

TENDER DOCUMENT

FOR

**Execution of balance Civil, Electrical and Hydro Mechanical works of
Mandal Dam under North Koel Reservoir Project, Jharkhand and Bihar**

TENDER NO: WAP/NK/DAM/JHARKHAND/2026

TECHNICAL SPECIFICATIONS

2nd Call



TECHNICAL SPECIFICATIONS

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NORTH KOEL RESERVOIR PROJECT, JHARKHAND / BIHAR

PART –II

THE TECHNICAL SPECIFICATIONS (CIVIL WORKS)

SECTION - 1

1.0 PREAMBLE

The technical Specifications (hereinafter called TS) shall form a part of the contract and shall be read in conjunction with other bidding documents. If required during the construction, the Employer / Engineer-in-charge may issue special specifications modifying, amending, and supplementing the requirements spelt in this Technical Specifications. In such a case, the provision in the Special Specification shall prevail over those in the Technical Specification.

The Technical Specifications give general information about execution of various items of works under the Contract. It is the intent of these specifications to establish acceptable standards of quality as specified in the technical specifications. Minor deviations in details due to manufacturer's standard shop process will be considered for acceptance provided that, in the opinion of the Employer, the proposed substitutions are equal in quality to those specified.

All works shall be executed in conformity with the approved construction drawings and instructions issued by the Employer for construction. Execution of works contemplated under these specifications shall includesetting out of works, all the procurement and supply of required Man power (skilled and un-skilled) and Materials (inclusive of octroi and all other taxes and charges as levied, if any), Equipment, Plant and Machineries, office, stores and workshop etc., transportation, handling and placement of Materials and Equipment to site, in complete, professional and diligent manner. All works shall comply with the quality requirements defined in the relevant sections of these specifications and other sections of the bidding document to the satisfaction of the Employer.

The contractor shall supply all materials, equipment, machinery, personnel and labour, required for the execution of the Works mentioned in Bill of Quantities (BOQ)

Contractor is required to give his unit rates of each item of BOQ including the cost of all activities required to complete the work as per given specifications and approved drawings. No separate payment shall be made for establishing the working facilities, for complying with an environmental obligation required by applicable laws and regulations and supply of all materials, equipment, machinery, personnel and labour etc. required for the execution of the Works. Cost of these activities/facilities shall be spread over the various items given in BOQ and deemed to be including in Unit Rates of the items.

SECTION – 2

WORKING FACILITIES AND SAFETY MEASURES

- 2.1** The contractor shall design, provide, erect/ commission, operate and maintain all the working facilities including shipment and mobilization of material, equipment, machinery, personnel and labour, required for the execution of the Works, such as but not necessarily limited to the following within the specified time schedule:

Camp Facilities

Plant and Equipment

Electric Power Supply system for project construction

Water supply System

Telephone and Communication Network

Sewage and Waste Water Disposal System

Fire Fighting Equipment

Transportation System

Field Testing Laboratory for quality control

Working Facilities shall be subject to the Employer's approval. The Contractor shall comply with all laws, regulations, and ordinances relating to the construction and operation of the working facilities applicable in State of Jharkhand.

Materials for the working facilities shall be of first-class quality and if not new, in best condition. The capacity and number of equipment shall conform to the specific minimum requirements for the works they are intended for and the climatic conditions prevailing at the site. The Contractor shall maintain all his equipment and machineries with sufficient spare parts, special tools for repair work and complete standby units of vital parts to guarantee a continuous operation without untimely delays. The Contractor shall be fully responsible for any delays due to disregard of said necessity.

The Contractor shall, prior to dispatching any items of the Working Facilities, give written notice to the Employer with clear indications about the purpose of the items, the kind, date and place of consignment for approval. Said notice must be given in due time to allow for a possible cancellation in case the items do not comply with the requirements as stipulated. The Employer will issue the response within 7 days of receipt of the notice.

Should the Employer determine that the equipment furnished does not meet all requirements, the deficiencies shall be corrected by the Contractor before further use, or the deficient equipment shall be replaced with satisfactory equipment. Any cost incurred in the correction or replacement shall be borne by the contractor. All Working Facilities shall be built in the areas as approved by the Employer.

2.2 CAMP OFFICE AND ACCOMODATION

The Camp and Facilities shall include Camp offices and Accommodation. The Contractor shall provide Lodging to the Employer/Engineer-in-Charge/ staff of the Employer, Contractor's Personnel present at site and visiting dignitaries, during the entire construction period. All working facilities shall be equipped with proper electric supply, water supply, telephone, sewage and waste water disposal system. He shall also make all arrangements for routine cleaning & housekeeping as required.

The contractor shall construct the office buildings as per Employer's requirement on priority basis. The Employer/ Engineer-in-charge office shall be properly furnished with sufficient furniture, fittings and fixtures and should be air conditioned. The maintenance of the offices and their surroundings and all furniture, fittings and fixtures etc, shall also be responsibility of the contractor.

2.3 MISC. WORKING FACILITIES

The Contractor shall construct and maintain warehouses, storage yard, a motor tool repair shops, workshops, vehicle sheds, garages, fuel storages etc. for the efficient execution of the work.

Warehouse(s) for the storage of materials, mechanical and electrical spare units, spare parts etc. and all repair shops shall be well secured, ventilated (if necessary) and waterproof and shall be installed with the necessary appliances/ adequate equipment and tools etc. necessary to carry out all works and repairs, which are usually done on the Site.

2.4 LABORATORY / QUALITY CONTROL

The contractor has to emphasize the necessity of the quality control with the objectives

- To achieve high order of quality of works as laid down in the specifications.
- Diagnosing and controlling various factors leading to deterioration in quality.
- Investigating reasons and suggesting ways and means for improvement.
- Adequate knowledge and experience of Quality control methods and of testing procedures.

The stages of controls will be selection of material, process of material and final products. The Contractor shall collect the samples as specified or as directed by the Employer, carryout the relevant test under the guidance of Employer or his representative, prepare the complete report and submit them to the Employer. All tests will be made according to the approved standards. The specialized testing requirements shall be fulfilled from established approved agencies like NIT, IIT, etc. In addition to that there shall be field test.

Test to be Conducted in Field -

S.No.	Content	Test	Frequency
1	Soil	Moisture Content	
		Density/Field density	
		Proctor's Compaction	
		Needle Penetration	
		Grain size analysis	
2	Sand	Sieve analysis for grading and F.M.	In beginning or whenever changed
		Bulk age	
		Moisture Content	
		Silt Percentage	
		Relative density	
3	Cement	Consistency	Once
4	Coarse aggregate	Sieve analysis for grading	Once
		Abrasion	

5	Fresh concrete/ Mortar	Slump Test	Twice per mixture
		Unit Wt.	
		Air Content	
6	Hardened Concrete / Mortar	Compressive strength	
7	Fresh Mortar Mix	Cement Sand ratio test	
8	Bricks	Dimensions test	
		Water absorption	
		Efflorescence	
		Compressive strength	

The public participation should also be ensured by involving Panchayti Raj Institutions at appropriate levels before execution, during execution and after the execution, simultaneously, all relevant Authorities should also be kept informed regarding every activity.

The payment will be released after the satisfaction of quality and quantity. The mandatory inspections of the supervisory staff of the construction wings as well as of Quality control wings will be carried out.

2.5 PLANT AND EQUIPMENT

The Contractor shall provide all construction plants and equipment necessary for the efficient execution of the work described in the bill of quantity as per specifications. The Contractor shall also deploy additional equipment on the direction of employer, if needed, for timely completion of Works.

2.6 ELECTRIC POWER SUPPLY SYSTEM

The Contractor shall provide and keep operational throughout the Time of Completion his own generating facilities of such capacity as considered necessary to supply all participants at his Site and in his camps. The power generating sets shall be installed in separate buildings with concrete foundations. The power supply to the construction sites, camps and the entire project area shall be designed for continuous operation, 24 hours a day, with sufficient capacity to satisfy peak and emergency demands. The Contractor shall also furnish, install and maintain the electrical distribution system to the Employer's site office.

2.7 WATER SUPPLY SYSTEM

The Contractor shall design, construct, equip, operate and maintain two separate water installations at the Site necessary for the adequate supply of Raw water and Potable water. There shall be no cross connections of any kind between the raw and potable water supply systems. Raw Water shall be used for construction purposes only of adequate quality. It shall be treated to the extent necessary to meet specified requirements (e.g. for concrete). Only potable water of high quality meeting relevant requirements for drinking water shall be piped into buildings. Adequately treated water which complies with the current sanitary standards will be accepted for human consumption. Storage tanks with a reserve capacity equivalent to two (2) days of normal usage will be required for the drinking water system. The Contractor shall take drinking water samples from time to time if so requested by the Employer. The samples shall be sent for chemical and bacteriological analyses to approved laboratories at his expense and the results of the analysis shall be obtained within 7 days of the sampling.

The Contractor shall furnish, install, operate and maintain all pumps, piping fittings, valves, storage tanks, purification plant and chlorination for the water supply and distribution Systems, adequate in quantity and pressure.

2.8 COMMUNICATION NETWORK SYSTEM

The Contractor shall supply, install, operate and maintain an appropriate telecommunication network, High Speed Internet, complete with standby power supply, to connect his offices with those of the Employer's, camp, site, laboratories, workshops, stores, aggregate plants, batching plants, dam site, and first aid station and all of his other work areas within the Site. The Contractor shall furnish a directory of the various equipments installed at the Site and make it available to the Employer.

2.9 SEWAGE AND WASTE WATER DISPOSAL SYSTEM

The Contractor shall design, construct, equip, operate and maintain all the installation necessary to properly collect and dispose of sewage from his camps, Employer's site office

and other construction facilities. The Contractor shall not under any circumstances, discharge sewage or contaminated water into natural stream or any open areas. Collection and Disposal of sewage shall be performed in accordance with the current related standards and laws in force.

2.10 TEMPORARY ACCESS AND CONSTRUCTION ROADS

The Contractor shall design, construct and maintain the construction roads and related works that may be necessary, from the existing roads and tracks to the various work areas, and other areas such as camps, stores, plants, disposal areas and any other areas related to the work at his own cost. Additionally, the Contractor shall improve where necessary and maintain all the existing roads and tracks in and adjacent to the project area to the satisfaction of the Employer for guaranteeing normal traffic for any kind of vehicle.

The main construction roads built or improve by the Contractor shall be wide enough to allow heavy weight traffic in both directions. The longitudinal road grades shall be as required by the traffic conditions and in any case, shall not be greater than 1 in 20 except for short sections where grades of up to 1in 12 may be allowed. The road surface shall consist of a well-compacted layer of selected material. The roads shall be provided with appropriate drainage arrangements. The Contractor shall maintain the construction roads together with the existing roads in and adjacent to the project area for the use of heavyweight equipment. The Construction roads as well as existing roads will be utilized by the Employer and other Contractors and the contractor will not be entitled for any payment for such use.

2.11 LAND FOR WORKING FACILITIES

Land for working facilities will be provided to the Contractor free of cost on as is where basis. Cost of clearing/modification of the existing land and development of any additional land if required, by the Contractor for working facilities shall be borne by the Contractor.

2.12 SITE SECURITY

The Contractor shall employ adequate security guards at the worksite and at the construction camps on 24-hours duty including Sundays and holidays. Storage areas shall be fenced, lighted and regularly patrolled by security guards. Warehouse buildings and explosive magazines shall be kept locked and keys accounted for at all times. The Contractor shall be entirely responsible for the losses occurring in his installations and those of the Employer, resulting from carelessness on the Contractor's part.

2.13 SAFETY MEASURES

The contractor shall be responsible for ensuring throughout the contract period all the safety measures at site of work so as to prevent loss of life, property and damage to partially or completed works and protect persons or property from injury. The contractor shall comply with any safety instruction given by the Engineer-in-charge in the performance of the works.

The contractor shall erect and maintain all necessary temporary fencing, barricades, barriers, sign and light and provide fire alarm, fire extinguishing and firefighting services at strategic points on the site.

In use, handling and storage of explosives, the contractor shall comply with all applicable laws and regulations concerning storage, handling and use of explosives prevailing in State of Jharkhand. All such laws, regulations and rules etc., as are amended from time to time shall be binding on the Contractor. The Contractor shall arrange mobile / portable explosive magazines of suitable capacity and explosive van under license from concerned explosive authorities. The Contractor shall arrange the security system for the Contractor's own magazine house and mobile / portable magazine house. Blasting caps or other exploders, detonators or fuses shall not be stored, transported or kept in the same place in which dynamite or other explosives are stored, transported or kept. It is strictly forbidden to transport any personnel on transport means while carrying explosives. The Contractor shall limit the handling of explosives to full-service personnel and have them thoroughly

instructed about dangers and consequences. In order to distinguish full-service personnel from other individuals, full-service personnel shall wear arm bands and other identifying insignia.

2.14 FIRE FIGHTING EQUIPMENT

The Contractor shall provide firefighting equipment necessary to ensure the safety of the Work against fire. The Contractor shall supply and maintain an abundant length of fire hoses, fire buckets, sand buckets, approved fire extinguishers and alarm systems installed in the work area work and camp sites. The Contractor shall have on the Site, at all times a trained firefighting and first-aid crew with the necessary mobilization means.

2.15 FIRST AID AND MEDICAL CARE FACILITIES

The Contractor shall comply with laws and health standards presently in force in the Country. In the event of illness of an epidemic nature breaking out, the Contractor shall carry out and comply with all orders, arrangements or regulations, which may be issued by the Government or local authorities.

The Contractor shall in all respect be fully responsible for ensuring necessary first aid service at the Site and maintain an ambulance to move a serious patient or injured personnel to nearby hospital or other appropriate accommodation as and when required. The contractor shall engage qualified resident first-aid staff. This facility shall also be available for use of the site staff of Employer present.

2.16 ENVIRONMENTAL OBLIGATIONS

The contractor shall, during the whole period of the Works comply fully with all applicable laws and regulations relating to environmental protection, mitigating measures for reducing environmental impacts and remedial works on completion of the works. This obligation shall extend to the construction sites themselves, all the contractor's site installations, and all quarries, borrow areas etc.

2.17 FINAL CLEAN-UP

Upon the completion of works, or when any plant has completed its functions, the Contractor shall dismantle and demobilize all temporary facilities and remove all refuse, debris, objectionable material, and shall fill, grade and dress all excavated areas in a clean and proper condition acceptable to the Employer. All such areas, as far as possible, shall conform to the natural appearance of the landscape.

2.18 SUBMITTALS

The Contractor shall submit to the Employer for approval the drawings of layout and details of proposed working facilities at least 15 days prior to commencing the work.

