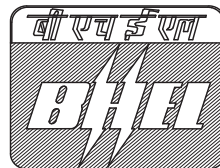
SHEET 1 OF 26

VOLUME: II B

SECTION - D

BORED CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001



Bharat Heavy Electricals Limited

Project Engineering Management

Power Sector, BHEL House

Asian Games Village Complex

Siri Fort, New Delhi-110049



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 2 OF 26

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL REQUIREMENTS
3.00.00	MATERIALS
4.00.00	PILE INSTALLATION
5.00.0	SAMPLING, TESTING, AND QUALITY ASSURANCE
6.00.00	PILE TESTING
7.00.00	CODES AND STANDARDS
8.00.00	RATES AND MEASUREMENT
	ANNEXURE-A
	ANNEXURE-B
	ANNEXURE-C
	ANNEXURE-D
	TABLE - 1



**TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES**

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 3 OF 26

**TECHNICAL SPECIFICATION FOR INSTALLATION OF BORED
CAST-IN-SITU PILES**

1.00.00 SCOPE

This specification covers the installation of bored cast-in-situ reinforced concrete vertical piles of specified load carrying capacity and diameter for various structures. This specification also covers carrying out initial and routine load tests on piles to assess their vertical, horizontal and pull out load carrying capacities.

2.00.00 GENERAL REQUIREMENT

2.01.00 This specification along with specific requirements under Annexure-A covers the technical requirements for piling work.

2.02.00 The work shall include supplying and providing necessary materials, mobilization of all necessary equipments (Annexure-B), providing necessary engineering supervision through qualified and technical personnel, skilled and unskilled labour, etc. as required to carryout the complete piling work, and submission of records as per schedule.

2.03.00 The Contractor shall carryout all works as mentioned in Scope above. All works shall be executed to the satisfaction of the Engineer.

2.04.00 Pile capacities in vertical compression, horizontal, pullout loads for various pile diameters are given in Annexure-A.

2.05.00 The Contractor shall confirm and guarantee the "Safe Load" capacities by conducting both initial and working load test on piles as mentioned in the specific requirements.

2.06.00 The Contractor shall submit along with tender documents his tender design of piles based on soil data furnished by the Owner along with this specification. The ultimate load capacity of a pile may be estimated using suitable static formula and the minimum factor of safety shall be 2.5. However, safe load carrying capacity shall be conformed and guaranteed by conducting initial and routine load tests.

2.07.00 In case of initial or routine load test piles, if the Contractor fails to establish the safe load capacity as per his design, the Owner has the right to either derate the pile capacity on prorata basis or insist the Contractor to modify the pile design, to achieve the desired safe load capacity at no extra cost to the Owner.

2.08.00 Derating is acceptable up to 90 percent. In such case, additional piles shall be installed as per the design requirements.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 4 OF 26

- 2.09.00 The Owner shall decide whether to derate or modify the design based on the design considerations such as providing additional piles in the designed pile cap, provision for extending the pile cap size, etc.
- 2.10.00 In case the Owner decides to modify the design instead of derating the pile, the contractor shall carry out the same and install separate test piles and test the same to guarantee the safe load at no extra cost to the Owner. However no extra shall be charged for the additional test piles as well as testing of these piles as per agreed contract conditions.
- 2.11.00 In case of working piles, if the pile does not meet the guaranteed capacity or rejected due to any other reason, the Contractor shall install extra piles at no extra cost to the Owner. Further, the extra cost, due to the increase in the pile cap size if any, on account of extra piles, shall be borne by the Contractor.
- 2.12.00 It is essential that all equipment and instruments are properly calibrated both at commencement and immediately after the completion of tests so that they represent true values. Certificates to this effect from an approved institution shall be furnished to the Engineer. If the Engineer so desires the Contractor shall arrange for having the instruments tested at an approved laboratory at no extra cost to the Owner and the test report shall be submitted to the Engineer. If the Engineer desires to witness such tests Contractor shall arrange to conduct the test in his presence.
- 2.13.00 The Contractor shall make his own arrangements for locating the coordinates and position of piles as per drawings supplied to him and for determining the Reduced Levels (RL) of these locations with respect to the benchmark indicated by the Engineer. Two established reference lines in mutually perpendicular direction shall be indicated to the Contractor. The Contractor shall provide at site all the required survey instruments to the satisfaction of the Engineer so that the work can be carried out accurately according to specifications and drawings.
- 2.14.00 The contractor shall assure the quality of piling work including cleaning of pile bore, quality of concrete, integrity of piles, etc.
- 2.15.00 **AVAILABLE SUB-SOIL DATA**
An abstract of the sub soil data is furnished in the tender document. However, the detailed soil investigation report shall be made available for reference of the bidder, if so required, at the office of the Owner. The soil data furnished is in good faith and only for the guidance of the Bidder, to arrive at design parameters and construction methods.
- 3.00.00 MATERIALS**



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 5 OF 26

3.01.00 General

All materials viz cement, steel, aggregates, water, etc. which are to be used for pile construction shall conform to relevant IS codes for properties, storage and handling of common building materials. However, aggregates more than 20 mm size shall not be used.

