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

No. PW/NGP/PUR/UKAI-CVL2/496

FOR

CIVIL WORKS FOR 2 NOS ID FAN & 6 NOS OF ESP COLUMNS, 28 NOS OF DUCT SUPPORT FOUNDATION & STRENGTHENING OF 6 NOS ESP COLUMN FOUNDATIONS, CONSTRUCTION OF SWAS ROOM, SOX/ NOX ROOM, ID FAN LUB OIL UNIT ROOM ETC

AT

GSECL, UKAI, SONGARH, UNIT-2 (120MW)
DIST- SURAT, GUJRAT

PART I - TECHNICAL BID

(VOLUME- II)

TECHNICAL SPECIFICATION

BOOK NO.

BHARAT HEAVY ELECTRICALS LIMITED
(*A GOVERNMENT OF INDIA UNDERTAKING*)
POWER SECTOR - WESTERN REGION
SHREEMOHINI COMPLEX
345-KINGSWAY, NAGPUR - 440 001

BHARAT HEAVY ELECTRICALS LIMITED

(A GOVERNMENT OF INDIA UNDERTAKING)
POWER SECTOR - WESTERN REGION
345, KINGS WAY - NAGPUR 440 001

TENDER SPECIFICATION NO. : BHE/PW/PUR/UKAI-CVL2/496

NAME OF THE WORK :

CIVIL WORKS FOR ID FAN FOUNDATION-2 NOS, ESP COLUMN – 6 NOS, DUCT SUPPORT FOUNDATION – 28 NOS , AND STRENGTHENING OF 6 NOS ESP COLUMN FOUNDATION ROOMS FOR SWAS, SOX/NOX AND ID FANS LUB OIL UNITS ETC AT 120 MW UNIT # 2 GSECL, UKAI, SONGARH, , DIST- SURAT, GUJRAT

EARNEST MONEY DEPOSIT: Please see Section-15 of Special Conditions of Contract.

LAST DATE AND TIME FOR
RECEIPT OF OFFERS: Please visit web page www.bhel.com -> **"Tender Notification"** and **"View Corrigendum"**

THESE TENDER DOCUMENTS CONTAINING PART**-I** TECHNICAL BID VOL –I & II AND PART**- II** (VOL-III) PRICE BID, ARE ISSUED TO:

M/s. ……

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PLEASE NOTE:

1) **THESE TENDER DOCUMENTS ARE NOT TRANSFERABLE.**
2) **TENDERER SHALL NOTE THAT THEIR OFFER WILL BE CONSIDERED SUBJECT TO THE APPROVAL OF BHEL'S CUSTOMER M/s GESCL.**

For Bharat Heavy Electricals Limited

SR MANAGER (PURCHASE)
PLACE: NAGPUR
DATE:

TECHNICAL SPECIFICATION

1.0 The works to be performed under this contract consist of providing all labour, supervision, material, scaffolding, construction equipments, tools and plants, temporary works, supplies, transportation and all incidental items not shown or specified but reasonably implied or necessary for the proper completion of work in all respects. Testing of all materials, concrete, earthwork other allied works, preparation of bar bending schedules on the basis of construction drawings are included on the rates of items of work. Works shall only be carried out with approved drawing for construction.

2.0 Supply, Fabrication and erection of structural steel work if any, non destructive testing etc. Complete as per Quality Plan/Customer requirements.

3.0 The area of work shall be cleared of all vegetation, rubbish and other objectionable matter and materials remove, shall be burnt or otherwise disposed of as directed by BHEL/BHEL'S CUSTOMER.

4.0 All gold, silver, oil or other minerals of any description and all precious stones, coils, treasures, realise, antiques, and other similar things which may be found in or upon the site shall be the property of BHEL. The contractor shall duly preserve the same and from time to time deliver the same to such person or persons as BHEL may from time to time appoint to receive the same.

5.0 All the works areas shall be adequately flood lighted to the satisfaction of BHEL/BHEL'S CUSTOMER when the work is in progress during the night shifts.

6.0 **Layout and Levels**

Before start of the work, Contractor has to establish one Bench mark pillar & one grid reference pillar from existing point/ structures available nearby the ID fan area in consultation with BHEL/BHEL'S CUSTOMER to avoid the mismatch with existing systems within their quoted item rate. All further work shall be carried out with this reference. The contractor shall maintain a certified copy of drawing (joint protocol) showing such approved reference lines, marks and levels and shall not remove any of them without the prior approval of BHEL/BHEL'S CUSTOMER. The reference points and pillars thus established in the works area shall be fully protected and maintained by the contractor at their own expenses for entire period of work. He shall repair and rebuild the same in case of any damage.

The contractor shall layout the work from these reference base lines in consultation with BHEL/BHEL'S CUSTOMER and shall be responsible for the correctness of all measurements.

7.0 **Setting of Laboratory:**

The contractor shall either set up his own laboratory in the very close vicinity of the work site or shall arrange the testing in any outside approved lab. as per the directions of BHEL/BHEL'S CUSTOMER at his cost.

8.0 **Item should be read in conjunction with corresponding technical specification & description of item. In case of conflict, BHEL's decision shall be final & binding.**

10.0 No separate payment for dewatering of sub-soil or surface water if required during the execution of work including monsoon period would be made by the Employer and the rates in the B.O.Q for various items would be deemed to be inclusive of all such dewatering, if necessary.

11.0 Design drawings showing enough details for the construction as per the specification shall be furnished to the contractor in a phased manner and sequentially as far as possible.

SPECIFICATION FOR EARTH WORK

1.0 SCOPE

1.1 This specification covers the earth work in excavation, filling, grading and leveling of site for foundation, trenches, cable trenches etc. generally comprising of soil, rock etc.

1.2 Methods of measurements are indicated in these specifications, Where not so specified, latest version of I.S. 1200 (Part - I) shall be applicable. The workmanship shall conform to the provision of IS: 3764 (Safety Code).

1.3 Supplying, providing and operating of necessary measuring and testing devices and materials including consumables, if any, are included in the scope of work. No separate measurement or payment for testing the work shall be made but rates quoted for the items shall include the cost of such tests which are required during the course of execution of the job.

1.4 All tools and tackles, equipment, machinery used in this work shall be of standard quality and manufactured by reputed concerns conforming to IS Code or equivalent thereof. Classification of various types of soil encountered during the excavation, shall be in accordance with clause 2.0. Any material used for back filling should be got approved by BHEL. Any material which is of sub-standard quality procured and brought to site shall be rejected by BHEL/BHEL'S CUSTOMER. The contractor upon such rejection by BHEL shall remove the materials from the site at his risk and cost and no extra compensation whatsoever shall be paid on this account.

1.5 In addition to these specifications latest Indian Standard codes shall be used where applicable.

1.6 In case of conflict amongst the various provisions of specifications the decision of BHEL shall be final and binding on the Vendor.

2.0 MATERIALS

2.1.0 Material for excavation

For the purpose of classification of the various soils met during the course of excavation the following classifications are to be followed.

2.1.1 Soft Rock

It shall include rock removable in the opinion of BHEL without blasting such as lime stone, sand stone, weathered rocks, hard conglomerates etc. by splitting with the help of crow bars, wedges, pavement breakers, pneumatic tools hammers or such implements.