2.19 MEASUREMENT AND PAYMENT

No separate payment for establishing the working facilities shall be made. Cost of all the working facilities as specified above shall be included in the Item Unit Rates of works.

No separate payment shall be made for complying with an environmental obligations required by applicable laws and regulations, and all such costs incurred by the Contractor to this end shall be considered as being included in the Unit Rates.

SECTION - 3

CONSTRUCTION MATERIALS

3.1 All materials such as stones, aggregates, cement, admixtures, water, reinforcement steel, structural steel, water stops etc.required for use in the construction of works under this agreement shall be procured by the contractor at the work site in sufficient quantity such that performance of any particular work shall not be held up for shortage of any material at any time. These shall conform to the requirements laid in this section and/or relevant Indian Standard codes or where not covered by these standards then to the International Standards. A list of few relevant standards is given in Annexure -3.1 for ready reference.

All materials are subject to the approval of the Employer. Any material considered to be sub-standard or not up to the satisfaction of the Employer, shall not be used and shall be removed from the site immediately as and when directed by the Employer at contractor's cost and responsibility.

3.2 MATERIALS FOR CONSTRUCTION

3.2.1 STONES / BOULDER

The river side earthen slopes are protected against river action by covering them with hand placed stones / boulders. This pitching is intended to remain in its laid position. Stones/ Boulders for pitching shall be hard, sound, durable and free from weathering decay and defects like cavities, cracks, flaws, sand holes, injurious veins, patches of loose or soft materials and other similar defects that may adversely affect its strength and appearance. As far as possible, stones shall be of uniform color, quality and texture. Generally, stones shall not contain crypts crystalline silica or chart, mica and other deleterious materials like iron-oxide organic impurities etc. The stones shall be obtained from quarries, approved by the Engineer-in-Charge. Stones with round face shall not be

used. The crushing strength in unconfined compression test shall not be less than 150 kg/cm² when tested on any plane. Samples of stone from quarries shall be tested for compressive strength in accordance with IS: 1121. The compressive strength testing shall be conducted with the load parallel to the bedding plane and also perpendicular to the bedding plane. The stone samples shall also be tested for water absorption and also for soundness to ensure suitability of stones for use.

3.2.2 AGGREGATES

Coarse Aggregates

Coarse aggregates shall consist of hard, strong, clean, compact, unalterable, non flaky rock, with no particles of foreign matter. It shall have no adherent coating and shall be free of lumps of clay, loam, roots, sticks and other organic matter, alkali or other deleterious substances, and shall meet the requirements of IS: 383 except where otherwise specified hereafter. The percentage of deleterious substances in each portion of coarse Aggregate, When delivered to the mixer, shall not exceed the limits as indicated in Table below

Maximum quantity of Deleterious Substance in Coarse Aggregates

Material	Max % by weight of Total Sample
Material passing No. 300 sieve	0.5
Clay lumps	0.5
Light weight material	1.0
Other deleterious substances	1.0
Total percentage of all deleterious substances	<3

The sum of all percentages of deleterious substances, in each portion to be delivered to the mixer, shall not exceed 3% by weight.

Coarse aggregates will be rejected if it fails to meet the following requirements:

Abrasion test, Los Angeles type;

if the loss exceeds either 10% by weight for 100 revolutions, or 30% by weight

for 500 revolutions;

Resistance to the sodium sulfate action;

if the average loss by weight, after 5 cycles, exceeds 10 %;

Specific gravity;

if the specific gravity of the material (on the basis of surface-dry basis) is below 3.60.

The grading of the coarse aggregate within the separated size groups and shall conform to the following requirements as delivered to the mixer.

Grading of Course Aggregates

IS Sieve Designation	Percentage passing (by weight) for nominal size of				
	63mm	40mm	20mm	16mm	12.5mm
75	100	-	-	-	-
63	85-100	100	-	-	-
37.5	0-30	85-100	100	-	-
19	0-5	0-20	85-100	100	-
16	-	-	-	85-100	100
11.2	-	-	-	-	85-100
9.5	-	0-5	0-20	0-30	0-45
4.75	-	-	0-5	0-5	0-10

When crushed and uncrushed aggregates are mixed, they shall be blended uniformly, and the crushing and blending operations, as well as the amount of crushed material blended, shall at all times be subject to the approval of the Employer. The shape of the particles in the fine and coarse aggregate shall be generally spherical or cubical. Manufactured coarse aggregates, containing more than fifteen (15%) percent elongated or flat particles, shall not be used. An elongated particle is defined as a particle having a maximum length of more than five (5) times its maximum width. A flat particle is defined as a particle in which its maximum diameter or length is more than five (5) times its maximum thickness.

Fine Aggregates(Sand)

Fine Aggregates (Sand) shall be clean, strong, hard, compact, unalterable and

without flaky fragments of rock, and shall be free from adherent coating, clay loam, alkali, organic material or other deleterious substances. Fine aggregate shall meet the requirements of IS- 383 except where specified hereafter. The maximum quantity of deleterious substances in fine aggregate must not exceed 5%. Fine Aggregate will be rejected if:

- ✓ It has a specific gravity (on the basis of weight of saturated surface dry basis) of less than 2.60.
- ✓ It has a loss of more than 10% by weight of the fraction retained on sieve No 50 when subjected to five (5) cycles of soundness test using sodium sulfate solution.

The grading of fine aggregate shall also be controlled so that the fineness modulus, in at least nine out of ten test samples of the fine aggregate as-delivered to the mixer, shall not vary more than 0.30 from the average fineness modulus of all samples previously taken unless different instructions are given by the Employer.

The fineness modulus of fine aggregate to be used in concrete and for mortar required for masonry shall be between 2.6 and 3.0 and that for plaster shall be between 1.0 and 1.5. The maximum quantity of silt shall not exceed 8%. Quantity passing through 150 microns IS Sieve shall not be more than 10%. Grading of fine aggregate when tested shall conform to the following requirements as per IS- 515.

Grading of Fine Aggregates

Sieve Size	Percentage Passing	
	Natural Sand	Manufactured Sand
480 (4.75mm)	95 to 100	95 to 100
340 (3.36mm)	80 to 95	75 to 90
130 (1.18mm)	45 to 80	50 to 70
60 (600 micron)	30 to 45	30 to 50
30 (300 micron)	5 to 30	15 to 30

15 (150 micron)	1 to 5	8 to 13
8 (75 micron)	0 to 1	0 to 1

Storage of Aggregates

Fine and coarse aggregates shall be stored separately on a hard, dry and level patch of ground in such a manner as to prevent inclusion or intrusion of foreign matters, or the intermixing of various sizes. Height of the stacks shall not exceed 1.5m. While stockpiling, the aggregates shall not form pyramids resulting in segregation of different sized materials. aggregates shall be tested for the following as per IS-3386:

- ✓ Determination of Particle size and shape
- ✓ Estimation of organic impurities
- ✓ Surface Moisture Content
- ✓ Determination of 10% fine value

3.2.3 CEMENT

All the cement to be, used in the Works shall comply with Standard specifications for Ordinary Portland Cement or as directed by the Employer. All cement used in the Works shall be from the same manufacturer unless otherwise approved in writing by the Employer. The Contractor shall deliver with 250 tons of cement a certificate, by which the cement is guaranteed to comply with the requirements of the Specifications. The certificate shall indicate the date of arrival of each consignment at the concrete plant, the quantity consigned and the identification of the bags at the factory from where the cement originates.

The Employer reserves the right to take samples soon after delivery or at a later stage and to require the performance of tests of the cement that the Contractor uses or intends to use. No cement shall be used until the Employer has indicated that the same is satisfactory. If the tests demonstrate that the delivered cement is not satisfactory, it shall be replaced at the expense of the Contractor. The

Employer may order the removal of any concrete produced with cement that does not comply with the requirements of this Specification. White cement shall be as per IS-8042.

Cement to be used in the Works shall be delivered in bags. The cement of each type has to be clearly indicated on each delivery. Cement in bags shall be delivered to the Site in strong bags, factory-sealed, unbroken or undamaged and uncontaminated by moisture, oil or other substance. Cement of each type proposed to be used has to be stored in sufficient quantity so as not to hamper the construction progress at any time. Immediately upon arrival on site, the cement shall be stored. All storage facilities shall be subject to the approval by the Employer. Cement of different type shall have to be stored separately and all storage facilities shall be arranged in a way to avoid mistake by mixing up different cement types. All cement in bags shall be stored in a storage room (as per codal provisions) and be arranged so as to permit easy access for inspection and definite identification of all cement in the storage. The floor of the stores shall have a wooden deck at least 30-30 cm above ground and shall be provided with water proof membranes. Storage of cement in bags on the ground will not be permitted under any circumstances. Cement in bags shall be stored in stocks not higher than 8 layers. Storage of cement at the site shall be at Contractor's expense and risk. In the event of any damage occurring to cement due to faulty storage or on account of negligence on his part, such damages shall be the liability of the Contractor.

The transportation of cement including loading and un-loading facilities shall be performed in trucks with clean weather tight compartments, sealed and adequately constructed to protect the cement from exposure to moisture. Re-bagging of the contents of broken or damaged bags will not be permitted. If the cement has deteriorated during transportation, handling or storage, it shall be removed immediately from the site at the Contractor's expense.

Cement shall be used in the same chronological order as delivered to the site to

avoid storing some stocks for too long. Any cement, which has been stored onsite for more than sixty (60) days, has to be representatively sampled if so instructed by the Employer, and if the last results are not satisfactory, the cement shall be removed from the site at the Contractor's expense. Such retesting will be at the expense of the Contractor.

3.2.4 WATER

The water used for mixing, rinsing and curing concrete and / or processing concrete aggregates, shall be clean and free from oil, salt, alkali, silt, organic matters or other substances deleterious to concrete such as clay and mud, etc. Generally, portable water shall be used. The water turbidity shall not exceed 3,000 parts per million. The following concentrations may be taken to represent the maximum permissible limits of deleterious materials in water:

Limits of Acidity: To neutralize 300ml sample of water, not more than 3ml of 0.1 N caustic soda solutions shall be required.

Limits of Alkalinity: To neutralize 300ml sample of water, not more than 0.1ml of 0.1N hydrochloric acid shall be required.

Percentage of solids should not exceed

Organic: 300ppm (0.03%)

Inorganic: 3000ppm (0.03%)

Sulfates: 500ppm (0.05%)

Alkali chlorides: 1000 (0.1%)

If water from local natural sources contains, at certain times, quantities of Impurities in excess of these limits, the Contractor will be required to take all necessary measurements for ensuring its purity before use. Water found satisfactory for mixing is suitable for curing. However, the water used for curing should not produce any objectionable stain or deposit on the surface.

3.2.5 ADMIXTURE

Concrete admixtures shall comply with IS- 9103. For each type of admixture, the contractor will submit to the Employer the catalogs and samples of at least three manufacturers with recognized worldwide reputation in concrete admixtures. The contractor will execute tests on the samples of admixture, as required by the Employer, after their delivery to the site laboratory in order to verify the quality and the proportion. After the end of the tests, the Employer will approve the products, which have given the best technical results with the minimum quantity for volume of concrete treated. Admixture containing calcium chloride shall not be used.

The admixtures, which have to be mixed in the same class of concrete, must be supplied by the same manufacturer and shall have a uniform quality in the different stocks, and this will be supplied along with manufacturer's test certificate. Liquid or powdered admixtures shall be stored in such a way that the materials are used in the same chronological order as their delivery to the site. Admixture, which has been in storage at the site for longer than six months, shall not be used until retest proves to be satisfactory.

Water- reducing-retarding Admixture

A water reducing or a water-reducing-retarding admixture may be used in all classes of concrete. The final quantity of water-reducing or water-reducing-retarding admixture in the various classes of concrete shall be established by laboratory tests carried out by the Contractor and will reduce the quantity of mixing water not less than 10% and increase the setting time approximately by 3 hours.

Air Entraining Admixture

The contractor may use an approved air-entraining admixture in all concrete works. The amount of, air-entraining admixture used in concrete mix shall be such as will affect the entrainment of the percentage of air within the specified range.

Expanding Agent

The Contractor may use an expanding agent in a small amount of the concrete and mortar used in the Works where and when directed by the Employer. The expanding agent shall consist of an approved aluminum powder or other approved material. The amount of expanding agent used in the concrete or mortar shall be as approved by the Employer.

3.2.6 REINFORCING STEEL

All steel used for reinforcement shall be clean, free from oil, grease, paints, dust, mortar, scales, kinks rust or any rolling defects or bends other than those required as per drawings or directions of the Employer. The reinforcement shall be any of the following:

- i. Mild steel and high tensile steel bars and hard drawn steel wire conforming to IS: 432-1960 as revised from time to time.
- ii. High yield strength steel (cold twisted deformed bars) [Fe-500] conforming to IS: 1786-1966 as amended from time to time.

Bar stock shall be periodically tested for quality, from time to time during the progress of the work. If any bar stock does not conform to the requirements of the specifications /drawings, it shall not be used in the work. Reinforcements shall be arranged according to the diameter, grade and length in a store room (as per codal provisions) as to permit easy approach for inspection and identification

3.2.7 STRUCTURAL STEEL FOR HYDRO-MECHANICAL WORKS (GATES AND HOIST)

All members and components listed in Annexure 5.2 under these specifications and specification drawings shall be fabricated out of unused high grade materials free from any kind of defects and imperfections. All the materials shall conform to the standards specified in these specifications and on the specification drawings, however, if for any reasons the contractor desires to deviate from these standards, he shall submit a statement stating the exact nature of deviations or substitutions along with complete and detailed specifications and test reports of the materials

which are proposed to be used as substitution or deviation, for the approval of the Employer, prior to the fabrication work is taken up in hands. All such materials or articles or supplies, which are not manufactured by the contractor, shall be the product of recognized and reputed manufacturer.

The contractor shall furnish a list of names of the manufacturer(s) of the bought out complete material/equipment, which are contemplated for incorporation in the work, together with their performance characteristics and other pertinent reports along with the samples of the materials, shall be submitted for approval of the purchaser. However the approval of purchaser shall not relieve the manufacturer from the responsibility of supply of suitable materials. Any material or equipment used or installed with no prior approval of the purchaser shall be at risk and cost of the contractor. Recommended materials for some of the components of different type of gates & hoists involved are given below.

3.3 TESTING OF MATERIALS

All materials provided by the Contractor shall be tested for conformity of the specification and the test result shall be submitted to the Employer for acceptance. In addition to above, the Contractor shall carry out the relevant tests at site as specified under different item of works.