3.02.00 CONCRETE

Concrete shall be manufactured either by central batching plant or Ready Mix concrete. However, for initial test piles suitable method as approved by the Engineer may be used. Concrete shall conform to IS: 10262 & IS: 456.

3.02.01 Technical Specification for Cement Concrete (Plain and Reinforced) works along with IS: 2911 Part I/Sec 2 shall be followed for concrete works of piles. Use of plasticiser to control the water cement ratio shall be permitted on specific approval from the Engineer. Water cement ratio shall not be greater than 0.5.

3.02.02 Grade and minimum cement content
Minimum grade of concrete shall be as per Annexure-A conforming to IS: 456. Minimum cement content of 400 Kg/M³ of concrete shall be used for M-20 grade concrete.

3.02.03 Slump of concrete
The slump of concrete shall vary between 150 to 180 mm.

3.03.00 REINFORCEMENT

3.03.01 Longitudinal reinforcement in pile shall be high strength deformed steel bars conforming to IS: 1786 unless specified otherwise. Lateral reinforcement in pile shall be of mild steel conforming to IS: 432 Part-1 or HYSD bars as per IS: 1786.

3.03.02 The longitudinal reinforcement shall be provided considering the combination of vertical (compression and tension) and horizontal loads. However, the minimum longitudinal reinforcement shall be 0.4 percent of the sectional area calculated on the basis of nominal pile diameter. Minimum six numbers of bars shall be provided for longitudinal reinforcement. The diameter of longitudinal reinforcement bars shall not be less than 12mm. The stipulated minimum reinforcement shall be provided for the full length of pile.

3.03.03 The longitudinal reinforcement shall project 50 times its diameter above cut off level unless otherwise indicated.

3.03.04 The laterals shall be tied to the longitudinal reinforcement to maintain its shape and spacing. The laterals may in the form of links or spirals. The minimum diameter



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 6 OF 26

of the links or spirals shall be 6 mm and the spacing of the links or spiral shall not be less than 150 mm and in no case more than 250 mm.

3.03.05 Reinforcement cage shall be sufficiently rigid to withstand handling and installation without any deformation and damage. As far as possible number of joints (laps) in longitudinal reinforcement shall be minimum. In case the reinforcement cage is made up of more than one segment, these shall preferably be assembled before lowering into casing tube/pilebore by providing necessary laps as per IS: 456.

3.03.06 The minimum clear distance between the two adjacent main reinforcement bars shall normally be 100 mm for the full depth of cage.

3.03.07 The laps in the reinforcement shall be such that the full strength of the bar is effective across the joint and the reinforcement cage is of sound construction.

3.03.08 Laps shall be staggered as far as practicable and not more than 50% bars shall be lapped at a particular section. Lap joints shall be staggered by at least 1.3 times the lapped length (Centre to Centre).

3.03.09 Proper cover and central placement of the reinforcement cage in the pile bore shall be ensured by use of suitable concrete spacers or rollers, cast specifically for the purpose.

3.03.10 Minimum clear cover to the longitudinal reinforcement shall be 50 mm, unless otherwise mentioned.

3.03.11 Bundling of bars is not permitted.

4.00.00 PILE INSTALLATION

Installation of piles shall be carried out as per pile layout drawings, installation criteria, and the direction of the Engineer.

4.01.00 Equipment and Accessories

4.01.01 The equipment and accessories for installation of bored cast-in-situ piles shall be selected giving due consideration to the sub soil conditions, ground water conditions and the method of casting, etc. These shall be of standard type and shall have the approval of the Engineer.

4.01.02 List and details of equipment and accessories proposed to be used for the job shall be submitted along with the bid.

4.01.03 The capacity of the rig shall be adequate so as to reach the specified founding level.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 7 OF 26

4.01.04 Provision shall be kept for chiselling within the pilebore, as specified elsewhere in this specification. Chiselling shall be carried out only with the approval of Engineer.

4.02.00 Installation Criteria

4.02.01 For determining the founding level of piles in soil as specified elsewhere, the Contractor shall have to perform Standard penetration test (SPT) as per IS: 2131 in a separate bore hole. The SPT shall be conducted at 1.0 m interval between the depths covering 5 metres each above and below the specified founding level. The bore shall be 100 mm diameter and method of boring shall conform to IS: 1892.

4.02.02 For determining founding level of piles in rock, as specified elsewhere socketing horizon shall be established by the Contractor by collecting rock cores of NX size in a separate borehole, and testing the same for uniaxial compressive strength (UCS). Cores shall be collected by double tube core barrel attached with diamond bit. Coring shall be done upto a depth as indicated in the "specific requirements." Coring in rock shall conform to IS: 6926.