2.1.2 Hard Rock

It shall include sub-surface/surface strata which require blasting in the opinion of the 'BHEL' for excavation, but where blasting is prohibited for any reasons, excavations has to be carried out by chiseling, wedging or any other method approved by BHEL.

The mere fact that Vendor resorts to blasting shall not classify the soil under hard rock.

2.1.3 Soil

All soils which can be excavated by normal means such as shovels, pick axe, spade etc and which do not fall under 2.1.1 or 2.1.2 shall be classified under this head.

2.1.4 The type of soil met during excavation shall be classified by BHEL, whose decision will be final & binding on the Vendor

2.2.0 Materials for filling

As far as possible , selected excavated earth shall only be used for back filling. In case excavated earth is not found to be suitable for back filling, the same has to be brought from out side from contractors own source. Materials used for back filling shall be got approved by BHEL before being brought to site. The rate shall be inclusive of all taxes, levies, duties, Royalties & any other charges required to be paid for earth to be brought from out side.

2.2.1 Earth

Normally excavated earth shall be used for refilling. In case such earth contains deleterious salts it shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock the boulder shall be broken into pieces not bigger than 15cm size in any direction mixed with fine materials consisting of decomposed rock murrum or earth as available as to fill up the voids as far as possible and then the mixture used for filling. Selected earth if brought from borrow pits shall be got approved by BHEL.

2.2.2 Sand

Where backfilling is required to be done with sand the same shall be to the approval of BHEL. Coarse or fine sand free from silt and clay and deleterious organic matter shall be used. Sand filling has to be flooded with water and compacted.

2.2.3 Lean Concrete

This has to be got approved by BHEL before placing over the performed surface. Back filling lean concrete of normal mix 1:4:8 (1 cement : 4 sand : 8 Aggregate of 40mm size) to be used, where excavation has been done beyond the lines shown on drawing.

2.2.4 All materials used for backfilling, shall be free from rubbish roots, hard lumps and other foreign organic materials.

3.0 GENERAL

3.1 The Vendor shall at his own expenses without extra charges, make provisions for pumping, dredging or bailing out water, lighting, fencing and protection against risk of accident due to open excavation, the excavations shall be kept free from water until the work in foundations is completed and trenches refilled, till the structure is stable against uplift due to sub- soil water as per the direction of BHEL.

3.2 Loose, soft or bad ground encountered in excavation at the required depth shall on BHEL's instructions be excavated to a firm bed, the difference made up to the required level with lean concrete as desired by BHEL.

3.3 Any obstacle encountered during the course of excavation shall be reported immediately to BHEL and shall be dealt with as instructed by him.

3.4 Any ancient carvings, relics of antiquity, coins curious which may be discovered or excavated by the Vendor shall be property of the Owner and shall be delivered to BHEL.

3.5 The Vendor shall obtain prior permission of BHEL before concreting the foundation and the excavation pit has to be got approved by BHEL.

3.6 Excavation of rock shall be done such that extra excavation beyond the required widths and depths as shown in drawings is not made.

If any extra excavation is particularly in depths are made by the Vendor, the Vendor shall make up such extra excavations with concrete to the required level and shape. No extra payment on this work shall be entertained by BHEL.

The measurement of rocks when made from stacks of spoils, shall be reduced by **30%** for voids for payment as excavation. In case of blasting, instructions

obtained from BHEL shall be followed as described in following clauses. The cost of total blasting shall be borne by the Vendor.

3.7 Where level for different soil strata cannot be precisely marked and defined, the Vendor shall stack different soils of various classification separately for measurement purposes and then dispose off as directed.

3.8 The measurement from stacks in case where excavation consisting of various classification/type of soils and where levels of various strata cannot be precisely fixed, the total quantity shall be computed from the trench measurement. To work out the quantity of hard rock and soft rock, measurements of stacks to be reduced by **30%**. This quantity shall be deducted from the total quantity computed from trench measurement to obtain quantity to be considered as soil.

4.0.0 EXECUTION

4.1.0 Site Clearance

Before the commencement of earthwork, the entire area coming under cutting and filling shall be cleared of shrubs, vegetation, grass brushwood, trees of girth up to 300mm measured at a height of 1.0m above ground and all rubbish removed upto a distance of 50.0m outside the periphery of the area under clearance. The rooting of trees be removed to a minimum depth of 60cm below ground level or a minimum of 30 cm below formation level which ever is lower. The hollows to be filled up with earth leveled and rammed. Trees of girth more than 300mm and height more than 1.0m above ground shall be cut only after obtaining permission from BHEL. Payment for such removal shall be made extra. Existing structures such as old buildings, culverts, pipe lines, sewers etc. if so required by BHEL shall be dismantled/rerouted and payment of which shall made separately.

4.2.0 Setting out and making profiles

4.2.1 The Vendor shall be responsible for the true and proper setting out of the works in relation to the original points lines and levels of reference and for the correctness of the levels dimensions and alignment of all parts of the work and for the provision of all necessary instruments appliances labour in connection there with. If at any time during the progress of works any error shall appear or arise in the position of levels, dimensions or alignment of any part of the works the Vendor shall at his own expense rectify such errors to the satisfaction of BHEL. The checking of any line or level by BHEL shall not in any way relieve the Vendor of his responsibilities.

4.2.2 The Vendor shall take levels of the area to be excavated before starting any excavation work at an interval of not more than 10.0m or as directed by BHEL.

4.2.3 The Vendor shall layout and provide one or more permanent bench mark at some central place before the start of the work from which all important

levels for the excavations shall be set. The Vendor shall provide all labour and material for setting levels at his own cost.

4.3.0 Earthwork in excavations

4.3.1 Excavation shall be carried out in any material met on the site to the lines, levels and contours shown on the detailed drawing and shall remove all excavated materials to soil heaps on site or transport for use as filling on the site as directed.

4.3.2 Excavated material suitable for back filling shall be deposited at a safe distance about 50m from excavated pit to avoid congestion at site. Surplus earth should be immediately disposed-off to the disposal yard inside/outside the plant as directed by BHEL.

4.3.3 Suitable type of shoring and strutting wherever necessary, shall be adopted to withhold the face of earth or cutting in slope as per requirements and as directed by BHEL.

4.3.4 Foundation pits shall not be excavated to the full depth unless construction is imminent. The last 15 cm depth of the excavation shall not be removed until concreting work is imminent. The full depth may at the discretion of BHEL, be excavated and the bed covered with 100mm thick layer of lean concrete of (1:4:8) mix, after watering and consolidating the bed.

4.3.5 The Vendor shall provide suitable drainage arrangements to prevent surface water entering foundation pits. The vendor shall engage pumps or other approved means to keep excavation free of water where excavation is carried out below ground water table.

4.3.6 If the bottom of any excavation has been left exposed by the vendor and that in the opinion of BHEL it has become deleteriously affected by the atmosphere or by water, then the vendor shall remove such portions of the deteriorated foundation material and shall make good such portions with lean concrete. All expenses for such additional concreting and excavation shall be borne by the Contractor.

4.3.7 Where excavation is done in excess of the depth required, the vendor shall, at his own expense fill up such extra excavation to the required level with concrete as directed by BHEL.

4.3.8 Where working space is required outside the underground structure, extra excavation as actually required may be done. However, payment for such extra work shall be governed by provision of IS 1200.