3.4 SUBMITTALS

The Contractor shall, specify in his Technical proposal and subsequently also, if required by the Employer, the sources from which the cement, steel, etc will be obtained. In case, the specified source (s) is not acceptable to the Employer, the contractor shall be required to substitute the source by an acceptable source. Additional suppliers and change of suppliers shall be subject to the approval of the Employer.

At least thirty days prior to the commencement of procurement / supply of any material, the Contractor shall submit the details of such procurement / supply to

the Employer for his approval. The detail shall include the source of his purchase and the quantity thereof to be obtained from each source. A typical mill test report performed by the factory for the physical and chemical properties for each consignment of cement shall also be submitted. No materials shall be procured / ordered without prior approval of the Employer.

The contractor shall submit the Representative sample of the materials as required by the Employer for his Approval. However approval given by the Employer for that material shall not relieve the contractor of his full responsibility for proper quality and performance of any material or any obligations there to under the contract.

3.5 MEASUREMENT AND PAYMENT

No measurement and payment for supply of any construction material as discussed above shall be made separately since the cost of the materials including all taxes/ royalties, labour, transport, handling, storage, tests and all other charges involved, shall be inclusive in the Unit Rates of the respective item of works as per Contract.

The contractor shall supply the boulders/stones on the direction of Engineer-in-charge for keeping reserve at site or for any other purpose. the contractor will stack the boulders/ stone in nearly 1m high chattas (stacks). The chattas will be numbered by enamel paint on the small plastered area on the top of each chatta. The measurement of the boulders/stones will be done by volume of boulders/stones in cubic meter (m^3) by measuring the length, width and height of each chattas. The height of each chatta shall be measured at 4 points and average of these values shall be taken as height for calculation of the volume. The payment shall be done on the basis of item unit rate quoted in bill of quantities as per Contract.

The rate shall include royalty at quarry, loading at quarry, carriage from the quarry to site, unloading and stacking at site.

Annex-3.1**List of Reference Standards/ Specification for common Construction Material**

S.N.	Code No.	Title of Code
For Aggregate		
1.	IS-383	Specifications for natural aggregates
2.	IS-515	Specifications for natural and manufactured aggregates
3.	IS-1121 (P-I to P-IV)	Method of test for determination of strength and properties of natural building stones
4.	IS-1124	Tests for absorption of water of Stones
5.	IS-1126	Method of Test for determination of durability of natural building stones
6.	IS-1127	Recommendations for dressing of Natural Building Stones
7.	IS-1129	Recommendations for dressing of natural building stones
8.	IS-2116	Sand for Masonry Mortars
9.	IS-2230	Sampling of Sand
10.	IS-2386	Testing of aggregates for concrete
11.	IS-3083	Storage of aggregates
12.	IS-4082	Recommendations for Handling and Storage of Building Materials
13.	IS-8381	Recommended practice for quarry stones for construction purposes
For Cement		
14.	IS-269	Ordinary Portland Cement (33 grade)
15.	IS-8112	Ordinary Portland Cement (33 grade)
17.	IS-12269	Ordinary Portland Cement (53 grade)
17.	IS-8041	Rapid hardening Portland Cement
For Reinforcing Steel		
18.	IS-1566	Specification for hard-drawn steel wire fabric for concrete reinforcement
19.	IS-1786	Specification for cold twisted steel bars Fe-415
20.	IS-8500	Medium and High strength Structural steel
For Water		
21.	IS-356	Water
For Admixtures		
22.	IS-9103	Admixtures for Concrete

Annex-3.2

List of Reference Standards/ Specification for structural steel

S.No.	Reference	Recommended Materials	Component
Fixed Wheel Gate			
1.	IS-2062 Grade E250, Quality B	Structural Steel	Skin plates, Stiffeners
2.	—— do ——	Structural Steel	Main horizontal girders, Vertical girders etc.
3.	—— do ——	Structural Steel	Seal bases, Track bases, Seal seat bases Seal clamps guide shoes
4.	—— do ——	Structural Steel	Anchor plates, Anchorages etc.
5.	—— do ——	Structural Steel	Side guide tracks
6.	IS-1570 (Part-V)	Stainless steel, X04Cr18Ni10	Seal seats
7.	IS-1570 (Part-V)	Corrosion resistant steel plates X30Cr13 (BHN of wheel track should be more by minimum 50 points than that of wheel)	Wheel tracks
8.	IS-1030/IS-2004/1875	Cast steel/Forged Steel	Wheel
9.	IS-1570 (Part-V)	Stainless Steel	Wheel pin
10.		Spherical Roller SKF or equivalent Bearing	Bearings in Wheels
11.	IS-11855, IS-15466	PTFE clad solid bulb music note and double stem type respectively	Side and top Rubber Seals
12.	IS-11855, IS-15466	Wedge type rubber seal	Bottom seal
For Slide Type Gate			
1.	IS-2062 Grade E250, Quality B	Structural Steel	Skin plates, Stiffeners
2.	—— do ——	Structural Steel	Main horizontal girders, Vertical girders etc.
3.	—— do ——	Structural Steel	Seal bases, Track bases, Seal seat bases Seal clamps guide shoes
4.	—— do ——	Structural Steel	Anchor plates, Anchorages etc.
5.	—— do ——	Structural Steel	Side guide tracks
6.	IS-1570 (Part-V)	Stainless steel, X04Cr18Ni10	Seal seats
7.	IS-1570 (Part-V)	Corrosion resistant steel plates X20Cr13	Slide tracks
8.	IS-318	Bronze	Slide Pad
9.	IS-11855, IS-15466	PTFE clad solid bulb music note and double stem type respectively	Side and top Rubber Seals

10.	IS-11855, IS-5466	Wedge type rubber seal	Bottom seal
11.	IS-2062 Grade 250,Quality B	Structural steel	Steel liner
For Electrically Operated Rope Drum Hoist and Hoist Bridge			
1.	IS-2062 Grade E250,Quality B	Structural Steel	All structural members for steel trestles and hoist bridge etc.
2.	IS-2062 Grade E250, Quality B IS : 1030	Structural Steel, Cast steel	Rope drum
3.	IS : 2266	Improvised plough steel (galvanized)	Wire rope
4.	IS : 2004 IS: 1875	Forged steel	Hook and wire rope socket
5.	IS : 1030 IS : 1875	Cast steel Forged steel	Gears
6.	IS : 2004	Forged steel	Pinions
7.	IS-2062 Grade E250, Quality B IS : 2004	Structural Steel Forged steel	Shafts
8.	IS-2062 Grade E250, Quality B IS : 1030	Structural steel Cast steel	Sheaves/Pulleys
9.	IS : 318 IS : 305	Lead Tin Bronze Aluminium bronze	Bronze bushing
10.	IS : 2048/2291/2292	Forged steel	keys and Cotters
11.	IS : 325	Standard manufacturer	Motor
12.	IS : 9968/ 8130		Cable and conductors
13.	IS : 9537		Conduits
14.	IS : 2147 IS : 4237 IS : 2516	Standard manufacturer	Switch gear
15.	IS : 5669 IS:5692 & other applicable standards	Standard manufacturer	Ball & roller bearings
For skew Hoist			
1.	IS-2062 Grade E250, Quality B IS : 2004	Structural Steel Forged steel	Lifting rod / wheel
2.	IS : 1030 IS : 1875	Cast steel Forged steel	Gears

SECTION - 4

JUNGLE CLEARANCE AND FELLING OF TREES

- 4.1** The contractor shall provide all The construction plants and equipment, skilled and auxiliary personnel and material necessary to commensurate with the various tasks and requirement associated with preparation of the site. Safety of the workmen and others in all respect shall be the responsibility of the contractor.

Operation of site preparation shall be strictly limited to the area to be occupied by the indispensable works unless otherwise directed by the Employer. Clearing shall be extended to approximately 5m beyond the limit of the works for permanent structures. For temporary works, such extension shall be as minimum required.

4.2 CLEARING AND GRUBBING

The portion of the right of way, where required for constructing the work under these specifications, shall be cleared of all jungle, bushes, rubbish, shrubs, small trees and other objectionable matter.

Trees having girth (measured at a height of 1 m above the ground level) above 300mm shall be numbered suitably and cut only getting approval of the Employer. Felling trees shall include taking out roots up to 250mm below the sub grade level. Trees designated by the Employer shall not be cut and shall be protected from injury.

The Employer reserves the right to reinstate any damage to vegetation and surface of the ground beyond the areas of the works (including temporary works) at the expense of the Contractor.

The timber and other useful materials should be stacked as directed by Employer and handed over to the Department. After handing over useful material to department the waste material shall be disposed off as removed from the site of work before the date approved by the Employer. The clearing operation shall be in accordance with clause 4.1, and 4.2 of IS: 4701 Indian code of practice for earthwork.

All waste materials to be burned shall be piled neatly and when in suitable condition shall be buried or burned completely at proper place defined for by Employer. Piling for burning shall be done in such manner and in such locations as to cause the least fire risk. All burning shall be so thorough that the materials are reduced to ashes. Necessary precautions shall be taken to prevent fire from spreading to areas beyond the limits of cleared areas and suitable equipment and supplied for use in preventing and suppressing fires shall be kept available at all times. In filling reaches, all holes and hollows whether originally existing or produced by digging up roots shall be filled with suitable earth, well rammed and leveled off.

4.3 SUBMITTALS

At least 15 days before beginning of the works, the contractor shall submit program of works indicating schedule of time, the area to be covered and the arrangement that he intends to adopt to carry out the work, to the Employer for his approval.

4.4 MEASUREMENT AND PAYMENT

Measurement and payment for the site clearance all jungle, bushes, rubbish, shrubs, small trees and other objectionable matter shall be done in square meter (m²) for the area cleared as per required for the work. No measurement shall be for any extra area if cleared by the contractor for his convenience or by his requirement and payment shall be based on the item unit prices quoted in bill of quantities as per Contract.

For felling of trees having girth (measured at a height of 1 m above the ground level) above 300mm, the measurement shall be done in numbers and payment shall be based on the unit prices quoted in bill of quantities for the item as per Contract.

The cost of all works, Man and materials, Tools & Plants etc. required for the above work shall be deemed included in the item unit price quoted in bill of quantities as per Contract.

SECTION –5

EXCAVATION FOR FOUNDTION OF STRUCTURES

- 5.1** The excavation for the foundation of structures shall conform to the final dimensions, lines, side slopes and grades shown in the approved construction drawings or as directed by Engineer-in-charge. The work includes all activities for proper setting out works, Clearing, grubbing/stripping of top soil as necessary. The contractor shall provide all The construction plants and equipment, skilled and auxiliary personnel and material necessary to commensurate with the various tasks and requirement associated with clearing, grubbing and stripping and excavation of the working areas as per drawings, specifications and/or direction of Employer.

The contractor shall provide and install suitable safeguards approved by the Employer for protection from damage of the existing structures, drains and facilities etc. adjacent to the works being carried out. Safety of the workmen and others in all respect shall be the responsibility of the contractor.

All materials obtained from excavation shall remain Employer's property. All salvaged materials of value in the opinion of the Employer shall be segregated from the excavated materials and stacked separately in a regular manner at locations as directed by Employer.

The method and practice for all types of excavation shall conform to the specifications of latest editions of the IS codes. The list of I.S codes applicable to this section, but not limited to, is given in end of this section.

5.2 EXCAVATION

Before taken up of excavation operations, all buried logs, stumps, roots and other unsuitable materials etc. shall be removed from the limits of the work site and disposed of. The entire area of the structure foundation shall then be stripped to a

depth of 50cm in general or as directed by Employer. Material from stripping operation under the foundations shall be disposed off on the approved adjacent areas or on the exhaust borrow areas, as directed by Employer. The useful material obtained shall be suitably utilized.

Excavation includes excavation of all material which shall include earth, gravel, hard laterite, hard conglomerate, cemented gravel, all boulders and soft disintegrated rock. It is expected that nearly all excavation can be accomplished using conventional equipment.

Excavation for foundation shall be to the bottom of the lean concrete and as shown in the construction drawings. The contractor shall prepare the foundation of the structure by method which will provide firm foundation for the structure. The Bottom and sides of excavation upon which or against which the structures to be placed shall be finished to the prescribed dimensions and made to correct level and well consolidated. Soft/ defective spots shall be dug out and filled with leveling concrete as directed by Employer. Excavation shall be performed as far as practicable in dry conditions. The contractor shall construct, operate and maintain drainage system, including drainage trenches, pumps, Pump sump, Pipelines etc. to dewater all appearing water, service water and ground water encountered during excavation.

The contractor shall strictly follow the safety regulations in order to prevent accidents. All trenches of more than 1.5 m depth into which men enter shall be securely shored and strutted and timbered. Notwithstanding, anything said above, no work shall be continued until adequate shoring is provided even in trenches of less than 1.5m depth, if there is a doubt as to safety of the work without shoring. Where the sides of trenches are sloped, but not within 1.5m of the bottom, the vertical sides shall be shored and shoring shall extend at least 30cm above the vertical side. When open spaced sheathing is used, a toe board shall be provided to prevent material rolling down the slope and falling into part of the trench with vertical walls.

The contractor shall not excavate outside the limits of excavations. If , at any point in excavation, the natural foundation material is disturbed or loosened, for any reason: or any excess depth/ width excavated beyond the specified levels/ dimensions on the drawings, subject to permitted tolerances, shall be made good at the cost of contractor with suitable material /concrete as directed by the Employer. The following tolerances shall apply for all excavations.

	Description	Allowable Tolerance (cm)
a.	Bed or formation levels for construction	+0 , -10
b.	Side slope (perpendicular to slope)	+4 , -10
c.	Top elevation	+10 , -0

No extra payment will be made for the excavation beyond the designed profile.

The contractor shall have to remove all materials arising from excavations. The subsequent disposal of the excavated material shall be as per direction of Employer. All useful material obtained by excavation shall be stockpiled in the location or in the vicinity of the works as directed by Employer.

5.3 BACKFILL

Backfill shall be placed at the lines and grades shown on the drawings. The surface to receive the filling shall be first prepared free from all roots, vegetation or spoil and wetted. All backfill shall be placed carefully and spread in uniform layers so that all spaces around rocks/clods will be filled. Backfill shall be brought up as uniformly as practicable on both sides of walls and all sides of structure to prevent unequal loading. The backfill material shall be selected material containing no stones larger than 8 cm. or as approved by Engineer-in charge and obtained from excavation or approved borrow pit. Unless otherwise shown on the drawing, the backfill around structure shall be compacted in horizontal layers not exceeding 15 cm. after compaction. The compacting equipment shall be so selected as to give maximum safety to the structure.

