

**CUSTOMER: NTPC LIMITED**

**3 x 250MW BONGAIGAON TPS**

**VOLUME II-B**

**CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS FOR  
“REFURBISHMENT OF FGD SYSTEM”  
AT NTPC BONGAIGAON (3X250 MW), KOKRAJHAR DIST,  
ASSAM**

**SECTION – D**

**GENERAL TECHNICAL SPECIFICATION**



**Bharat Heavy Electricals Limited**  
Boiler Auxiliaries Plant  
Ranipet - 6, Tamilnadu

## **PREAMBLE**

### **VOLUME – II-B**

This volume is having following section:

**Section-D:** This section comprises of technical specification.

**Note:** In case of any conflict between section-D and specification or requirement mentioned elsewhere, the decision of Engineer in charge will be final.

**SECTION – D comprises of sub-sections as mentioned below:**

**Sub-section D1: Earthwork in excavation and backfilling**

**Sub-section D2: Cement concrete (Plain and reinforced) and formwork**

**Sub-section D4: Roof and underground structures water proofing, insulation and allied works**

**Sub-section D8: Miscellaneous Metal**

**Sub-section D9: Masonry and allied works**

**Sub-section D10: Finish to masonry and concrete**

**Sub-section D16: Road & drainage**

**Sub-section D17: Fabrication of structural steelwork**

**Sub-section D18: Erection of structural steelwork**

**Sub-section D19: Roof decking**

**Sub-section D21: Bored cast-in-situ RCC piles**

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## **VOLUME: II B**

### **SECTION - D**

#### **SUB-SECTION – D1**

### **EARTHWORK IN EXCAVATION AND BACKFILLING**

**SPECIFICATION NO. 4-FW-000-00969-01**



**Bharat Heavy Electricals Limited**  
**Boiler Auxiliaries Plant**  
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## **STANDARD TECHNICAL SPECIFICATION FOR EARTHWORK IN EXCAVATION AND BACKFILLING**

### **1.0.0      SCOPE**

This specification covers earth work excavation in all types of soil, soft rock and hard rock including setting out, clearing and grubbing, shoring, dewatering, back filling around foundations/pipelines to grade, watering, compaction of fills, testing, approaches, disposal of surplus earth, protective fencing, lighting etc relevant to the structures and locations covered under 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) Supplying and providing all labour, supervision services, earth moving machineries, surveying instruments including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.
- b) Preparation and submission of working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering including drainage, space for temporary stacking of soils, disposal area, fencing etc and all other details as may be required by the engineer.
- c) To carry tests and submit to the Engineer, test results of fill materials and degree of soil compaction of fill whenever required by the Engineer to assess the quality of fill.
- 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. including procurement of necessary licenses from proper authorities.

#### **2.2.0      Work to be provided by others**

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

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## 2.3.0 Codes and Standards

All works 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	Method of measurement of building and civil engineering works, Part-I: 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	Indian Standard 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 this specification/IS Codes, any other standard practice as may be specified by the engineer shall be followed.

## 2.4.0 Conformity with Designs

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

## 2.5.0 Materials

### 2.5.1 General

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

### 2.5.2 Material for Excavation

For the purpose of identifying the various strata encountered during the course of excavation, refer clause no. 3.4.0 for the classification of earth strata.

### 2.5.3 Material for Filling

Material to be used for back filling shall be free from vegetations, roots, salts, rubbish, lumps, organic matter and any other harmful chemicals etc and shall be got approved by the engineer. Normally excavated earth shall be used for back filling. In case such earth contains deleterious salts, the same shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock and if filling with the same is permitted by the engineer

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in writing, then the filling with rock shall be done 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 backfilling 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. The selected earth from the borrow areas shall be got approved by the engineer. The borrowed material shall be free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods etc. The contractor shall obtain and submit necessary clearances/permissions from the concerned authorities for the borrow areas/materials acquired to the engineer.

If specified, the back filling shall be done with clean well graded sand from approved quarries free from harmful and deleterious materials.

## 2.6.0 Quality Control

All works shall confirm 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	Back filling	(a)	On quality of fill material
		(b)	On moisture content of back fill
		(c)	On degree of compaction achieved

## 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

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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**

The contractor shall prepare and submit the detailed drawings/schemes for excavation and back filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of slopes, shoring, approaches, dewatering, drainage, berms etc. for the approval of engineer.

#### **3.1.0 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 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 same shall be rectified by the contractor at his own risk and cost.

#### **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**

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut shall be approved by the engineer and marked. Cutting of trees shall include removing roots as well. After the tree is cut and roots taken out, the pot holes formed shall be filled

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with good earth in 250mm layers and compacted unless directed otherwise 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 to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timber, fire woods 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

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

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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 ;
- 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 excavation shall be done to the minimum dimensions as required for the safety and working facility. In each individual case, the contractor shall obtain prior approval of the engineer for the method he proposes to adopt for the excavation including dimensions, side slopes, shoring, dewatering, drainage and 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 the line, slopes and grades as shown on the drawings and/or as directed by the engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders (if any) projecting out of the excavated surfaces shall be removed if they are likely to be a hindrance to the work/workers in the opinion of the engineer.

Method of excavation shall in every case be subject to the approval of the engineer. The contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works etc including the safety of the workmen. If any slip occurs, the contractor shall remove all the slipped

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materials from the excavated pit without any extra cost to the engineer/owner. All loose boulders and semi detached rocks which are not inside but so close to the area to be excavated and may liable to fall or otherwise endanger the workmen, equipment of the work etc during excavation in the opinion of the engineer shall be stripped off and removed away from the area of excavation. The method to be used for removal shall be such that it should not shatter or render unstable or unsafe the portion which was originally sound and safe. In case any material not required to be removed initially but later to become loose or unstable in the opinion of the engineer shall also be promptly and satisfactorily removed.

The rough excavation may be carried out 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 (in all types of soil and rock) is done to a depth greater than that shown on the drawing or as directed by the engineer, the excess depth up to the required level shall be filled with cement concrete not leaner than 1:4:8 or richer as directed by the engineer at the own risk and cost of the contractor. In case where excavation in soil, soft rock (including weathered rock) and hard rock are involved, the excavation in each stratum shall be carried out separately with the approved methodology and as per the instructions of the engineer.

All excavated materials such as rock, boulders, bricks, dismantled concrete blocks etc shall be the property of the owner and shall be stacked separately as directed by the engineer. All gold, silver, oil, minerals, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the owner and the contractor shall duly preserve the same to the satisfaction of the engineer/owner. The contractor shall deliver the same to such person or persons as may be authorized or appointed from time to time by the owner to receive the same.

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

### 3.5.2 **Excavation in All Type of Soil and in Soft Rock**

The excavation in all type of soil, soft rock including decomposed rock etc shall be carried out as per the approved proposal and as directed by the engineer. 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. Foundation pits shall not be excavated to the full depth unless construction is imminent. The last

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150mm depth shall be excavated once concreting work is imminent. At the discretion of the engineer, the full depth may be excavated and the bed be covered with lean concrete as specified after watering and compacting the bed. As the excavation reaches the required dimensions, lines, levels and grades etc, the work shall be got checked and approved by the engineer. In 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 protection works before the excavation will be restarted.

### 3.5.3 Excavation in Hard Rock

Hard rocks shall normally be excavated by means of 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. Where the excavated surface is not stable against sliding, necessary supports such as props, bracings or bulkheads shall be provided and maintained during the period of construction. Where the danger of falling loose rock/boulder from the excavated surfaces deeper than 2m exist, steel mesh anchored to the lower edge of the excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

### 3.5.4 Blasting

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

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

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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.

#### 3.5.4.1 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.

#### 3.5.4.2 Storage of Explosives

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

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

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any

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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.

### 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 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.

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### 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 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

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charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

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

### 3.5.4.5

#### Restrictions in 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.

### 3.5.5

#### Disposal

The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.

- a) By using it straightway for backfilling.
- b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.
- c) i) By either spreading  
or  
ii) By spreading and compacting at designated disposal areas.
- a) By selecting the useful material and stacking it neatly in designated areas

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as indicated by the engineer for use in backfilling by some other agency.

### **3.5.6 Disposal of Surplus Materials**

All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer. All good and sound rocks obtained from excavations and all assorted materials of dismantled structures are the property of the owner and if the contractor wants to use it, he shall have to obtain it from the engineer at a mutually agreed rate. All sound rocks and other assorted materials like excavated bricks etc shall be stacked separately.

### **3.5.7 Protection**

The contractor shall notify the engineer as soon as the excavation is expected to be completed within a day so that he shall inspect it at the earliest. Immediately after approval of the engineer, the excavation must be covered up in a shortest possible time. But in no case the excavation shall be covered up or worked on before approval by the engineer. Excavated material shall be placed 1.5m or half the depth (of excavation) whichever is more from the edge of the excavation or further away if directed by the engineer. Excavation shall not be carried out below the foundation level of the structure close by until the required precautions are taken. Adequate fencing is to be made enclosing the excavation. The contractor shall protect all the underground services exposed during excavation. All existing surface drains in the work area shall be suitably diverted by the contractor before taking up excavation to maintain the working area neat and clean.

### **3.5.8 Dealing with Surface Water**

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 excavation shall be kept free of water and slush. Grading in the vicinity shall be controlled to prevent the surface water running into the excavations. The contractor shall remove any water inclusive of rain water and subsoil

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water etc accumulated in the excavation by pumping or other means as approved by the engineer and keep the excavations dewatered and/or lower the subsoil water level to 300mm below the founding level until the construction of foundation and backfilling are completed in all respects.

Sumps made for dewatering must be kept clear of the foundations. The engineer's prior approval on the method of pumping to be adopted shall be taken; but in any case, the pumping arrangement shall be such that there shall be no movement or blowing in of subsoil due to the differential head of water during pumping.

### **3.5.10 Timber Shoring**

Close or open type timber shoring as approved by the engineer depending on the nature of sub-soil, depth of pit or trench and the type of timbering shall be adopted. Timbers made out of approved quality shall only be used. 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 250mm wide(min.) and 40mm thick(min.) sections as directed by the engineer. The boards shall generally be placed vertically in pairs, one on each side of the cut and shall be kept apart (maximum spacing is limited to 1.20m) by horizontal walers of strong wood cross strutted with wooden struts or as directed by the engineer. The length of wooden 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 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 into the ground. No portion of the vertical side of the trench or pit shall remain exposed to avoid any slipping out of earth.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started from 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**

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In case of open timbering, vertical board of 250mm wide(min.) and 40mm thick(min.) shall be spaced sufficiently apart to leave unsupported strips of maximum 500mm average width. The detailed arrangement, size of timber and the spacing etc shall be subjected to the approval of the engineer. In all other respects, the specification for close timbering shall apply to open timbering as well.

### **3.6.0 Treatment of Slips**

The contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides of the excavations. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips still occur, the same shall be removed by the contractor with his own risk and cost.

### **3.7.0 Backfilling**

#### **3.7.1 General**

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

In locations where sand filling is required, the sand used should be clean, well graded and be of the quality normally acceptable for use in concrete.

#### **3.7.2 Filling and Compaction in Pits and Trenches all Around the Structures**

As soon as the work in foundation has been accepted, the spaces around the foundation in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc and filled with approved earth in layers not exceeding 250mm (in loose thickness). Each layer(loose) shall be watered, rammed and properly compacted to the required degree to the satisfaction of the engineer. Earth shall be compacted with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the engineer. The moisture content of the fill material during compaction shall be controlled near to its optimum moisture content so as to obtain the required degree of compaction. The final surface shall be trimmed and levelled to proper profile as desired by the engineer.

#### **3.7.3 Plinth Filling**

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The plinth shall be filled with earth in layers not exceeding 250mm (in loose thickness) and each layer shall be watered and compacted to the required degree 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 surface of fill shall be trimmed to the slope intended to be provided for the floor.

### 3.7.4 Filling in Trenches for Water Pipes and Drains

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 250mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of trenches excavated in rock, the filling upto a height of 300mm or the diameter of the pipe whichever is more above the crown of the pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash as per the availability at site and shall be filled in compacted layers not exceeding 250mm. The remaining filling shall be done in layers with the mixture of boulders (of size not exceeding 250mm) and fine material as specified elsewhere in the specification. Each layer shall be watered, rammed and compacted to the required degree and to the satisfaction of the engineer.

### 3.7.5 Filling in Disposal Area

Surplus materials from excavation which are not required for backfilling shall be disposed of in the designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250mm thick when loose, watered and compacted with the help of a compacting equipment as per the directions of the engineer. In wide areas, rollers shall be employed and compaction shall be 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 the contractor to dispose the surplus materials without compaction which can be done by tipping the spoils from a high bench neatly maintaining a proper level and grade of the bench.

### 3.8.0 Approaches and Fencing

The contractor should provide and maintain proper approaches for the workmen and inspection. The roads and approaches around the excavation should be kept clear at all times so that there is no hindrance to the movement

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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 around 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 dimension 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 are filled back to the required lines, levels and grades by placing ordinary cement concrete of 1:4:8 proportion and/or richer and/or by compacted earth as directed by the engineer. The choice of the grade of concrete will be a matter of unfettered discretion of the engineer. Over excavation of the sides shall be made good by the contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all the temporary approaches encroaching inside the excavation have been removed.

#### **4.2.0      Backfilling**

The degree of compaction required will be as per the stipulation laid down in IS:4701 and the actual method of measuring the degree of compaction will be as decided by the engineer. The work of back filling will be accepted after the engineer is satisfied with the degree of compaction achieved.

### **5.0.0      RATES AND MEASUREMENTS**

#### **5.1.0      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 section 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.

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- 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.
- d) 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.
- e) In case blasting in hard rock is envisaged, the unit rate quoted for earth work shall include the cost of storage and safety arrangements for the materials required for blasting. No separate payment will be made on this account.

## 5.2.0

### 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 respectively 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 excavation 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

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looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rock so arrived shall be taken as soil.

#### **6.0.0 INFORMATION TO BE SUBMITTED BY THE BIDDER**

##### **6.1.0 With Tender**

Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.

##### **6.2.0 After Award**

After award of the contract the successful bidder shall submit the following for approval.

a) Within 30 days of the award of contract, the contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation for the various foundations and the time required for backfilling and compaction after completion of foundation for the structures. The earthwork programme shall be planned in accordance with the foundation programme. The programme should also show how the excavation and backfilling quantities will be balanced minimizing the temporary stacking of spoils. It is to be noted that the engineer even after initial approval of the programme may instruct the contractor to enhance or to retard the progress of work during the actual execution in order to match with the progress of foundations. The initial programme being submitted by the contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of the award of contract, the contractor shall submit the drawings for earth work in excavation and backfilling showing detail of slopes, shoring, approaches, sump pits, dewatering lines, fencing etc for the approval of the engineer.

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**SPECIFICATION NO. 4-FW-000-00969-02**

**SECTION – D**

**SUB SECTION – D2**

***GENERAL TECHNICAL SPECIFICATION***

**CEMENT CONCRETE (PLAIN & REINFORCED)**



**Bharat Heavy Electricals Limited**  
**Boiler Auxiliaries Plant**  
**Ranipet - 6, Tamilnadu**

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## **SUB-SECTION – D2**

### **CEMENT CONCRETE (PLAIN & REINFORCED)**

#### **1.00.00    SCOPE**

##### **1.01.00    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. Special requirements for structures such as reinforced concrete chimney, cooling towers, etc. have been covered under the respective specifications. Those specifications shall be used in conjunction with this specification.

**1.02.00** 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 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. However, should the list be not exhaustive and does not cover any aspect of the work, then relevant Indian and, in its absence, relevant International code shall apply.

##### **2.00.00    General**

##### **2.01.00    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) Prepare Bar bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.
- c) Prepare working drawings of formworks, scaffolds, supports, etc.
- d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.
- e) Prepare detailed drawings of supports, templates, hangers, etc. required for

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installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

As decided by the Engineer some or all of the drawings & schedules prepared under item (b) to (e) above will have to be submitted for approval.

- 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.

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 Performa for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

## **2.02.00 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.

## **2.03.00 Information to be submitted by the Tenderer**

### **2.03.01 With Tender**

The following technical information's are required with the tender:

- a) Source and arrangement of processing of aggregates proposed to be

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adopted.

- b) Type of plant and equipment proposed to be used.
- c) Names of firms with which association is sought for to execute the special items of work in the contract.
- d) Types of formwork proposed to be used.

#### **2.03.02 After Award**

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

- a) Programme of Execution

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.

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 free of cost, for approval. The Engineer for future reference will preserve approved samples. 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.

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vii) Foundation quality Rubber Pads.

c) Design Mix

Design mix as per specification giving proportions of the ingredients, sources of aggregates and cement, along with 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) Bar Bending Schedules

Bar Sending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 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 2.01.00 (c).

f) Detailed Drawings for Templates & Temporary Supports for embedment As per Clause 2.01.00 (e).

g) Mill Test Reports for Cement & Reinforcing Steel.

h) Inspection Reports

The Engineer in accordance with Clause 2.04.00 of this specification may desire inspection Reports in respect of Formwork and Reinforcement and any other item of work as.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification or as directed by the Engineer.

j) Any other data, which may be required as per this specification or as directed by the Engineer.

## 2.04.00 Conformity with Design

The Contractor will prepare checklists in approved Performa, 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

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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 Cards 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. The Pour Cards along with accompaniments will be 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.

#### **2.05.00 Materials to be used**

##### **2.05.01 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.

##### **2.05.02 Cement**

Ordinary Portland cement of grade-43 as per IS:8112/fly ash based Portland puzzolona cement conforming to IS:1489 (Part-1) shall preferably be used in reinforced/plain cement concrete works for all areas other than for the critical structures identified below. However, other types of cement such as ordinary Portland cement conforming to IS:269, Portland slag cement conforming to IS:455 respectively can be used under special circumstances. Cement used in all concrete mixes shall be in general of grade 33/43 unless design requires a higher grade. Ordinary Portland cement shall be used for following structure.