4.4.0 **Excavation for cable trenches and ducts**

4.4.1 The excavation shall be protected with adequate shoring, strutting as necessary to avoid slips.

4.4.2 Removal of buried piping or cables shall not be done without prior permission of BHEL. The vendor, if necessary, shall provide all measures to protect such lines. Removal/diversion of such underground services shall be done by contractor in consultation with BHEL within their quoted item rate. However, materials required shall be issued by BHEL free of charge. The vendor shall take sufficient measures to keep the excavation free from water.

4.5.0 **Back filling around foundation and plinth**

4.5.1 Back filling around completed foundation shall be done to the lines and levels shown on the drawing including any framing of the surfaces as may be necessary. This will be done from approved earth from excavation. Compaction equipment shall be used to produce minimum of 95% modified proctor's density or as indicated on drawings. Where sufficient suitable materials is not available from excavation BHEL may direct to import suitable earth from different source. The re- filling shall be done in horizontal layers of thickness not exceeding 15cm free from pockets with careful watering and ramming. When filling reaches the finished level the surface shall be flooded with water, unless otherwise directed, for atleast 24 hr. allowed to dry and then the surface again compacted as specified above to the satisfaction of BHEL.

Where specified proctor density measurements to be taken, the vendor shall not fill in around any work until and unless it is approved by BHEL.

4.5.2 Payment for backfilling shall be based on volume of consolidated fill. This volume shall be derived from the difference between the volume of excavation and the structure or trenches as the case may be. The rate shall include cost of extracting suitable approved earth from excavated soil, carriage up to place of back filling, placing watering, compacting in layers trimming and dressing finished surface and disposal of surplus material as directed. Backfilling of excavation beyond limits as shown on approved drawings or as directed by BHEL will not be paid for and shall be to the account of the contractor.

4.6.0 Removal of surplus earth

4.6.1 Surplus earth and other debris shall be removed from construction site to the area demarcated by the BHEL.

4.6.2 Payment shall be made only for lead beyond initial **100m** from construction area. Rate shall include loading, transportation, dumping, stacking or spreading as per directions of BHEL. Payment shall be made on cubic meter basis on the difference of measurements of the volumes of the excavated pits and the measurements of the back filling.

4.7.0 Measurement of lead and lift

4.7.1 For carriage of excavated material away from or to a work spot, extra leads where separately quoted shall be measured beyond the first 100m. The

lead shall be measured along the shortest permissible route of movement. No positive or negative lift will be measured if mechanical means or animal transport is used.

4.8.0 Excavation by blasting

4.8.1 Blasting shall not be permitted for excavation in hard rock due to being very close to existing running unit. Contractor has to use any other suitable methods like chiseling, chemical grouting, rock breaker arrangement in excavator etc. in case hard rock is mat with. However in specific request of contractor, they can be permitted for controlled blasting on absolute necessity on prior approval. Permission for blasting shall be on discretion of BHEL/BHEL's Customer. On getting permission, a valid blasting license shall be obtained by the Contractor from authorities concerned . The item rate shall be inclusive of all this aspects.

4.8.2 The use and storage of all explosives in magazines shall be subject to the approval of concerned authorities and shall be to the satisfaction of BHEL.

4.8.3 The contractor shall be responsible for any accident to workmen, public or owner's property due to blasting operations in absence of adequate protection from his end. The Contractor shall also be responsible for strict observance of rules laid down by the Inspector of explosives or any other authority concerned.

4.8.4 Where blasting is permitted it shall be carried out strictly in accordance with arrangements previously agreed in writing by BHEL.

4.8.5 Safety codes IS 4081 & IS 6922 should be followed in connection with the blasting work.

4.9 Dewatering

All excavations shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The contractor shall remove by pumping or other means approved by BHEL any water inclusive of rain water and subsoil water accumulated in excavation & keep all excavations dewatered until the foundation work is completed and backfilled. The pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction.

5.0 **Mode of measurement**

The length, breadth and depth shall be measured correct to the nearest cm in case the measurements are taken with tape. For rounding of the numericals the latest Indian Standard Code should be referred to. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm, the cubic contents shall be worked out to the nearest two places of decimal in cubic meters.

5.2 Where the ground is not fairly uniform or where the site is required to be leveled, levels shall be taken before the start and after the completion of the work. The quantity of excavation in cutting shall be computed from these levels.

5.3 Where ordinary rock and hard rock is mixed, the measurement of the excavation shall be done by methods as described in clauses 3.5. The two kinds of rocks shall be stacked separately and measured in stacks. The net quantity of the two units of rocks shall be so arrived by applying deduction of 30% for looseness in stacks. If the sum of net quantity of two kinds of rocks exceeds the total quantity of the excavated material, then the quantity for each type of rock shall be worked out from the total quantity in the ratio of net quantities in stack measurements of the two type of rocks. Where stacking in not feasible, the method suggested by BHEL shall be followed.

5.4 Where soils, ordinary rock or hard rock are mixed, the measurements for the entire excavation shall be taken as indicated in clause 3.7. Excavated material from hard rock and ordinary rock shall be stacked separately measurements for each shall be reduced by 30% to allow for voids and to arrive at the net quantity. The difference between the entire excavation and the quantity of hard rock and ordinary rock measured above shall be taken as excavation in ordinary soil or hard soil as the case may be.

5.5 Where it is not possible or convenient to take measurements from borrow pits or cutting, excavation shall be worked out from filling. The actual measurements of fill shall be calculated by taking levels of the original ground before start of work but after site clearance and after compaction of the fill clearance and after compaction of the fill at suitable intervals and quantity of earthwork so computed shall be reduced by 10% in case of consolidated fills, by 5% in case of consolidation done by heavy mechanical means to arrive at net cubic contents. No such deduction shall however be made in case of:

i) Consolidation done by heavy mechanical means at optimum moisture content.

ii) Any other particular measurements which may arise during excavation as decided by BHEL-in- charge.

6.0 Rates

Rate for earthwork shall include following

6.1 Excavation and depositing earth as indicated in the item.

6.2 Setting out works, profiles etc.

6.3 Clearing all shrubs, roots, rank vegetation these not exceeding 300mm girth.

6.4 All labour and material required for excavation and also for fencing and protection against risk of accident to open excavation including planking strutting, gangway with hand rail, cross open trenches etc where necessary during the progress or work.

6.5 Forming (or leaving) 'dreadmen' or 'tell-tales' in borrow pits and their removal after measurement.

6.6 Forming (or leaving) steps in sides of deep excavation and their removal after measurement.

6.7 Bailing out or pumping of water in excavation arising from rains and sub soil water.

6.8 Protection to and supporting of existing services i.e. pipes, water mains, cable etc. wherever, required.

6.9 Making good surplus excavation over that shown in drawings with lean concrete.

6.10 Compaction equipment and tests required for back filling.

6.11 Storage and safety arrangements for materials required for blasting.

6.12 In case of transportation of earth from identified source **royalty** & other taxes shall be paid by owner & any other tax such as octroi (if any) etc. shall be paid by vendor.

6.13 Getting permission from local/statutory authorities (if required) before commencement work / during the execution as the case may be. No extra shall be payable for obtaining approvals & shall be deemed to have been included in the item rate.

SPECIFICATION FOR RCC WORK

1.0 SCOPE

This specification covers furnishing including requirements in regard to the quality, handling, storage of ingredients, proportioning, batching, mixing, design of concrete mix, sampling and testing of concrete and also requirements in regard to the quality, storage, bending and fixing of reinforcement, transportation, installation, curing, repairing, finishing, testing, protection, maintenance and handing over of plain and reinforced concrete, cast in situ or precast, for use in structures and locations covered under the scope of the contract.