The backfill compaction under and over the pipe shall be in accordance to clause

9.2.4, 9.2.5 and 9.2.6 of I.S. 783. In case of a pipe laid in the high embankment, the embankment shall be built to an elevation above the top of the pipe equal to external diameter of the pipe and then a trench shall be excavated. The vertical surfaces of the trench shall not be more than 20 cm. beyond the outside diameter of the pipe. The pipe shall be laid in position and then suitable backfill material shall be placed around the pipe and carefully compacted in layers, not more than 15 cm. after compaction up top of the pipe. Thereafter, a loose fill of depth equal to external diameter of the pipe shall be placed before further layers are added and compacted.

5.4 DISPOSAL OF MATERIAL

All suitable material removed in excavation or as much it may be used in the construction of canal embankments / roadway embankment / guide bunds / afflux bund and for backfill around structure. When directed by Engineer-in charge, excess material shall also be placed in low areas adjacent to bridge sites and canal banks. The soil excavated, which is not suitable or not required for embankments, backfills or other required earth work, shall be deposited in waste banks on Right of Way owned or controlled by the Government as directed by the Engineer-in-Charge.

5.5 SUBMITTALS

Within 15 days of taking over the site, the contractor shall submit to the Employer for approval, his proposal for excavation together with pertinent data for each stage of excavation in each work area. the contractor shall furnish the following details n his proposal:

- a. Details of the proposed setting out method before commencing the work
- b. Description of working method and sequence of excavation
- c. Proposal for controlling groundwater and details of associated plant and equipment proposed to be deployed, where dewatering is felt necessary.
- d. Preliminary design and procedure for blasting if necessary.

5.6 MEASUREMENT

Measurement for excavation in soil or rock will be made according to volume of solid mass, actually excavated in its natural state by measuring the length, breadth and depth of cutting corrected to 5mm. The volume computations shall be based on surveys of the original surface and surface after completion the final excavation. The excavation in soil and rock shall be measured separately. The L.F. books, the section sheets (in which the levels are plotted) and the calculation sheets shall be treated as adjuncts to the measurement books.

Excavation works for working facilities, e.g. access and temporary service roads, camps, etc. will not be measured. The contractor shall include the cost of such works in the respective pay-items.

5.7 PAYMENT

Payment for excavation in soil or rock shall be made at the unit prices given in the contract. The unit prices shall include all cost required for carrying out all operations such as setting out, top soil removal or stripping, Marking out, drilling and blasting, protection, drainage and dewatering and cleaning of excavated surface. Stockpiling, transportation and disposing of the excavated materials etc. including labour, equipment, tools and plant, material, safe guards and incidentals necessary to complete the work to specifications. No measurement and payment for dewatering shall be made extra.

Over excavation caused due to inappropriate working method or negligent work, no payment will be made either for the over-excavation/over-break beyond the pay line. The contractor shall be responsible for all cave-in, erosion and over-break. He shall make all repairs at his own cost ordered by the Employer. The cost in connection with cave-ins and rock falls due to geological conditions which could not be avoided by proper excavation and support methods, will be reimbursed to the contractor, at the reduced rate as approved by the Employer ,

Extra excavation not described in the Schedule of quantity or not shown on the drawings, but considered necessary may be done only if approved by the Employer. The cost of such excavation including supporting work and concrete required to fill them back shall be included in the unit price of excavation in the schedule of quantity and shall not be paid separately even though this extra excavation has been approved by the Employer.

I.S. codes to be referred for earth work

Sl.No.	I.S. Number	Short Title
01	IS:4701	Code of practice for earth work on canal
02	IS:3764	Safety code for excavation work
03	IS 4081	Safety code for Blasting and related Drilling operations
04	Is: 9758	Guide lines for De-watering during construction
05	IS:1200	Measurement of building and Civil Engineering works
06	IS 3701	Safety code for excavation works.
07	IS 3698	Safety code for scaffolding
08	IS 3696	Safety code of ladders
09	IS 4082	Recommendation of stacking and storage of construction materials at site.
10	IS 783	Practice for laying concrete pipes

SECTION - 6

EARTHWORK ON CANAL/FLOOD EMBANKMENT

6.1 The earthwork on canal/ flood embankment covers excavation and construction of embankments as shown on the construction drawings or as directed by Employer. The work includes all activities for proper setting out works, clearing, grubbing of top soil as necessary. The contractor shall provide all The construction plants and equipment, skilled and auxiliary personnel and material necessary to commensurate with the various tasks and requirement associated with work as per drawings, specifications and/or direction of Employer. Earth work shall conform to the Indian Standards and /or International Standards (Annex.6.1). The materials obtained from excavation may be used for construction of embankment if found suitable.

Prior to the commencement of work the axis line of the proposed embankment shall be marked by stones or pegs each at about 30 m interval and Curves shall be laid out. Top and bottom edges of the excavation and toe of all embankments suitably peg marked. Reference pegs should also be driven into ground at a fixed distance outside peg markings. All levels shall be referred to an established bench mark not subject to subsidence or interference.

The land over which embankments are to be formed and other excavation is to be carried out shall be cleared of all trees, bushes, rubbish, ant hills and other objectionable matter. The cleared materials shall be suitably disposed off. In filling reaches, all holes and hollows whether originally existing or produced by digging up roots shall be filled with suitable earth, well rammed and leveled off. The boulders in the top strata shall be removed and filled with suitable material.

6.2 EARTH WORK IN CUTTING

In case of flood embankment, the excavation may be needed if the upper layer of pervious soil is to be removed or a clay cutoff is to be provided up to impervious foundation level.

In case of canal, the excavation may be needed if the canal section is in cutting / partial cutting. The excavation of canal section in all kinds of soil and Disintegrated (D.I.) rock shall be done according to dimensions and grades shown on the drawings or as directed by the Employer. In case of lined canals, proud equivalent to thickness of the lining and in bed on the underside of the lining be left unexcavated temporary and the removal of this proud shall be done just before trimming and placement of lining. Both edges of the bank, specially the inner one shall be neatly aligned symmetrically to the centre line of the channel. They shall be absolutely straight in straight reaches and smoothly curved on bends. All gangways, roads and stopping shall be such that they fall within the canal section so that final dressing of slope will consist of digging only and no filling will be required.

Excavation may be carried out by manual labour or by excavating machines. The choice of type of excavating machine to be used will depend on the nature and quantity of materials to be excavated and also on the leads and lifts involved. Except for the areas of rock, all areas to be excavated shall be pre-wetted so that at the time of excavation moisture content shall be about the optimum. However in case the excavated material is not to be used for embankment, such pre-wetting is not necessary.

Rock may be excavated by the following methods :

- a) Quarrying out by hand with suitable rock wedges and hammers, steel bars, picks, etc, and breakings with rock hammers;
- b) Loosening by use of pneumatic paving breakers;
- c) Drilling suitable holes by hand jumpers or pneumatic drilling machines, and breaking up rock with plugs and features;
- d) Drilling holes by hand jumpers or pneumatic drilling machines as above, but breaking the rock with suitable commercial explosives, or blasting devices; and
- e) Ripping with suitable heavy duty tractors where the rock formation falls within the range of rip ability of commercially available units.

Blasting if needed shall be done in such a manner as not to cause over break. Special

care shall be taken to prevent over-breakage or loosening of material on bottoms and side slope against which rigid lining is to be placed. Final cutting for 45-60 cm in hard rock shall be carried out by controlled blasting or trimming or with the help of pneumatic paving breakers. Above the lined sections, the rock may be allowed to stand at its steepest safe angle and no finishing is required other than removal of rock masses which are loose and are liable to fall.

Wherever ground water is met during excavation adequate measures shall be taken to dewater the cutting. The choice of method to be employed and type of equipment to be used would depend on the nature of ground and the volume of water to be dealt with. Suitable arrangements for drainage shall be provided to take surface water clear of the excavation during the progress of work. Sumps may be constructed at suitable places and water collected may be pumped out.

All excavated materials within economic lead, suitable for construction of canal embankment should be used in its construction. Where the canal is aligned on sloping ground excavated material not required for the construction of embankment on the higher side shall be deposited on the lower side. Where canal is on level or nearly level ground the material from excavation shall be deposited on embankments on both sides of the canal. The excavation shall be allowed to progress from the valley ends of the reach towards the ridge in conformity with the layout given.

If there is excess of material from the excavation than needed for construction of embankments of canals, it should be deposited outside the embankments on either side of the canal in the form of spoil banks leaving a suitable berm and cross drains as directed by the Employer. A gap 3 m wide at toe may be left in spoil banks at 150 m intervals for the purpose of drainage.

6.3 EARTH WORK IN EMBANKMENT

Before commencing the work, the ground surface in a width little more than the total

width of the embankment (except rock surfaces) shall be wet by sprinkling water and ploughed to clear all vegetation and roots. The top soil in a depth adequate to move all perishable material and any soil which may become unstable on saturation or may interfere with development of proper bond between the foundation and embankment shall be removed. Open furrows 20 cm deep below natural ground surface at intervals of not more than 1 m shall be made. However, where the ground surface is below the bed level of the canal the entire surface of the foundations for both side embankments shall be stripped to a depth of 20 cm. For small canals (minors), only one large embankment shall be constructed and then the canal cross-section shall be excavated in the middle.

The toe of the slope on each side of the embankments shall be lock-spitted (Dag-Belled) and marked by pegs, firmly driven into the ground at intervals of about 20 m. Embankments may be built by manual labour or by machinery depositing the materials directly from excavation. Embankment shall be built in layers generally not exceeding 25 to 30 cm in thickness (loose layer) and to full width of the embankment. Each layer shall be commenced from the edge farthest from excavation. Top of each layer shall be kept slightly depressed in the centre. Each layer shall be compacted to 95% proctor density using smooth / sheep foot roller.

The roller shall travel over the embankment evenly and compacting over whole surface. Each pass of roller shall have a overlapping of 15cm to 20cm with the previous pass strip. The number of passes shall be sufficient to produce specified density. To cover up any lapses in the compaction due to the inability rollers to cover the edges of the bank resulting from the safe limits and to allow sufficient width for labourer to work conveniently a lip cutting width of not less than 50 cm horizontally should be provided. Depending upon the nature of soil and the side slopes of the embankment, the lip cutting width may be in the range of 50 to 100 cm.

Blending of two or more materials shall be done to obtain suitable soil to secure the best practicable degree of compaction, impermeability and stability. The proportions

for blending should be ascertained by laboratory test. The excavating and hauling equipment shall travel over the embankment to evenly distribute the material and compacting effort over whole surface. Prior to and during compaction operations, the embankment shall have optimum moisture content required for the purpose of compaction and this moisture content shall be fairly uniform throughout the layer. The moistening of the material shall be performed at the site of excavation but such moistening shall be supplemented as required by sprinkling water at the site of compaction, if necessary. If the moisture content is greater than optimum content for compaction, the compaction operation shall be delayed until such time as the material has dried to the optimum moisture content. The dry bulk density of the soil fraction in compacted embankment material shall be not less than 95 percent of the maximum dry bulk density at optimum moisture content.

When compaction of cohesion less, free draining , material, such as sands and gravels is required in case of zoned embankment, the material shall be deposited in horizontal layers of not more than 30cm thickness and compacted to the relative density not less than 70% when tested in accordance to IS 2720(part-XIV)1983. The compaction shall be done by tampers, crawler tractors, vibratory plate compactor or vibrating rollers. The excavation and placing operation shall be such that the materials when compacted will be blended sufficiently to secure the best practicable degree of compaction and stability. Water shall be added to the material as may be required to obtain the specified density.

It should be ensured that one monsoon is passed for proper consolidation. In case any settlement takes place in the embankment after its completion and a cracks is induced in the embankment , a trench of minimum required width shall be dug along the crack in the embankment for a depth to which the crack has extended plus minimum 0.25 m or to a depth of 1 m whichever is more. The width of the trench shall, however, shall not be less than 0.5 m. This trench shall be filled back with a thorough mixture of clay and fine sand having plasticity index of 10 or less, and should be placed in 150 mm thick

layers and thoroughly compacted.

For lined canals it should be ensured that one monsoon is passed for proper consolidation before lining is done.

Material for Embankment

Where excavation does not furnish sufficient suitable material for embankments, additional material required may be procured from the borrow pits. The location of borrow pits will depend on the material that is being sought which in turn depends on the design consideration. It may be necessary to survey the soil by means of auger borings or trial pits to determine the extent and nature of the deposits in the borrow area. The borrow area shall not be designated within a distance of five times the height of embankment from the outer toe.

Where the embankment is constructed by taking material from borrow pits care shall be exercised that all large clods are broken and no clod bigger than human fist, say 8 to 10 cm, roots, grass and other rubbish are buried in the banks. In areas, where gravel and stone is mixed with earth, these should be removed as far as possible. But the areas where all gravel material cannot be economically removed, cobbles, stones of size greater than 40 mm should be removed to ensure proper compaction. All materials shall be deposited in embankments so that cobbles, gravel are well distributed through other material.

Tests for Compaction of Earthworks

The following tests shall be carried out for determining compaction:

- a) Density moisture relationship of the soil shall be determined in accordance with IS : 2720 (Part VII)-1980 and IS : 2720 (Part VIII)- 1974
- b) Density of the soil in field shall be determined in accordance with IS : 2720 (Part XXVIII)-1974 or IS : 2720 (Part XXIX)-1975.
- c) Moisture content of soil shall be in accordance with IS : 2720 (Part II)-1973.

6.4 CATCH WATER DRAINAGE

Effective system of catch water drainage shall be provided to prevent damage due to rain. The catch water drains shall be constructed on the outer wedge of the bank and the bank surface slope shall be away from the canal/river side so that no rain water is entered in canal. The water flowing in the catch water drains shall be discharged in the toe drain of the embankment through chutes at spacing of 50m intervals.

6.5 SUBMITTALS

15 days before start of canal construction work, the contractor shall submit to the Employer for approval, the following details:

- a. The reach to be taken up
- b. Details of the proposed setting out method before commencing the work.
- c. The description of working method.

6.6 MEASUREMENT AND PAYMENT

After clearance of land and removal of humus, cross sections shall be taken at every 10m interval. The levels along the cross sections shall be observed at every 1.5 m. and at obligatory points with reference to standard, bench marks already established. The cross section shall be taken in presence of Employer and contractor or their authorized agent. The cross sections shall be entered direct in measurement book and signed by the contractor or his authorized representative in token of acceptance. The cross sections plotted in ink and signed by the contractor shall be kept for safe custody in Engineer-in Charge office along with original contract documents. The permission to start earth work shall only be given after the above formalities have been completed. It will be incumbent on the contractor to seek permission in writing to start the earth work.