4.02.03 In case it is not possible to test the cores so obtained for uniaxial compressive strength, cores shall be tested for point load strength index and correlated to obtain uniaxial compressive strength.

4.02.04 Number of boreholes for carrying out SPT in soil or uniaxial compressive strength in rock, shall vary from one in 100 to 150 piles or pile group of 150 Sqm depending on the site condition and as decided by the Engineer. However, at the location of initial load test piles, one such borehole shall be done.

4.02.05 A protocol between contractor and BHEL site shall be maintained regarding the strata at founding level. SPT value and UCS from the nearest borehole shall be indicated therein.

4.02.06 The founding level of the pile shall be decided based on the criteria elaborated in the specific requirements under Annexure-A. Concreting shall not be done until the above conditions for founding level are satisfied.

4.02.07 Approval of founding level by the Engineer shall in no way absolve the Contractor of his responsibility to guarantee the Safe load capacity of the piles as indicated in this document.

4.03.00 Control of position and alignment

4.03.01 Piles shall be installed as accurately vertical as possible. The permissible limits for deviation with respect to position and (inclination) alignment shall conform to IS: 2911 Part I/Sec. 2, which is reproduced below for ready reference.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 8 OF 26

- a) The maximum deviation of vertical piles shall not exceed 1.5 per cent in alignment.
- b) Piles shall not deviate more than 75 mm or D/4 whichever is less (75mm or D/10 whichever is more in case of piles having diameter more than 750mm) from their designed position at the working level.

4.04.00 Boring

4.04.01 Boring operations shall be done by rotary or percussion type drilling rigs using reverse mud circulation (RMC) method. Rotary hydraulic pulley shall be preferred.

4.04.02 The Contractor shall satisfy himself about the suitability of the method to be adopted for site. If DMC (direct mud circulation) or RMC is used Bentonite slurry shall be pumped through drill rods by means of high-pressure pumps. The cutting tool shall have suitable ports for the bentonite slurry to flow out at high pressure. If on mobilisation, the Contractor fails to make a proper bore for any reason, the Contractor has to switchover to other boring methods as approved by the Engineer at no extra cost to the Owner.

4.04.03 Working level shall be above the cut off level. After the initial boring of about 1.0m a temporary guide casing of suitable length shall be lowered in the pile bore. The diameter of guide casing shall be of such diameter, so as to give the necessary finished diameter of the concrete pile. The centre line of guide casing shall be checked before continuing further boring. Guide casing shall be minimum of 1.0m length. Additional length of casing may be used depending on the condition of the strata, ground water level etc.

4.04.04 Use of drilling mud (bentonite slurry) for stabilizing the sides of the pile bore is necessary wherever subsoil is likely to collapse in the pile bore. Drilling mud to be used shall meet the requirement as given in Annexure-C.

4.04.05 The bentonite slurry and the cuttings, which are carried to the surface by the rising flow of the slurry, shall pass through settling tanks of adequate size to remove the sand and spoils from the slurry before the slurry is recirculated to the boring. The bentonite slurry mixing and recirculation plant shall be suitably designed and installed.

4.04.06 The bentonite slurry shall be maintained at 1.5m above the ground water level during boring operations and till the pile is concreted. When DMC or RMC method is used the bentonite slurry shall be under constant circulation till start of concreting.

4.04.07 The size of cutting tools shall not be less than the diameter of the pile by more than 75mm. However, the pile bore shall be of the specified size.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 9 OF 26

4.05.00 Chiselling

4.05.01 Chiselling may be resorted to with the permission of the Engineer below the socketing horizon. The chiselling tool or bit shall be of adequate size and weight so as to reach the desired depth.

4.06.00 Cleaning of Pile bore

4.06.01 On completion of the pile bore upto the required depth, the bottom of the hole shall be cleaned very carefully before concreting work is taken up. Cleaning shall ensure that the pile bore is completely free from sludge/bored materials, debris of rock/boulder etc. Necessary checks shall be made as given in clause 5.0 to confirm the thorough cleaning of the pile bore.

4.06.02 Pile bore shall be cleaned by fresh drilling mud through tremie pipe after placing reinforcement and just before start of concreting.

4.06.03 Pile bore spoil along with used drilling mud shall be disposed off from site as directed by the Engineer.

4.06.04 Pile bore bottom shall be thoroughly cleaned to make it free from sludge or any foreign matter before and after placing the reinforcement cage.

4.07.00 Adjacent Structures

4.07.01 When working near existing structures care shall be taken to avoid any damage to such structures.

4.08.00 Concreting

4.08.01 The Contractor shall carry out concrete mix design in accordance with IS: 10262 and submit mix design calculations and get them approved from the Engineer well in advance for installation of piles. Adequate number of tests on cubes, etc. shall be carried out as mentioned in clause 5.0 to ensure concrete of the minimum specified strength in accordance with IS: 456 at requisite workability (slump).

4.08.02 Concreting shall not be done until the Engineer is satisfied that the bearing strata (soil/rock) met with at the termination level of pile.