- a) TG foundation top deck and sub structures including raft.
- b) Spring Supporting decks of all machine foundations.
- c) Structures requiring grade of concrete of M30 and above.

In special cases, Rapid Hardening Portland Cement, Low Heat Cement, Sulphate resistant cement, high strength Ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.

For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.

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#### **2.05.03 Coarse Aggregate**

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as Coarse Aggregate. Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity, and free from deleterious materials. It shall be properly graded. Coarse aggregates shall be either crushed gravel or stone. All aggregates shall meet the requirement of IS:383:1970. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works. Petrographic test shall be carried out by the contractor free of cost for checking the quality of rock from quarry. This test shall be repeated by the Contractor free of cost for change in quarry or as directed by the Engineer. The results shall be checked for reactivity of silica in aggregate with alkalis of cement.

#### **2.05.04 Fine Aggregate**

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 are 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 in works. Sand shall be hard, durable, clean and free from adherent coatings or organic matter and clay balls or pellets. Sand when used as fine aggregate in concrete shall conform to IS:383. For plaster, it shall conform to IS:1542 and for masonry work to IS:2116.

#### **2.05.05 Water**

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Generally, IS: 3550 will be followed for routine tests. Acceptance of water shall be as per IS: 456.

#### **2.05.06 Admixture**

Only admixtures 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 IS-9103 and may be one of the followings:

- a) Accelerating admixture
- b) Retarding admixture
- c) Water reducing admixture
- d) Air entraining admixture

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e) Water proofing admixture

The contractor shall inform the Engineer about the type of admixture which he is planning to use in different areas within the scope of work for the approval of the Engineer. The admixture shall be of proven make and from a reputed manufacturer. It should not have any adverse effect on strength, durability of concrete and reinforcement. Super plasticizers conforming to IS: 9103 or ASTMC-494 shall only be used as admixture having the above properties either individually or in a combination as per the direction of the Engineer.

#### **2.05.07 Reinforcement**

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

#### **2.06.00 Storage of Materials**

##### **2.06.01 General**

All materials shall be stored so 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 the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

##### **2.06.02 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 warehouses 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.

##### **2.06.03 Aggregates**

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Aggregates shall be stored on raised surface constructed by providing planks or steel plates or on concrete or brick masonry pavement. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads 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.

#### **2.06.04 Reinforcement**

Reinforcing steel shall be stored consignment-wise and size-wise 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 at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

#### **2.07.00 Quality Control**

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 affects 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.
- e) Formwork: Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing

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and shoring and coating.

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

Material tests or Certificates to satisfy relevant IS Specification.

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.

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 & Bearing 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.

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### **3.00.00      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.

#### **3.01.00      Washing and Screening of Aggregates**

Washing and screening of coarse and fine aggregates to remove fines, dirt, or other deleterious materials shall be carried out by approved means as desired by the Engineer.

#### **3.02.00      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 including plasticisers of approved make may be used with the Engineer's approval 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 owner 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.

#### **3.03.00      Grades of Concrete**

Concrete shall be in one of the grades designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed. Minimum cement content shall be as per IS: 456.

#### **3.04.00      Proportioning and Works Control**

##### **3.04.01      General**

“Design Mix Concrete” and “Nominal Mix Design” is defined as follows for use in this specification:

- a) Proportioning of ingredients of concrete made with preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".
- b) Proportioning of ingredients of concrete made without preliminary tests

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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 M-15 or lower only 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.

### **3.04.02 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

- 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) The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies, which it is expected to be subjected to in actual service.
- e) The mix design shall have required workability and characteristic strength as per IS: 456. The quantity of cement, aggregates, and admixtures shall be determined by mass.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete in structural design. The Contractor will strictly abide by the same in his design of concrete mix installation. 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.

### **3.05.00 Strength Requirements**

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall

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be as per IS:456. All other relevant clauses of IS:456 shall also apply.

### **3.06.00 Minimum Cement Content**

The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at site. Based on various tests results and as per Engineer, the environment condition shall be adopted for which minimum cement content shall be considered. No extra payment shall be made on account of any variation in environment condition.

- a) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.
- b) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.
- c) The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

### **3.07.00 Water-Cement Ratio**

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

- a) The requirement of strength.
- b) The requirement of durability.

### **3.07.01 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. 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.

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In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS: 456 and no tests are necessary. The acceptance test criterion for nominal mix concrete shall be as per IS: 456.

### 3.07.02

#### **Durability Requirement**

Tables 4 & 5 of IS: 456 give 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 criteria, the former should 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. Trial mix shall be carried out accordingly. 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.

### 3.08.00

#### **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:

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### TABLE-V

#### 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 equipments, roads
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion of 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. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests.

#### **3.09.00 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

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Reinforced concrete  
Except foundation - 20 mm

Ordinary Plain concrete and Reinforced  
concrete foundations - 40 mm

Mass concrete - 80 mm

Lean concrete - 40 mm

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

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.

**3.09.01** Temperature control of concrete in top decks of machine foundations (i.e. of TGs, BFPs, Fans and Mills) as extra payable over RCC item of BOQ:

The temperature of fresh concrete shall not exceed 23°C when placed. A suitable measuring device for measuring the temperature of concrete as approved by the Engineer shall be used. For maintaining the limiting temperature of the 23°C, crushed ice shall be used as mixing water. The ice shall be formed of water conforming IS: 456. The Contractor shall establish the quantity of crushed ice to be mixed in order to achieve the limiting temperature of 23°C.

**3.09.02** Base raft of Turbo Generator foundations and top decks of all machine foundations shall be cast in a continuous operation without any construction joint.

**3.10.00 Mixing of Concrete**

Ingredients of the concrete mix shall be measured by weight. Concrete shall always be mixed in mechanical mixer. Water shall not normally be charged

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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 at no extra cost to the Owner 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.

Batching Plant shall conform to IS: 4925. The measuring gauges of batching plant shall be periodically calibrated for which the contractor shall provide standard weights. The accuracy of all gauges shall be within limits prescribed by the Engineer.

When hand mixing is permitted by the Engineer, for unimportant out of the way locations in small quantities, 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 at no extra cost to the owner.

### 3.11.00

#### 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, segregations 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

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and thoroughly cleaned before, commencement of concrete mixing. Such equipments shall be kept free from set concrete.

### **3.12.00 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 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
- 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. Earth foundation on which direct placement of concrete is allowed, will be consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placement, before it has sufficiently set and hardened.

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.

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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 or cement slurry will be spread thoroughly on the rock Foundation or construction joint just prior to placement of concrete.

After concrete has been placed, it shall be spread, if necessary & 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, reinforcement, and formwork are not displaced or distorted during placing & 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.

Slabs, beams, and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Mouldings, 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 there from shall be set right by the Contractor at his own expense 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 -at the Contractor's expense.

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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.

### **3.13.00 Construction Joints and Cold Joints**

#### **3.13.01 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 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 embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12.

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 at the middle of the span.
- c) A joint in a suspended floor slab shall be vertical and at the middle 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 submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

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### **3.13.02 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 systematically 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 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 raise 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.

### **3.14.00 Repairs, Finishes, and Treatment of Concrete surfaces**

**3.14.01** 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 at the Contractor's cost. 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 at no extra cost to the Owner, All concrete work shall be inspected by the Contractor immediately after the forms are removed

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& 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 shape.
- c) Cleaning of reinforcement & embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.
- 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 by cutting out defective concrete.
- i) Grouting with cement sand slurry of 1:1 mix.
- j) Repairing with a suitable mortar either cement or resin modified mortars.
- k) Polymer modified patching and adhesive repair& mortar for beams & columns.

### **3.14.02 Finishing unformed Surface**

The contractor shall provide normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc. 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 reinforced 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 over trowelling, 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.

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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 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) Beans, 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.

**3.15.00**

**Protection and Curing of concrete**

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, 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

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	arrangements made by the Contractor. Quality of water for curing shall be as per IS: 456.		
	If permitted by the Engineer, liquid curing compound 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 a thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall be emulsified paraffin based and shall comply with ASTM requirements for acceptance.		
	The curing compound shall be applied following the final finishing operation and immediately after disappearance of water 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 at no extra cost.		

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 the Engineer notices any lapse on the part of the Contractor, 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 recover the cost thereof from the Contractor, or deduct certain amount from contractor's payment for the part where inadequate curing was noticed entirely at the discretion of the Engineer.

### **3.16.00 Reinforcement**

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

#### **3.16.01 Bar Bending Schedules**

The Contractor shall prepare **optimized** Bar Bending Schedules showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, progressively, starting within one week of receipt of approval on corresponding design of RCC structure. As decided by the

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Engineer, some or all the detailed drawings and schedules will have to be submitted for approval. 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. The contractor for record and distribution shall submit six prints of the final drawings & schedules with one reproducible print.

### **3.16.02 Cleaning**

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

### **3.16.03 Bending**

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 with the final Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any cutting, 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 shall be bent by machine or other approved means producing a gradual and even motion. 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.

### **3.16.04 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 mild steel chairs and/or concrete spacer blocks. 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 or by tack welding in case of Bar larger than 25 mm dia., as may be directed 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.

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### **3.16.05 Welding / Coupler for Splicing**

Lapping shall normally do splicing of reinforcement. For M.S. reinforcement bars, butt-welding may be done, if permitted 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. For High yield strength deformed bars, lap welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards as per IS: 9417. Welding of High yield strength deformed bar shall not be allowed.

Splicing of reinforcement using mechanical coupler may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian standards for "Reinforcement couplers for mechanical splices of bars in concrete" as per IS: 16172. Corrosion test in the coupler-bar connections exposed to marine or severe environmental conditions to rule out any risk of galvanic corrosion will be done by the contractor at no extra cost. Proper fitting & fixing of mechanical coupler to rebar shall be ensured at site for each coupled joint as per inspection testing plan developed at site in consultation with manufacturer of coupler. If so required at site, coupler/ threading on rebar shall be such that two bars can be coupled by moving couplers not rebar (as being heavy reinforcement weight and L shaped, it is not feasible to rotate the rebar for fixing up the coupler) at no extra cost.

### **3.16.06 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. 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 does 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.

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### **3.17.00 Cold Weather Concreting**

When conditions are such that the ambient temperature may be expected to be 5°C or below during the placing and curing period, the work shall conform to the requirement of IS: 456 and IS: 7861.

### **3.18.00 Hot Weather Concreting**

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS: 7861 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 38°C while placing. Positive temperature control by precooling, post cooling or any other method, if required, will have to be done by the contractor at no extra cost.

### **3.19.00 Concreting under water**

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

### **3.20.00 Form Work**

#### **3.20.01 General**

If it is so desired by the Engineer, the contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centring and get them approved by the Engineer. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centring 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 centring shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers 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 and horizontal pressure 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

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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 and concrete of adequate strength shall be used. Bolts passing 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 in true plumb and thoroughly cross-braced to keep them so. All floor and beam centring shall be crowned not less than 8 mm in all directions for every 5 metres span. 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 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.

### **3.20.02**

#### **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, sawdust 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 or other compound 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.

### **3.20.03**

#### **Design**

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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 repropping shall not be done except with the specific 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.

#### **3.20.04      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.

#### **3.20.05      Removal of Forms**

Formwork shall be kept in position after casting of concrete for a minimum period as mentioned in IS: 456, however the period of retaining form in position can be extended as per drawing, instruction of Engineer or as required for satisfactory completion of work without any extra cost. Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if the Engineer 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 there from 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 without any extra cost to the Owner, The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

If any other type of cement other than ordinary Portland cement and Rapid hardening cement is used, the time of removal of forms shall be revised such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form.

#### **3.20.06      Tolerance**

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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 -  $\pm 5$  mm
- b) Plumb - 1 in 1000 of height
- c) Levels -  $\pm 3$  mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface & 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.

### 3.20.07 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.

### 3.20.08 Classification

Generally, the "ordinary" class formwork shall be used unless otherwise specified.

- 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 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 by the Engineer. He may also permit utilization 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

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timbers or of plywood, which can be shaped correctly.

**3.21.00      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.

**3.22.00      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 shown on drawings and secure the same as may be required. The materials 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 paint with one coat of approved anti- corrosive paint and/or bituminous paint without any extra cost to the Owner. 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, frame 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) Dowel bars, etc. for concrete work falling under the scope of other contractors.
- e) Lugs or plugs for door and window frames occurring in concrete work.
- f) Flashing and jointing in concrete work.
- g) Any misc. embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these

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embedded items shall be entirely the responsibility of the Contractor.

### **3.23.00 Expansion and Isolation Joints**

#### **3.23.01 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 free of cost to the Owner. 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.

#### **3.23.02 Bitumen Board/ Expanded Polystyrene Board**

##### **a) Bitumen Board**

Bitumen impregnated fibreboard 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.

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### 3.23.03 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 either metallic like G.I., Aluminums, or Copper, or non-metallic like rubber or P.V.C.

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 vulcanized.

#### a) Metal Sealing Strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing. The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to establish that it is leak proof. If required, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

##### i) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant Indian Standards for heavy-duty work. At the joints, the overlapping should be for a minimum length of 50 mm.

##### ii) Aluminium Strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737 of 19000 grades or 31000 grade (Designation as per IS: 6051). A minimum lap of 50 mm length is required at the joints.

##### iii) Copper Strips

The Copper strips shall be minimum 18 SWC in thickness and 300 mm

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width unless specified otherwise and shall conform to the relevant Indian Standards. It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

**b) Non-metallic Sealing Strips**

These 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 unlike metal strips, 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 & the edges accurately.

**c) 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 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

Maximum Safe Continuous Temperature : 75°C

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		Ultimate Elongation : Not less than 350%	
<p>b) P.V.C., Sealing Strips</p> <p>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 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</p>			
<p>Specific Gravity : 1.3 to 1.35</p> <p>Shore Hardness : 60A to SOA</p> <p>Tensile Strength : 10 - 15 N/Sq.mm</p> <p>Maximum Safe Continuous Temperature : 70 Deg.C</p> <p>Ultimate Elongation : Not less than 275%</p>			
<b>3.23.04</b>	<b>Bitumen Compound</b> <p>When shown in drawing or 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.</p>		
<b>3.23.05</b>	<b>Isolation Joints</b> <p>Strong and tough alkathene sheet or equivalent, 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.</p>		
<b>3.23.06</b>	<b>Pad</b> <p>Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. 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.</p>		

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### **3.24.00 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 stone chips 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 specified on drawings, admixtures like Aluminium powder, "Ironite" etc. may have to be added with the grout in required proportions. Premixed non-shrink grout of approved manufacture having proper strength shall be used with Engineer's approval for important machineries.

### **3.25.00 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 surface. 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 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 7 (seven) 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. The yard shall preferably be fenced.

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.

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

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per drawings. If centrings 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.

### **3.26.00      Waterproofing of Concrete Structure**

#### **3.26.01      General**

Where required, waterproofing of concrete structures shall be ensured internally by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints. In addition to the above measures, the structures shall be made watertight by adopting "structural waterproofing" as per specification. 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 free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

#### **3.26.02      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 metallic, rubber, or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint shall 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

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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	-	5 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.m (approx.)

The whole operation shall be done as per manufacturers specification. The contractor shall provide manufacturer's supervision at no extra cost to the owner.

**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 waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the concrete has set to seal the voids in concrete near 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. The cost of such manufacturer's supervision shall be borne by the contractor.

### 3.26.03

#### Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar/plaster shall conform to IS: 2645. The admixture shall not cause decrease of strength of concrete/plaster at any stage and it shall be 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 reducing concrete admixture shall be used to provide a waterproof concrete, For achieving high strength concrete having cement content around 400 kg/cu.m. a melamine based super plasticizer will be preferable.

- In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application

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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 at no extra cost 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 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 at no extra cost. On completion, the Plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

#### **3.26.04 Structural waterproofing**

- a) Nozzles spaced as required after the concrete is completed shall be drilled into surfaces to be rendered watertight. Non-shrink cement grout with waterproofing compound as per manufacturers specifications shall be injected under pressure to seal all voids. Special care shall be taken at joints by providing additional nozzles. The pressure grouting shall be done on the internal surface.
- b) External Treatment

Two layers of (1:4) plaster of 12 mm thick each with waterproofing compound as per manufacturer's specification shall be provided on outer surface of concrete underground structures.

#### **3.26.05 Protective coating on Inside Surface.**

Two coats of cement based two 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.

#### **3.26.06 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 should be hessian base and/or fibre base as specified in Drawing. If required by the Engineer, tests as specified in relevant IS Codes

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shall be arranged by the Contractor without charging any extra to the Owner.

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

Cleaning the surface, keeping it dry, providing, necessary corner fillets and cement rendering and cutting chases, etc. shall be done as per drawings and/or instructions. If any protective brickwork on/against concrete sub-bases or walls are required, the same shall be provided. A twenty (20) years guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this 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.

### **3.26.07 Polyethylene Films: Application in Walls or base of structures**

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 polyethylene 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 polyethylene 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 cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane 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 cellophane 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 bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.

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- vi) Lay 250-micron polyethylene film as second layer similar to (iii)above.
- viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.
- ix) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.
- x) Protecting with a layer of 75 mm plain cement concrete M-10, 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.

**3.27.00 Protective Coating on Concrete Surface**

**3.27.01 On Foundation**

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

**4.00.00 SAMPLING AND TESTING**

**4.01.00 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.

**4.02.00 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 as per guidelines of IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The Contractor shall carry out the tests without any expense to BHEL. 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 Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the BHEL 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.