All information pertaining to plain and reinforced concrete shown and noticed on the drawings shall be considered part of this specification and shall supercede this specification where information there on contrary to the contents of these specifications.

2.0 GENERAL

2.1 Work to be provided for by the Contractor

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

(a) Furnish all labor, supervision, services, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportation, etc., required for the work.

(b) Prepare progressively and submit for approval detailed drawings and Bar Bending Schedules for reinforcement bars showing the position and details of spacers, supports, chairs, hangers, etc.

(c) Design and prepare working drawing of formwork, scaffolds, supports, etc, and submit for approval.

(d) Submit for approval shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedment hangers, openings, frames, etc.

(e) Submit for approval detailed drawings of supports, templates, hangers etc., required for installation of various embedment like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, opening etc.

(f) Submit for approval detailed schemes of all operations required for executing the work e.g. Material handling, Placement of concrete, Services, Approaches, etc.

(g) Design and submit for approval concrete mix designs required to be adopted on the job.

(h) Furnish samples and submit for approval results of tests of various properties of the following :-

(i) Concrete

(ii) The various ingredients of concrete.

(iii) Embedment

(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, specifications and schedule of items.

(j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by BHEL, a guarantee in approved proforma for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor jointly and severally.

2.2 Work by others:

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

3.0 **APPLICABLE CODES AND STANDARDS**:

3.01 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 BHEL, shall be followed :

IS : 226 - Indian Standard Specification for Structural Steel (Standard quality)

IS : 269 - Indian Standard Specification for Ordinary or Low Heat Portland Cement.

IS : 383 - Indian Standard Specification for Coarse and Fine aggregates form Natural Source for Concrete.

IS : 432 - Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard- Drawn Steel Wire for Concrete Reinforcement.

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: 515 - Specification for natural & manufactured aggregates for use in mass concrete.

IS : 516 - Indian Standard Specification for Methods of Test for Strength of Concrete.

IS : 1139 - Indian Standard Specification for Hot Rolled Mild Steel and Medium Tensile Steel and high yield strength steel Deformed Bars for Concrete Reinforcement.

IS: 1977 - Specification for Structural Steel (Ordinary)

IS : 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete

IS : 1566 - Indian Standard Specification for Hard Drawn Steel Wire Fabric for Concrete Reinforcement.

IS : 1786 - Indian Standard Specification for Cold Twisted Steel Bars for Concrete Reinforcement.

IS : 1200 - Methods of measurement of Building and Civil Works.

IS : 3385 - Bitumen Primer for use in water proofing and damp proofing.

IS : 10262 - Recommended guide lines for concrete mix design.

IS : 1489 - Specification for portion pozzolana cement.

IS: 1791 - Indian Standard Specifications for Batch Type Concrete Mixers

IS: 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete (Parts I to VIII)

IS: 2502 - Code of Practice for handling and fixing of bars for concrete reinforcement.

IS: 2505 - Indian Standard Specification for Concrete Vibration, Immersion Type.

IS: 2506 - Indian Standard Specification for Screed Board Concrete Vibrators.

IS : 2722 - Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and double bucket type)

IS : 2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction.

IS : 3025 - Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry.

IS : 3085 - Indian Standard Specification for Method of Test

for Permeability of Cement Mortar and Concrete.

IS : 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids.

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 : 4031 - Indian Standard Specification for Method of Tests for Hydraulic Cement.

IS : 3696 - Safety Codes for Scaffolding and (Part I & II) ladders.

IS : 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes.

IS : 4656 - Indian Standard Specification for Form Vibrators for Concrete.

IS : 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant

IS : 4926 - Indian Standard Specification for Ready Mixed Concrete.

IS : 4990 - Indian Standard Specification for Plywood for Concrete Shuttering Work.

IS : 5512 - Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials.

IS : 5513 - Indian Standard Specification for Vicat Apparatus Factor Apparatus.

IS : 5515 - Indian Standard Specification for Compaction Factor Apparatus

IS : 5816 - Indian Standard Specification for Method of Test for Splitting Tensile Strength of concrete

3.02 All standards, specifications, codes of practice referred to herein shall be the latest of current edition including all official amendments and revisions applied thereto.

3.03 In case of discrepancy between these specifications and those referred to herein these specifications shall govern.

3.04 In the event of any controversies arising from interpretations of the various specifications, the decision of BHEL shall be treated as final and binding on the contractor.

4.0 CONCRETE MATERIALS

4.01 M25/M20 grade of concrete shall be used in RCC work for all foundations. Grade of Concrete shall be indicated in AFC drawings. Plain cement concrete shall confirm to M7.5 only.

4.02 All fine and course aggregates proposed for use in the project shall be subject to the approval of BHEL and after specific materials have been accepted, the source of supply of such materials shall not be changed without prior written approval of the owner.

4.03 Samples of aggregates for mix design and determination of suitability shall be taken under the supervision of BHEL and delivered to the laboratory well in advance of the scheduled placing of concrete. Records of tests, which have made on proposed aggregates, shall be furnished to BHEL well in advance of the work for use in determining aggregate suitability.

5.0 FINE AGGREGATES

5.01 Fine aggregates shall consist of natural sands.

5.02 The sand accepted for the work shall meet with ll requirements of IS 383 and acceptable to BHEL. The Bidder rate shall be based on the use of this sand.

5.03 Fine aggregates for concrete, shall confirm to IS 383. The fine aggregates shall be clean, hard strong, durable with uncoated grains. The fine shall not contain any clay, loan , alkali, organic matter mica, salt, organic water or other deleterious substances which can be injurious to the setting qualities or strength of the concrete.

5.04 The sand shall be so graded that concrete of the required economy, workability density and strength can be produced using the specified water cement ratio, unless otherwise directed, sand shall be graded accordingly to grading zones, I,II or III as stipulated in IS 383.

5.05 Fine aggregates shall be tested for soundness in accordance with IS 2386. The fineness modules shall not be less than 2.8 nor more than 3.2. The fineness modules can be determined by adding cumulative percentages retained on the five IS 460 sieves of sizes (2.36 mm, 1.18 mm, 600 micron , 300 micron , 150 micron confirming to IS 460 1962 and dividing by 100) Sand having a specific gravity below 2.60 (Saturated surface dry basis)shall not be used without special permission of BHEL.

5.06 Sand shall be free from all vegetable substances and injurious amounts of dust, clay lumps, soft or elongated or flaky particles, shale alkali, organic matter loan mica and other deleterious substances. Sand shall be prepared for use by such screening or washing, or both, as necessary to remove all objectionable

foreign matter while separating the sand grains to the required size fractions. The percentages of deleterious substances in sand delivered to the mixer shall not exceed the following. In the event of the absence of fines or of any particular size due to top gradation in sand available from one source, and sand from various sources shall be mixed in proper proportion for correct gradation.

Particular	Percentage by weight
Material passing IS 75 micron sieve	03
Shale	01
Coal and lignite	01
Clay lumps	01

Some of the percentages of all deleterious materials however shall not exceed by 5.