4.08.03 The time interval between the completion of boring and placing of concrete shall not exceed 6 hrs. In case the time interval exceeds 6 hrs the pilebore shall be abandoned. However, the Engineer may allow concreting provided the Contractor extends the pile bore by 0.5 m beyond the proposed depth, and clean the pilebore. The entire cost of all operation and materials for this extra length shall be borne by the Contractor.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 10 OF 26

- 4.08.04 Proper placement of the reinforcement cage to its full length shall be ensured before concreting.
- 4.08.05 Concreting shall be done by tremie method as specified by IS: 2911 (Part I /Sec.2). The level of drilling mud shall be maintained sufficiently above the ground water level.
- 4.08.06 The concreting operations shall not be taken up when the specific gravity of bottom slurry is more than 1.2 and sand content more than 7%. The drilling mud sample shall be collected from the bottom of pilebore as mentioned in clause 5.
- 4.08.07 Consistency of the drilling mud suspension shall be controlled throughout the concreting operations in order to keep the bore stabilized as well as to prevent concrete getting mixed up with the thicker suspension of the mud.
- 4.08.08 It shall be ensured that volume of concrete poured is at least equal to the theoretically computed volume of pile shaft being cast.
- 4.08.09 The temporary guide casing shall be withdrawn cautiously, after concreting is done upto the required level. While withdrawing the casing concrete shall not be disturbed.
- 4.09.00 Cut off level (COL)**
- 4.09.01 Cut off level of piles shall be as indicated in drawings released for construction or as indicated by the Engineer.
- 4.09.02 The top of concrete in pile shall be brought above the COL to remove all laitance and weak concrete and to ensure good concrete at COL for proper embedment in to pile cap.
- 4.09.03 When the pile cut off level is less than 1.0 metre below the working level, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection. In case COL of pile is more than 1.0 metre below working level then concrete shall be cast to a minimum of one metre above COL.
- 4.10.00 Sequence of Piling**
- 4.10.01 Each pile shall be identified with a reference number.
- 4.10.02 The convenience of installation may be taken into account while scheduling the sequence of piling in a group. This scheduling shall avoid piles being bored close to other recently constructed piles.
- 4.11.00 Building up of Piles**



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 11 OF 26

4.11.01 If any pile, already cast as per construction drawing, requires any extra casting due to any change in cut off level or the cast pile top level is less than the specified level or for any other reason, then the pile shall be built-up by using atleast one grade higher concrete than that used for concreting of the same pile, ensuring proper continuity with the existing concrete and to the satisfaction of the Engineer. Necessary reinforcement as per design requirement and suitable shuttering shall be provided before casting the concrete. Surrounding soil shall also be built up to the required level by proper compaction to ensure lateral capacity of the pile.

4.12.00 Breaking off of Piles

4.12.01 If any pile already cast, requires breaking due to lowering in cut off level or for any other reason, then the same shall be carried out, not before seven days of casting without affecting the quality of existing pile such as loosening, cracking etc. and to the satisfaction of the Engineer.

4.13.00 Preparation of Pile head

4.13.01 The soil surrounding the piles shall be excavated upto the bottom of the lean concrete below the pile cap, with provision for working space, sufficient enough to place shuttering, reinforcement, concreting and any other related operations.

4.13.02 The exposed part of concrete above the COL shall be removed/chipped off and made to a uniform level at COL, but not before seven days of casting of pile.

4.13.03 The projected reinforcement above COL shall be properly cleaned and bent to the required shape and level to be anchored into the pile cap.

4.13.04 The pile top shall be embedded into the pile cap by 50mm or clear cover to reinforcement, whichever is higher.

4.13.05 All loose material, like debris due to chipping/breaking of pile head to the desired level, shall be removed and disposed off as directed by the Engineer.

4.14.00 Rejection and Replacement of Defective Piles

4.14.01 The Engineer reserves the right to reject any pile which in his opinion is defective on account of load capacity, structural integrity, position, alignment, concrete quality etc. Piles that are defective shall be pulled out or left in place as judged convenient by the Engineer, without affecting the performance of adjacent piles. The Contractor shall install additional piles to substitute the defective piles as per the directions of the Engineer, at no extra cost to the Owner.

4.15.00 Recording of Piling Data



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 12 OF 26

4.15.01 The Contractor shall record all the information during installation of piles. Typical data sheet for recording pile data shall be as shown in Appendix D of IS: 2911 Part I/Sec.2. The pile data shall also include all the details as in Annexure-D. On completion of each pile installation, pile record in triplicate shall be submitted to Engineer within two days of completion of concreting of the pile.

5.00.00 SAMPLING, TESTING AND QUALITY ASSURANCE

5.01.00 Facilities required for sampling and testing of materials, concrete, etc. in field and in laboratory should be provided by the Contractor. The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and this Specification. Where no specific testing procedure is mentioned the tests shall be carried out as per the prevalent accepted engineering practice and as per the directions of the Engineer. Tests shall be done in the presence of the Engineer or his authorized representative. In case the Engineer requires additional tests, the Contractor shall arrange to get these tests done and submit to the Engineer the test results in triplicate within three days after completion of any test.