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#### **4.03.00      Aggregates**

The contractor shall carry out any or all the tests on 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.

#### **4.04.00      Water**

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 acceptance criteria will be as per IS: 456.

#### **4.05.00      Admixture**

##### **4.05.01      Air Entraining Agents**

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder 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 that, 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.

##### **4.05.02      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.

#### **4.06.00      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 IS: 456. To control the consistency of concrete from every mixing plant, slump tests 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 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 at his own cost. In the course of dismantling, if any damage is done to the embedded

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		items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.	
<b>5.00.00      ACCEPTANCE CRITERIA</b>			
<b>5.01.00      Standard Deviation</b>			
Standard deviation shall be based on test results and determination of Standard deviation shall conform to IS: 456.			
<b>5.02.00      Acceptance Criteria</b>			
The strength requirements and acceptance criteria shall conform to IS: 456.			
<b>5.03.00      Inspection and Core Tests</b>			
Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to IS: 456.			
<b>5.04.00      Load Test</b>			
Load tests of structural members as per IS:456 may be required by the Engineer, when the strength of test specimen results falls below the required strength.			
If the member shows evident failure, the Contractor shall make the structure adequately strong free of cost to BHEL.			
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. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.			
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, free of charge by the Contractor to the satisfaction of the Engineer.			
<b>6.00.00      RATES AND MEASUREMENTS</b>			
<b>6.01.00      Cast-in-situ Concrete</b>			
<b>6.01.01      Rates</b>			
a) The unit rates shall include the cost of labour, materials, equipment, handling, transporting, botching, mixing, placing in position, vibrating, compacting, finishing, curing, testing, etc. at all elevations. This shall include the cost of curing by regular wetting or by using curing compound.			

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- b) The unit rates shall include for all working conditions including at locations under water, liquid, mud, in or under foul positions and extreme weather conditions.
- c) The unit rates for exposed concrete works (including machine foundations) shall include all incidentals, rendering, smoothening with carborandum stone, finishing with a paste of cement sand mortar, curing, etc.
- d) The unit rates shall include all arrangement for maintaining stability of structure during execution.
- e) Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.
- f) Nothing shall be payable to the Contractor on account of facilities and arrangement provided by him for conducting ultrasonic pulse velocity (UPV) tests or other relevant tests to ascertain grade and quality, etc. of the concrete in case the concrete quality is in doubt and contractor has to establish the quality by further tests. In case of any defects, the Contractor shall rectify the same by cement/epoxy grout at his own cost.

However, mandatory UPV test as specified in the drawings shall be carried out including arrangement of all its facilities, staging, etc. and shall be payable to the contractor as per BOQ item.

- g) The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.
- h) The quoted rate shall include the cost of MIX design, making of all trial mixes using admixtures and mixing in concrete etc. complete.

## 6.01.02 Measurements

- a) Actual volume of concrete work as executed or as per drawings issued, whichever is less shall be measured in cubic metres to the nearest two decimals.
- b) No deductions shall be made for the following:
  - i) Ends of dissimilar materials embedded inside for example, beams, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sqcm in cross section;
  - ii) Opening upto 0.1 sq.m.

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- iii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.
- iv) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.
- c) The concrete works of different grades; below and above ground floor finished level shall be measured separately, unless otherwise specified in the schedule of items. Accordingly rates shall be applied for concrete in foundation for concrete below ground floor finished level and concrete in superstructure for concrete above ground floor finished level.
- d) For temperature control measures, measurement shall be done in terms of quantity of concrete in cum. in concreting of which the ice have been used or cooling of aggregates has been done to keep the temperature of freshly laid concrete to less than 23°C.

#### **6.02.00 Reinforcement**

##### **6.02.01 Rates**

- a) The unit rates shall include for cover block, providing binding wire, welding, separator pieces between two or more layers of reinforcement required for keeping the steel in position, etc. at all elevations.
- b) No extra will be paid for transportation from stores, cleaning, straightening of steel, cutting, bending, binding with annealed wire, welding, tack welding, placing the reinforcement modification of already embedded reinforcement, if required, due to faulty fabrication or placement and other cost of tools and plants, materials, labours, return of unused steel to the store, etc. **If reinforcement steel issued is by BHEL to the contractor for use in reinforcement steel work, the unit rate shall include stacking of cut pieces/ scrap steel generated out of reinforcement steel work as per size (dia) for easy retrieval for further use.**
- c) However, lap welding of reinforcement steel if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour and binding wire saved for not providing lap length shall be made. Similarly, splicing of reinforcement bars using mechanical couplers if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour and binding wire saved for not providing lap length shall be made.
- d) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).

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e) Generally members are straight and have straight edges. However, for bending, binding, placing of reinforcement in any curved member in length or cross section or both, no extra payment shall be made.

#### **6.02.02 Measurements**

- a) Bar or any other type of reinforcement used like hard drawn steel wire fabric etc. for reinforced concrete shall be measured by weight in tonnes. The weight shall be arrived at by multiplying the actual or theoretical length measured alongwith standard hooks, cranks, bends, authorized laps, etc. whichever is less by the sectional weights. Claims for payment for this item shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS Section weight. Nothing extra will be payable to the Contractor on account of, difference in weight, if any, due to different methods adopted for issue and measurement.
- b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tonnes.

#### **6.03.00 Formwork and Staging**

##### **6.03.01 Rates**

- a) The unit rates shall be inclusive of all staging, scaffolding, making the formwork watertight, etc. for all elevations and in all types of works.
- b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.
- c) The unit rates shall include the cost of labour, materials etc. and the extra time, which shall be required for the removal of shuttering/ support for satisfactory completion of work.
- d) No extra payment shall be made on account of difficulty, wastage etc. for placement/removal of formwork between the network of closely placed steel beams or for the lacing/bracing portions and ribbed slab constructions.
- e) Payment for curved shuttering shall be made for curved members/wall whose centerline radius in plan is less than 6m.
- f) If the contact surface area in pockets is less than or equal to 0.1 sq.m. in each case, payment shall be done under item for providing formwork in pockets.

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#### **6.03.02 Measurements**

- a) Formwork for different classes (types) shall be measured separately as the actual surface in contact with the concrete and paid on area basis unless included in the rate for concrete. The unit of measurement shall be in sq.m.
- b) Openings upto 0.1 sq.m or boxing left for inserts etc. for facility of Contractor's work, shall be neglected as if nonexistent for the purpose of formwork measurement of surface in which the openings occur.

For suspended floor, no deduction shall be made for flange area of secondary steel beams.

- c) No measurement shall be taken for the formwork in pockets, openings, chases, blockouts, etc. in concrete, the contact surface area is less than or equal to 0.1 sq.m. in each case.
- d) For pockets, if the contact surface area is less than or equal to 0.1 sq.m. in each case, measurement shall be done under item for providing formwork in pockets.
- e) Formwork, if required, for joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.

#### **6.04.00 Embedded Parts**

##### **6.04.01 Rates**

- a) The unit rate for erection of embedded steel parts, supplied by Engineer shall include transportation from Owner's store to the place of work, erection & installation including setting material in concrete, etc. complete.
- b) The unit rate for MS pipe embedments and PVC pipe embedments shall include cutting, welding, fabrication, erection, embedding, and transportation to site. Unit rate shall also include the cost of the pipes.
- c) Rate for expansion fasteners shall include cost of fasteners, installation, and fixing including cost of washers and nuts and site testing if required.

##### **6.04.02 Measurements**

- a) The measurement of the embedded steel parts fabricated and installed by the Contractor shall be based on the calculated weight of steel sections in tonne corrected to second place of decimal.

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- b) Embedded steel parts supplied by Owner and installed by Contractor Measurement shall be done for the net weight of the embedments installed in tonnes correct to second place of decimal.
- c) For PVC pipes/conduits, measurements shall be in quintals correct to second place of decimal for the net weight.
- d) For mild steel pipes, measurement shall be in quintals, correct to second place of decimal, for the net weight of the steel pipe supplied, fabricated, and installed.
- e) The lugs shall be measured in Kg. correct to second place decimal for the net weight.
- f) The expansion fasteners shall be measured in number according to tension capacity.
- g) The rails shall not be treated as embedded steel part and the track shall be measured in running metres along the centre line and paid for under separate item of work as specified in schedule of items. Other related civil items associated with the laying of track shall be measured separately and paid under respective items of works.

**6.05.00 Groutings**

**6.05.01 Rates**

Rate shall include the cost of surface preparation, admixtures, and curing.

**6.05.02 Measurements:**

- a) Measurement shall be in cubic decimeters.
- b) Measurement for grouting shall be by volume of the block out, pockets or bolt hole upto the top surface of foundation concrete and shall be calculated from the dimensions shown on the drawings.
- c) Measurement for underpinning shall be by volume between the top surface of the foundation concrete and the underside of the base plate, the plan dimensions being as indicated on the drawings.
- d) No deduction shall be made for shims, bolts, shear keys and such other embedments.
- f) Pressure injection grouting with cement based grout if required as per drawing shall be applied at appropriate spacing to cover the desired

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surface area and measurement shall be made for the surface area grouted in sqm as per BOQ item. However in water retaining structures, the structural grouting if required to ensure water tightens shall not be payable separately as deemed to be covered in water retaining concrete item of BOQ.

**6.06.00 Joints**

**6.06.01 Rates**

The unit rate shall include all the activities described in the schedule of items.

**6.06.02 Measurements**

a) Bitumen Board/Expanded polystyrene.

The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.

b) Water Stops

The measurement for water stops shall be in running metres of actual length of the joint covered, for specified thickness, width, and shapes. No separate measurement shall be made for laps/splices for cross-joints and mitered joints.

c) Metal Cover Strips

The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.

d) Vibration Damping Resilient Pads

The measurement for this item shall be in square metres for the specified thickness, measured correct to the second place of decimal, of the actual finished surface area.

**6.07.00 Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete**

**6.07.01 Rates**

The unit rates shall include the cost of all necessary propping, shoring, underpinning scaffolding, safety measures, temporary enclosures, disposal/stacking of serviceable/unserviceable materials, etc. for all types of work and for all grades of concrete.

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In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.

In the case of chipping work, the cutting of reinforcement shall be paid separately.

If the serviceable material including reinforcement steel from dismantled structure is allowed to be used/taken out by bidder, suitable rebate shall be given by bidder.

#### **6.07.02 Measurements**

- a) Dismantling of PCC and RCC work shall be measured in cu.m separately. Measurement of all work, except hidden work shall be taken before execution of work and no allowance for increase in bulk shall be allowed. Specifications for deductions of voids, openings etc, shall be done on the same basis as that applied for construction work.
- b) Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).
- c) Cutting of reinforcement in chipping work for making of pockets and openings shall be measured in sq. cm. of cross-sectional area.

#### **6.08.00 Precast Concrete**

This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.

#### **6.08.01 Rates**

- a) The unit rate shall include cost of preparation of casting yard, formwork, concrete and its casting, finishing as specified, setting filling of gaps between adjacent pre-cast concrete units with concrete, or cement mortar, curing, handling, erection, grouting, welding, preparation of supporting surface, etc.

#### **6.08.02 Measurements**

The measurement of pre-cast concrete members shall be on the basis of volume of concrete in cubic metres nearest to second place of decimal. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings up to 0.1 sq.m. The setting of element with cement mortar shall not be measured separately. The filling of concrete cement mortar between the gaps of adjacent precast units shall be considered while

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computing the volume of pre-cast concrete work and shall be paid for under this item itself.

## 7.00.00

### LIST OF IS 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: 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
- IS: 455 - Indian Standard Specification for 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: 702 - Indian Standard specification for industrial bitumen.
- IS: 1199 - Indian Standard Specification for Methods of Sampling and

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	Analysis of Concrete				
	IS: 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing				
	IS: 1489 - Indian Standard Specification for Portland Pozzolona Cement				
	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 Steel Bars and Wires for Concrete Reinforcement.					
IS: 1791 - Indian Standard Specification for Batch Type Concrete Mixers.					
IS: 1838 - Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type).					
IS: 2185 - Indian Standard Specification for Hollow Cement Concrete Blocks					
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: 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: 2571 - Code of practice for laying in-situ cement concrete floors.					
IS: 2645 - Integral cement water proofing compound					

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	IS: 2722 -	Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)	
	IS: 2750 -	Indian Standard Specification for steel scaffoldings.	
	IS: 2751 -	Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction	
	IS: 2770 -	Indian Standard Specification for Method of Testing Bond in Reinforced Concrete	
	IS: 3025 -	Indian Standard specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry	
	IS: 3067 -	Code of practice for general design details and preparatory work for damp proofing and water proofing of building.	
	IS: 3201 -	Indian Standard Specification for Design and Construction of Precast Concrete Trusses	
	IS: 3370 -	Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids	
	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 Scaffolding and Ladders	
	IS: 3812 -	Indian Standard Specification for Fly Ash for Use as Admixture for Concrete	
	IS: 4014 -	Code of practice for steel tubular scaffolding.	
	IS: 4031 -	Indian Standard Specification for Method of Tests for Hydraulic Cement	
	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	

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	<p>Concrete Arches</p>				
	<p>IS: 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes</p>				
	<p>IS: 4656 - Indian Standard Specification for Form Vibrators for Concrete</p>				
	<p>IS: 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant</p>				
<p>IS: 4926 - Indian Standard Specification for Ready Mixed Concrete</p>					
<p>IS: 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work</p>					
<p>IS: 4991 - Indian Standard Specification for Blast Resistant Design of structure for Explosion above ground</p>					
<p>IS: 4995 - Indian Standard Specification for Design of Reinforced Part-I &amp; II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials</p>					
<p>IS: 4998 - Indian Standard Specification for Design of Reinforced Concrete Chimneys.</p>					
<p>IS: 5256 - Code of practice for sealing joints in concrete lining on canals.</p>					
<p>IS: 5512 - Indian Standard Specification for Flow Table for use in Tests of Cement and Pozzolanic materials</p>					
<p>IS: 5513 - Indian Standard Specification for vacate Apparatus.</p>					
<p>IS: 5515 - Indian Standard Specification for Compaction Factor Apparatus.</p>					
<p>IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.</p>					
<p>IS: 5624 - Indian Standard Specification for foundation bolts.</p>					
<p>IS: 5751 - Indian Standard Specification for Precast Concrete Coping Blocks.</p>					
<p>IS: 5816 - Indian Standard Specification for Method of Test for Splitting Tensile strength of Concrete Cylinders.</p>					
<p>IS: 5891 - Indian Standard Specification for Hand operated Concrete</p>					

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	Mixers.				
	IS: 5892 -	Indian Standard Specification for transit mixer and agitators.			
	IS: 6452 -	Indian Standard Specification for High Alumina Cement for Structural Use			
	IS: 6909 -	Indian Standard Specification for Super sulphated 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: 7293 - Safety code for working with construction machinery.					
IS: 7320 - Indian Standard Specification for Concrete Slump Test Apparatus.					
IS: 7861 - Indian Standard Specification for Recommended Practice Part-I&II for Extreme Weather Concreting.					
IS: 7969 - Safety Code for Storage and Handling of Building Materials.					
IS: 8041 - Indian Standard Specification for Rapid Hardening Portland cement.					
IS: 8112 - Indian Standard Specification for high strength 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: 9012 - Recommended method for shotcreting.					

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<p>IS: 9013 - Indian Standard Specification for Method of Making, Curing, and determining compressive Strength of Accelerated-cured Concrete Test Specimens.</p> <p>IS: 9077 - Code of Practice for Corrosion Protection of Steel Reinforcement in RB and RCC Construction.</p> <p>IS: 9103 - Indian Standard Specification for Admixtures for Concrete.</p> <p>IS: 10262 - Recommended Guidelines for Concrete Mix Design.</p> <p>IS: 13311 - Non-destructive testing of concrete.</p> <p>SP: 34 - Handbook of concrete, reinforcement and detailing.</p>		

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	<b>STRUCTURES WATER PROOFING,</b>	<b>SECTION - D SUB SECTION - D4</b>
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## **VOLUME: II B**

### **SECTION – D**

#### **SUB-SECTION – D4**

## **ROOF AND UNDERGROUND STRUCTURES WATER PROOFING, INSULATION AND ALLIED WORKS**

**SPECIFICATION NO. 4-FW-000-00969-04**



**Bharat Heavy Electricals Limited**  
**Boiler Auxiliaries Plant**  
**Ranipet - 6, Tamilnadu**

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## **ROOF AND UNDERGROUND WATER PROOFING, INSULATION AND ALLIED WORKS**

### **1.00.00 SCOPE**

This section covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof and underground waterproofing, insulation and allied works for buildings and at locations covered under the scope of this package.

### **2.00.00 INSTALLATION**

#### **2.01.00 GRADING UNDERBED**

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

#### **2.01.01 Cement Mortar Underbed**

The underbed grading plaster shall be average 25 mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The sand and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

#### **2.01.02 Cement Concrete Underbed**

The underbed cement concrete shall be used where the subgrade is more than average 25 mm thick. It shall consist of cement concrete 1:2:4 nominal mix

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by volume with 12 mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

## 2.02.00

### INSULATION

The Tenderer shall, along with the tender, send specifications of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation, the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12 mm and it shall be cured for seven days.

## 2.02.01

### Foam Concrete

This shall be of lightweight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl/sq.m. hr degree C. Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to withstand the usual workload and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

## 2.02.02

### Expended Polystyrene Blocks

The expanded polystyrene block Insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 Kcl m/sq.m h °C. It must be strong enough to withstand without any deformation under the workload and standard loads expected on the roof.

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The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall secure manufacturers supervision at no extra cost to the Owner.

#### **2.03.00 Fillets**

Fillets at Junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix volume.