6.0 COARSE AGGREGATES

6.01 Coarse aggregates for concrete shall confirm to IS 383. Coarse aggregates shall consist of crushed stones, broken trap, granite or any other suitable rock and shall be composed of clean, uncoated grains free from injurious amounts of soft elongated laminated pieces, alkali, mica, organic matter or other deleterious substances.

6.02 It is proposed that the coarse aggregate shall be black basalt metal as obtained from approved stone quarry. It shall however confirm to the requirements of this specification. The contactor shall be permitted only to bring boulders to the site works.

6.03 Natural gravel (if permitted by BHEL) and crushed rock shall be screened and / or washed for the removal of the dirt or dust coating, if so demanded by BHEL The gradation of the coarse aggregate shall confirm to able IS 383 “Percentage passing for graded aggregate of nominal size”.

6.04 The coarse aggregate pieces shall be angular in shape and shall have granular or crystalline surfaces. Friable, flaky, and laminated pieces mica and shale shall be present only in such quantities that will not, in the opinion of BHEL, adversely affect the strength and / or durability of concrete.

6.05 The size of the aggregate shall not be larger than ¼” of the narrowest dimension between sides of the forces of the member for which the concrete is to be between reinforcing bars, whichever is smaller. In no case the aggregate shall exceed a maximum size of 40 mm in any direction.

6.06 The amount of fine particles in the free stage or as loose adherent shall not exceed 1% when determined by laboratory sedimentation tests. After 24 hours of immersion in water, a previously dried sample, shall not have gained more

than 5 % of the weight .No coarse aggregate of less than 2.6 specific gravity (saturated surface dry basis) shall be used , without written approval of BHEL.

6.07 The percentages of the deleterious substances in the coarse aggregate delivered to the mixer shall not exceed the following:-

Particular	Percentage by weight
Material passing IS 75 micron IS sieve	01
Clay lumps	01
Coal and lignite	01
Soft fragments	-
Shale	-

7.0 CEMENT

7.01 Cement shall be in accordance with IS 269 and shall be **ordinary Portland cement** of reputed company such as ACC, L&T cement for general use .Brands of cement are subjected to BHEL's/BHEL's Customer's approval .Changing the brands of cement for the construction of the same structure will not be permitted.

7.02 A Certified reports attesting to be the confirmation of the cement to the required specification by the cement manufacturer's chemist shall be furnished to BHEL for every batch/lot of Cement. Cement should be from fresh batch.

7.03 Should at any time BHEL have reasons to consider any cement in the contractors possession defective, then irrespective of it's origin and/or manufacturer's test certificates such cement if desired by BHEL will be tested in the BHEL's Customer's Laboratory and unless and until the results of such test are found satisfactory it shall not be entitled to any claim of any nature on this account.

8.0 CEMENT ADMIXURES

8.01 Admixtures will be permitted only when specified on the drawings or approved by BHEL in writing. The type of admixture to be used shall depend on the specific gravity, which it is desired to import to the mix. Under no circumstances ultimate 28 days strength of the concrete shall be reduced by the use of any admixture.

8.02 The manufacturer specifications concerning the use of his product and qualities to be used shall be rigidly followed. When admixtures are used, the mix design shall be corrected accordingly. For accelerating the setting of cement, BHEL may specify products such as accelerex etc. The same shall be used strictly as per manufacturer's recommendations and as and when approved/ directed by BHEL.

STANDARD TABLES FOR CEMENT CONCRETE WORKS

TABLE – I

GRADES OF CONCRETE

Designation	Specified Characteristic compressive-strength at 28 days N/mm2
M-10	10
M-15	15
M-20	20
M-25	25
M-30	30
M-35	35
M-40	40

TABLE -II

PROPORTIONS FOR NOMINAL MIX CONCRETE

Grade of Concrete	Total quantity of dry aggregates by mass per 50 kg of Cement, to be taken as the sum of the Individual Masses of Fine and Coarse Aggregate (Max)	Proportion of Fine Aggregate to Coarse Aggregate (BY MASS)	Quantity of Water per 50 kg of Cement (Max.)
1	2	3	4
	Kg.		Liters
M - 5	800	Generally 1:2 but subject	60
M - 7.5	625	to an upper	45
M - 10	480	Limit of 1:1.1 and a lower Limit of 1:2.1	34
M - 15	350		32
M - 20	250		30

*Note-1 : The proportions of the fine to coarse aggregates should be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer and the maximum size of coarse aggregate becomes larger. Graded coarse aggregate shall be used.

Example : For an average grading of fine aggregate (that is, Zone II of IS: 383-1970) the proportions shall be 1:11, 1:2 and 1:21 for maximum size of aggregated 10mm, 20mm and 40mm respectively.

TABLE - III

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

(FOR GUIDANCE)
CEMENT/TOTAL AGGREGATE RATIOS

WORK ABILITY	WATER/ CEMENT RATIO	RATIO BY WEIGHT OF CEMENT TO GRAVEL AGGREGATE		RATIO BY WT. OF CEMENT TO CRUSHED STONE AGGREGATE	
		20 mm size	38 mm size	20 mm size	38 mm size
Very low	0.4	1:4.8	1:5.3	1:4:5	1:5:0
Slump	0.5	1:7.2	1:7.7	1:6:5	1:7.4
	0.6	1:9.4	1:10	1:7.8	1:9.6
0.25mm	0.7	1:10.0	1:12	1:8.7	1:10.6
Low	0.4	1:3.9	1:4.5	1:3.5	1:4.0
Slump	0.5	1:5.5	1:6.7	1:5.0	1:5.5
25.50	0.6	1:6.8	1:7.4	1:6.3	1:7.0
mm	0.7	1:8.0	1:8.5	1:7.4	1:8.0
Medium	0.4	1:3.5	1:3.8	1:3.1	1:3.6
Slump	0.5	1:4.8	1:5	1:4.2	1:5.0
50-100mm	0.6	1:6.0	1:7.3	1:5.2	1:6.2
High	0.4	1:3.2	1:3.5	1:2.9	1:3.3
Slump	0.5	1:4.4	1:5.2	1:3.9	1:4.6
100-175	0.6	1:5.4	1:6.7	1:4.7	1:5.7
Mm	0.7	1:6.2	1:7.4	1:5.5	1:6.5

Note-1. Notwithstanding anything mentioned above, the cement/Total Aggregate Ratio is not be increased beyond 1:9.0 without specific permission of BHEL.

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

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

.

Strength Requirements

The strength requirements of concrete where ordinary Portland cement or Portland pozzolana slag cement is used, shall be as per Specification which conforms to IS: 456. All other relevant clauses of IS: 456 shall also apply.

Minimum cement content

The minimum cement content for each of concrete shall be as shown below:-

TABLE -IV

MINIMUM CEMENT CONTENT SPECIFIED FOR DIFFERENT GRADES OF CONCRETE

Grade of Concrete	Minimum Cement Content/Cu.M. of Finished Concrete
M-7.5	160 Kg
M-10	200 Kg
M-15	326 Kg
M-20	360 kg
M-25	420 kg
M-30	500 kg

(a) The minimum cement contents mentioned above are for average conditions, In case the cement can be reduced due to continuous and consistent favorable conditions, on account of better quality of cement and aggregates, use of large size of aggregates and better quality control, then the Engineer may instruct lower cement content, and the Contractor shall abide by the stipulations laid down hereunder.

(b) Sufficient number of trial mixes (to be decided by BHEL) 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.