5.02.00 The Contractor shall maintain records of all inspection and testing, which shall be made available to the Engineer. The Engineer at his discretion may waive some of the stipulations for small and unimportant concreting operations and other works.

5.03.00 Materials found unsuitable for acceptance shall be removed and replaced by the Contractor. The work done by this unsuitable material shall be redone as per specification requirements & and to the satisfaction of the Engineer at no extra cost to the Owner.

5.04.00 Quality Assurance Programme

- a) The Contractor shall submit and finalize a detailed Field Quality Assurance Programme within 30 days from the date of award of the contract, according to the requirements of this specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of field quality plan, etc. On finalized field quality plan, the Owner shall identify, customer hold points, beyond which work shall not proceed without written approval from the Engineer. The testing apparatus/equipment installed in the field laboratory shall be calibrated/ corrected by the qualified persons as frequently as possible to give accurate testing results.
- b) Frequency of sampling and testing, etc. and Acceptance Criteria are given in Table - 1. The testing shall be done at field laboratory or any other laboratory approved by the Engineer. However, the testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. The materials shall be tested to meet all the specified



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 13 OF 26

requirements before acceptance at manufacturers premises or at independent government approved laboratory. Tests indicated in the table are for cross checking at site the conformity of the materials to some of the specifications.

5.05.00 Testing of Concrete

5.05.01 Concrete and other materials shall be tested for quality, strength and other properties. Details of testing shall be as specified under technical specification for Cement concrete (Plain and Reinforced).

5.05.02 One sample consisting of six test cubes shall be made from the concrete used in each test pile, three to be tested after 7 days and three after 28 days.

5.05.03 For working piles, minimum one sample consisting of six test cubes shall be made from the concrete for the first ten piles, three to be tested after 7 days and three after 28 days. Thereafter, minimum one sample consisting of three test cubes for every 10 piles shall be tested for the 7-days & 28-days cube strength.

5.05.04 In preparation of test cubes or specimens vibrators shall not be used.

5.05.05 Concrete shall be tested for slump at every 1-hour interval during concreting of piles.

5.05.06 The frequency of sampling and testing of concrete and materials shall be done as per technical specification for cement concrete (Plain & Reinforced).

5.05.07 The acceptance criteria shall be as mentioned in Table-1.

5.06.00 Testing for position and alignment

5.06.01 Each pile shall be checked for its position with respect to specified location. Each pile bore shall be checked for its alignment.

5.06.02 Permissible limits for deviation shall be as specified under clause no. 4.03.

5.07.00 Properties of Drilling mud

5.07.01 Properties of drilling mud shall be checked as per requirement under Annexure C. Prior to the commencement of piling work and thereafter minimum once in a week or as found necessary by the Engineer, one sample consisting of 3 specimens shall be tested. Acceptance criteria applicable are as specified else where with 5% variation. This relaxation is not applicable for properties of drilling mud before concreting.

5.07.02 Density of the drilling mud shall be checked in each pile before concreting.

5.08.00 Check for Pile bore



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 14 OF 26

- 5.08.01 On completion of boring and cleaning the bottom of each pilebore shall be checked from the sample collected from near the bottom of pile bore or by any other methods as approved by the Engineer, to ensure that it is free from pilebore spoil/debris and any other loose material, before concreting. Concreting shall be done only after the approval of the Engineer.
- 5.08.02 For sampling of drilling mud from the pilebore the following method or any other suitable method shall be adopted.
- A solid cone shall be lowered by a string to the bottom of pilebore. A sampler tube closed at top with a central hole (hollow cylinder) is lowered over the cone, and then a top cover shall be lowered over the cylinder. Care shall be taken for proper fittings of assembly to minimize the leakage while lifting the cone assembly to the ground surface. The slurry collected in the sampler tube shall be tested for density and sand content.
 - Use of borehole camera for checking the pile bore spoil and strata is acceptable on approval of the Engineer.
- 5.09.00 Pile Integrity test**
- 5.09.01 Low strain integrity test shall be conducted on 50% of the jobs piles and on all test piles or as directed by Engineer. The system shall have the computer readout facility and report on the findings of this shall be furnished to the Owner. This test shall be used to identify the job piles for routine load test.
- Piles shall be trimmed to cut off level or sound concrete level. No pile cap blindage work should be undertaken prior to this test. The cast in-situ piles should not be tested before 14 days of casting.
- 5.09.02 The test shall be undertaken by persons trained and experienced and capable of interpreting the results with specific regard to piling. This test is limited to testing the integrity of the shaft and is not intended to replace the use of static load testing.
- 5.09.03 Low Strain Integrity Test Methodology:
- In this test, a low stress wave is set up in the pile shaft and is also known as Sonic Integrity or Sonic Echo test.
 - A small metal/hard rubber hammer is used to produce a light blow on top of the pile. The shock wave travelling down the length of the pile is reflected back from the toe of the pile and recorded through a suitable transducer/accelerometer in a computer for subsequent analysis.
 - The primary shockwave, which travels down the length of the shaft, is reflected from the toe by the change in density between the concrete and sub strata. However, if the pile has any imperfections or discontinuities within



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 15 OF 26

its length these will set up secondary reflections, which will be added to the return signal.