#### **2.04.00 Waterproofing Treatment**

##### **2.04.01 Bitumen Felt Treatment**

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with bitumen felts shall be done following relevant IS: 1346. Bitumen felt shall conform to IS: 1322 and Bitumen primer to IS: 3384.

The bonding materials shall consist of blown type conforming to IS: 702 or residual bitumen conforming to IS: 73 or a mixture of the two to withstand local conditions of prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self-finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.

Normal treatment with one layer of felt, heavy treatment with two layers of felt



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or Extra Heavy treatment with three layers of felt shall be indicated. Brief details of the various treatments shall be as follows:

a) Normal Treatment - Five courses

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 3) Hessian base self finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 5) 20 mm thick pressed precast concrete tiles with 15 mm, thick 1:4 cement-sand mortar underbed.

b) Heavy Treatment - Seven Courses

With Hessian base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 3) Hessian base self-finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 5) Hessian base self-finished felt, type 3, grade I.
- 6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With fiber base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Not applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 3) Fiber base self-finished felt, type 2, grade 2.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

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5) Fiber base self-finished felt, type 2, grade 2.

6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

c) Extra Heavy Treatment – Nine courses

With fiber based felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 3) Fiber-base self-finished felt type 2, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (min.)
- 5) Fibre base self-finished felt type 2, grade 1.
- 6) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 7) Fibre base self-finished felt type 2, grade 1.
- 8) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 9) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With Hessian base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 3) Hessian base self-finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 5) Hessian base self-finished felt, type 3, grade 1.
- 6) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

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- 7) Hessian base self-finished felt, type 3, grade 1.
- 8) Hot applied bitumen at the rate of 1.2 kg/sqm. min.
- 9) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

However, in special cases, more courses, or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the existing top course shall be completely removed and all damaged felts or other defects repaired.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that felt cuttings etc. do not find their way into rainwater down comers.

## 2.04.02 Elastomeric Membrane

### a) Material

The material shall consist of high solid content Polyurethane based cold liquid applied coatings as per ASTMC836-89a comprising of urethane pre-polymers extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic or any other equivalent material permitted as per ASTM and approved by the Engineer. The material shall consist of high solid coating designed to give a high-build film. The material shall not be diluted. The coating shall have physical feature like high viscosity, 90% solids, high resistance to impact, abrasion and cracking, superior tensile strength, application limit of 70°C minimum, 300% elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to roof substrates (RCC, tiles, brick, and metals), having a minimum life of 10 years. It should also be resistant to acid (mild concentrated), alkalies and have a very low water absorption rate (0.5%) max. at ambient temp. after 7 days.

The pack shall not be older than 9 months after the date of manufacture and packing.



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**b) Primer coat**

It shall consists of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush over the prepared bed as an adhesion coat of an application rate of minimum 6 sq.m per litre.

The primer shall be allowed to dry for minimum of 2hrs. time before the successive finishing coats of P.U. liquid membrane are applied.

**c) Finishing coats :**

The finishing coats shall consist of two successive liquid coatings of high solids content urethane pre-polymers or equivalent material to form an elastomeric membrane. The overall dry film thickness shall be 1.5mm subject to minimum 500 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for a minimum of 150mm over the finished roof surface. It shall be continued into rain water pipes by atleast 100mm.

The final coat of P.U. liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a later of polyscrim cloth /fabric to be embedded between 2 finishing coats.

**d) Surface Finish :**

Areas of roof treatment which are vulnerable to accidental damage shall be provided with wearing course consist of minimum 20 mm thick PCC of Grade M15 (using 12.5mm size aggregate) cast in panel of maximum size of 1.20m x 1.20m and reinforced with 0.56mm diameter galvanised chicken wire mesh and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided in place of stone grit and cement painted. The tiles shall be laid as per IS:1443.

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#### **2.04.03      Waterproofing By Epoxy Resin Based Application**

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin-based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration fire, sun exposure, and light duty traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labour for the application as free of cost to Owner. This item shall carry a guarantee as specified.

#### **2.04.02      Flashing**

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified or directed by the Engineer, metal flashing shall be provided. The materials shall be 18 Gage or 22 G G.I. sheets, as specified or as directed by the Engineer.

#### **2.05.00      WATER-PROOFING OF UNDERGROUND STRUCTURES**

Basements, ducts, pits, tunnels (excluding tanks) etc below the ground water table and in contact with soil are covered under this. Bonding material shall be blown bitumen of 85/25 grade conforming to IS: 702.

Waterproofing shall be provided on the outside of walls and top of RCC slab and shall be carried out upto 150mm above ground level. The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:

- 2 layers - for depths up to 5m below ground level
- 3 layers - for depths beyond 5m below ground level

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	<b>2.05.01</b>	<p>Method of laying the bitumen felts and workmanship shall be as per IS: 1609 and IS: 3067. Water proofing work shall be taken in hand only when the sub-soil water level is at its lowest; the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed.</p> <p>For this purpose drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps.</p> <p>In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area.</p> <p>Adequate arrangement shall be made to protect the sides of excavation from slipping while the work is in progress.</p> <p>The base concrete or mud-mat shall be rendered smooth by a 20mm thick sand-cement plaster (6:1). Any sharp edges/corners, over which the waterproofing course is to be laid, shall be eased out by means of cement.</p> <p>The surface must be dry before the next operation is carried out.</p> <p>Water proofing/damp proofing treatment:</p> <p>A) Heavy Treatment (Two layers of felt)</p> <ul style="list-style-type: none"> <li>i) Primer (For vertical faces only), as per I.S. 3384.</li> <li>ii) Hot applied blown bitumen at the rate of 1.2 Kg/m<sup>2</sup></li> <li>iii) Hessian base, bitumen felt type 3 grades 2</li> <li>iv) Hot applied blown bitumen @ 1.2 Kg/m<sup>2</sup></li> <li>v) Hessian base, bitumen felt type 3 grade 2</li> <li>vi) Hot applied blown bitumen @ 1.2 Kg/m<sup>2</sup></li> </ul> <p>B) Extra Heavy treatment (Three layers of felt)</p> <ul style="list-style-type: none"> <li>i) Primer (for vertical faces only) as per I.S. 3384</li> <li>ii) Hot applied bitumen at the rate of 1.2 Kg/m<sup>2</sup></li> <li>iii) Hessian base bitumen felt type 3 grades 2</li> <li>iv) Hot applied bitumen at the rate 1.2 Kg/m<sup>2</sup></li> </ul>	

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- v) Hessian base bitumen felt type 3 grades 2
- vi) Hot applied bitumen at the rate of 1.2 Kg/m<sup>2</sup>
- vii) Hessian base bitumen felt type 3 grades 2
- viii) Hot applied bitumen at the rate of 1.2 Kg/m<sup>2</sup>

The surface must be dry before the next operation is carried out at each stage said above.

The laying of felt over the bitumen so applied that it shall always commence on the floor, and shall be carried over to the walls only after treatment of the floor is complete. The minimum over lapping at sides and ends of strips shall be 10cm. Point for subsequent layers completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar (1:3) or 6cm thick cement concrete (M 15) or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the bitumen layers to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way; the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth where necessary with a coat of cement plaster (1:3), the felts laid as for the floor, ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar (1:3) over the projecting mud-mat, the space between the wall and felt being grouted with cement.

### 3.00.00

### ACCEPTANCE CRITERIA AND GUARANTEE

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The contractor shall give a guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof waterproofing treatment work. The guarantee shall be for materials and workmanship as under:

For Bitumen Felt Treatment under clause no. 2.04.01: 5 years in case of normal treatment, 10 years for heavy treatment and 20 years for extra heavy treatment.

For Elastomeric Membrane under clause no. 2.04.02: 10 (ten) years

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In case guarantee is more stringent in owner specification, more stringent guarantee shall be applicable. The mode of execution of the guarantee shall be such, which shall be acceptable to the Owner.

#### **4.00.00 I.S. 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 of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

- a) IS: 73 - Paving Bitumen
- b) IS: 702 - Industrial Bitumen
- c) IS: 1203 - Methods of testing tar and bitumen
- d) IS: 1322 - Bitumen felts for waterproofing and damp proofing.
- e) IS: 1346 - Code of practice for waterproofing of roofs with bitumen felts.
- f) IS: 1609 - Damp-proofing Treatment using Bitumen Felts – Code of Practice
- g) IS: 3067 - Code of practice for General design details and preparatory work for Damp-proofing and waterproofing of buildings
- h) IS: 3384 - Bitumen primer for use in waterproofing and damp proofing.

#### **5.00.00 RATES AND MEASUREMENT**

##### **5.01.00 Rates**

Rates shall be for complete work, including the cost of all materials and labour, as detailed in the specification unless any portion is specifically excluded in the "Schedule of Items".

No extra shall be paid for finishing around opening, sleeves, pipes, ducts, inserts, etc.

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No separate payments shall be made for cleaning of surface, treating of cracks and surface preparation.

**5.02.00      Measurement**

The finished work shall be measured in Sqm of actual surface area for the purpose of payment.

No deduction shall be made and no extra shall be paid for openings upto 0.4 sqm.

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### **SECTION - D**

#### **SUB-SECTION – D8**

#### **MISCELLANEOUS METAL**

**SPECIFICATION NO. 4-FW-000-00969-08**



**Bharat Heavy Electricals Limited**  
**Boiler Auxiliaries Plant**  
**Ranipet - 6, Tamilnadu**

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## MISCELLANEOUS METAL

### **1.00.00      SCOPE**

This section covers supply, fabrication and erection of miscellaneous metal items of light nature in gates, balcony and stair hand rails, structural works, ladders, hangers, masonry anchors, anchor bolts, fasteners, chain link fencing, barbed wire fencing etc. as specified or shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast of mild steel, aluminium, brass, cast iron, M.S.& galvanized M.S. sheets, aluminium sheets, expanded metal, wire mesh as shown on drawings or specified.

### **2.00.00      INSTALLATION**

#### **2.01.00      Fabrication/casting**

##### **2.01.01      General**

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

##### **2.01.02      Shop Connections**

- a) All shop connections shall be riveted or welded except when noted otherwise on drawings.
- b) Welding of steel shall be done in accordance with IS: 816.
- c) Welding of aluminium shall be done accordance with IS: 2812, "Arc welding of Aluminium and Alloys." Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

##### **2.01.03      Shop Coat**

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill seals, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. When specified steel work shall be galvanised or painted with a coat of zinc chromate primer. Aluminium surfaces, which shall come in contact with masonry, shall be given one coat of bituminous paint.

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#### **2.02.00 Erection**

##### **2.02.01 Bracing**

The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected, including erection of equipment and operation of the same.

##### **2.02.02 Temporary Bolting-Up**

As erection proceeds the Contractor shall plum up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever erection equipment or other loads are carried by members during erection, proper provision shall be made to take care of the stresses resulting from the same.

##### **2.02.03 Turned Bolt**

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

##### **2.02.04 Welding**

Where specified on drawings, welding shall be done in accordance with IS: 816 for steel and IS: 2812 for Aluminium & Alloys.

##### **2.02.05 Cutting and Fitting**

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.

##### **2.02.06 Drifting**

Correction minor misfits and a reasonable amount of reading and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections, reaming that weakness the members or make 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

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parts by moderate use of drift pins or a moderate amount of reaming and slight chipping and cutting shall immediately be called to the attention of the Engineer-and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

#### **2.02.07 Spot Painting**

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials and used for the shop paint or equivalent.

#### **2.02.08 Good**

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

#### **2.02.09 Grouting**

All bearing plates, loose, lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1½:3 concrete with 6 mm down stone chips or as specified in schedule of items.

#### **2.02.10 Anchor Fasteners**

The anchor fasteners shall be of two type viz. light duty for carrying tensile load upto 0.5MT per fasteners and heavy duty for carrying tensile load of 0.5MT to 5.0MT per fasteners. These anchor fasteners shall be fixed into concrete. The Contractor shall submit the Manufacture's literature showing the average pull out and average shear value for anchor of various sizes. Anchors shall be fixed in position strictly as per the manufacturers instructions and as approved by the Engineer.

#### **Heavy Duty Anchor Fasteners**

The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of capacity of 2.5 for the characteristic load of the anchor. Minimum size of anchor shall be M8 (8mm). All anchors shall be from the approved manufacturers like HILTI or equivalent.

- a) Anchor fasteners shall be supplied and fixed in position by the contractor. Anchor fasteners can be of mechanical bonding or chemical bonding.
- b) Capacity of the anchor shall be established after considering the effect of concrete grade, embedment depth, concrete thickness, anchor spacing and edge distance from the concrete edge.
- c) The selection for the particular type of bonding for the anchors shall be made after considering the concrete grade, available embedment depth, load to be transferred, space available for installing anchors.

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- d) The mechanical bonding anchor are torque controlled anchors made from carbon steel of grade 8.8 as per IS:1367 part 3. Anchors in bolt as well as nut version are acceptable. The bolt version anchors consists of bolt washer, sleeves, plastic section, expansion sleeves and a cone. Nuts version anchor consists of nuts, threaded rod, washer, sleeves, plastic section, expansion sleeves and a cone. All steel component of anchor shall be electro galvanised to minimum 5 micron coating thickness. The plastic section shall be of polyacetal Derlin 100 or equivalent.
- e) Chemical bonding anchor shall consist of foil capsule and threaded rod. The foil capsule shall contain the resin and hardener. The threaded rod shall have chiselled tip. The behaviour of anchors under fire shall conform the heating curves as per ISO:834. Anchors of size M8 to M24 shall conform to grade 5.8 and anchors of size M27 to M39 shall conform to grade 8.8 as per IS:1367 part 3. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness.

### **Light Duty Anchors**

This anchor shall comprise of stud, nut, washers, expansion sleeve. The one end of the stud shall have thread and the other end shall have cold formed conical head. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness. The expansion sleeve shall preferably be of stainless steel of SS316. The anchors shall conform to minimum grade 5.8 as per IS:1367 part 3.

### **2.02.11 Pipe Joints**

MS pipes or GI pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot joined and caulked with hemp and molten head.

### **2.03.0 FENCING**

#### **2.03.01 Chain Link Fencing**

The material requirement shall conform to IS: 2721 latest edition. The chain link fencing shall be woven from 3.15mm dia. wire with mesh size of 50mm. The mesh wire shall not vary from specified dia. by more than  $\pm 0.05$ mm. all steel wire shall be hot dipped galvanised wire. The dia shall be measured over the galvanised coating. The line wire shall be 4.0mm dia. mild steel. The stirrup wire for securing the line wire to the intermediate post (RCC/structural steel) shall be 2.5 mm diameter mild steel. The tying wire for securing the chain link fencing to the line wire shall be 1.6mm diameter mild steel. Hair pin chain staples for fastening down the bottom of galvanised chain line fencing to the concrete sill shall be 3.15mm wire. The ends shall be bent outwards for securing anchorage.

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Cleat for eye bolts shall be of uniform size and shall consist of mild steel angle of 75 x 50 x 8 mm. The eye bolts strainer shall consist of bolt with welded eye sufficiently threaded and fitted with a nut and washer. Two-way eye bolt strainer shall have suitable ring nuts fitted after the wires have been strained on one side. Stretcher bar shall consist of mild steel flats 25 x 4.75 mm. They shall be secured to the cleats by steel bolts.

The chain link fencing shall be strained between each pair of straining posts and secured to each straining posts by means of a stretcher bar. One of top line wire shall be threaded through appropriate adjacent row of mesh, care being taken that no meshes in the row are bypassed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The fencing shall be attached to the top and bottom line wire by wire ties spaced at 150mm apart and to the other middle line wire by wire ties spaced at 450mm apart.

The bottom of fencing shall be treated as follows:

Continuous concrete sill 125mm wide x 225mm high for full length between posts shall be cast with the top 25mm above GL and 25mm below the chain link fencing. Hair pin staples shall be threaded through the bottom row of mesh at 750mm c/c and set in the sill to a depth of 150mm.

## 2.03.02

### Barbed Wire Fencing

The barbed wire shall be conform to IS:278 latest edition. The barded wire shall be galvanised and galvanising shall conform to the requirement laid down for 'light-coated wire' of IS:4826 and it shall be smooth and relatively free of lumps etc. Wire with excessive roughness blisters, salammoniac spots shall be rejected. The barbed wire shall be made from two line wire and two point wire of 2.5 mm thickness each. The barbs shall have four point and shall be formed by twisting two point wires, each two turns, tightly around both or one line wire ( Type A - around both line wire, Type B - around one line wire) making altogether four complete turns. The barbs shall be so finished that four points are set and located or locked as far as possible at right angle to each other. The barbs shall have a length of not less then 13mm and not more than 18mm. The distance between two barbs shall be  $75\pm12$ mm.

Straining posts shall be provided at all ends and corners of fences or at changes in direction or acute variation in level and at intervals not exceeding 66 M on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3.0m. Struts shall be fitted to all straining posts behind the chain link fabric in the direction of line of fence. There shall be four evenly spaced row of line wire in all. The top line wire shall be doubled, making five line wire in all. The bottom wire shall be closed to the ground. Each line wire shall be strained tightly by means of eyebolts strainers or winders at each straining points. Each line wire shall be secured to each intermediate post by a

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wire stirrup passed through a hold in the post and secured to the line wire by three complete turns on each sides of the post. The barbed wire shall be fitted with one dropper at the centre of each bay, secured to the wire so that they could not be bunched together. Droppers for barbed wire shall be of mild steel of not less than 25 x 4.75 mm thick with 38 x 4.85 mm half round staples for fastening the barbed wire to them. Bracing for the rows of barbed wire shall be approved by the Engineer.