(c) All tests will be taken 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.

(d) BHEL 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.

In case there is a downward revision of the minimum cement content from that specified in the contract, the particular unit rate of concrete will be reduced by an amount equal to the cost of cement saved calculated at the issue rate.

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

The CONCRETE mix design shall be based on Indian standard method as given in I.S 10262.

Strength Criterion:
In case of "design mix Concrete", the water-cement ratio of such value as to give acceptable preliminary and work 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 BHEL. Frequent checks on work test will have to be carried out and the water-cement ratios will be revised if the work tests produce unsatisfactory results. Not withstanding anything above the Contractor's responsibility to produce satisfactory work test results and to bear all the consequences in case of default remains unaltered.

In case of Nominal mix concrete the maximum water- cement ratio for different grades of concrete is specified in IS : 456 and no preliminary tests are necessary. The acceptance test criteria for work tests of ordinary concrete shall be as per IS: 456.

Durability Requirement :
Table-III gives the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by durability consideration is lower than that required from strength criterion, the former shall be adopted.

TABLE – V

MAXIMUM PERMISSIBLE WATER/CEMENT RATIOS FROM DURABILITY CONSIDERATIONS FOR DIFFERENT TYPES OF STRUCTURES AND DEGREES OF EXPOSURE USING ORDINARY PORTLAND CEMENT

EXPOSURE CONDITIONS

Type of Structure	Severe wide range of Temperature of frequent alternations of freezing & thawing (use Air Entrained concrete only)			Mild Temperature rarely below freezing or rainy or arid		
	In Air	At the water line or within the range of fluctuating water level or spray		In Air	At the water line or within the range of fluctuating water level or spray	
		In fresh water	In sea water or in contact with sulphate (concentration more than 0.2%)		In fresh water	In sea water or in contact with sulphate (concentration more than 0.2%)
This sections such as railings, kerbs, sills, ledges, ornamental or Architectural concrete, piles, pipes and all sections with less than 1" concrete cover to reinforcement.	0.49	0.44	0.40	0.53	0.49	0.40
Moderate sections walls, abutments, piers, girders, beams	0.53	0.49	0.44	*	0.53	0.44
Exterior portions of heavy mass sections	0.58	0.49	0.44	*	0.53	0.44
Concrete deposited by Tremic under water		0.44	0.44		0.44	0.44

Concrete slabs laid on ground	0.53			*		
Concrete which will later be protected by enclosure or back fill but which may be exposed to freezing & thawing for Several years before such protection is offered.	0.53			*		
Concrete protected from the weather, interiors of bldgs, concrete below ground which is free from sulphate attack.	*			*		

*Water/Cement ratio should be selected on basis of strength and workability requirements.

Mixing of Concrete :

Concrete shall always be mixed in a mechanical mixer unless specifically approved by BHEL for concrete to be used in unimportant out of the way locations and in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are al- ready 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 BHEL. Mixers shall not be loaded above their rated capacity as this prevents through 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 and 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 BHEL 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.

When hand mixing is permitted by BHEL, 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.

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 all precautions, segregation does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by BHEL, concrete shall be transported in deep containers which will reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipments shall be kept free from wet concrete.

Placing and Compacting Concrete :

Where specifically covered, the relevant I.S. code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in the relevant I.S. Code for any particular aspect of work, any other standard code of practice, as may be specified by BHEL, 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 rammed and consolidated as directed by BHEL 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, embedment, joint seals etc. shall be approved in writing by BHEL before concrete is placed. As for as possible, concrete shall be placed in the formwork by means approved by BHEL and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500mm shall have to be approved by BHEL. 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 BHEL will have to be adopted.

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

A layer of mortar of thickness between 12mm to 25mm as directed of the same or less w/c ratio and the same proportion as that of the concrete being placed and/or cement slurry will be spread thoroughly on the foundation or construction joint just prior to placement of concrete. The cost of application of such cement slurry and/or mortar will be deemed to be included in the unit rate of concrete.

After concrete has been placed, it shall be spread, if necessary and thoroughly compacted by approved mechanical vibration to a maximum subsidence without segregation and thoroughly worked around reinforcement or other embedded fixtures into correct form and 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 1S 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 BHEL, 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 BHEL. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable. No concrete shall be placed in open, while it rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins of 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 BHEL, Moulding, throating, drip course, etc. shall be poured as shown on the drawings or as desired by BHEL. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as shown on drawings or as directed by BHEL. Any deviation there from shall be set right by the contractor at his own expense as instructed by BHEL.

In case the forms or supports get displaced during or immediately beyond tolerance limits, BHEL may direct to remove the portion and reconstruct or repair the same at the Contractor's expense.

BHEL shall decide upon the time interval between two placements of concrete of different ages coming in contract 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 disturbed.

Construction Joints and Cold Joints :

Construction Joints :

It is always desirable to complete any concrete by continuous pouring in one operation. However due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete at certain predetermined stages. These joints will be formed in manner specified in the drawings/instructions. 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. For water retaining structures and leak- poof buildings suitable and approved water stops may be installed at the construction joints as per clause 3.23. For machine foundations (e.g. Turbo generator) one stage of construction Joints between base raft and columns will be allowed :

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 75mm 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 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 BHEL for study and approval, without which no construction joint will be allowed.

Cold Joints:

An advancing face of 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 then 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 alight hard 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 12mm in thickness, will 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 vibrators deep into the old layer of concrete.

(c). In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise in spite 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.

Repairs, finishes and Treatment of Concrete Surfaces:

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 and 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. BHEL 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 will be inspected by the contractor immediately after the forms are removed and he will promptly report occurrence of any defects to BHEL. All repair works will be carried out as per the instruction and in the presence of BHEL or his representative. Generally, repair work will consist of any or all of the following operations:-

a. Sack rubbing with mortar and stoning with carborundum stone.

b. Cutting away the defective concrete to the required depth and shape.

c. Cleaning of reinforcement and embedments.

d. Roughening by sand blasting or chipping.

e. Installing additional reinforcement/welded mesh fabric.

f. Dry packing with stiff mortar.

g. Plastering, guniting, concreting etc.

h. Placing and compacting concrete in the void left by cutting out defective concrete.

Finishing unformed surface:

The Contractor is to include in his quoted rate for concrete the provision of normal finishes in unformed surfaces which can be achieved by screeding, floating, trowel ling, etc. as and where required by BHEL without any extra cost to the Owner. Exposed reinforced concrete surfaces shall be finished smooth with 6mm thick cement mortar plaster 1:3 (1 cement and 3 fine sand). No extra payment shall be made on this account. 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 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 BHEL, the surface shall be scored and marked without any extra cost to the Owner to provide better bond. While monolithic finish is specified or required concrete shall be compacted and struck off at the specified levels and slopes with a screed, prefer- ably 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 smoothen 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 BHEL may instruct marking the floor in a regular geometric pattern after the initial trowelling.

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 sub- stances, 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 BHEL.

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 BHEL 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 days after final setting. Curing by continuous sprinkling of water will be allowed if BHEL is satisfied with the adequacy of the arrangements made by the contractors.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. BHEL's decision regarding the adequacy of curing is final. In case any lapse on the part of the contractor is noticed by BHEL, 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, BHEL 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 pay for the part where inadequate curing was noticed at a reduced rate, entirely at the discretion of BHEL.