- d) By analysis of the captured signal and knowledge of the conditions of the ground, age of concrete, etc. a picture of the locations of pile shaft defects can be built up. The observed signals are amplified into digital display as velocity versus length records providing information on structural integrity of piles.
- e) The stress wave velocity and approximate pile lengths are provided as input for the integrity testing. The stress wave velocity is dependent on the Young's Modulus and mass density of pile concrete.
- f) More than one recording of signals shall be done until repeatability of signals is achieved on the same pile.
- g) The tests shall be conducted at 3-6 locations to cover the entire cross section of the pile.

6.00.00 PILE TESTING

Pile load test shall be carried out as per IS:2911 Part-4 (latest edition) or as directed by Engineer.

6.01.00 INITIAL LOAD TEST

Initial load test shall be carried out on separately cast piles for confirmation of estimated pile capacities and to fix a more accurate driving criteria viz. set/bow, total number of blows and approximate depth etc. of founding level. At least 2 nos. of tests shall be conducted for each mode (vertical compression, pull out and lateral). The maximum test load shall be as mentioned in bill of quantities.

6.02.00 ROUTINE LOAD TEST

Routine load tests shall be carried out on job (working) piles for 0.5% of total no. of piles (for each mode and type). Maximum test load shall be 1.5 times the design safe load capacity. Piles showing unsatisfactory results as per load test results shall be treated as defective piles. Defective piles shall be removed or left in place and replaced by additional piles as directed by Engineer at no extra cost to the owner. Any additional cost towards design implications, if any, due to above shall be born by the contractor.

7.00.00 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. In case any particular aspect



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 16 OF 26

of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

- IS: 432 - Specification for mild steel and medium tensile steel bars (Part 1 & 11) and hard drawn steel wire for concrete reinforcement.
- IS: 456 - Code of practice for plain and reinforced concrete.
- IS: 1200 - Measurement of Building and Civil Engineering works (Part 23) Piling.
- IS: 1786 - Code of practice for twisted steel high strength deformed bars for concrete reinforcement.
- IS: 1892 - Code of practice for Subsurface Investigation for foundation.
- IS: 2131 - Method of Standard Penetration Test for Soils
- IS: 2911 - Code of practice for design and construction of pile foundations - Bored cast-in-situ concrete piles.
- IS: 2911 - Code of practice for design and construction of pile foundation - Load test on piles.
- IS: 6926 - Code of practice for Diamond core Drilling for Site Investigation for River Valley Projects.
- IS: 10262 - Recommended guidelines for concrete mix design.

8.00.00 RATES AND MEASUREMENTS

The clauses below shall apply for item rate contracts only. They shall not be applicable to turnkey/lump sum Contracts.

8.01.00 Rates

8.01.01 The items of work in the schedule of items, describe the work in brief. The various items in schedule of items shall be read in conjunction with the corresponding sections in the Technical Specifications, including amendments, and additions, if any. For each item in schedule of items, the unit rate shall include for the activities covered in the description of the item as well as for all necessary operations described in the specification and specific requirements.

8.01.02 The unit rates shall include for minor details which are obviously and fairly intended, and which may not have been included in the description in these documents, but are essential for the satisfactory completion of the work. Unit rates shall also include for all safety measures as required by codal provisions,