### 3.00.00

#### ACCEPTANCE CRITERIA

- a) All items shall be correct shape, size, weight etc. shown on drawings and schedule of items.
- b) For installed items, the tolerances shall be as follows
  - i) Permissible deviation from, straightness – 1 in 1000.
  - ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.
- c) All castings shall be free from blowholes, cracks, and other blemishes.
- d) All MS wire fencing shall be in true vertical plain, and shall not bulge.

### 4.00.00

#### IS CODES

- IS:278 Specification for Galvanised Steel Barbed wire for fencing.
- IS:816 Code of practice for use of Metal Arc welding for general construction in mild steel.
- IS:1367 Industrial Fasteners – Threaded steel fasteners - Technical supply condition.
- IS:2721 Specification for Galvanised Steel Chain Link fence fabric.
- IS:2812 Arc welding of Aluminum and Alloy

### 5.00.00

#### RATES AND MEASURMENTS

##### 5.01.0

##### Rates

Rates shall include supply, fabrication and installation for misc. metals works as required for completion of works like gates, fencing, handrails, ladders, hangers, anchors etc., unless otherwise specified in Schedule of Items. Rate for fencing shall also include excavation, concreting and supply, erection

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& fabrication of post (post made of either structural steel or reinforced cement concrete), unless any specific item is excluded.

#### 5.02.0 Measurements

Measurement for MS gates shall be in MT.

Measurement for galvanised MS wire fencing shall be in Sqm.

Measurement for Anchors shall be in nos. for the type as specified in schedule of items.

Measurement of other misc. metals shall be done in MT unless otherwise specified in schedule of items.



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**Bharat Heavy Electricals Limited**  
**Boiler Auxiliaries Plant**  
**Ranipet - 6, Tamilnadu**


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### MASONRY AND ALLIED WORKS

#### 1.00.00 SCOPE

This section covers furnishing, installation including handling, transporting, batching, mixing, laying scaffolding, centering, shuttering, finishing, curing, protection, maintenance and repair of common building materials till handing over of masonry and allied works for use in structures and locations covered under the scope of this package.

#### 2.00.00 MATERIALS

##### a) Brick

Bricks for general masonry work shall be of class designation 7.5 of nominal dimensions as per standard specification under IS: 1077, well burnt, of uniform size, shape and colour, free from cracks, flaws or modules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps holes etc. Water absorption after 24 hours immersion shall not exceed 20% by weight for bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved samples shall be retained by the Engineer for further comparisons and reference. Any brick not found up to the specification shall be removed immediately from site at the Contractor's own cost.

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded; to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

##### b) Stone

All stones shall be obtained from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without



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loose grains and free from any dull, chalky, or earthly appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

### c) Cement

Cement used shall be Ordinarily Portland Cement or Portland Slag Cement or Portland Pozzolana Cement conforming to IS Codes and shall be fresh when delivered. In special cases, Rapid Hardening Portland Cement, Low Heat Cement etc. may be permitted or directed to be used by the Engineer. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

### d) Coarse Aggregate

Coarse aggregates shall be as per IS: 383 latest editions, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concrete or the specified proportions and strength and of consistence that will work readily into position without



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segregation.

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass, or any other injurious substances at any stage.

Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

e) Sand

Sand shall be hard, durable, clean, and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosion to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded and shall be as per relevant IS Code. Sand for concrete shall conform to IS: 383.

f) Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

g) Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings, which may impair proper bond. Structural steel shall conform to IS: 2062. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432. Cold twisted steel bars shall conform to IS: 1786. Hand drawn steel wire fabric shall conform to IS: 1566. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

**3.00.00      INSTALLATION**

**3:01.00      Soling**

**3.01.01      Brick Soling**

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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 in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of item. 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.

### **3.01.02 Stone Soling**

The stones for soling shall be selected on the basis of thickness of soling specified in the Schedule of Items. 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.

### **3.02.00 Brick-on-Edge**

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.

### **3.03.00 Masonry**

#### **3.03.01 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.

#### **3.03.02 Cement Mortar**

Cement mortar shall be prepared with materials specified in clause 2.00.00. Sand for masonry mortar shall conform to IS: 2116. Cement and sand in the specified proportion shall be mixed dry thoroughly and minimum water added to attain required workability.

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 without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

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### 3.03.03 **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.

### 3.03.04 **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 brickwork shall be cleaned at the end of days work. If face bricks are specified, 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.

### 3.03.05 **Reinforced Brickworks**

Reinforcements shall be as specified. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions.

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### **3.03.06 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.

### **3.03.07 Exposed Stone work**

Stonework, which is to be kept exposed, shall be as shown on approved drawing. 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. area shall be built and approved by the Engineer and all works shall match with this sample.

### **3.03.08 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.

### **3.03.09 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 and specified. 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 waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

### **3.03.10 Mouldings, Cornices, Drip Course**

These shall be made as shown in drawings. Bricks or stone shall be cut and

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dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with Carborundum stone.

### **3.03.11 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.

### **3.03.12 Embedding of fixtures**

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

### **3.03.13 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.

### **3.04.00 Damp Proof Course (DPC)**

Unless otherwise specified Damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1½:3 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.

### **3.05.00 Damp Proof Membrane**

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 shown as drawings or as specified. 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, at his own expense, 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.



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### 3.05.00 Plinth Protection

Plinth of buildings shall be protected with brick-on-edge paving of minimum 750mm width unless otherwise shown on the drawings. The treatment shall consist of laying bricks in cement mortar 1:6 (1 cement: 6 sand) over a 75mm thick bed of dry graded brick aggregate, 40mm nominal size, grouted with sand. The top shall be finished with 1:2 cement mortar pointing (1 cement: 2 sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50. The brick aggregate shall be well graded, broken from well burnt or slightly overburnt and dense brickbats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

The ground shall first be prepared to the required slope around the building. The high portions of the ground should be cut down; hollows and depressions filled up to the required level from the excavated earth and rammed so as to give uniform outward slope. The bed shall be watered and rammed with heavy iron square rammers. Surplus earth, if any, shall be disposed off beyond a lead of 50m or as directed by the Engineer.

Over this, 75mm thick bed of aggregate of 40mm nominal size, shall be laid with a minimum outward slope of 1 in 50. Aggregates shall be carefully laid and packed, bigger sized being placed at the bottom. The brick aggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.6 cubic metre per square metre area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance. After the subgrade has been compacted thoroughly, brick flooring with bricks of specified strength in cement mortar 1:6 (1 cement: 6 sand) shall be laid.

The bricks shall be laid on edge in Diagonal/Herring Bone Bond or other pattern as specified or as directed by the Engineer. Bricks shall be laid on 12mm thick mortar bed and each brick shall be properly bedded and set home by gentle tapping with handle of trowel or wooden mallet. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of the portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface shall present a true plain surface with the required slope.

The pointing shall be done in cement mortar 1:2 (1 cement: 2 sand). The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge. The mortar shall not spread over surface of the masonry.

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Brick flooring & pointing shall be kept wet for a minimum period of seven days. These shall be protected from rain by suitable covering when the mortar is green.

#### **4.00.00 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.

#### **5.00.00 RATES AND MEASUREMENTS**

##### **5.01.00 Rates**

Unit rate for masonry work shall include the following:

- Raking out joints for plastering or pointing or finishing the joint flush as the work proceeds.
- Preparing top sand sides of existing wall for joining old with new work.
- Providing, dismantling and removing the scaffolding.

Unit rate for DPC shall be inclusive of formwork and bitumen painting.

##### **5.02.00 Measurement**

Brickwork in wall of half brick thickness shall be measured separately in Sqm stating the wall thickness and more than half brick thickness shall be measured by volume. Plaster thickness shall not be considered for computation of volume.


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Masonry work in sub structure and super structure shall be measured separately, unless otherwise specified in the Schedule of items.

No deductions shall be made and no extra payment shall be made for following:

- a) Opening upto 0.1 Sqm each in area. In calculating the area of the opening lintels or sills shall be included along with the size of the opening.
- b) Drainage holes and recesses for cement blocks to embed holdfasts for doors, windows etc.
- c) Pipe and fixtures upto 300mm dia. and nothing extra shall be paid for the mortar used for fixing.
- d) Ends of dissimilar materials ( i.e. joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps, etc); up to 0.1 sqm in section;
- e) Chases of section not exceeding 50 cm in girth;
- f) Iron fixtures, such as wall ties and hold fasts for doors and windows;
- g) Cement concrete blocks as for hold fasts and holding down bolts;
- h) Wall plates, bed plaros, and bearing of slabs, CHAJJAS and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;

Reinforcement in masonry work shall be paid separately under respective items.

Damp proof course shall be measured in Sqm. No deduction shall be made and no extra shall be paid for opening upto 0.1 Sqm in area.

Plinth protection shall be measured under respective item of works executed required for completion of the work as specified.

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### **SECTION - D**

#### **SUB-SECTION – D10**

### **FINISH TO MASONRY AND CONCRETE**

**SPECIFICATION NO. 4-FW-000-00969-10**



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**Boiler Auxiliaries Plant**  
**Ranipet - 6, Tamilnadu**

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## FINISH TO MASONRY AND CONCRETE

### **1.00.00      SCOPE**

This Section covers finishing, 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 minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

### **2.00.01      INSTALLATION**

#### **2.01.00      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 flushed 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 of the Engineer shall be taken as to the acceptability of the base.

### **2.02.00      PLASTERING**

#### **2.02.01      Mortar**

Mortar for plastering shall be as specified.

For sand cement plaster, sand and cement in the specified proportion shall be

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mixed dry, on a watertight platform and minimum water added to achieve working consistency. The sand for plaster shall conform to IS: 1542.

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.

#### **2.02.02 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, without any extra cost to the Owner, 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.

#### **2.02.03 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, color and finish.

##### **a) Standard Finish**

Wherever punning is indicated, the interior plaster shall be finished rough; otherwise the interior plaster shall generally be finished to a smooth surface.

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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 2.02.02 but using Coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat 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 editions.

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 2.02.02. While the mortar is still plastic small pebbles or crushed stone of size generally from 10mm to 20mm 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 oil 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 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**

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Ordinary plaster as described under Clause 2.02.02 after being leveled and allowed to stiffen for a few hours, shall be scraped 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.

**h) Sand Faced Plaster**

The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 14mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item or work. The scratch coat shall be cured for at least 7 days & then allowed to dry. The second coat shall be 6mm thick and it shall not be applied until at least 10 days have elapsed after the application of scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation & without joints; finish shall be straight, true, & even. The mortar of this coat shall be as specified under the respective item of work. White sand for finish shall be used for the second coat & for finishing work. Sand for finish shall be of even coarse size & shall be dashed on the surface & sponged.

**2.02.04**

**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.

**2.03.00**

**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

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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 finishes with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scalped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

#### **2.04.00 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 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 and 4 parts sand by volume mixed as specified in plastering, Clause 2.02.01. The application, finish etc. shall be as specified under relevant clause above. Where called for a 2 mm Plaster of Paris punting shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

#### **2.05.00 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 punting 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.

#### **2.06.00 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. areas and approval of the Engineer taken. The work shall

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then be taken in hand as per approved sample.

#### **2.07.00 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 drawings 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 non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanized (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.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

#### **3.00.00 ACCEPTANCE CRITERIA**

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

#### **4.00.00 I.S. CODE**

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 of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

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IS: 1661: Code practice for cement and cement-lime plaster finish on wall & ceilings.

IS: 4101: code of practice for external facings and veneers.

## **5.00.00 RATES AND MEASUREMENT**

### **5.01.00 Rates**

Rates shall also include providing, dismantling and removing of scaffolding, surface preparation, curing and all type of surface, shapes/ profiles and at all elevations.

### **5.02.00 Measurement**

All plastering shall be measured net (on surface area on which it is applied) in Sqm. Plaster work shall be classified according to the type used and shall be measured separately. Plaster on ceiling and walls shall be measured separately. Soffits of stairs shall measured as plastering on ceiling.

No deduction shall be made for opening not exceeding 0.5 Sqm and for ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sills of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

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**Boiler Auxiliaries Plant**  
**Ranipet - 6, Tamilnadu**

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## **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.

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#### **1.04.00 Materials To Be Used**

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

#### **2.00.00 Codes and Standards**

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

- a) Specification for road and bridge works of Ministry of Shipping & Transport (Road Wing) Published by the IRC
- b) IRC: 19 - Standard specification and code of practice for Water bound Macadam
- c) IRC :SP 11 - Hand Book of Quality Control for Construction of Roads and Runways
- d) IS:456 - Indian Standard Code of Practice for Plain and Reinforced Concrete.
- e) IS:2212 - Code of Practice for Brick work
- f) IS: 783 - Code of Practice for Laying of Concrete Pipes
- g) IS: 1201 - Methods of testing tar and bituminous materials to 1220
- h) IS: 73 - Specification for paving bitumen
- i) IS: 215 - Specification for Road tar
- j) IS: 216 - Coal tar pitch
- k) IS: 217 - Specification for cut-back bitumen
- l) IS: 454 - Specification for cut-back bitumen from waxy crude
- m) IS: 1834 - Specification for hot applied sealing compound for joint in concrete
- n) IS: 1838 - Specification for performed fillers for expansion joints in concrete, non extruding and resilient type

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Part I      Bitumen impregnated fibre

Part II      CNSL Aldehyde resin and coconut pith

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

p) IS: 1077 -      Common burnt clay building bricks

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

r) 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  $\pm 25\text{mm}$  therefrom. The corresponding tolerance for edges of the roadway and lower layers of the pavement shall be  $\pm 40\text{mm}$ .

### 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       $\pm 25\text{ mm}$

Sub-base       $\pm 20\text{ mm}$

Base course       $\pm 15\text{ mm}$

Wearing course  $\pm 10\text{ mm}$

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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)	18	12	
1	2	3	4	5	6	7
1.	Earthen sub-grade	25	30	-	-	-
2.	Granular sub-base	15	-	30	-	-
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-
4.	Water Bound Macadam with normal size metal (20-50 mm and 40-63 mm size), Bituminous Penetration Macadam	12	-	-	30	-
5.	Surface dressing** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam	12	-	-	20	-

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	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**

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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.

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**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 skewses/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.

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### 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 construction has been thoroughly compacted to the requirements set down hereunder. Moisture content of the fill material shall be checked at the source

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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. 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.

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**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 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**

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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.

### 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.

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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 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.

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

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

### **3.06.00 Kerb**

#### **3.06.01 Material**

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

#### **3.06.02 Laying**

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

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

### **3.07.00 Sub-base (Granular Sub-base)**

#### **3.07.01 Description**

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

#### **3.07.02 Materials**

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kankar etc or combinations thereof depending upon the grading required. The mixed

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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	G ra di n g 2	G ra di n g 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

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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 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

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conformity with the lines, grades and cross-sections shown on the approved drawings.

### 3.08.02 Materials

#### a) Coarse Aggregates - General Requirements

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

**Table – V**

#### **Physical Requirements of Coarse Aggregates for Water Bound Macadam**

Sl.No.	Type of Construction	Test	Test method	Requirements
1.	Sub-base	Los Angeles Abrasion Value * or Aggregate Impact Value	IS : 2386 (Part IV) 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) 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**

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

### c) Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table – VI. However the use of Grading-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 80 mm 63 mm 40 mm 20 mm	100 65 - 85 25 - 60 0 - 15 0 - 5
2.	63 mm to 40 mm	80 mm 63 mm 50 mm 40 mm 20 mm	100 90 - 100 35 - 70 0 - 15 0 - 5
3.	50 mm to 20 mm	63 mm 50 mm 40 mm 20 mm 10 mm	100 95 - 100 35 - 70 0 - 10 0 - 5

### d) Screenings

Screenings to fill 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-

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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.

**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 10.0 mm 4.75 mm 150 micron	100 90 - 100 10 - 30 0 - 8
B	10 mm	10 mm 4.75 mm 150 micron	100 85 - 100 10 - 30

#### e) Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value 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

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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 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.

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### e) Application of Screenings

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

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms or hand brooms or with both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids 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

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resulting slurry after filling the voids form a wave ahead of the wheels of the moving roller.

#### **h) Setting and Drying**

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam 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.

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### **3.10.00 Bituminous Macadam Binder Course**

#### **3.10.01 Description**

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

#### **3.10.02 Materials**

##### **a) Binder**

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

##### **b) Aggregates**

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

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\*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.

**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

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12.5 mm	10 - 30	-
10 mm	-	35 - 60
4.75 mm	-	15 - 35
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

### c) Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate Grading-A and B respectively unless directed otherwise by the Engineer. The quantity of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

### d) Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. A variation in binder content upto  $\pm 0.3$  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

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coated uniformly. The mixture shall be transported from the mixing plant to the point of use in a suitable vehicle. The vehicle employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

#### **e) Spreading**

After mixing, the mix shall be spread immediately by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However in restricted locations and in narrow widths where the available plants cannot operate in the opinion of the Engineer may permit manual laying of the mix. The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg. C.

In multilayer construction, the longitudinal joint in one layer shall offset 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 breakdown 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

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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.

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.

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### 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**

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

##### Aggregates for Carpet

i)	Stone Chippings - 12mm size ; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
ii)	Stone Chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
	Total	0. 27 Cu.m

##### Binder for premixing (quantities in terms of straight run bitumen)

i)	For 0. 18 Cu.m of 12 mm size stone 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

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Total	14.6 Kg
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### **3.11.03 Construction Operation**

#### **a) Weather and Seasonal Limitations**

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

#### **b) Preparation of Base**

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

#### **c) Tack Coat**

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

#### **d) Preparation of Premix**

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer in boilers of suitable design avoiding local overheating and ensuring a continuous supply. The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified. The mixing of binder with chipping shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

#### **e) Spreading and Rolling**

The premixed material shall be spread on the road surface with rakes to the

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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 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**

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### a) Binder

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

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

### b) Stone Chippings for Type A Seal Coat

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

### c) Fine Aggregate for Type B Seal Coat

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

## 3.12.03 Construction Operations

### a) Preparation of Base

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

### b) Construction of Type-A Seal Coat

The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the

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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 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.