Cold Weather Concreting:

When conditions are such that the ambient temperature may be expected to be 4.5^{o}C or below during the placing and curing period, the work shall conform to the requirements of I.S. 7861 (II) without any extra financial implication.

Hot Weather Concreting:

When depositing concrete in very hot weather, the Contractor shall take precautions and shall conform to the requirements of I.S. 7861 (I) without any extra financial implication . Temperature of concrete to be maintained shall be either specified in the AFC drawing or as per the instruction of BHEL Engineer at site.

9.0 WATER

9.01 Water used for mixing concrete shall not be salty or blackish and shall be clean and free from injurious amounts of oils, acids, alkalies, organic materials and other deleterious substances which may weaken the concrete and cause efflorescence of attack on the steel in the RCC in the concrete. Acceptance tests for water shall be as set out in IS 456 and all water must be approved by the Testing Laboratory .

10.0 REINFORCEMENT

10.01 Reinforcement bars shall be either plain round mild steel of grade-I in accordance with relevant IS 432 and relevant portion of I.S. 456: 1964 or high yield strength deformed bars (HYSD bars) in accordance with relevant IS 1786 or IS 1139 as shown and certified in the drawing. Wire mesh or fabric shall be in accordance with IS 1566. Binding wires to be procured by the contractor shall be 1.63 mm or 1.22 mm (16 to 18 SWG diameter) and shall confirm to IS 280-1951.

10.02 Steel procured by the contractor shall be of tested quality. No re-rolled material will be accepted unless tests show that they fully comply with the IS–432-1960. If demanded by BHEL, the contractor shall submit the manufacturer's test certificate for steel. Random tests on such steel may be performed by BHEL /BHEL's Customer as per relevant Indian Standards. Steel not confirming to specifications shall be rejected. Item rate shall be inclusive of all such tests.

10.03 All bars and binding wires shall be free from grease oil , dust , dirt , scales , loose rust and bituminous materials and shall be thoroughly cleaned before being fabricated.

10.04 Reinforcement shall have the size and shape and be spaced and located as shown and called for in AFC drawing. Substitution of reinforcement will not be permitted except upon written approval for BHEL.

10.05 Reinforcement steel manufactured by main manufacturers such as SAIL, TISCO shall be used with prior approval of BHEL.

11.00 Storage of materials shall be subject to the approval of the owner/ BHEL.

11.01 Aggregates shall be stored in stockpiles at one location approved by the BHEL/BHEL'S CUSTOMER. Stockpiles aggregates shall be stored carefully on a clean hard surface to prevent contamination with deleterious foreign materials and be protected against wet weather to maintain the moisture content reasonably constant. Aggregates of different sizes shall be stored separately and handled in such a manner as to avoid intermixing of different sizes of aggregates. Every care shall be taken to see that stone grit does not get mixed with coarse aggregates due to man handling or wind action.

11.02 Coarse aggregates shall be piled in layers not exceeding 1.25 m in height to prevent coning or segregation. Each layer shall cover the entire area of the stockpile before succeeding layers are started. Aggregates that have been segregated shall be rejected. Rejected material may be accepted after re-mixing, provided successive tests indicate uniformity of gradation.

11.03 The contractor shall have to make his own arrangements for storage of cement in hi possession.

11.04 Cement shall be delivered, stored and handled in a manner that will prevent the intrusion of foreign materials damage by water breakage of packages etc. Packed cement shall be stored in the original bags until ready for use. Empty cement bags shall be preserved by the contractor in the serviceable condition.

11.05 Storage shall be in suitable shelters and in a manner affording ready access to an identification of each batch. Tarpaulins protection for cement shall be permitted only during transportation of cement between storage and concrete, mixers. Caked or reclaimed cement or partly set cement or cement showing evidence of deterioration, damages etc shall be condemned and shall not be used.

11.06 Reinforcing steel and wire mesh shall be stored above ground surface upon platforms, skids or other supports. Care shall be exercised to prevent damage during handling and storage and to protect them as far as practicable from surface deterioration by direct contact with undesirable elements or by exposure to conditions producing rust and corrosion.

11.07 Concrete mix shall be designed so as to provide the grade of concrete having required workability and characteristic strength not less than the approved value. The procedure of concrete mix given in Indian Standard Recommended Guidelines should be followed. Mix design to be got approved by BHEL/BHEL'S CUSTOMER.

During construction, all the concrete samples in the form of cubes shall be tested as per IS 1199 and IS 516 and as directed by BHEL. The contractor at his own cost shall do all mix design work including testing of cubes etc.

METHOD OF MEASUREMENT

Concrete:

a) Actual volume of work as executed or as per drawings issued, whichever is less, shall be measured in Cu.M. Deductions for openings, conduits, pipes, ducts, pockets, chases, etc. shall be made provided they are larger than 0.1 Sq.M. in area each (for each opening upto and less than 0.1 Sq. M. in area the formwork shall not be paid for separately).

No deduction shall be made for embedded fixtures including reinforcements, sleeves, anchor bolts and similar items.

b) Precast concrete work shall be measured in the same way as specified in foregoing paragraph. No separate payment shall be made for formwork. Lifting hook where required in the design, shall be treated as reinforcement steel and paid accordingly. Payment shall be due only after erection grouting and curing of the precast units in proper position unless otherwise provided for in the contract. All breakages and damages of the precast units will be to the contractor's account and shall be replaced free of charge to the owner.

Reinforcement:

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 will be arrived at by multiplying the actual or theoretical length, whichever is less, by the Sectional weights. In case the Owner issues the reinforcing steel, the sectional weights will be the same as were applied at the time of issue. In case the steel is to be supplied by the Con- tractor, the sectional weights to be adopted will be the I.S. Sectional weight or as per actuals which will be arrived at by accurately measuring representative samples as directed by the Engineer, whichever is less.

b) Standard hooks, cranks, bends, authorized laps etc. shall be measured.

c) Lap welding or butt welding if permitted will be measured diameter-wise per joint. The actual length of steel in lap will be measured separately in case of lap welding. The rate quoted for the smaller size bar will be applied in case of joint between two bars of different diameters.

d) Separator pieces between two or more layers of steel shall be measured.

e) No payment shall be made for binding wires, spacer block, supports, chairs, hangers, etc. of height 300 mm and less, required for keeping the steel in position unless otherwise specified in the con- tract. For supporting horizontal reinforcement at heights larger than 300 mm support, drawings will be prepared by the Contractor and payment will be made for the supports as approved by the Engineer, r as actually placed, whichever is less, at the same rate as for reinforcement.

f) No extra will be paid for modification of already embedded reinforcement, if required due to faulty fabrication or placement.

g) Dowels neither shown on the drawings nor instructed by the Engineer, but required for construction facilities and /or sequence, shall not be measured.

12.0 Formwork:

12.01 General:

The Contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centering and get them approved by BHEL. 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 centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specification permitted otherwise by BHEL.

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

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used. 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 BHEL immediately and rectified free of charge as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and walls, plywood or other approved forms shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so. All floor and beam centering shall be crowded not less than 8 mm in all directions for every 5 meters span.

Unless specifically described on the drawings on else- where to the contrary, bevelled forms 25 mm by 25 mm shall be fixed in the formwork at all corners to pro- vide chamfering of the finished concrete edges without any extra charge. The form work should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places; where they are necessary and as may be directed by BHEL. 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.