The final cross section shall again be taken at same chainage after completion the earth work. the quantities of earth work shall be worked out by superimposing the observed cross sections, on the initial cross sections already plotted. The difference of final cross

section and initial section will be the basis of calculating the volume of earth work done using simson' one third rule.

For taking cross sections strictly at the same points reference pillars shall be fixed by the contractor at his own cost. The contractor shall maintain them intact during the progress of his work in case any damage is done to these pillars the contractor shall replace them promptly. No extra payment shall be made on this account.

In partial cutting and partial filling section of canal, the quantity of cutting shall be the total quantity of cutting minus the total quantity of the fill.

Payment shall be made at the unit rate per cubic meter of soil excavation and soil placement separately. The payment for the soil placement shall be done for the 90% quantity considering 10% for settlement allowance.

The unit rate shall include the cost of materials ,all tools & plants, labour , finishing/repair, testing & quality control and all other costs necessary for execution of the works satisfactorily as per specifications/Drawings and/or as directed by the Employer .

Annexure 6.1

CODE NO.	TITLE OF CODES
IS- 4701:1982	Code of practice for earthwork on canal
IS-2720 (PART II): 1973	Determination of moisture content
IS-2720(PARTVII&VIII): 74	Determination of moisture content & dry density relation
IS-2720 (PART XIV): 1982	Code of practice for determination of density index of cohesion less soil
IS-2720(PARTXXVIII):1974	Determination of dry density of soil, in place, by sand replacement
IS-2720(PART XXIX): 1975	Determination of dry density of soil, in place, by core cutter method
IS-10750:1994	Planning and design of guide banksfor alluvial rivers- Guide lines

SECTION - 7

CONCRETE WORK AND FORM WORK

7.1 The work under this section covers construction of cast-in-place concrete in the structures. The structures shall be built to the lines, grade and dimensions shown on the approved drawings. The dimension of each structure as shown in the drawing will be subject to such modification as may be found necessary by the Engineer-in charge.

The work under this section shall consist of:

- Supply of all concrete constituents including labour, plant and equipment etc"
- Manufacturing, transporting, placing, protecting and curing of concrete
- Constructing, erecting and dismantling form work
- Placing materials for expansion and construction joints with water stops,
- Placing embedded items.

The Contractor shall perform the concrete works in accordance with the Specifications, the Drawings and the instructions of the Employer. The Contractor shall provide and adopt all safety measures for workmen, plant and equipment and others, in execution of concrete works at his own cost and responsibility. The approval given by the Employer to the Contractor's plants and equipment or their operation or any construction method shall not relieve the Contractor of his full responsibility for the proper and safe execution of concrete work or any obligations under the Contract

All ingredients of concrete like cement, aggregates, water, admixture, etc shall be in accordance with the specifications laid in section- 3 'construction Materials'. The concrete production method, testing and admixtures etc- shall conform to the standards and codes listed in end of this section (Annex-7.1). When not covered by those standards, relevant Indian standards shall be followed.

The concrete to be produced and placed according to this Specification shall be of highest quality and uniformity. In all phases of his operations, the Contractor shall be

subjected to strict inspection to assure concrete of the best quality. Special emphasis will be placed on the uniformity of the concrete aggregates, water-cement ratio, consistency, air content and the temperature control of the concrete at the time of placement in the formwork, as well as the density and finishing when placed.

7.2 EXECUTION

7.2.1 Batching

Proportioning of concrete which is composed of cement, fine and coarse aggregates, admixtures and water, shall mean the process of determining the quantities of the various ingredients to be used to produce concrete of the required strength and in accordance with the other requirements of the specifications. The Contractor shall provide suitable arrangements upto the satisfaction of the Employer, for batching of each ingredients of concrete by weight. Every delivery point of aggregates and cements into the mixer charging hopper shall have a weighing unit or otherwise as directed by the Employer.

7.2.2 Mixing

The components of the concrete shall be mixed in proven type mixers. Mixers shall be mechanically operated mixers, of either the tilting (conical drum) or as approved by the Employer. Mixers shall not be charged in excess of the capacity recommended by the manufacturer. The Employer may direct a reduction in the batch size when mixer performance tests indicate that it is necessary. Mixers shall be capable of combining the materials into a uniform mixture without segregation.

The mixing of each batch shall continue for not less than the time recommended by the batch plant manufacturer. The minimum mixing periods recommended by the batch plant manufacturer are conditional on the materials being fed into the mixer in a manner which will facilitate efficient mixing and on operation of the mixer at its designed speed. The Employer reserves the right to specify a lesser time, if hot weather or other conditions cause quick stiffening of the concrete.

The mixers shall be maintained in satisfactory operating conditions, and mixer drums shall be kept free of hardened mortar. Should any mixer, at any time, produce unsatisfactory results, leak mortar, or cause waste of materials, its use shall be promptly discontinued until it is repaired.

The Employer shall have the right to reject the concrete in any of the following events:

- When mixing operations have not been started within thirty (30) minutes after the cement is added to the aggregates;
- when more than fifteen (15) minutes have elapsed between the discharging of the mixer and the actual placing of the concrete, without agitating the concrete mix;
- When more than one (1) hour has elapsed between the adding of the cement to the aggregates, and the actual placing of the concrete; even when agitator trucks are used for transport of concrete;
- When the mixture does not comply with the Specifications.
- None of the concrete rejected by the Employer shall be utilized in any of the permanent works.
- The retempering of concrete, which has partially hardened, that is, remixing with or without additional cement, aggregate or water shall not be permitted.

7.2.3 Transportation

Concrete shall be conveyed from the mixer to the place of final deposit and finally poured as rapidly as practicable by approved methods, which will prevent segregation, loss of ingredients or damage by exposure to the atmospheric agents, and shall be deposited as nearly as is practicable to its final position.

Concrete can be conveyed by truck mixers and agitators, buckets, chutes and pipes,

and other equipment approved by the Employer. Conveying equipment shall be of such size, design and condition to ensure a practically continuous supply of concrete at the point of placement, and a concrete placing in approximate horizontal layers while the previous layer is still soft. The maximum height from which the concrete shall be dropped shall not exceed one and a half meters, except where the use of suitable equipment to confine and control the falling concrete is specifically authorized by the Employer. All conveying equipment shall be supported independently of the forms. The conveying equipment shall be kept free from hardened concrete and foreign materials, and shall be cleaned at frequent intervals.

Should the concrete show signs of segregation when it reaches the placing point, and provided that the maximum permissible time has not elapsed, it shall be remixed by mechanical means in the vicinity of the placing; otherwise it shall be rejected at Contractor's expense.

In particular, the Contractor shall take appropriate measures to avoid excessive loss of moisture by evaporation, during the transportation and placing of the concrete. Addition of water in the mixture to make up for the evaporation losses shall not be permitted.

7.2.4 Placing

All concrete placing equipment and methods shall be subject to the approval of the Employer. At least 48 hours before the start of concreting, the Contractor shall submit drawings and sketches for shoring and scaffolding and the drawings showing details of embedded part (if any). Concreting of any part of the work will be authorized only after verification and acceptance of the following items:

- The characteristics of the concrete mix to be used,
- The concreting program, type and quantity of equipment for placement and compaction, including the hourly placement rates,
- The availability at the site, of equipment and material necessary for finishing,

curing and protection of concrete,

- The condition and cleanliness of forms, adjacent concrete or other surfaces, reinforcement and embedded parts,
- Conformity of the installation, including shoring and scaffolding, with the formwork drawings,

Concrete placing shall not be started until all form works, reinforcement, installation of embedded parts, and preparation of the surfaces of rock, and hardened concrete involved in the placement have been inspected and approved by the Employer. The Contractor shall notify the Employer at least 48 hours, in advance to allow a reasonable time for inspection before placing begins. Concrete placed without prior knowledge and approval of the Employer may be required to be removed and replaced at the Contractor's expense.

Preparation of Foundation and Abutment

Before placing concrete, all prejudicial materials shall be removed from the places to be occupied by the concrete, and surfaces which will be in contact with the concrete. The surface of soils and rock against which concrete is to be placed, shall be moistened thoroughly so that moisture will not be drawn from the freshly placed concrete, unless otherwise directed by the Employer. In area where the nature of the soil or rock is such that it will be softened if washed with water, blowpipes and compressed air shall be used.

Any water flowing over the surface of the excavation shall be diverted through proper drains to a sump, or shall be removed by other approved methods in order to prevent the washing away of the freshly deposited concrete or any of its constituents.

Surfaces of construction joints and surfaces of block-outs shall be washed thoroughly with air-water jets immediately prior to placement of adjoining concrete. Pools of water shall be removed from the surfaces of construction joints before new concrete is placed. Surfaces of contraction joints shall be cleaned thoroughly of accretions of

concrete or other foreign material by scraping, chipping or other approved means. whenever possible a layer of fine concrete (concrete without coarse aggregate) with a thickness of about 2 cm, shall be placed over the rock surface and construction joints before concreting when 40 mm (1.6") coarse aggregate is present in the mixture. This layer shall be thoroughly brushed into all rock crevices to ensure complete contact between rock and concrete. All fine concrete shall be placed within a quarter of an hour after mixing, and shall be covered with the subsequent concrete before the fine concrete begins to set. Any bonding fine concrete that takes initial set before coarse concrete is placed upon it shall be removed and replaced at Contractor's expense.

Method of Placing

The concrete shall be deposited generally in horizontal layers in such a manner as to maintain, until completion of the pour, plastic surface approximately horizontal. The thickness of each layer shall range from 30 to 60 cm as approved by the Employer and the placement shall be carried out at such a rate that no concrete surface can reach an initial set, before additional concrete is placed thereon.

The lift thickness shall depend upon the ambient temperature, etc. at the time of placement and space be based on temperature studies made by the contractor. However, the maximum lift of pouring shall not exceed 2.00 m unless otherwise instructed or approved by the Employer. The Employer may authorize higher lifts or layers where concrete can be placed or consolidated in thick layers.

Concrete shall be deposited as closely as possible, directly into its final position and in such a way as to avoid segregation or modification of other properties. Bouncing concrete off forms, reinforcing steel or any other obstruction is prohibited. Distributing of concrete with vibrators or by other means will not be permitted. For locations when direct placement is not possible, and in narrow forms, hopper and trunks must be provided, of a size to allow a proper placing. Any tendency to segregation shall be corrected by shoveling stones into mortar, rather than mortar

into stones.

Concrete that is of excessive slump, segregated, partially hardened, or unworkable, shall not be placed in forms or if placed, shall be removed and dumped as directed by the Employer, at the Contractor's expense.

Each layer of concrete which shall be placed and compacted with suitable types of equipment, until the concrete is consolidated to the maximum practicable density, shall be free of pockets of coarse aggregate, and fits tightly against all form surfaces and embedded materials. Construction equipment used for spreading, vibrating or other operation must absolutely not spatter loose oil, fuel and grease on the concrete.

If a placement is stopped before completion, bulkheads shall be used to make a vertical joint. Any unconsolidated concrete shall be removed before completing the placement. During placement, and until curing has been completed, the concrete shall be protected to the satisfaction of the Employer, against the harmful effects of exposure to sunlight, wind and rain.

Placing Restriction

a. Reinforced Structures and Embedded parts

Where concrete has to be dropped through reinforcement, care shall be taken so that no segregation or displacement of bars occurs. Closed chutes, elephant trunks, or tremies receiving hoppers, shall be used to place concrete in deep forms, around reinforcement, or other places not readily accessible for direct placing.

Extreme care shall be devoted to placing the concrete around the various embedded parts, to ensure that unbalanced loading and impact from placing concrete will not cause distortion or dislocation of parts. Both during and after placing of a lift, careful checks shall be made by the Contractor to see that the parts requiring accurate setting have not been displaced.

Mechanical vibrator shall not be used for placing concrete around movable embedded parts, except as approved by the Employer: in this case concrete shall be consolidated thoroughly by hand spading and tamping.

b. Rain

outdoor concreting shall not be started during rains unless the contractor has taken all protective measures including proper shelters so that during transport and placing, the concrete maintains the consistency tested at the mixing plant. Should concreting be already in process, the Contractor shall provide proper shelters in order to complete the pouring operation. In any case, placing operations shall be suspended, if the rain affects the quality of concrete, i.e. when the slump of vibrated concrete is 25 mm or more than the slump tested at the mixing plant for the class of concrete being poured or if the Employer directed.

c. Water

No concreting shall be carried out under water, unless it is foreseen on the Drawings or is approved by the Employer. The "drop-bottom bucket" or "tremie" method shall be used to pour concrete under water.

d. Block-outs and Recesses

The Contractor shall place concrete in block-outs, recesses, etc., constructed as shown on the Drawings or as directed by the Employer, after the installation and adjustment of metal work has been completed. Before concrete is placed in the block-outs, recesses, etc, the surfaces of the concrete previously placed shall be roughened and cleaned. The roughening shall be performed by chiseling or other methods so as not to crack or scatter any other part of the concrete surface. All concrete, which is not hard, dense and durable as determined by the Employer, shall be removed to the depth required to secure a surface to the satisfaction of the Employer. The Contractor shall place the concrete in a way to ensure satisfactory bond with the existing concrete, to secure complete contact with metal work to be embedded and to avoid

any displacement. Where directed by the Employer, concrete placed in recesses, etc., shall contain an approved expanding agent or non-shrink grout. No force or load shall be applied before the concrete reaches its 28 days strength.

7.2.5 Compaction

Concrete shall be compacted with mechanical vibrating equipment, supplemented by hand spading and tamping, to a maximum practicable density so that it is in complete contact with the forms, reinforcement and other embedded parts.

The vibration shall be carried out by means of immersion type high-frequency vibrators, of the electrically driven or compressed air types, or by means of engine driven vibrators. For the consolidation of concrete where immersion vibrations shall prove impracticable, vibrators rigidly attached to the forms shall be adopted subject to the approval of the Employer.

When vibrating a layer of fresh concrete, the vibrator shall be held in a near-vertical position. The immersion of the vibrator shall be sufficiently deep to vibrate the entire depth of a new layer: the vibration should penetrate several centimeters into the layer below, to ensure thorough union of the layers. No new layer of concrete shall be placed, before the underlying one has been thoroughly vibrated. Immersion points for the vibrators shall be adequately spaced, so as to make sure that every part of the concrete has been properly vibrated. Care shall be taken to prevent contact of vibrators against reinforcement steel especially that starting initial set. Vibrators shall not be allowed to come into contact with forms or finish surfaces. Spreading concrete horizontally with vibrators is prohibited. Vibrators shall not be applied to reinforcing steel, embedded parts or formwork. Excessive vibration, causing segregation and laitance, and tending to bring water to the surface, shall be avoided.