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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 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

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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/permited by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water etc as required shall be done by the Contractor.

Side slips if there be any shall be removed by the Contractor. After laying of the pipes are completed, backfilling of the trenches shall be done as per "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.

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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.

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

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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.

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### **SECTION - D (PART I)**

#### **SUB-SECTION – D 17**

#### **FABRICATION OF STRUCTURAL STEEL WORK**

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## **SUB-SECTION – D XVII**

### **FABRICATION OF STRUCTURAL STEEL WORK**

#### **1.00.00 SCOPE**

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract.

#### **2.00.00 GENERAL**

##### **2.01.00 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 the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval.
- 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 rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections,
- 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 Dispatch lists, Rivet and Bolt List and any other list of bought out items 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.

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	i) Maintain a fully equipped workshop at site for fabrication, modification and repairs of steelwork at site as may be required to complete the works in accordance with the Contract.		
<b>2.02.00</b>	<b>Work by others</b>		
	No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.		
<b>2.03.00</b>	<b>Codes and standards</b>		
	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:		
	IS : 226 - Structural steel (Standard Quality)		
	IS : 800 - Code of Practice for general construction in steel.		
	IS : 806 - Code of practice for use of steel tubes in general building construction.		
	IS : 808 - Rolled steel beams, channels, and angle sections		
	IS : 813 - Scheme of symbols for welding		
	IS : 814 - Covered electrodes for metal arc welding of structural steel		
	IS : 815 - Classification and coding of covered electrodes for metal arc welding of structural steels.		
	IS : 816 - Code of practice for use of metal arc welding for general construction in mild steel		
	IS : 817 - Code of practice for training and testing metal arc welders		
	IS : 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations		
	IS : 822 - Code of practice for inspection of welds		
	IS : 919 - Recommendations for limits and fits for Engineering		

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<p>IS : 961 - Structural Steel (High Tensile)</p> <p>IS : 1148 - Rivet bars for structural purposes</p> <p>IS : 1149 - High tensile rivet bars for structural purposes</p> <p>IS : 1161 - Steel Tubes for structural purposes</p> <p>IS : 1200 - Method of measurement of steelwork and ironwork (Part 8)</p> <p>IS : 1239 - Mild Steel Tubes</p> <p>IS : 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (dia 6 to 24 mm)</p> <p>IS : 1364 - Precision and semi-precision hexagon bolts, screws, nuts and 1 locknuts (dia, range 6 to 39 mm)</p> <p>IS : 1367 - Technical supply conditions for threaded fasteners</p> <p>IS : 1442 - Covered electrodes for the metal arc welding of high tensile structural steel</p> <p>IS : 1608 - Method for tensile testing of steel products other than sheet strip, wire and tube</p> <p>IS : 1730 - Dimensions for steel plate, sheet, and strip for structural and general engineering purposes.</p> <p>IS : 1731 - Dimensions for steel flats for structural and general engineering purposes</p> <p>IS : 1852 - Rolling and cutting tolerances for hot-rolled steel products</p> <p>IS : 1977 - Structural steel (ordinary quality) St-42-0</p> <p>IS : 2062 - Steel for General Structural Purposes</p> <p>IS : 2074 - Ready mixed paint, red oxide Zinc chromate priming</p> <p>IS : 2595 - Code of Practice for Radiographic Testing</p> <p>IS : 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel</p> <p>IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles</p>			

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IS : 3757 - High strength structural bolts

IS : 4759 - Specifications for Hot-Dip Zinc Coatings on Structural Steel and other allied products

IS : 7205 - Safety Code for Erection of Structural Steelwork

IS : 7215 - Tolerances for fabrication of steel structures

IS : 7280 - Bare wire electrodes for submerged arc welding of structural steels.

IS : 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels.

#### **2.04.00 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.

#### **2.05.00 Materials to be used**

##### **2.05.01 General**

All steel materials required for the work will be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, 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 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 tones or less of any particular section.

The arc welding electrodes shall be of approved reputed manufacture and conforming 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 container of electrodes,

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

#### **2.05.02 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:

- a) IS : 2062 - Steel for general structural purposes
- b) IS : 961 - Structural steel High Tensile
- c) IS : 1977 - Structural steel (Ordinary quality) St-42-0

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

#### **2.05.03 Rivet Steel**

All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable:

- a) IS : 1148 - Rivet Bars for structural purpose
- b) IS : 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.

#### **2.05.04 Electrodes**

All electrodes to be used under the Contract shall be of approved reputed manufacture, low hydrogen electrode and shall comply with any of the following Indian Standard Specifications as may be applicable

- a) IS : 814 - Covered electrodes for metal arc welding of structural steel
- b) IS : 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel

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- c) IS : 1442 - Covered electrodes for the metal arc welding of high tensile structural steel
- d) IS : 7280 - Bare wire electrodes for submerged arc welding of structural steels

#### **2.05.05      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 than 44 Kg/mm<sup>2</sup> and a minimum elongation of 23 per cent on a gauge length of 5.6  $\sqrt{A}$ , where "A" is the cross sectional area of the test specimen

- i) IS: 1367: Technical supply conditions for threaded fasteners
- ii) IS: 1608: Method for tensile testing of steel products 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.

#### **2.05.06      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:

- a) IS : 2062 - Steel for general structural purposes
- b) IS : 961 - Structural Steel ( High Tensile Quality)
- c) IS : 1977 - Structural steel ( Ordinary Quality ) St-42-0

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d) IS : 6649 - Hardened washers

**2.05.07 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, Red oxide Zinc Chromate Priming.

**2.06.00 Coal Bin**

**2.06.01** Shape of bins shall be circular, polygonal, square, or rectangular in plan. Bottom hopper portion may have be conical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.

**2.06.02** For general requirements, fabrication and construction details IS: 9178 (Pt.1 & 11) shall be followed as general guidance. The bins shall be fabricated and erected in segments.

**2.06.03** The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face.

**2.06.04** Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process.

**2.06.05** Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as detailed in the drawing.

**2.07.00 New Erection Marks**

**2.07.01** Additional structures involving new erection marks may be required to be added at any stage of work.

**2.07.02** All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.

**2.07.03** All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.

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<b>2.08.00</b>	<b>ELECTRO FORGED STEEL GRATINGS</b>				
<b>2.08.01</b>	Factory made fabricated electro forged gratings unit with steel conforming to IS: 2062 shall be supplied, fabricated, transported, erected and aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc.				
<b>2.08.02</b>	All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The contractor shall submit the grating design for different spans and load intensities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise.				
<b>2.08.03</b>	The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing or openings as indicated in the design/ scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed.				
<b>2.08.04</b>	The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance.				
<b>2.08.05</b>	Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.				
<b>2.08.06</b>	The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates, and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.				
<b>2.08.07</b>	Opening in gratings for pipes or ducts that are 150mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.				
<b>2.08.08</b>	Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.				
<b>2.08.09</b>	Unless otherwise indicated on the drawings, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.				

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**2.08.10** Grating units shall be provided with all necessary clips, bolts, nuts and lock washers required for proper assembly and rigid installation and fastening to abutting units supporting structural steel framing members.

**2.08.11** The gratings shall be of reputed make and manufacturer, as approved by Engineer. The unit rate quoted by him for this item shall be inclusive of transport of gratings to the project site, all taxes, duties etc. He shall also provide all facilities and access to the Engineer or his representative to carry out inspection during all stages of manufacturing of gratings.

**2.08.12** Maximum deviation in linear dimension from the approved dimension shall not exceed 12mm.

**2.08.13** All fabricated grating section and accessories shall be blast cleaned to near white metal surface (Sa 2½) followed by either of the following two:

- (a) Two coats of red lead primer and two coats of black enamel finish paint.
- (b) Hot dipped galvanization at 610 gm/sq.m.

in the shop prior to erection at site, as the approved drawing.

**2.08.14** Prior to finishing all surfaces shall be cleaned, free from rust, mill scale, grease, oil, or any other foreign matter by blast cleaning. BS: 4232 shall be followed for blast cleaning.

**2.08.15** Primer can be applied by spray guns or by brushes, however the finish paint shall necessarily be applied by means of spray guns. The applied coatings shall be uniform, free from voids and streaks; drilled or punched holes shall be touched up prior to erection or assembly.

**2.09.00** **GALVANIZATION OF GRATINGS**

**2.09.01** Purity of Zinc to be used-for galvanizing shall be 99.5% as per IS: 2 15

**2.09.02** After the shop work is complete, the structural material shall be punched with erection mark and be hot double dip galvanized. Before galvanizing the steel section shall be thoroughly blast cleaned to near white metal surface (Sa 2½).

**2.09.03** The weight of the zinc coating shall be at least 610 gm/m<sup>2</sup> - unless noted otherwise.

**2.09.04** The galvanized surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be cleaned and smooth and shall be free from defects like discoloured

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<p>patches, bare spots, unevenness of coating, spelter that is loosely attached to the steel, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.</p>																					
<b>2.09.05</b>	There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633.																				
<b>2.09.06</b>	When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose.																				
<b>2.09.07</b>	Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the galvanizing plant, shall render the entire, production in the relevant shift liable to rejection.																				
<b>2.09.08</b>	All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains.																				
<b>2.09.09</b>	If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage, if so directed the galvanizing may have to be redone in the similar manner as stated above at no extra cost to the Owner.																				
<b>2.10.00</b>	<b>STAINLESS STEEL HOPPERS (As per BOQ item)</b>																				
<b>2.10.01</b>	<b>Material</b>																				
<p>In case SS Hopper is to be fabricated &amp; erected as per BOQ item with SS415M, following specification shall be followed.</p> <p>Stainless steel hopper of grade SS 415M as manufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper. SS 4 15M having the following chemical composition shall be used.</p>																					
<table> <thead> <tr> <th><b>Material</b></th><th><b>%</b></th><th><b>Remarks</b></th></tr> </thead> <tbody> <tr> <td>Carbon</td><td>10.03%</td><td>Max.</td></tr> <tr> <td>Silicon</td><td>1.60%</td><td>Max.</td></tr> <tr> <td>Manganese</td><td>0.80% to 1.50%</td><td></td></tr> <tr> <td>Phosphorous</td><td>0.03%</td><td>Max.</td></tr> <tr> <td>Sulphur</td><td>0.03%</td><td>Max.</td></tr> </tbody> </table>				<b>Material</b>	<b>%</b>	<b>Remarks</b>	Carbon	10.03%	Max.	Silicon	1.60%	Max.	Manganese	0.80% to 1.50%		Phosphorous	0.03%	Max.	Sulphur	0.03%	Max.
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Chromium	10.80% to 12.50%	
Nickel	1.50%	Max.
Titanium	0.75%	Max.
Nitrogen	0.03%	Max.

**The mechanical properties shall be as follows:**

<b>Description</b>	<b>Value</b>	<b>Remarks</b>
Hardness Rock Well B Scale	90	Max.
Tensile Strength	450 MPa	Min.
Yield Strength	300 MPa	Min.
Elongation	25%	Min.

## **2.10.02 Fabrication**

The fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant I.S. and international specification as well as stipulations contained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.

## **2.10.03 Fabrication Drawings**

- Fabrication drawing shall give the cutting plan for each hopper plate. Such, cutting plan shall be based on the size of the Stainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use. Such optimization may also required adjustment in the size of the each element of hopper plate and also additional weld joints.
- The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrication, weight of cut and scrap pieces

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generated. Contractor shall return to the Owner's store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel pieces to the Owner's store will call for the penal recovery at three (03) times the maximum procurement rate for the weight of stainless steel pieces not returned to the store.

c) In case the contractor does the cutting of the stainless steel without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the penal recovery at the rate mentioned above.

#### **2.10.04 Cuffing**

Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edges shall be ground smooth afterwards by contractor within the unit rates quoted by him. All the edges shall be ground smooth before they are welded.

#### **2.10.05 Jointing**

Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di-oxide mixture shall be avoided. 308L and 315L electrodes/fillers shall be used for the welding of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Engineer. On the basis of the welding procedure, the Contractor shall conduct qualification test.

#### **2.10.06 Bending**

The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile.

#### **2.10.07 Welding sequence**

The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer.

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## **2.10.08 Acceptance Criteria of Fabricated Structures**

The acceptance of the fabricated structure work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory results from the inspection and testing of the welded structure joints and the test specimens, general workmanship being good meeting the tolerance requirements given in IS: 7215.

## **2.11.00 BEARINGS**

### **2.11.01 PTFE (Poly tetra fluorethylene) slide bearing**

#### **a) General**

The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Engineer, for required vertical loads, as per the construction drawings and for a maximum displacement of  $\pm 50$  mm.

#### **b) Material**

PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/cm<sup>2</sup>. In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm.

The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (compressive) load not less than 500 kg/cm<sup>2</sup> and shear loads upto 40 kg/cm<sup>2</sup>.

#### **c) Installation**

The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be

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placed on this layer while it is still workable and the bearing is levelled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam slightly above the top of the bearing. The upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the beam is lowered on to the temporary supports it comes into full contact with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed.

#### **2.12.00 Storage of material**

##### **2.12.01 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 and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date 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.

##### **2.12.02 Steel**

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section wise 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.

##### **2.12.03 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.

##### **2.12.04 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.

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## 2.12.05 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.

## 2.13.00 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 free of cost 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.

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

- a) Steel: Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
- b) Rivets, Bolts, : Manufacturer's certificate, dimension checks, Nuts & Washers material testing.
- c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.
- d) Welders : Qualifying Tests
- e) Welding sets : Performance Tests
- f) Welds : Inspection, X-ray, Ultrasonic tests
- g) Paints : Manufacturer's certificate, physical inspection

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h) 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.

#### **2.14.00 Standard dimensions, forms and weights**

The dimensions, forms, weights and tolerances of all rolled shapes rivets, 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.

#### **2.15.00 Fabrication Drawings**

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and erection of structural Steelworks, for approval. Within one week after receipt of approval on design of any steel structure (part or full) based on the approved design. As decided by the Engineer, six (6) copies each of some or all of the detailed fabrication drawings will have to be submitted for approval.

The sequence of preparation of fabrication drawings shall match with the approved fabrication and erection schedule. The above-mentioned approval for fabrication drawings will be accorded only towards the general conformity with the design requirements as well as specifications. The approval of 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 fabrication drawings shall include but not 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 bolts location etc.
- c) Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.
- d) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

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e) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

These drawings shall give all the necessary information for the fabrication, erection, and painting of the steelwork in accordance with the provisions of this Specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information necessary for fabrication of the various components of the steelwork, including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, 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 fabrication 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 carry out at his cost any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

### **3.00.00 WORKMANSHIP**

#### **3.01.00 Fabrication**

##### **3.01.01 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 general construction in steel and other relevant Indian Standards or equivalent.

##### **3.01.02 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 on IS: 1552 - 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°C.

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### 3.01.03 **Cutting**

Shearing, cropping, or sawing shall affect cutting. 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 gouges 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.

### 3.01.04 **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.

### 3.01.05 **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 web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed clearances shall be provided.

## 3.02.00 **Riveted and bolted construction**

### 3.02.01 **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 rivet or bolt plus 3 mm subject to a maximum thickness of 16 mm

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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 rivet or bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the rivet or 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 BS 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 rivets or bolts shall not be formed by gas cutting process.

### 3.02.02 Assembly

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. 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 rivets or 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.

Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with the holes. Rivets shall be heated uniformly to a temperature not exceeding 1125°C they shall not be driven after their temperature has fallen below 540°C.

Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single

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riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio is below 75%, all the rivets in the particular section or group shall be cut, removed and replaced and tested again at the Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary.

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 shown on drawing or directed by the Engineer.

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 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.

### **3.03.00 Welded Construction**

#### **3.03.01 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.

#### **3.03.02 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.

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### **3.03.03 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°).

The work shall be positioned for flat welding whenever practicable.

### **3.03.04 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 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 shod splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded 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.

### **3.03.05 Welding technique**

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 m 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

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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.

### **3.03. 12      Temperature**

No welding shall normally be done on parent material at a temperature below (-) 5°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°C and 0°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 hand warm. 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°C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

### **3.03. 13      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.

### **3.03. 14      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 capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

### **3.04.00      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 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc; after welding/riveting 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 of channels are fixed with such accuracy that they are not reduced in thickness by machining by more

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than 1.0 mm.

### **3.05.00 Slab bases and caps**

Bases and caps fabricated out of steel slabs, except when cut 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. 12.00 Lacing bars**

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

### **3. 13.00 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.

### **3.14.00 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.

### **3.15.00 Floor Grating**

All grating units shall be rectangular in pattern and of pressure locked assembly. The size and spacing of bearing bars and cross bars shall be as approved in detailed drawings. Alternatively diamond pattern grating if approved may be used.

The grating shall be made in panel units designed to span as indicated in structural steel framing drawing or as directed by the Engineer.

The grating units shall be finished free from warps, twists, or any other defects. Grating work shall include cutouts and clearance openings for all columns, pipes, ducts, conduits etc. The gratings shall be notched, trimmed, and neatly finished around components of the steel structures encountered.

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Binding strip shall be provided on the grating to suit the profile. Openings in gratings shall be provided with steel bar toe plates of not less than 5 mm thickness and 100 mm width.

Unless otherwise indicated on drawings, all penetrations of grating units shall be made up in split section, accurately fitted, and neatly finished. Grating units shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm.

### **3.10.00 Chequered Plates**

Minimum thickness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cut edges properly ground. Stiffeners shall be provided wherever required from design consideration.