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 17 OF 26

- local regulations, acts, bye-laws, etc. and for execution of work to the satisfaction of the Engineer.
- 8.01.03 The quoted rate for each item shall be inclusive of mobilization of all plant, equipment, scaffolding, labour, materials, skilled and unskilled labour, and demobilization after completion of work, supervision, establishing the level and coordinates at each work.
- 8.01.04 The quoted rate for piling for a particular diameter and capacity of pile shall remain valid for the actual lengths provided /to be provided irrespective of the minimum length specified elsewhere in this specification.
- 8.01.05 The quoted rate for piling as per description of item works shall be inclusive of providing all plant equipment, labour, materials, skilled and unskilled labour, making observations, establishing the ground level and coordinates at each location of pile by carrying levels from one established bench mark and distances from one set of grid lines furnished by the owner.
- 8.01.06 The quoted rate for piling shall be inclusive of bailing out all the pile bore spoil from the pilebore, keeping the borehole free from bored material/debris etc. and disposing the bored/chiselled material along with the drilling mud upto 2 Km. beyond plant boundary or as directed by Engineer, flushing the pile bore by fresh bentonite before concreting, collection of samples from bottom of pilebore, transporting to laboratory, testing and reporting of results.
- 8.01.07 The quoted rate for piling shall include shifting of plant and equipment from one pile location to another pile locations, providing temporary casing pipe and removal of the same after completing, concreting, supply of necessary materials, equipment and manpower, cost of boring by approved method as specified, circulation of bentonite slurry and cleaning of borehole free from sludge, as specified, etc.
- 8.01.08 The quoted rate for piling shall also include chiselling, if any, required for socketing the pile in rock.
- 8.01.09 The quoted rate for the piling shall include concreting by termite method, length of pile above COL, withdrawal of guide casing, cost for preparation of pile head and disposal of debris etc., resulting from breaking off of pile upto COL, upto a distance of 2 Km from the plant boundary or as directed by Engineer.
- 8.01.10 The quoted rate for piling shall also include providing reinforcement and its cleaning, straightening, cutting, bending, binding with annealed wire, welding, tackwelding, providing concrete cover blocks, spacers, placing the reinforcement cage in pile casing/bore and other cost of tools and plants, materials, labours, carting the steel from store to piling site and return of unused steel to the Owners storage point, etc.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 18 OF 26

8.02.11 Plasticiser/Admixture when used as directed by the Engineer shall be included in piling rates.

8.01.12 The quoted rate for piling shall include for all quality assurance requirements, but not limited to providing for technical inspection, transportation of samples to laboratory, testing samples, maintaining and submitting all test records, etc.

8.01.13 The quoted rate for boring in separate borehole shall be inclusive of performing of SPT at regular intervals as specified and collecting rock cores from boreholes, upto the depth as specified shall be inclusive of transporting to laboratory, testing and reporting of the results.

8.01.14 Unit rate for low integrity test shall be inclusive of mobilization of the entire set of equipment, computer readout, printer, and equipment which may not have been included in the description but are essential for the satisfactory completion of the work as per internationally accepted practice. The rate quoted shall be inclusive of repeatability of test, preparation of pile top surface etc.

8.02.00 Measurement

8.02.01 Piling length shall be measurement by linear measurement from pile cut-off level to the tip of pile in meters upto second place of decimal separately for each diameter and capacity of pile. The length of pile to be cast above cut off level, as per specification, and as approved by Engineer, shall be considered for cement reconciliation only. Theoretical diameter of piles shall be considered for reconciliation of cement consumption. No extra payment shall be made for the length from existing ground to cut-off level.

8.02.02 Reinforcement steel shall be measured for reconciliation purpose only and the measurement shall be done for providing and placing reinforcement in piles, by weight in tones, up to third place of decimal in the following manner:

- i) The weight shall be arrived at by multiplying the actual length measured alongwith standard hooks, rings or spirals, spacers, cranks, bends, authorized laps, etc. by sectional weight. These shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS code's sectional weight. Nothing extra shall be payable to the contractor on account of difference in weight, if any, due to different methods adopted for issue and measurement.
- ii) Standard hooks, cranks, bend, authorized laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tones.
- iii) Dowels, neither shown on the drawings nor instructed by the Engineer, but required for construction facilities shall not be measured.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 19 OF 26

- 8.02.03 Breaking off of piles, due to subsequent change in design cut off level, shall be measured separately. This shall be measured in cubic metres upto second place of decimal. This will be payable only when the pile is cast and on the basis of written instruction of the Engineer for lowering of COL.
- 8.02.04 Measurements for the item of boring in a separate borehole shall be measured in metres from ground level upto the depth as specified, upto second place of decimal. Item of work of boring in soil and coring in rock shall be measured separately for the actual length of boring in soil and coring in rock.
- 8.02.05 The item for pile integrity test shall be measured in terms of no. of piles tested.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 20 OF 26

ANNEXURE-A

Specific Requirements for Bored Cast-in-situ RCC Piles

A1.0 Minimum cement concrete grade M-25

Minimum cement content 400 Kg/M³

A1.1 Safe load

Diameter of Pile

Diameter of Pile (mm)	Vertical/ Compression (MT)	Horizontal/ Lateral (MX)	Pull out/Tension (MT)
*	*	*	*
*	*	*	*

A2. Installation criteria

The installed pile(s) shall satisfy the following criteria.

A2.1 In Soil/weathered Rock

- Minimum length of the pile shall be _____ * m below COL.
- The pile shall be terminated after penetrating through the strata having SPT penetration less than ___ * cm for ___ * blows, for a minimum length of _____ * times the diameter of the pile.

A2.2 In Rock

- Piles shall be installed and socketed into the rocks for a length (socketing length) equal to _____ * times the pile diameter subject to a minimum of _____ * meter below the socketing horizon.
- Socketing horizon shall consist of rock strata having minimum uniaxial compressive strength of _____ * kg/sq.cm.

A3. Average cut-off level for tender design and initial load test can be assumed as _____ * m below ground level.