Provisions shall be made to ensure that any entrapped air, formed during the placing of concrete, be allowed to escape, by leaving effective air vents in the formwork. Care shall be taken to provide a dense envelope of concrete surrounding the water stops

with no voids or honeycombing.

Vibration or disturbance of concrete, which is partially hardened, will not be allowed. Necessary traffic over new concrete shall be on independently supported timber walkways so constructed that the fresh concrete is not disturbed.

7.2.6 Green Cutting

The Contractor shall remove laitance on concrete surfaces, on which another lift of concrete will be placed, by green cutting with a high velocity water jet or air-water jet. Green cutting shall be performed before concrete has taken its final set so that all laitance will be removed, but that large pieces of aggregate will remain embedded in the matrix. Materials which are loosened or dislodged as a result of green cutting shall be completely removed from the surface of the lift.

7.2.7 Temperature Control

The Contractor shall make the necessary provisions in the concrete material storage, handling and batching facilities as required for complying with the cold and hot weather concreting requirements as per standard practices. All precautions needed for manufacture, transportation, placement, curing and protection shall be taken during extreme weather conditions as per standard practices and guidelines. For mass concreting, the Contractor shall also determine the layer and lift thickness during various weather conditions based on ambient temperature at site during different periods. The proposed sequence of concreting including lifts/layer, time intervals along with studies made shall be supplied in advance for the approval of Employer.

Cold weather conditions shall be considered to be in effect, whenever the temperature is at or below 4°C and can be expected to fall lower. During cold weather conditions, the minimum temperature of the fresh concrete mixture leaving the mixture shall be as follows :

Mass Concrete	10°C
Structure concrete	12° C
Thin structure concrete	15° C

Hot weather condition shall be considered to be in effect, whenever the temperature is above 25°C and is expected to rise. During hot weather condition the temperature of the fresh concrete at the point of placing shall not exceed 32°C for all structures. In order to meet these requirements, the Contractor shall be prepared to undertake any or all of the following corrective measures:

- supply coolest mixing water;
- spray the coarse aggregate stockpile with cool water;
- prevent exposure of batching, mixing and conveying equipment to direct sunlight;
- spray the forms and reinforcing with cool water;
- add ice flakes in concrete mixture.

7.2.8

Joints

Construction Joints

The shape and position of all construction joints shall be proposed by the Contractor and are subject to the approval by the Employer, if not shown on the Drawings and/or as instructed by the Employer. Construction Joints shall be sealed by water stops or other means if so shown on the Drawings or as instructed by the Employer.

After the initial set, but before final hardening of the concrete, un-shuttered surface of-the joint shall be washed with water and/or compressed air jets to thoroughly remove the top layer of mortar and all semi-detached parts from the surface, and to expose the upper half of the big-size aggregates, however, without loosening or undercutting them.

If the surface of a lift with reinforcing steel is congested and is relatively inaccessible, or if for any other reason disturbing an unhardened surface is considered undesirable, green cutting by air-water jets will not be permitted and the use of wet sand blasting will be required after hardening of the concrete. When employed in the preparation of construction joints, wet sand blasting shall be performed immediately before final

cleaning for the following lift. The operation shall be continued until all unsatisfactory concrete and all laitance, coatings, stains, debris, and other foreign materials are removed.

When construction joints are not covered with concrete within twenty (20) days after their formation, the Contractor shall apply wet sand blasting or roughen all surfaces by light jack hammering, when preparing for the next lift. The extent of concrete to be removed will be indicated by the Employer.

Expansion or Contraction Joints

Joints shall be provided at the locations indicated on the Drawings, or as directed or approved by the Employer. In no case shall any fixed metal embedded in the concrete, continue across an expansion or contraction joint. The expansion or contraction joints can be of the smooth and even or dented type to guarantee the contact of the structures. The opposite faces, which form the joint, shall be completely separate. Expansion or contraction joints shall be sealed by water-stops and/or joint sealants.

The Contractor shall undertake the pouring of the second surface only after the first one has thoroughly hardened. When shown on the Drawings or ordered by the Employer, a sheet of plain joint filler or other approved material may be placed in contact with the first pouring before starting the second pouring.

7.3 FINISHING OF CONCRETE

Allowable deviations from plumb or level and from alignment, profile, grades and dimensions shown on the Drawings, are defined as "tolerances" and are to be distinguished from irregularities in finish as described herein. The classes of finish and the requirements for finishing of concrete surfaces shall be as shown on the Drawings, or as hereinafter specified.

Finishing of concrete surfaces shall be performed only by skilled workmen. The Contractor shall be advised as to when finishing of concrete will be performed. Unless

inspection is waived in each specific case, finishing of concrete shall be performed only in the presence of the Employer. Concrete surfaces will be tested by the Employer where necessary to determine whether surface irregularities are within the specified limits.

Surface irregularities are classified as "abrupt" or "gradual". Offsets caused by displaced or misplaced formwork, or by loose knots or otherwise defective form timber will be considered as abrupt irregularities, and will be tested by direct measurements. All other irregularities will be considered as gradual irregularities, and will be tested by the use of a template, consisting of a straight edge or the equivalent thereof for curved surface. The length of template will be 1.5 m for testing of formed surfaces, and 3.0 m for testing of unformed surfaces.

Formed Surface

The classes of finish for formed concrete surfaces are designated by use of symbols F1, F2, F3 and F4. Bag rubbing or sand blasting will not be required on formed surfaces, other than that necessary for the repair of surface imperfections. Unless otherwise specified or indicated on the Drawings, the classes of finish shall apply as follows:

class F₁ (Swan)

This finish is generally intended for surfaces against which backfill, concrete or grout will be placed being permanently invisible. These surfaces shall not be subject to any special treatment, except for the repair of defective concrete, tie rod holes, etc. Gradual irregularities may be up to 25 mm and abrupt irregularities up to 10 mm.

Class F₂ (Wrought)

This finish is required for structural surfaces permanently exposed to view. Irregularities may be up to 8 mm and abrupt irregularities up to 5 mm.

Class F₃ (Pre-cast Quality)

This finish is required for prominent or important architectural features and for

precast concrete units. The Surface shall be also capable to be subjected to the passage of fast flowing water. No abrupt irregularities are permitted and the gradual irregularities shall not exceed 6mm.

Class F₄ (Frigid Accurate)

This finish is required for formed concrete surface when accurate alignment and evenness of surface are essential for prevention of the destructive effects of water action. This surface will be exposed to water flow of high velocity. No abrupt irregularities are permitted and the gradual irregularities have to be limited to less than 4 mm.

Unformed Surface

The classes of finish for unformed concrete surfaces are designated by the symbols U1, U2 and U3, defined as follows:

Finish U₁

This finish concerns surfaces that will be covered by backfill and shall be used as the first stage of U2 and U3 finishes. Finishing operations shall consist of sufficient leveling and screening to produce even, uniform surfaces. Gradual surface irregularities shall be such as not to impair the structural properties of the work.

Finish U₂

This finish concerns surfaces not permanently concealed by second stage of U3 finish. Floating shall be started as soon as the screeded surface has stiffened sufficiently, and shall be done at least to forms screeded marks and be uniform in texture. In areas required by the Employer , a light brooming of the surfaces will be required to provide a non-skid surface. If U3 finish is to be applied, floating shall be continued until a small amount of mortar without excess water is brought to the surface, so as to permit effective troweling. Abrupt surface irregularities are not admitted and the gradual ones shall not exceed 5 mm. Joints and edges shall be tooled where shown on the Drawings or as directed.

Finish U₃

This finish concerns surfaces where an accurate surface is required. When the floated surface has hardened sufficiently to prevent excess fine materials from being drawn to the surface, steel troweling shall be started. Steel troweling shall be performed with firm floated surface and produce a dense and uniform surface free from blemishes and trowel marks. Abrupt surface irregularities are not admitted and the gradual ones shall not exceed 2 mm.

7.4 REPAIR OF CONCRETE

Any indentation, irregularity and bulge occurring beyond the specified tolerance, or any voids and honeycombs, fractures or other damages, shall be repaired. Repairs shall be performed by skilled workmen. The Contractor shall inform the Employer before starting the repair work, materials, procedures and operations used in the repair of concrete and the finished work shall be done in accordance with the orders and instructions of the Employer.

In general the repair work shall be started within 24 hours after stripping of the formwork. Concrete damaged by any cause and concrete that is honeycombed, fractured or otherwise defective, and concrete, which, because of excessive surface depressions must be cut back and rebuilt, shall be replaced with mortar, concrete or epoxy resin as specified hereafter or as otherwise directed by the Employer .

Where bulges and abrupt irregularities protrude shall be reduced by bush hammering and grinding so that the surfaces are within specified limits. Dry pack filling shall be used for holes that have surface dimensions smaller than the depth of the hole for holes left by the removal of fasteners from the ends of form tie rods for grout insert holes and for narrow slots cut for repair of crack. Filling of holes left by the removal of fasteners from the end of tie rods in surface for which finish F1 is specified will not be required. Dry pack shall not be used for filling behind reinforcement or for filling hole that extend completely through a concrete section.

Mortar tilling, placed under impact by use of a mortar gun shall be used for holes too wide for dry pack filling and too shallow for concrete filling and no deeper than the far side of the reinforcement that is nearest to the surface. Concrete filling shall be used for holes extending entirely through concrete sections for holes which are greater in area than 100 Sq.cm and deeper than 10 cm and for holes in reinforced concrete which are greater in area than 500 sq.cm and which extend beyond reinforcement. Epoxy resin should be for holes of depth below 6.0cm.

All materials, procedure and operations used in the repair of concrete shall be as per relevant IS specifications. All filling shall be bonded tightly to the surfaces of the hole and shall be sound, free from shrinkage cracky and dummy areas after the fillings have been cured and have dried. All fillings in surfaces for which finish F3 is specified shall contain sufficient white Portland cement to produce the same colour as that of the adjoining concrete.

All patching shall be done with extreme care so that patches will not be easily noticeable. Dry patching mortar shall comprise one part of cement to two parts of sand by volume and just enough water to hold the ingredients together. The mortar shall be placed in layers of 2.5 cm. Each layer shall be thoroughly tamped and the finishing layers shall be smooth to form the surface continuous with the surface of holes. The specification shall be in accordance with IS: 457 and other relevant IS Codes.

7.5 FORMS

Forms shall be used whenever necessary to confine the concrete, and to shape it to the required lines, grades and dimensions shown on the Drawings. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, and shall provide concrete surfaces conforming to the requirements of the finishes specified. Forms shall be sufficiently tight to prevent the loss of mortar from the concrete. Where re-usable forms are used, the original strength, rigidity,

tightness and surface smoothness of the forms shall be maintained throughout their usage. The form surfaces in contact with the concrete shall be treated or protected to avoid chemical reactions or discoloring of the concrete surface. The use of forms with bruises, irregularities and forming curst incrustations shall not be permitted.

Forms shall be placed so that the joint marks on concrete surfaces are, as much as possible, in alignment both horizontally and vertically.

The support for forms shall be such that no deflection occurs under the weight of wet concrete and other loads.

Form Requirements for Various Finishes

The type of form sheathing or lining shall be in accordance with the following minimum requirements for the formed surface finishes as specified in Clause "Finishing".

Where Finish F1 is specified, forms may be of any grade of steel and wood sheathing, free from surface roughness or irregularities.

When Finish F2 is specified, forms shall be of pressed fiberboard, ordinary lumber, and plywood or steel sheathing, free from surface roughness or irregularities.

Where Finish F3 or F4 are specified, forms shall be of at least 20 mm thick plywood, 30 mm thick first class timber or steel sheathing with plate not less than 3 mm thick, with very smooth and uniform surfaces. Steel lining shall not be permitted.

The first class timber used in the forms shall be free from warp, and wooden forms shall be made of dressed lumber of uniform thickness and width, which is free from loose knots, decay, or other defects" Steel sheathing shall be defined as a steel plate supported by structural shaped steel.

Forms for curved surfaces and transition sections shall be constructed to conform accurately to the required curvatures. Dimensions from horizontal and vertical base

lines will be given at several sections throughout the length of the curved or transition sections. Erection templates shall be used on all curved frameworks where necessary to meet the requirements for curvature.

Cleaning and Lubricating

At the time of concrete placing, the inner surface of the forms, the contacts and connections shall be free from any incrustation, mortar, grout or other foreign matter that may contaminate the concrete. Prior to pouring, the surface of the forms, with the sole exception of those made of rough wood, shall be smeared with a bond breaking compound such as emulsified oil, or with refined mineral paraffin oil, designed to prevent sticking of concrete on the forms. The treatment of the forms shall not cause harmful effects, or stains, on the concrete surface' or on the reinforcement system. Bond-breaking compounds shall be applied before reinforcement is placed if this procedure is feasible.

Oil treatment shall be made in such a manner as to avoid spillage on previously placed concrete. All excess oil on the forms surfaces, and any oil on the concrete, metal or other parts to be embedded in the concrete, shall be carefully removed.

Form Ties and Bolts

The design of forms ties shall be such that no metal shall be within 20 mm of any exposed surface, except where Finish F1 is specified. Where Finish F1 is specified, ties shall be terminated within the forms surfaces, or cut off flat with the form surfaces. Wire ties will be permitted only where Finish F1 and F2 are specified. Sufficient forms ties and bolts shall be used on both sides, and within a few centimeters of construction joints, to ensure the forms fit snugly against the concrete previously placed, and shall remain in tight contact during placing operations. After completion of the concreting the Contractor shall withdraw the bolts and securely fill up the holes with cement mortar patch, as required by the Employer.

The terminal part of the wire ties, if their use is allowed, shall be shaped in such a

manner that cutting and removal will not damage the concrete surfaces exposed to the sight. Possible damage to the concrete due to the aforementioned operations shall be required in accordance with clause "Repair of Concrete.

Chamfering Strips

Chamfering strips shall be placed in the forms, to produce beveled edges on permanently exposed exterior corners in concrete surfaces and exposed joints except where specifically not required by the Employer. Re-entering corners on such surfaces will not require beveling, unless requirement for beveling is indicated on the Drawings. Unless otherwise specified, chamfering strips for exterior beveled comers shall be from 30 to 50 mm.

Embedded items

The contractor shall install embedded items such as pipes and block-out as shown on the Drawings or as directed by the Employer . The embedded items shall be tied to forms or other structures so as not to be displaced.

Removal of forms

The removal of the forms shall be carried out when the concrete has reached sufficient strength, so that no damage will be caused by removing. No forms shall be removed within the specified time after the end of concrete placing, except for special cases where shorter time is approved by the Employer.