### **3.11.00 Architectural Clearances**

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

### **3.11.00 Shop connections**

- All shop connections shall be otherwise riveted or welded as specified on the Drawings.
- Heads of rivets on surfaces carrying brick walls shall be flattened to 10 mm thick projection.
- 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 at no extra cost to the exchequer.

### **3.13.00 Castings**

Steel castings shall be annealed.

### **3.14.00 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 dispatch. 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

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such a way as will facilitate the check of interchange ability.

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<p><b>3.15.00</b> <b>Shop painting</b></p> <p><b>3.15.01</b> <b>General</b></p> <p>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.</p> <p>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 methods of loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by the 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 trough sweeping with a fibre brush.</p> <p><b>3.15.02</b> <b>Inaccessible parts</b></p> <p>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.</p> <p><b>3.15.03</b> <b>Contact surfaces</b></p> <p>Contact surface shall be cleaned in accordance with sub-clause 3.13.1 before assembly.</p> <p><b>3.15.04</b> <b>Finished surfaces</b></p> <p>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.</p> <p><b>3.15.05</b> <b>Surfaces adjacent to field welds</b></p> <p>Unless otherwise provided for, surfaces within 50 of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.</p>					

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### **3.16.00 Galvanizing**

#### **3.16.01 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 Galvanizing 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.

#### **3.16.02 Surface Preparation**

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, 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.

#### **3.16.03 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.

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 leaving been dipped twice, it shall be rejected. Special care shall be taken

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not to injure the skin on galvanized surfaces during transport, handling, and erection. Damages, if occur, shall be made good in accordance or as directed by the Engineer.

#### **4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY**

##### **4.01.00 Inspection**

Unless specified otherwise, inspection to all, work shall be made by the 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 free of charge, 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.

##### **4.02.00 Testing and Acceptance Criteria**

###### **4.02.01 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. 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.

###### **4.02.02 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. Cost of all tests shall be born by the contractor.

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

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#### 4.02.02 **Welding**

- a) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for size, length of weldment and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc.
- b) Non-destructive examination shall be carried out to determine soundness of weldments as follows:
  - i) 10% at random on fillet-joints.
  - ii) 100% on all butt-joints.
- c) Should the ND tests indicate defects like improper root penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rewelded. All defects shall be rectified by the Contractor at no extra costs.
- d) All electrodes shall be procured from approved reputed 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 tones of welded fabrication, the Engineer may ask for 1(one) test-destructive or non-destructive including X -ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor.

#### 4.02.04 **Rivets, bolts, nuts and washers**

All rivets, bolts, nuts, and washers shall be procured from M/s. Guest Keen William Ltd. or equivalent and shall confirm 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. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.

#### 4.02.05 **Shop painting**

All paints and primers shall be of standard quality and procured from approved

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manufacturers and shall conform to the provisions of the relevant Indian Standards.

#### **4.02.12 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 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

#### **4.03.00 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 shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures.

#### **4.04.00 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 some of the tests at an appropriate laboratory at the contractors cost.

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 acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. 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.

#### **4.05.00 Delivery of materials**

##### **4.05.01 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

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#### **4.05.02 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.

#### **4.05.03 Shipping**

Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. 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
- 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

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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 packing 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 at no additional cost to the Owner. 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 bills of the Contractor.

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

## **5.00.00 INFORMATION TO BE SUBMITTED**

### **5.01.00 With Tender**

The following information is 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.

- i) Preparation and approval of fabrication drawing
- ii) Procurement of Materials
- iii) Fabrication and shipping of all anchor bolts
- iv) Fabrication and shipping of main steelwork.

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- v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos as applicable.
- vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork.
- vii) Final date of completion of all shipments.

**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.

**5.02.00 After Award**

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

- a) Complete fabrication drawings, material lists, cutting lists, rive and bolt lists, field welding schedules based on the approved design drawings prepared by him 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 up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.
- c) Detailed monthly material reconciliation statements relevant to the Work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials.
- d) Results of any test as and when conducted and as require by the engineer.
- e) Manufacturer's mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.

**6.00.00 RATES AND MEASUREMENT**

**6.01.00 Rates**

**6.01.01** The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of items shall be read in conjunction with these specifications including amendments and additions, general conditions of

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<p>contract, special conditions of contracts, and other tender documents, if any. For each item of Schedule of Items, the bidder's rates shall include the activities covered in the description of the item as well as all necessary operations described in the Specifications.</p>			
<b>6.01.02</b>	The bidder's rates shall include cost of all 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. Rates shall also include for taking all safety measures.		
<b>6.01.03</b>	The bidder's -rates for all items of schedule of items shall include complete cost towards plant, equipment, erection and dismantling of scaffolding, men, materials and consumables, skilled and unskilled labour, levies, taxes, royalties, duties, transport, storage, repair/rectification/maintenance until handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work.		
<b>6.01.04</b>	No claims shall be entertained, if the details shown on the 'Released for Construction' drawings differ from those shown on the bid/tender drawings.		
<b>6.01.05</b>	Rates shall be inclusive of all leads and lifts/elevation.		
<b>6.01.06</b>	The bidder's rates for Structural Steel shall include for fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, erection scheme, alignment, welding, including preheating and post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus/waste steel materials including cut pieces/waste steel, provision of additional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.		
<p><b>The rates for fabrication are inclusive of all tests on welds and material and no extra shall be payable for quality tests specified for fabrication of structure in shop or at site.</b></p> <p><b>Separate BOQ items for test on welds like radiography or Ultrasonic, DPT, magnetic particle tests are kept for tests on material/fabrication not covered under regular fabrication item of BOQ.</b></p>			
<b>6.01.07</b>	The bidder's rates for foundation bolts assembly shall include fabrication, threading, heat treatment, erection, installation, and alignment of complete bolt		

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assembly with nuts, locknuts, anchor plates, stiffener plates, protective tape, etc. This shall also include the cost of all materials not issued by the Owner. Material issued by Owner will be specified in GCC.

**6.01.08** The bidders rates for application of inorganic primer shall include surface preparation to near white metal surface by blast cleaning, abrasives, touch up painting, suitable enclosure to avoid contamination and the necessary statutory approval from the factory inspector/pollution control board etc. regarding the method of blast cleaning and abrasives used, and getting approval of the specialized agency supplying the primer specified.

**6.01.09** The bidder's rates for application of finish painting system shall include surface preparation, application of intermediate (under) coat, finish coat and final finish coat, and getting approval of the specialized agency supplying the finish paint.

**6.01.10** The bidder's rates for electro-forged gratings (if specified) shall include supply, fabrication, transportation to the site, erection and alignment of factory made electro-forged gratings, all taxes, duties thereon etc. The rates shall also include preparation of grating design for different spans and load intensities, preparation of design and fabrication drawings, edge preparation, blast cleaning followed by finish paint.

**6.01.11** The bidder's rates for galvanization of factory made electro-forged gratings (if specified) shall include the application of hot dipped galvanization as finish over the fabricated gratings and the treatment to be given for prevention of white storage stains, as per the technical Aspiration.

**6.01.12** The bidder's rates for permanent mild steel bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types of Structural Steel works, as per the technical specification.

**6.01.13** The bidder's rates for high strength structural bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types, of Structural Steel works, as per the technical specification.

**6.01.14** The bidder's rates for dismantling, additions to, alterations in and/or modifications shall be inclusive of all operations such as lowering of material, carriage etc., as mentioned in the technical specification. Unutilised steel pieces cut/removed shall be returned to the project stores free of charge. Non-return of unblitzed steel pieces to the Owner's store would be considered as wastage and recovery would be affected as per the provision of contract for structural steel consumption. This shall not include the weight of temporarily dismantled/supported members, connected member.

**The bidder should prepare an optimised cutting plan as per fabrication**

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<p><b>drawing to utilise the steel material upto maximum extent and minimise the wastage/scrap. Quantity of wastage/scrap of material should be limited to the percentage mentioned elsewhere in the conditions of tender/contract specifications.</b></p>			
<b>6.01.15</b>	The bidder's rates for re-erection of erection marks after additions to, alterations in and/or modifications shall be inclusive of all operations mentioned in technical specification for the calculated weight of the rectified/modified erection mark rejected at site. This shall not include the weight of temporarily dismantled/supported members, connected member. All the operations mentioned above for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been modified/rectified before erection shall not be paid under this item but shall be paid under relevant item of fabrication and erection of steel work of Schedule of items for the modified weight.		
<b>6.01.16</b>	The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning etc. along with any taxes, duties thereon etc.		
<b>6.01.17</b>	The bidder's rates for Stainless Steel hopper (if specified) shall include fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, all other operations mentioned in the technical specification. The rates shall also include for erection scheme, alignment, making cutting plan, cutting, jointing, bending, rolling, grinding, drilling, bolting, assembly, edge preparation, welding including pre-heating, post-heating, testing of welders, inspection of welds, inspection and testing, protection against damage in transit, stability of structures, installation of temporary structures etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus / waste steel materials including cut pieces/waste steel, provision of additional butt / weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.		
<b>6.01.18</b>	The bidders rates for preformed flexible open ended bellow strap of neoprene (if specified) shall include supply and transportation, installation in position, drilling, bolting, aligning etc. complete along with any taxes, duties thereon etc.		
<b>6.01.19</b>	The bidder's rates for Stainless Steel Hand Rail (if specified) shall include complete Hand Rail including, materials, fabrication, grinding & finishing, stainless steel beading, stainless steel cleats, stainless steel fasteners, neoprene gaskets, preparation of shop drawing but excluding the cost of glazing. The Owner shall supply no material for this item of work.		

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## **6.02.00 MODE OF MEASUREMENT**

**6.02.01** The measurement for the item of foundation bolts assembly including that of nuts; locknuts shall be based on the calculated weight of steel installed in Metric Tonne, corrected to second place of decimal. The weight of the foundation bolt shall be calculated in the same way as that done for the item of fabrication, erection, alignment of structural steel. The weight of the nut / locknut shall be taken as per actual weight supplied by the contractor and accepted by the Engineer.

**6.02.02** The measurement for the item of fabrication, erection, alignment, welding, etc. of structural steel work shall be based on the approved weight of steel nearest to a Kg, by applying the unit weight as adopted at the time of issue of structural steel on the measurements worked out as given below.

**6.02.03** For ISMB, ISMC, ISA, flats, round bars, square bars and pipes, length shall be taken as per distance between planes normal to the axis of the member passing through the extreme points of the section.

**6.02.04** Gussets plates in trusses, and bracings, brackets plates, stiffeners, and skew cuts if any in plates for butt welds, the area shall be assumed as the minimum circumscribed rectangle. **However deduction for any notch/skew cut shall be made as mentioned in clause no-6.02.06.**

**6.02.05** For bunker wall plates, the minimum-circumscribing rectangle of the individual plate/pieces out of which these wall plates are assembled by butt-welding, shall be measured. Care shall be taken to ensure maximum utilization of cut-pieces generated by providing extra butt joints (for which no extra payment shall be made).

**6.02.06** For all other plates, where the area of any notch/skew cut in the plate is less than 0.05 sq.m. the area of the plate shall be assumed as that of the minimum circumscribing rectangle for the purpose of measurement and calculation of area for the purpose of payment. However, if the area of any notch/skew cuts in a plate is more than 0.05 sq.m, **the area of notch/skew cut shall be deducted from assumed minimum circumscribing rectangular area for the purpose of payment.**

**6.02.07** No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.05 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.05 sq.m.

**6.02.08** All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the

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circumscribing rectangle has been considered for payment.

**6.02.09** The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment.

**6.02.10** The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for welding/bolting.

**6.02.11** The bolts and nuts required for erection purpose shall not be paid for and may be taken away by the Contractor after final welding for members. Erection boltholes left after removal of erection bolts shall be suitably plugged with welds.

**6.02.12** The measurement for the item of application of inorganic primer including blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

**6.02.13** The measurement for the item of application of finish primer system shall be based on the weight on which the epoxy based finish primer is applied in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

**6.02.14** The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor, and accepted by the Engineer. Nothing extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units.

**6.02.15** The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal of gratings galvanized by the Contractor and accepted by the Engineer.

**6.02.16** The measurement for the item of permanent bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

**6.02.17** The measurement for the item of High Strength Structural bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

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**6.02.18** The measurement for the item of the work of dismantling, additions, alterations, reerection etc. shall be as given below

**6.02.19** For dismantling, the unmodified weight of the actually dismantled erection marks shall only be measured.

**6.02.20** For the work of addition to, alteration in and / or modification of 'erection marks' either in erected position or in the fabrication yard, measurement of weight for payment purpose shall be calculated as the arithmetic sum of weight of steel cut and removed from the erection mark, weight of steel reutilised out of such cut and removed pieces and weight of additional new steel pieces added to the erection mark.

**6.02.21** For re-erection the weight of the modified erection mark shall only be measured.

**6.02.22** The weight shall be measured nearest to kg. and shall be arrived in a manner similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel.

**6.02.23** The measurement for the item of PTFE bearings shall be based on the load carrying capacity of PTFE in MT, corrected to third place of decimal, supplied by the contractor and as accepted by the Engineer and as per the approved bearing schedule, for the total vertical load carrying capacity, for all bearings.

**6.02.24** The measurement for the item of stainless steel hopper shall be based on the actual finished weight of hopper weight in Kgs, corrected to second place of decimal. The hopper weight shall be arrived by multiplying of the inner surface area of the hopper with the unit weight of the hopper plate.

**6.02.25** The measurement for the item of flexible open-ended bellows straps of neoprene shall be based in running meter, corrected to second place of decimal. Bellow Straps shall be supplied as per the requirement of the approved drawings. The measurement shall be done for the inner circumference of the bunker on which neoprene has been fixed and for the length supplied by the Contractor 'and as accepted by the Engineer.

**6.02.26** The measurement for the item of Stainless Steel Hand Railing shall be based on finished weight of handrail in Kgs corrected to second place of decimal. The weight shall also include the weight of Stainless Steel fasteners, Stainless Steel beading, Stainless Steel cleats etc. The weight shall be the finished weight of Hand Rail, as accepted by the Engineer.

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## **VOLUME: II B**

### **SECTION - D (PART I)**

#### **SUB-SECTION – D 18**

#### **ERCTION OF STRUCTURAL STEELWORK**

**SPECIFICATION NO. 4-FW-000-00969-18**



**Bharat Heavy Electricals Limited**  
**Boiler Auxiliaries Plant**  
**Ranipet - 6, Tamilnadu**

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## **SUB-SECTION – D 18**

### **ERECTION OF STRUCTURAL STEELWORK**

#### **1.00.00 SCOPE**

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

#### **2.00.00 GENERAL**

**2.01.00** 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 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, riveting, 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 rectified with Engineer's approval. 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, leveling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.
- f) Painting of the erected steel structures.

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g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:

- Removal of bends, kinks, twists etc. for parts damaged during transport and handling.
- Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.
- Reaming of holes for use of higher size rivet or bolt if required.
- Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated.
- Fabrication of parts omitted during fabrication by error, or subsequently found necessary.
- Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.
- Carry out tests in accordance with this specification.

#### **2.02.00 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.

#### **2.03.00 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 main or reinforced concrete.

#### **2.04.00 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 sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specifications and/or the instructions o the Engineer.

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## **2.05.00 Material**

### **2.05.01 General**

All fabricated steel structures and connection materials shall be supplied by the Contractor to the site. The Contractor shall take delivery from railway wagons or trucks at site, and unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified hereinbefore.

### **2.05.02 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.

## **2.06.00 Storage of Materials**

### **2.06.01 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 and the cost incurred thereon shall be realised from the Contractor's dues.

### **2.06.02 Yard**

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and 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 must 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 at his own cost as directed by the Engineer.

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### **2.06.03      Covered Store**

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 at the cost of the Contractor.

### **2.07.00      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 :

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

### **2.08.00      Taking Delivery**

The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge.

### **3.00.00      WORKMANSHIP**

#### **3.01.00      Erection**

##### **3.01.01      Plant and Equipment**

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

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Engineer.

### **3.01.02 Method and sequence of erection**

The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.

### **3.01.03 Temporary Bracing**

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, free of cost to the Owner, 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.

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 free of cost to the Owner.

The requirement 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.

The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.

### **3.01.04 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 bylaws of state, Municipal or other local authorities.

### **3.01.05 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. For heavy columns,

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etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance under this Specification.

No permanent field connections by riveting, bolting or shall be carried out until proper alignment and plumbing has been attained.

### **3.01.06 Field Riveting**

All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

### **3.01.07 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.

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

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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-I 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 times dia or 200 mm	Bolt length exceeding 8 times dia or 200 mm	Remarks
1/2 turn	2/3 turn	<p>Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned.</p> <p>Tolerance on rotation-30° over or under.</p>

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 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 (See Note below the Table). 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.

**TABLE-II**

Nominal Bolt Diameter (mm) (Kg.M) of IS:1367	Torque to be applied for bolt class 8.8
20	59.94

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81.63

24

103.73

Note: The above torque values are approximate for providing tensions of 14.7 T for 20 mm dia.; and 21.2 T 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 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.

### 3.01.08 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.

### 3.01.09 Holes, Cutting and Fitting

No cutting of sections, flanges, webs, cleats, rivets, 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, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is obtain specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

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### **3.02.00 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.

### **3.03.00 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.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled, 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.

If required by the Engineer, certain admixtures like aluminium powder, "ironite" or equivalent, may be required to be added to the grout to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required flowability and compressive strength may also be used with Engineer's approval.

### **3.04.00 Painting after Erection**

Field painting shall only be done after the structure is erected, levelled,

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plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and masonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost 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 frosty 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 rivets, 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 Bolts and fabricated steel members who are galvanized or otherwise treated and steel members to be encased shall not be painted.