12.02 **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, saw dust, etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes, brooms,

etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that the 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.

12.03 **Design**:

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

12.04 **Removal of Forms**:

Before removing any formwork, the Contractor must notify BHEL well in advance to enable him to inspect the concrete if he so desires.

The contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and countersigned by BHEL 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. BHEL may, however, instruct to postpone the removal of formwork if he considers it necessary.

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

TABLE - VI

SCHEDULE FOR REMOVAL OF FORMS

	Part of Structure	Ordinary Portland cement Concrete
a.	Walls columns and vertical faces of all structural members.	24 to 48 hours as may be decided by BHEL.
b.	Slab (Props left under3 days	
c.	Beam soffits (props left under)	7 day
d.	Removal of props under **SLAB**:	
1.	Spanning up to 4.5 m	7 days
2.	Spanning over 4.5 m	14 days
e.	Removal of props under beams and arches.	
1.	Spanning up to 6m	14 days
2.	Spanning over 6m	21 days

For other cements, the stripping time recommended for ordinary Portland cement may be suitably modified as agreed by BHEL.

12.05 **Tolerance**:

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

a) Deviation from specified dimensions of cross
6 mm section of columns and beams. +12 mm

b) Deviation from dimensions of footings. -12 mm

i Dimensions in plan +50 mm

ii. Eccentricity 0.02 times the width of

		the footing in the direction of deviation but not more than 50 mm
iii.	Thickness	+ 0.05 times the specified thickness.

(Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel or dowels).

The tolerances given above are specified for local aberrations in the finished concrete surface and should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of BHEL. Any error, within the above tolerances limits or any other as may be specially set up by BHEL, 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.

12.06 **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 BHEL.

12.07 **Classification**:

Generally, the 'ordinary' class formwork shall be used unless otherwise directed by BHEL.

a. Ordinary: These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

b. Plywood: These shall be used in exposed surfaces, where a specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by BHEL. 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 surfaces are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

12.08 **Opening, Chases, Grooves, Rebates, Block outs etc**.:

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

12.09 Anchor bolts, Anchors, Sleeves, Inserts, Hangers/Conduits Pipe and other miscellaneous us embedded fixtures :

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as directed and secure the same as may be required. The materials, if required to be supplied by the Contractor, shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of BHEL. Exposed surfaces of embedded materials are to be painted 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 BHEL, free of cost to the owner.

Items to be embedded:

a) Inserts, hangers, anchors, frames around openings,
manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Dowel bars, etc. for concrete work falling under the scope of other Contractors.

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

e) Flashing and jointing in concrete work.

f) Any miscellaneous embedments and fixtures as may be required.

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

13.0 **Expansion & Isolation Joints**:

13.01 **General**:

Expansion and isolation joints in concrete structures shall be provided at specified 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, BHEL 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 specification. Prior approval of method of forming the joints should be obtained from BHEL before starting the work.

13.02 **Bitumen Board/Expanded Polystyrene Board:**

13.02.1 **Bitumen Board**:

Bitumen impregnated fibre board of approved manufacture 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 and, the joint shall be sealed with approved sealing compound to a depth of at least 25mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

13.02.2 **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 BHEL. 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.

METHOD OF MEASUREMENTS:

Formwork:

a) Formwork shall be measured as the actual surface in contact with the concrete and paid in Sq.M. unless included in the rate for concrete.

b) Formwork shall not be measured separately for precast concrete work, which shall be included in the concrete rates.

c) No payment for formwork or any other requirements in construction joints shall be made.

d) Openings upto 0.1 Sq.M. shall be neglected as if non-existent for the purpose of formwork measurement.

e) No extra measurement or payment shall be made for making the formwork waterproof or for supports, scaffolding, centering, approaches, etc.

f) No measurement shall be taken for the formwork in pockets, openings, chases, etc. in concrete if the cross-sectional area is less than or equal to 0.1 Sq.M. in each case. If the cross-sectional area of any opening exceeds 0.1 Sq.M. the formwork shall be measured under appropriate classification.

g) Fixing and removing pockets and openings of sectional area less than 0.1 Sq.M. shall be measured on number basis and paid separately.

Anchor bolts, Anchor sleeves, inserts, hangers, conduit pipes and other miscellaneous embedded fixtures:

a) These will be measured on theoretical weight basis of the complete inset handled by the contractor irrespective of the amount of insertion. Where theoretical weight cannot be assessed satisfactorily, the actual weight shall be allowed under certification of BHEL.

b) No extra to be paid for templates and other arrangement required to secure these in position. The protection of these materials with proper anti-corrosive paints/grease and covering with gunny bags against any damages till the structure is handed over, shall be the responsibility of the Contractor at no extra cost.

c) Any 'boxing' left for inserts, etc during construction, for facility of the Contractor's work, and later on filled in by the same Contractor after placing the insert shall be considered, for measurement purpose, as if the inserts, etc. were placed before concreting.

d) No extra payment shall be made for cleaning of the inserts, etc. required for bond with the concrete.

Expansion and Isolation Joints:

a) Expansion and isolation joints will be measured and paid on area basis. The drawings and/or schedule of items will describe the thickness, painting, filling material, sealing strips, metal fixtures, inserts, etc. to be used in the joint.

b) Formwork for the 'leading side ' of the joint will be measured and paid under the relevant item. No payment for the formwork for the 'following side' will be made even if the Contractor is required to use formwork for constructional facilities.

c) Joint sealing strips made out of Copper, Aluminum or G.I. or P.V.C. or rubber, will be measured and paid on area basis under relevant items. Rubber pads below foundation will be measured on area basis under the relevant item.

d) Any other fixtures and inserts like dowels, in- stalled as per drawing, riding plates, etc. will be measured and paid if under the respective item of the Schedule of Items.

e) All other work like installing, Bitumen coating, Bitumen boards, Expanded Polystyrene Boards, Alkaline sheets, Bitumen filler, etc. and trimming the top, repairs, finishes and other connect- ed items will be deemed to be included in the unit rate for Expansion/Isolation Joints.

Grouting Under Base Plates, etc.

Grouting shall be measured on theoretical volume basis neglecting the volume of embedded items. The cost shall include the cost of hacking the old concrete plus necessary formwork if any. Edges of the grouting shall be measured square even if chamfered. Necessary curing shall also be included.

14.0 CHECKING OF WORK AT SITE

The contractor will prepare check lists in approved proforma which will be called "Pour Cards". These Pour Cards will list out all items of work involved. The Contractor will inform BHEL, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to BHEL for all checking required in the pour. On satisfying himself that all details are in accordance with the drawings and specifications, BHEL will give written permission on the same "Pour Card" allowing the Contractor to commence placement of concrete. Details of all instructions issued by BHEL and the records of compliance by the Contractor, deviations allowed by BHEL and any other relevant information will be written on accompanying sheets attached to the Pour Card. These sheets, termed as "Progress Cards", will be prepared by the Contractor on approved proforma. The Pour Cards along with accompaniments will be handed over to BHEL 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 BHEL, the choice being dictated by the requirement 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 BHEL. Contractor should note that all the checking pertaining to field work shall be jointly carried out by BHEL/BHEL's Customer Engineer at site. Contractor has to co-ordinate with both the agencies in advance to facilitate the checking of work before commencement of concrete pouring. Work shall be carried out as per the Customer's requirement & as per AFC Drawings.