As a rule, the forms shall be kept in place at least for the time hereunder indicated after concrete has been placed:

Pier and retaining walls	48 hours
Columns and walls	96 hours
Beams and slabs with a span less than 6 m	14 days
The same with a span larger than 6 m	21 days

The minimum time which shall elapse between the completion of concreting and

removal of the forms for beams and slabs shall be established by the Employer for any particular structure, according to the design calculations. After authorization for removal, the forms shall be removed as soon as practicable, to avoid delay in specified curing of concrete, and also to enable earliest practicable repair of surface imperfections. Methods of form removal likely to cause overstressing of the concrete, or injury to the concrete surface, shall not be used. Forms and their supports shall be removed in such a manner as to allow the concrete to take the stresses due to its own weight uniformly and gradually. Provisions shall be made by means of suitable wedges, sand boxes or other devices, for the gradual relaxation of the support given by false work and centering.

7.6 CURING AND PROTECTION OF CONCRETE

Curing provisions shall be made so that:

- Hydration of cement is developed gradually and completely;
- Concrete does not quickly pass from plastic state to elastic state;
- Concrete is not cracked or damaged by high differential temperatures

The methods and materials used in the curing process shall be at all times, subject to the approval by the Employer. All equipment needed for adequate curing and protection of any concrete pour shall be ready to install before actual concrete placement begins.

The loss of moisture from concrete shall be prevented by water curing or by membrane curing for at least 7 days after placing. Water curing shall start as soon as the concrete has hardened sufficiently to prevent damage and continue during the period, when concrete is protected by the forms. Water curing shall be accomplished by keeping all surfaces of the concrete continuously moist by sprinkling, ponding, moist sand, moist burlap, or by moist wooden sheathing forms left in place. Water, sand and burlap shall be clean not to discolour the concrete. During extreme hot and cold weather, special curing method as required shall be used.

During the curing period concrete shall be protected against any potentially harmful attack, abrasion, vibrations or damage from traffic by independently supported walkways, or an effective cover of sand, or other types of covering.

7.7 POROUS CONCRETE

Porous concrete shall be used at locations shown on the drawings or as directed. Porous concrete shall be composed of one part of cement to five and a half parts of aggregate by weight. The fines in the aggregate (viz. sand) may be permitted up to ten percent to the total aggregate. Only so much water shall be used in the concrete as is required to produce paste which will coat the particles not fill the voids. In placing porous concrete care shall be taken to ensure that it is not over tamped or compacted. The porous concrete as laid shall be pervious and free draining when it hardens. As soon as the concrete hardens, so that paste cannot be washed away it should be kept moist for a minimum fourteen days. The compressive strength of porous concrete at 7 days as determined by test on 15 cm. by so 50 cm should not be less than 70 kg/cm² and the porosity at 7 days be such that water shall pass through a slab of the concrete 30 cm thick at a minimum rate of 500 liters/min meter of the slab with a constant 18 cm depth of water standing on the slab. The porous concrete shall be laid as shown in the drawings or as directed by the Executive Engineer to form porous drains in the masonry dam.

7.8 QUALITY CONTROL

The Contractor shall construct, operate and maintain the field laboratory as specified in Section 2 "Working Facilities" herein and shall carry out all test and analyses for determining the mix proportion of each class of concrete including test of aggregates, so as to produce concrete specified in this clause under the direction of the Employer.

The Contractor shall supply labor, materials and equipment necessary to sample and transport materials to the field laboratory from any part of the project area. The Contractor shall appoint an laboratory supervisor experienced in concrete technology, with not less than three years of relevant experience. The laboratory supervisor will be

authorized by the Contractor to sign for acceptance all documents related to laboratory activities.

The requirements for, and the methods of taking samples and testing concrete and components of concrete shall be in compliance with the IS Standards specified, or with other equivalent standards approved by the Employer.

Samples will mainly be of aggregates and concrete both fresh and cured. Samples shall be representative, taken according to the instructions given by the Employer and in a sufficient amount to enable the laboratory to perform any test considered necessary for the Works. The main test of controlling the quality of aggregates and concrete shall be as specified in the following table unless different instructions are given by the Employer.

The standard tests for the properties of aggregates, cement, water, and admixture, etc. as given below shall be carried out by the contractor, as and when directed by the Employer.

Tests for Quality Control of Aggregates and Concrete

Test	Frequency	Sampling Site
Fine Aggregate		
Gradation	Once a week or as required	Aggregate stockpile or Batching plant
Surface moisture	Twice a day or as required by the Employer	Batching plant
Organic impurities	As required by the Employer	Batching Plant
Coarse Aggregate		
Gradation	Once a week or as required	Aggregate stockpile or Batching plant
Concrete		
Compressive strength	Once every 150 m ³ or at least once for each of concrete placed at the time of sampling of test piece or as required by the Employer	Placing site and Batching plant
Slump	Once every hour of pouring,	Placing Site

Air content	Once every hour of pouring, at the time of sampling of test piece or as required by the Employer	Mixing plant or placing site as directed by the Employer
Temperature	Once every hour of pouring or at the time of sampling of test piece	Mixing plant and placing

Other standards tests for the aggregate, cement, water, admixture etc. as given in the specification shall be carried out by the Contractor at periodic intervals as directed by the Employer.

Test for Compressive Strength

The acceptance criteria of quality of concrete is laid down in IS:456-2000. The criteria are mandatory and various provisions of the code have to be complied before the quality of concrete is accepted. In all the cases, the 28-days compressive strength shall alone be the criterion for acceptance or rejection of the concrete. In order to get a relatively quicker idea of the quality of concrete, optional test for 7 days compressive strength of concrete be carried out. Following IS code shall be referred to for testing the compressive strength of the concrete.

1	IS:456-2000	Plain and Reinforced Concrete – Code of Practice. BIS, New Delhi
2	IS:10086-1982	Specification for Moulds and tamping rod for use in Testing of Cement and Concrete, BIS, New Delhi
3	IS:14858-2000	Compression Testing Machine used for testing of Concrete and Mortar Requirements, BIS, New Delhi.
4	IS:516-1959	Method of Tests for Strength of Concrete, BIS, New Delhi.

6 Cubes of 150 x 150 x 150 mm size (the nominal size of aggregate does not exceed 38 mm) shall be cast, 3 for 7-days testing and 3 for 28-days testing. For aggregates larger than 38 mm, bigger than 150 mm moulds are to be used. Cube moulds shall be provided with a base plate and they shall be as per IS:10086-1982.

The compression testing machine shall be as per IS: 14858-2000. The machine shall be

capable of applying the load at the specified rate, uniformly without shock using manual or automatic control. The percentage of error shall not exceed ± 1.0 percent of the indicated load. On regular basis the machine should be calibrated with in a period not exceeding 12 months from previous verification. The machine is required to be calibrated on original installation or relocation, subject to major repairs or adjustment and whenever there is reason to doubt the accuracy of the results, without regard to the time interval since the last verification.

Sampling

Sample of concrete for test specimen shall be taken at the mixer or in the case of ready mixed concrete from the transportation vehicle discharge. Such samples shall be obtained by repeatedly passing a scoop or pail through the discharge stream of the concrete. The samples thus obtained shall be mixed on a non-absorbent base with shovel until it is uniform in appearance. Sampling should be spread over the entire period of concreting and the frequency of sampling of concrete of each grade shall be as following. A set of 3 cubes (specimen) average strength will be a sample.

Quantity of concrete in the work (m³)	Number of samples
1-5	1
6-15	2
16-30	3
31-50	4
51 and above	4 plus one additional sample for each additional 50 m3 or part thereof.

Casting of cubes:

The cube mould plates should be removed, properly cleaned, assembled and all the bolts should be fully tight. A thin layer of oil then shall be applied on all the faces of the mould. It is important that cube side faces must be parallel. After taking concrete samples and mixing them, the cubes shall be cast as soon as possible. The concrete

sample shall be filled into the cube moulds in layers approximately 5 cm deep. In placing each scoopful of concrete, the scoop shall be moved around the top edge of the mould as the concrete slides from it, in order to ensure a symmetrical distribution of the concrete within the mould. Each layer shall be compacted either by hand or by the vibration as described below.

Compaction by hand: Each layer of the concrete filled in the mould shall be compacted by not less than 35 strokes by tamping bar. The strokes shall be penetrating into the underlying layer and the bottom layer shall be rodded through its depth. Where voids are left by the tamping bar the sides of the mould shall be tapped to close the voids.

Compaction by vibration: When compacting by vibration each layer shall be vibrated by means of an electric or pneumatic hammer or vibrator or by means of a suitable vibrating table until the specified condition is attained.

Curing: :

The casted cubes shall be stored under shed at a place free from the vibration at a temperature 22°C to 33°C for 24 hours covered with wet straw or gunny sacking. The cube shall be removed from the moulds at the end of 24 hours and immersed in clean water at a temperature 24°C to 30°C till the 7 or 28-days age of testing. The cubes shall be tested in the saturated and surface dry condition.

For the true representation of actual strength of concrete in the structure, extra cubes shall be cast, stored and cured as per the identical conditions of that structure, and tested at required age.

Testing of concrete cubes:

The dimensions of the specimens to the nearest 0.2 mm and their weight shall be noted before testing. The bearing surfaces of the testing machine shall be wiped clean and any loose sand or other materials removed from the surface of the specimen

which is to be in contact with the compression platens. The cube shall be placed in the machine in such a manner that the load shall be applied to opposite sides of the cubes as cast that is not to the top and bottom. The axis of the specimen shall be carefully aligned with the centre of the thrust of the spherically seated platen. No packing shall be used between the faces of the test specimen and the steel platen of the testing machine. As the spherically seated block is brought to bear on the specimen, the movable portion shall be rotated gently by hand so that uniform seating may be obtained. The load shall be applied without shock and increased continuously at a rate of approximately 140 kg/sq cm/min until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The maximum load applied to the specimen shall then be recorded and the appearance of the concrete and any unusual features in the type of failure shall be noted, see fig-1 and fig-2. The compressive strength of concrete shall be calculated from: Maximum load/Cross-Sectional area of cube and to be reported to the nearest 0.5N/mm².

Acceptance:

For the acceptance, the mean strength determined from any group of four-non overlapping consecutive test results and any individual test should comply with the appropriate limits as given in table below. The average value of set of three cubes (one sample) should have strength within the limits of $\pm 15\%$ of the average value. Otherwise the result of that sample will be invalid.

Characteristic Compressive Strength Compliance Requirement:

Specified grade	Mean of the group of 4 non-overlapping consecutive test results in N/mm ²	Individual test results in N/mm ²
M-15	$\geq f_{ck} + 0.825 \times \text{established standard deviation}$ (rounded off to nearest 0.5 N/mm ²) Or $f_{ck} + 3 \text{ N/mm}^2$, whichever is greater	$\geq f_{ck} - 3 \text{ N/mm}^2$
M-20 or above	$\geq f_{ck} + 0.825 \times \text{established standard deviation}$ (rounded off to nearest 0.5 N/mm ²)	$\geq f_{ck} - 4 \text{ N/mm}^2$

	Or $f_{ck} + 4 \text{ N/mm}^2$, whichever is greater	
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In case of doubt regarding the grade of concrete used either due to poor workmanship or based on results of cube strength test further tests should be conducted such as non-destructive test by Concrete Test Hammer, Ultrasonic Concrete Tester etc. Partial destructive test by drilling cores and testing them in compression. In no case fewer than three cores be tested. The final test includes the load testing on structure.

For any mix, a correlation between 7 and 28-day strength may be developed in laboratory. On the basis of this correlation, the results of the 7-day tests may be used as an index of the compressive strengths which should be expected at 28 days. If 7-day tests show compressive strengths that are too low, remedial measures may be directed at once by the Employer , without waiting for the results of the 28-day tests.

When the results of the tests taken in the field do not comply with the specifications, the Employer shall have the right to require that one or more of the following measures are taken:

Test the reserve cubes at fifty six (56) days in order to verify if the strength can be attained.

Extraction of a sufficient number of concrete samples (core taken with the rotary drilling method) from the structure for which a compressive test, or group of compressive tests, have given unsatisfactory results. These samples shall be taken and tested.

Performance of load tests, where possible, on the structure whose compressive tests were found unsatisfactory;

Other tests ordered case by case' using non-destructive testing methods, etc.

If, after carrying out such investigations, the Employer finds out that the concrete in the structure is not of the specified quality, he may order the strengthening or replacement of all or part of the entire volume of hardened concrete represented by the test failure, or any other part of the works, whose safety, in the opinion of the

Employer, is prejudiced or whose strength is impaired.

The expenses borne for the above mentioned investigation and tests as well as for demolition and reconstruction of defective works shall be at contractor's expense whenever it is proved that the concrete in place after twenty eight (28) days has a strength less than the specified one for its class.

7.9 SUBMITTALS

At least thirty (30) days prior to commencement of the concrete work, the Contractor shall submit the details of materials, concrete placing equipment, methods, schedule and details of his proposed mix proportion for the various classes of concrete specified as well as test results to the Employer for approval.

Prior to the start of any concrete work, the Contractor shall submit in advance the drawings showing the order, magnitude and construction joint proposed for the cast-in-place concrete and the detailed design he proposes to adopt for formwork to the Employer for approval but approval of the drawings shall not absolve the Contractor from his responsibility of their adequacy.

He shall also submit in advance, a weekly placing schedule including layer thickness where applicable, giving the detailed locations of the placement, the approximate placement volume and the date on which the concrete will be placed.

The design mix shall be prepared by the contractor for approval after testing (as per IS code) for M-20 concrete and above.

7.10 MEASUREMENT AND PAYMENT

For Concrete:

The quantity of cast-in-place concrete for all grades will be worked out separately by measuring various dimensions of the work done and then volume shall be calculated in M^3 . The payment shall be done on the basis of item unit rate quoted in bill of quantities as per Contract. The unit rate shall include the cost of materials, all tools

&plants, labour, finishing/repair, testing & quality control and all other costs necessary for execution of the works satisfactorily as per specifications/Drawings and/or as directed by the Employer. The cost of form work shall not be included in the rate of concrete and shall be paid separately.

Concrete placed in temporary works for the convenience of the Contractor rejected concrete, concrete to replace over-break due to the convenience or due to the fault of the Contractor or other defective work shall not be measured for payment.

For centering and shuttering:

The quantity of centering will be worked out by measuring the total surface area of the shuttering in M².The payment shall be done on the basis of item unit rate quoted in bill of quantities as per Contract.No extra payment shall be made for the centering.

The unit rate shall include the cost of materials, all tools & plants, labour, finishing/repair, testing & quality control and all other costs necessary for execution of the works satisfactorily as per Drawings.and/or as directed by the Employer.