The final painting shall be of tow coats of Synthetics Enamel painting or Aluminium paint of approved manufacture as per the approved "Schedule of Painting". The shades shall also be as per the approved schedule. Synthetic enamel paint shall conform to IS: 2932.

### **3.05.00      Final cleaning up**

Upon completion of erection and before final acceptance of the work by the Engineer, the contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

### **4.00.00      TESTING AND ACCEPTANCE CRITERIA**

#### **4.01.00      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 as per the Contract and no payment towards the cost of the dismantled portion and any connected

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work shall be made to the contractor. 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 free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

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 4.01.01, 4.01.02 and 4.01.03. The method of testing and application of loading shall be as approved by the Engineer.

#### **4.01.01 Stiffness Test**

In this test, the structure or member shall be subjected, 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 per cent of the maximum increase in strain or deflection recorded during the second test.

#### **4.01.02 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 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 the 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.

#### **4.01.03 Structure of same design**

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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.

#### **4.01.04 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 4.01.01 hereinbefore.

#### **4.02.00 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 steel work applicable to this Project and as specified below: The specified tolerance is mainly for welded erection. In case of bolted erection, no tolerance is desired so that all prefabricated bolt holes are matched on erection.

##### **I. For Buildings Containing Cranes**

Component	Description	Variation Allowed
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1.	2.	3.
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Main columns	a) shifting of column axis
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<p>at foundation level with respect to building line</p> <p>i) In longitudinal direction <math>\pm 3.0</math> mm</p> <p>ii) In lateral direction <math>\pm 3.0</math> mm</p> <p>b) Deviation of both major column axis from vertical between foundation and other member connection levels:</p> <p>i) For a column upto and including 10M height <math>\pm 3.5</math> mm from true vertical</p> <p>ii) For a column greater than 10M but less than 40M height <math>\pm 3.5</math> mm from true vertical for any 10 M length measured between connection levels, but not more than <math>\pm 7</math> mm per 30m length.</p> <p>c) For adjacent pairs of columns across the width of the building prior to placing of truss <math>\pm 9.0</math> mm on true span.</p> <p>d) For any individual column deviation of any bearing or resting level from levels shown on drawings. <math>\pm 3.0</math> mm</p> <p>e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating 3.0 mm</p> <p>Trusses</p> <p>least.</p> <p>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 greater than 10mm whichever is the</p> <p>Trusses</p> <p>b) Lateral displacement of top chord at center of 1/250 of depth of truss or 20 mm</p>			

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	span from vertical plane running through center of supports.	which ever is the least.
Crane Cirders	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 thermite welding.	1.0 mm.
	d) Deviation of crane rail axis from centre line of web.	± 3.5 mm
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.	
iv) 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 lox 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.		
<b>4.03.00</b>	<b>Acceptance</b>	
Structures and members have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.		

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## **5.00.00 INFORMATION TO BE SUBMITTED**

### **5.01.00 Before Tender**

#### **5.01.01 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.

**5.01.02** Constructional Plant and Equipment, Tools, Temporary works & manpower A detailed list Of all constructional plant and 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.

#### **5.01.03 Erection Yard**

A site plan showing the layout and location of the erection yard proposed to be established by the tenderer shall also 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.

### **5.02.00 After award of the Contract**

After award of the contract, the Contractor shall submit the following:

#### **5.02.01 Detailed Programme**

The Contractor shall submit a detailed erection programme within a month of the award of the Contract 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 required strength of various categories of workers in a proforma approved by the Engineer.

#### **5.02.02 Fortnightly Progress Report**

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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 5.02.01 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.

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## **VOLUME: II B**

### **SECTION - D**

#### **SUB-SECTION – D19**

#### **ROOF DECKING**

**SPECIFICATION NO. 4-FW-000-00969-19**



**Bharat Heavy Electricals Limited**  
**Boiler Auxiliaries Plant**  
**Ranipet - 6, Tamilnadu**

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## **ROOF DECKING**

### **1.00.00 Scope**

This section of the specification covers the supply, fabrication and erection of profiled light gauge Metal Decks (coated and painted) as roof decking to the main plant building and any other area as indicated in the drawings.

### **2.00.00 Material**

**2.01.01** The roof/slab over silo structure and similar structure consists of permanently colour coated metal decking, as floor / roof decking, of steel with zinc coated to class Z275 with minimum bare metal thickness (i.e. excluding the thickness of coating and painting) of 0.8mm of grade G250 as per AS1397 / grade SS255 as per ASTM A653M / grade S250GD as per EN 10326 or with minimum bare metal thickness ( i.e. excluding the thickness of coating and painting) of 0.6mm of grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A653M / grade S350GD as per EN 10326 or of grade G550 as per AS1397 / grade SS550 as per ASTM A653M / grade S550GD as per EN 10326 or alternatively aluminium feed material of minimum bare metal thickness of 0.9 mm of aluminium alloy of series 31000 and above as per IS : 737 and IS : 1254, steel / aluminium both colour coated with total coating thickness of 35 microns (nominal) dry film thickness (DFT) comprising of Silicon Modified Polyester (SMP with silicon content of 30% to 50%) paint or Polyester paint, of 20 microns (nominal) SMP or polyester paint on one side (exposed side) over 5 micron (nominal) primer coat and 5 micron (nominal) SMP or Polyester paint over 5 micron (nominal) primer coat on other side, (SMP and Polyester paint shall conform to Product type 4 of AS/NZS 2728), and of approved profile, sectional properties (suitable for the specified loading / deflection and purlins / runner spacing), colour and shade, at all levels, including all labour, materials, handling, transportation, special coated fasteners conforming to corrosion resistant class 3 of AS 3566 and tested for 1000 hours salt spray test, scaffolding, equipment, end and side laps, cutting of openings, preparation of working drawings, testing, etc., all complete, as per specifications, drawings and instructions of the Engineer.

### **3.00.00 INSTALLATION**

The Contractor shall furnish all labour, equipment and materials as required for the design, fabrication, coating, erection and fixing of the decking over purlins, painting and for the complete performance of the work in accordance with the construction drawings and as described herein.

The description, which follows, gives a general indication of the nature and extent of the work but is not necessarily exhaustive and does not purport to

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cover all the details/operations which will be necessary in order to carry out the work.

### **3.01.00      Detailed Design of Roof Decking**

The Contractor, in conjunction with the manufacturer, shall be responsible for the detailing of the profiled decking, fittings and fixtures and shall submit with his tender particulars of the proposed manufacturer and of the particular product proposed for use. The detailing is to be based on typical details furnished by the Engineer. The Contractor shall submit to the Engineer, two copies of the general arrangement and detailed working drawings for the proposed design, together with all calculations necessary to verify the adequacy and completeness of the design & detailing of decking sheets, fixtures, flashings and trims. After approval he shall supply further eight copies.

The Engineer will verify the correct interpretation of his requirements but may not necessarily check the design and details, and the Contractor shall be entirely responsible for the accuracy of the drawings and the correctness of the design and the suitability of the details. Manufacture of roof decking sheets shall not commence until the necessary approval of the Engineer has been obtained.

### **3.02.00      Erection & Fixing**

#### **3.02.01      Sequence of Manufacture/Erection**

Cutting Schedules, delivery to site and stacking arrangements in store shall ensure that sheets are erected in a sequence which follows that for the manufacture. The decking sheets shall be erected using an arrangement of sheets and joints to conform with the requirements of this specification. Decking erection for each elevation or feature shall commence at one end only and proceed towards the other end, in order to ensure tight fitting laps.

#### **3.02.02      Position and Location of Laps**

Side and end laps of roof decking sheets shall be located and positioned in such a manner as to provide the maximum weather protection taking into account the direction of the prevailing wind.

The lines formed by horizontal laps and fixing shall where possible, be continuous and coincide with the edges of large openings in the roof.

#### **3.02.03      Alignment of Sheets and Fixings**

All roof decking sheets shall be fixed plumb and level with all fixings evenly spaced and accurately lined. All dirt and grease shall be removed from the surfaces of the sheets as the work proceeds.

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### **3.02.04 Site Cutting**

Approval must be obtained before the roof decking sheets are cut at site. Generally cutting of sheets to length will not be permitted, only special cutting and trimming for small openings shall be allowed. Where possible, site cut edges shall be concealed at laps.

### **3.02.05 Damaged Sheets**

Distorted, blemished or water stained sheets and any other fittings shall not be used.

### **3.02.06 Laps**

End laps and side laps to roof decking sheets shall be sufficiently large to ensure that the decking complies with the weather tightness and other requirements of this specification. The length of each decking sheet shall be adjusted so that the end laps shall bear on the purlins. In no case end laps shall not be less than 150 mm and side laps shall not be less than 53 mm.

### **3.02.07 End Lap Fixings**

End lap fixings shall be located at least 25 mm from the end of each sheet.

### **3.02.08 Side Lap Fixings**

The spacing of side lap fixings shall ensure compliance with this specification regarding tightness. The spacing of these fixing screws shall not exceed 500mm. The fixing shall be located in the bottom flat of the corrugation.

### **3.02.09 Holes**

Holes in MS decking sheets shall be punched. In case holes are drilled holes, it is to be ensured that the holes do not go oversize due to the small thickness of the sheeting. All drilling swarf shall be removed from the surfaces of decking, supporting steel work, purlins etc.

### **3.02.10 Location and Spacing of Fixings**

Fixings shall be accurately located in position in the centre of the corrugations to ensure that the heads of bolts, nuts and washers bear squarely down on the surface of the sheeting and are not located at the edge or on the joints in supporting purlins.

### **3.02.11 Fixings**

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The tenderer shall submit with his tender details of the proposed method for securing the roofing sheets to the metal purlins. The roof decking sheets are to be fixed to the roof purlins with hex washer head white zinc plated heat treated carbon steel self drilling / self tapping screws of minimum thread diameter of 5.6mm. These self drilling screws shall be drilled through the roofing sheets and purlins supporting the roofing sheets. These purlins shall be suitably spaced as per the requirement of roofing sheets and the roofing sheets shall not sag more than span/250 for the loads likely to be imposed during concreting and in future. The self-drilling screws are to be spaced at a maximum distance of 390mm centre to centre along the length of the purlins and top chord of truss. The screws are to be located preferably in the valley only and shall be installed in accordance with the manufacturer's recommendations using tools approved by the manufacturer which do not damage the coating of the decking sheets.

#### **3.03.00 Protection during Construction**

Precautions shall be taken during the erection of the roof decking to ensure that partially erected decking are protected during inclement weather and damage at all times.

#### **3.04.00 Damage**

Any damage to coating & primer during transportation is to be redone with the similar type of coating as per the manufacturer's specification at no extra cost to the Owner.

#### **4.00.00 Acceptance Criteria**

The installation shall present a neat appearance and shall be checked for water tightness. The following shall be checked :

- a) Side and end laps
- b) Absence of damage in the sheeting.
- c) Conformity of fixings with the approved design.

#### **5.00.00 IS Codes**

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 of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

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IS : 513 - Specification for cold rolled carbon steel sheets.

IS : 3618 - Specification for phosphate treatment of iron and steel for protection against corrosion.

IS : 4431 - Specification for carbon & carbon manganese free cutting steel.

IS : 1573 - Electroplated Coatings of zinc on iron and steel.

#### **6.00.0      RATES AND MEASUREMENTS**

##### **6.01.00      Rates**

Rates shall be unit rate for complete item described in the Schedule of Items and shall include all wastage.

##### **6.02.00      Method of Measurement**

Roofing shall be measured for net area of the work done. Profiled sheeting (coated & painted) shall be measured in plan area of sheets and not girthed. No deduction shall be made for openings measuring up to 0.1 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.

No payments shall be made for laps.

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## **VOLUME: II B**

### **SECTION - D**

#### **SUB-SECTION – D21**

### **BORED CAST-IN-SITU RCC PILES**

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**Bharat Heavy Electricals Limited**  
**Boiler Auxiliaries Plant**  
**Ranipet - 6, Tamilnadu**

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## **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 REQUIREMENTS**

- 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.

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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.

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### **3.00.00 MATERIALS**

#### **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/M<sup>3</sup> of concrete shall be used for M-25 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.

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	<p><b>3.03.03</b> The longitudinal reinforcement shall project 50 times its diameter above cut off level unless otherwise indicated.</p> <p><b>3.03.04</b> 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 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.</p> <p><b>3.03.05</b> 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.</p> <p><b>3.03.06</b> The minimum clear distance between the two adjacent main reinforcement bars shall normally be 100 mm for the full depth of cage.</p> <p><b>3.03.07</b> 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.</p> <p><b>3.03.08</b> 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).</p> <p><b>3.03.09</b> 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.</p> <p><b>3.03.10</b> Minimum clear cover to the longitudinal reinforcement shall be 50 mm, unless otherwise mentioned.</p> <p><b>3.03.11</b> Bundling of bars is not permitted.</p>	
<p><b>4.00.00</b> <b>PILE INSTALLATION</b></p> <p>Installation of piles shall be carried out as per pile layout drawings, installation criteria, and the direction of the Engineer.</p> <p><b>4.01.00</b> <b>Equipment and Accessories</b></p> <p><b>4.01.01</b> 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.</p>		

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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.		
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.		
<b>4.02.00</b>	<b>Installation Criteria</b>		
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.		

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#### **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.

- 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

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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.

#### **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

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<p>minimum specified strength in accordance with IS: 456 at requisite workability (slump).</p> <p>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.</p> <p>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.</p> <p>4.08.04     Proper placement of the reinforcement cage to its full length shall be ensured before concreting.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p><b>4.09.00     Cut off level (COL)</b></p> <p>4.09.01     Cut off level of piles shall be as indicated in drawings released for construction or as indicated by the Engineer.</p> <p>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.</p> <p>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</p>			

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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**

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.

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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.		
<b>4.14.00</b>	<b>Rejection and Replacement of Defective Piles</b>		
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.		
<b>4.15.00</b>	<b>Recording of Piling Data</b>		
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.		
<b>5.00.00</b>	<b>SAMPLING, TESTING AND QUALITY ASSURANCE</b>		
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.		
<b>5.04.00</b>	<b>Quality Assurance Programme</b>		

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- 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 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**

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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.				
<b>5.07.00</b>	<b>Properties of Drilling mud</b>				
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.				
<b>5.08.00</b>	<b>Check for Pile bore</b>				
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) 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.				
	b) Use of borehole camera for checking the pile bore spoil and strata is acceptable on approval of the Engineer.				
<b>5.09.00</b>	<b>Pile Integrity test</b>				
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.				

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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:

- a) 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.
- b) 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.
- c) 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 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.

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## 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 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 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 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 Part I/Sec 2 - 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

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Part IV	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.
<b>8.00.00</b>	<b>RATES AND MEASUREMENTS</b>
	The clauses below shall apply for item rate contracts only. They shall not be applicable to turnkey/lump sum Contracts.
<b>8.01.00</b>	<b>Rates</b>
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, 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.

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<p>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.</p> <p>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.</p> <p>8.01.08 The quoted rate for piling shall also include chiselling, if any, required for socketing the pile in rock.</p> <p>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.</p> <p>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.</p> <p>8.02.11 Plasticiser/Admixture when used as directed by the Engineer shall be included in piling rates.</p> <p>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.</p> <p>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.</p> <p>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.</p>			

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#### **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.

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.

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### **ANNEXURE-A**

#### **Specific Requirements for Bored Cast-in-situ RCC Piles**

A1.0	Minimum cement concrete grade	M-25												
	Minimum cement content	400 Kg/M <sup>3</sup>												
A1.1	Safe load													
	Diameter of Pile													
		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center; padding: 2px;">Diameter of Pile (mm)</th> <th style="text-align: center; padding: 2px;">Vertical/ Compression (MT)</th> <th style="text-align: center; padding: 2px;">Horizontal/ Lateral (MX)</th> <th style="text-align: center; padding: 2px;">Pul lout/Tension (MT)</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; padding: 2px;">*</td><td style="text-align: center; padding: 2px;">*</td><td style="text-align: center; padding: 2px;">*</td><td style="text-align: center; padding: 2px;">*</td></tr> <tr> <td style="text-align: center; padding: 2px;">*</td><td style="text-align: center; padding: 2px;">*</td><td style="text-align: center; padding: 2px;">*</td><td style="text-align: center; padding: 2px;">*</td></tr> </tbody> </table>	Diameter of Pile (mm)	Vertical/ Compression (MT)	Horizontal/ Lateral (MX)	Pul lout/Tension (MT)	*	*	*	*	*	*	*	*
Diameter of Pile (mm)	Vertical/ Compression (MT)	Horizontal/ Lateral (MX)	Pul lout/Tension (MT)											
*	*	*	*											
*	*	*	*											
A2.	Installation criteria													
		The installed pile(s) shall satisfy the following criteria.												
A2.1	In Soil/weathered Rock													
	a)	Minimum length of the pile shall be _____ * m below COL.												
	b)	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													
	a)	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.												
	b)	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												

 <b>BHEL</b> <i>Maharashtra Company</i>	<b>TITLE:</b>	<b>SPECIFICATION NO. 4-FW-000-00969-21</b>	
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	<b>BORED CAST-IN-SITU RCC PILES</b>	<b>SECTION - D</b>	<b>SUB-SECTION – D21</b>
		<b>REV.NO.</b> 00	<b>DATE</b> 05/02/2020
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Installation criteria

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.

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**ANNEXURE-B****List of Equipments**

SI.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.

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#### **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.

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**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 -

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14. SPT\* N values in soil (from the nearest bore hole).  
+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.

 Maharashtra Company	<b>TITLE:</b> <b>TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU RCC PILES</b>	SPECIFICATION NO. 4-FW-000-00969-21	
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**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	