A4. A protocol shall be signed between BHEL site and contractor regarding,

Strata at the founding depth

Installation criteria



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 21 OF 26

Socketing depth

Density of bentonite before concreting

Slump of concrete.

Time interval between end of boring and start of concreting,

* Values shall be indicated separately depending upon subsoil strata of the site.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 22 OF 26

ANNEXURE-B

List of Equipments

Sl.No	Description	Capacity No.
1.	Piling Rigs	
2.	Chisel	3 T min 6 T max
3.	High pressure Mud Pumps	10 HP min 25 HP max
4.	Bentonite mixing plants	
5.	Concrete batching plant	
6.	Soil testing equipments	

Note:

1. The no. and capacity of the piling equipment varies for each work.
2. Additional equipments shall be mobilized if required as per the directions of the Engineer to match the work schedule at no extra cost to the Owner.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 23 OF 26

ANNEXURE-C

Bentonite suspension used for piling work shall satisfy the following requirements

- a) Liquid limit of bentonite when tested in accordance with IS: 2720(Part V) shall be more than 300 percent and less than 450 percent.
- b) Sand content of the bentonite powder shall not be greater than 7 percent.
- c) Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared bentonite suspension shall be between 1.034 and 1.10 gm/ml depending upon the pile dimensions and type of soil in which the pile is to be installed. However, the density of bentonite suspension after mixing with deleterious materials in the pilebore may be upto 1.25 gm/ml.
- d) The Marsh viscosity when tested by a Marsh cone shall be between 30 to 60 seconds.
- e) The differential free swell shall be more than 540 percent.
- f) The pH value of the bentonite suspension shall be between 9 and 11.5.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 24 OF 26

ANNEXURE-D
PILE DATA

1. Reference No. Location (Co-ordinates) _____ area.
2. Sequence of Piling
3. Pile diameter & Type
4. Working level (Platform level)
5. Cut off level (COL)
6. Actual length below COL
7. Pile termination level
8. Top of finished concrete level
9. Date and time of start and completion of boring.
10. Depth of Ground water table in the vicinity.
11. Type of soil at pile tip
12. Method of boring operation
13. Details of drilling mud as used:
 - i) Freshly supplied mud
 - Liquid limit -
 - Sand content -
 - Density -
 - Marsh viscosity -
 - Swelling index -
 - pH value -
 - ii) Contaminated mud
 - Density -
 - Sand content -
14. SPT* N values in soil (from the nearest bore hole).



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 25 OF 26

+UCS** value in rock (from the nearest bore hole).

* Standard penetration Test

** Unconfined compression strength

15. Chiseling if any, from..... m to m

16. Date and time of start and completion of concreting.

17. Method of placing concrete

18. Concrete quantity

Actual

Theoretical

19. Ref. Number of test cubes

20. Grade and slump of concrete

21. Results of test cubes

22. Reinforcement details:

Main Reinforcement

No. _____

Dia. _____

Depth _____

Stirrups: Type

No. _____

Dia. _____

Spacing _____

23. Any other information regarding obstructions, delay and other interruption to the sequence of work.



TITLE: - 2x660 MW KHARGONE STPP.
TECHNICAL SPECIFICATION FOR
INSTALLATION & TESTING OF BORED
CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-K13-600-C001

VOLUME - II B

SECTION - D | SUB-SECTION - D24

REV.NO. 01

SHEET 26 OF 26

TABLE -1
FREQUENCY OF SAMPLING AND TESTING

SI. No	Type of material work	Nature of Test/ characteristics	Method of Test & frequency	No. of test	Acceptance Criteria
1.	Pilebore size a) diameter b) length		Physical measurement	each pile	as per specification
2.	Founding level	to establish socketing horizon/ and or founding level & upto depth 5m below founding level.	in separate borehole meant for the purpose a) SPT in soils/ weathered rock b) Core & UCS value of rock	1 borehole for 100-150 piles or group of 150 Sqm	Annexure - B
3.	Bentonite (Mud) properties. a) Basic properties of bentonite before use. b) Contaminated mud from pile bore bottom before concreting	Liquid Limit, Marsh Viscosity, Specific gravity, sand content, swelling index, pH value. Density, sand content	in lab in lab	As per Cl. 5.7 Each Pile	As per Annexure C As per annexure C
4.	Position and Alignment	-	Physical or any Approved method	Each Pile	As per Cl. 4.3
5.	Cleaning of pilebore	-	As per Cl. 5.8	Each Pile	Pilebore be free from bored materialcuttings debris/sludge
6.	Reinforcement (R/F) Spacing of longitudinal R/F cover laps binding of laterals		Physical inspection and measurement	each cage	As per approved design
7.	Concrete a) Workability b) Cubes	Slump cone test Compressive Strength test	Each pile As per spec.	As per Cl. 5.5 As per Cl. 5.5	As per specification. As per IS: 456
8.	Materials like aggregate, sand etc.	As per technical specification for concrete and relevant IS codes			
9.	Pile head		Physical	each pile	