Annex-7.1

List of Reference Standards and Codes

Code No.	Title of Code
Aggregate	
IS-383	Specifications for natural aggregates
IS- 515	Specifications for natural and manufactured aggregates
IS- 1121(P-I to P-IV)	Method of test for determination of strength and properties of natural building stones
IS- 1124	Tests for absorption of water of Stones
IS- 1126	Method of Test for determination of durability of natural building stones
IS-2116	Send for Masonry Mortars
IS-2230	Sampling of Sand
IS -2386(P-I to VIII)	Methods of Test of aggregates for concrete
Cement	
IS -269	Ordinary Portland Cement (33 grade)
IS - 1489(P-r & P-II)	Portland - Pozzolana Cement
IS-8041	Rapid hardening Portland Cement
IS -8112	Ordinary Portland Cement (23 grade)

IS-12269	Ordinary Portland Cement (73 -grade)
Reinforcements	
IS-432	Specification for mild and medium tensile steel bars and hard- drawn steel wires for concrete reinforcements
IS-1566	Specification for hard-drawn concrete reinforcement
IS-1786	Specification for cold twisted steel bars Fe-217
IS- 2502	Code of Practice for Bending and fixing of bars for concrete reinforcements
IS-2771	Code of Practice for welding of mild steel plain and deformed bars for Reinforced concrete construction
IS-7727	Recommendations for detailing of reinforcements in RCC work
IS-8500	Medium and High strength Structural steel
Other Materials	
IS-356	Water
IS-356	Specification for Integral cement -Water proofing Compound
IS- 9103	Specification for Admixtures
Concrete Works	
IS-456	Code of Practice for Plain and Reinforced Concrete
IS- 457	Code of Practice for general construction of Plain and Reinforced Concrete for dams and other massive structures
IS-716	Method for Strength of Concrete
IS-1199	Method of Sampling and Analysis of Concrete
IS-1751	General requirements for Batch type Concrete Mixers
IS-1838(P-I)	Specification for performed fillers of expansion joints in concrete pavements and structures
IS-2505	General Requirements for concrete Vibrators, immersion type
IS-2645	Specification for Integral cement water proofing compounds
IS-2750	Specification for steel scaffoldings
IS-3384	Specification for Bitumen Primer for use in Waterproofing and Damp Proofing
IS-3558	Code of practice for use of immersion vibrators consolidating concrete
IS-4014(P-I & P-II)	Code of practice for steel tubular scaffoldings
IS-4082	Recommendations for Handling and Storage of Building Materials
IS-4925	Code of practice for Batching and Mixing Plant
IS-6509	Code of Practice for Installation of joints in concrete pavements
IS-7861(P-& P-II)	Code of Practice for Extreme Weather Concreting
SP-23	Handbook of Concrete mixes
SP-34	Handbook of concrete Reinforcement and Detailing

SECTION - 8

REINFORCING STEEL

8.1 The specifications described herein under relate to the reinforced concrete works which include all labour, materials, equipment and services required for the supply, handling, storing, cutting, bending, cleaning, placing and fastening into position all reinforcing steel as shown on the drawings, or as directed by the Employer to be carried out by the Contractors under this contract.

Unless shown otherwise on the drawings, the Reinforcing steel shall be High yield strength deformed bars conform to IS 1786-2008 High strength deformed steel bars and wire for concrete reinforcement and consist of the following grades or equivalent:

Bar Size (mm)	Grade	Min-Yield Strength (N/sq.mm)
8, 10, 12, 16, 20, 25, 28, 32	IS 1786 (Fe-500 grade)	500

The cutting, welding, placement and binding of reinforcing steel shall conform to the Indian Standards given in the end of this section (Annex-11.1) or, where not covered by these standards, to their equivalent International Standards.

Carrying out tests for quality of steel reinforcement to be used as required and directed by the Employer .

The Contractor shall provide materials free of oil, dirt, mud, loose mortar, loose rust, mill scale and coating which may reduce or destroy bond. The reinforcing steel that is reduced in section, has kinks and visible transverse cracks at bends, or is damaged shall not be used. Tight rust and mill scale or surface irregularities will be acceptable provided the weight, dimensions, including deformations, and tensile properties of wire-brushed test specimens are not less than those required by the applicable specification.

8.2 EXECUTION

The Contractor shall fabricate reinforcing steel to the dimensions and configurations as shown on the Drawings or as approved by the Employer. The Contractor shall prepare

all detail reinforcement drawings. These drawings shall include all bar-placing drawings, bar bending drawings, bar lists, and any other reinforcement drawings as may be required to facilitate fabrication and placement of reinforcing steel. The Contractor shall submit them to the Employer for approval.

Bending

All bars shall be cut to the lengths and bent in accordance with the bar bending schedules as approved by the Employer. Bars shall not be pre-heated for bending without the approval of the Employer. Once bent, bars shall not be straightened or re-bent. Bars shall be bent from 90^0 to 125^0 with free ends and extensions exceeding 4 bar diameter or 60 mm whichever is less. For Tie bar or stirrup hooks of bar size 16 mm and less,, the inside bend diameter shall not be less than 4 times the bar diameter.

Placing

Before the reinforcement bars are placed, the surfaces of the bars shall be cleaned of flaky rust, oil, or other foreign substances that are harmful to the bonding of reinforcement bars with concrete.

The Contractor shall place reinforcing steel in accordance with the approved placement drawings and schedules and the tolerances specified. Special care shall be exercised to prevent the reinforcement bars from being displaced during the placement of concrete. Intersecting points and splices of the reinforcement bars shall be fixed by using suitable clips or annealed wires, the diameter of which shall be more than 0.9 mm. The reinforcement bars in structures shall be placed and supported by use of lumps of mortar, metal spacers, metal hangers or other satisfactory devices to ensure required coverage between the reinforcement bars and the surface of concrete. The minimum cover of concrete to reinforcing steel shall be as in Table 8.1.

Table 8.1
Minimum Cover of Concrete to Reinforcement Steel

Condition of Placement	Minimum cover (mm)
Structures exposed to weather, backfill or submerged but accessible:	

DB 20 and larger bars	50
DB 16 and smaller bars	40
Structures submerged and not accessible and concrete placed directly against ground	80
Structures exposed to action of moving water	80
Structures not exposed to weather or not in contact with ground: beams, girders and columns principal reinforcing steel, ties, stirrups and spirals	40
Upper-structure beams, girder, and slabs without finishing	30
slabs with finishing	20
Substructure of buildings: beams, girders, columns and slabs	40
footing	60

The intersections of reinforcing steel shall be securely tied with black annealed wire. No reinforcing steel partially embedded in concrete shall be field-bent, except specifically permitted by the Employer.

Welded Splices

The Contractor shall use welded splices only if approved by the Employer. The joints shall be butt-welded by the electric-arc method. The ends of the bars shall be cleaned of all loose scale, rust, grease or other foreign materials and all welding shall conform AWS D1.4: structural welding code - Reinforcing Steel or as directed by the Employer .

Lapping

The number of splices shall be kept to a minimum. Location and length of lap splices shall be in accordance with "IS Standards or other equivalent standards". The minimum overlap of spliced bars of different sizes for M-20 grade concrete is given in Table 8.2 for ready reference.

Table 8.2 Lap Length of splicing

Diameter of Bars in mm	Grade of Bars	Min. length of overlap in splices in cm
8	MS Rounds	21
10	MS Rounds	35

12	Deformed Ribbed Bars	49
16	Deformed Ribbed Bars	65
20	Deformed Ribbed Bars	82
25	Deformed Ribbed Bars	94
32	Deformed Ribbed Bars	120

Tolerance for Placing Reinforcing Steel

Unless otherwise required by the Employer , reinforcement shall be placed within the following tolerances:

- For effective depth of 200 mm or less ± 10 mm
- For effective depth more than 200 mm ± 15 mm

8.3 INSPECTION AND QUALITY CONTROL

No placing of concrete shall be permitted without prior inspection and approval by the Employer for the reinforcing steel. When the Employer performs prior inspection and issues conditional approval for the reinforcing steel, the Contractor shall fulfill the said condition so as to properly complete the reinforcing steel. Unless the said conditions are fulfilled, no placing of concrete shall be permitted.

The Employer reserves the right to take samples and to instruct the Contractor to perform tests of the bars that the Contractor intends to supply and to use. The tests shall include, but may not be limited to, tensile and bending tests according to the relevant standards. No reinforcing steel shall be used until the Employer indicates that the same is satisfactory. If the tests demonstrate that the delivered steel is not satisfactory, it shall be replaced at the Contractor's expense.

The results of tests ordered by the Employer shall be assessed as follows:

- If two samples of six samples per diameter show in one or more of all tests performed unsatisfactory results, the reinforcing steel shall be rejected.
- In case one sample fails to meet the required test results in one of the tests, six new samples shall be taken and tested. All tests results of these new samples must turn out to be positive; otherwise the reinforcing steel shall be rejected.

The Employer may require the removal of any concrete reinforced with steel that does not comply with the requirements of this Specification.

8.4 SUBMITTALS

Upon receipt of reinforcing steel on site, the Contractor shall submit certified copies of mill test reports, including chemical analysis and physical properties. At least 30 days prior to fabrication, the Contractor shall submit data showing bar bending details, bar lists, placement drawings, placement schedules and delivery schedules, all prepared in accordance with applicable standards. At least 21 days prior to installation, the Contractor shall provide the Employer with representative splice samples for each bar size, if mechanical splicing is proposed.

8.5 MEASUREMENT AND PAYMENT

Measurement for payment for reinforcing bars will be per metric tonne of reinforcement steel including hooks, bends and splices actually installed and approved by the Employer . Actual lengths of reinforcement bars including permissible hooks, bends and splices will be measured. The weight of reinforcing bars will then be calculated for each size of bar from the unit weight as stated on the certified copies of manufacturer's reports, which the Contractor shall submit to the Employer. Before starting concreting, the Contractor shall make sure that the measurements of reinforcing bars placed in position have been recorded and that the Employer has certified the correctness of the reinforcement used.

Payment will be made at the unit rate per metric tonne as per the Contract, which shall include the entire cost of supply, handling, storage, cutting, bending, placing, wire clips, ties, separators and any other fastening devices.

No separate payment will be made for the following, which shall be included in the quoted unit price:

- Wire for tying reinforcement.
- Any additional reinforcement or splices required when Contractor's casting sequence differ from construction joints shown on the drawings.

- Any reinforcement steel placed by the Contractor for his own convenience in addition to those shown on the drawings.
- Devices like steel chairs, hangers, Spacers: small concrete blocks, other supports, ties and anchor rods etc. used to maintain reinforcing steel in position.
- Any reinforcing steel delivered for testing.
- Carrying out tests for checking butt welds to replace lapping/ splicing of reinforcing bars.
- Carrying out tests for quality of steel reinforcement to be used as required and directed by the Employer.

Annexure 8.1

CODE NO.	TITLE OF CODES
IS- 1566	Specification for hard-drawn steel wire fabric for concrete reinforcement
IS-1786	Specification for High strength deformed steel bars and wire for concrete reinforcement
IS-8500	Medium and high strength Structural steel
AWS D 1.4	Structural Welding Code- Reinforcing Steel
IS- 454	Code of practice - Plain and reinforced concrete
IS-2502	Code of practice for bending and fixing of bars for concrete reinforcement

SECTION.IX

DRILLING AND GROUTING

9.1 This section covers drilling and grouting works as stated below together with supply of all required materials, labour, plant and equipment for the works as per specification and drawings and /or directed by the Employer . The works involved under this section are, but not limited to:

- Drilling of test holes, grout holes, and other holes.
- Water Pressure Test and Lugeon Test
- Curtain Grouting

The Contractor is required to install and bring into operation drilling and grouting equipments to any position needed for adequate execution of his work. Diameter, depth and direction of boreholes shall be as shown on the Drawings and / or as directed by the Employer. No drilling or grouting work shall be executed prior to the approval of the Employer.

Drilling, grouting materials and performance of grouting, field and laboratory tests, etc. shall conform to the Indian Standards and /or International Standards (Annex. 9.1).

9.2 DEFINITIONS

For the purpose of work to be executed in this section the following definitions shall apply:

- (1) Water Pressure Test/ Lugeon Test

Lugeon test (Water Pressure) is defined as the process of measuring permeability of the rock mass. The purpose of this test is to obtain information on the rock quality in order to determine the consistency of the grout to be used and to moisten the surface of rock seams in order to avoid premature sealing of the seam by thickening of the grout mixture.

- (2) Curtain Grouting

Curtain Grouting is defined as the pressure grouting to form zones of low water permeability in the foundation rock of the main dam, spillway and appurtenant

structures and around the plug section to cutoff water leakage through the fissures, joints and cracks in the foundation rock mass.

(3) Primary Hole (P-Holes)

First series of holes to be drilled and grouted, usually at the maximum allowable spacing and are designated as Primary holes.

(4) Secondary Hole (S-Hole)

Second series of holes to be drilled and grouted, spaced midway between primary holes and are designated as S-holes.

(5) Tertiary Hole (T-Hole)

Third series of holes to be drilled and grouted spaced mid-way between previously grouted primary and secondary holes and are designated as (Tertiary) T-holes.

(6) Test Hole

Fourth series of holes to be drilled for grouting wherever necessary to achieve These holes are designated as C-holes. Testing of efficacy of grouting and also for desired impermeability of the grouted area.

9.3 GROUTING MATERIALS

In general, a grout is a homogenous colloidal mixture of cement and water, where necessary, sand shall be mixed proportionately as to be readily pump able. Admixtures shall also be added subject to the approval of the Employer. All materials shall be provided by the Contractor as required for an adequate performance of the works within given time limits. All required materials and consumables are subject to the approval of the Employer

(1) Cement

Cement shall be in general, Ordinary Portland Cement (OPC). Compatibility of the cement with the intended admixtures and the percentage of the same to be added shall be tested by the contractor prior to use. Cement shall be stored in adequate quantities and in an appropriate manner so that the quality remains unchanged.

(2) Sand

The sand shall be well graded and shall have a fineness modulus of 1.5 to 2.0.

100percentage of the sand shall pass through the U.S. Standard No. 16 (1.2 mm) sieve. The sand shall be stored in adequate quantities and in appropriate manner so that the degree of purity and the aggregate composition remain unchanged.

(3) Admixtures

All chemical admixtures used, such as accelerator or retarders or other chemicals shall be free of chloride. Any such admixtures shall not cause any steel corrosion or adversely affect the strength development and hardening pattern of the grout. The contractor shall be responsible for the suitability of the admixtures. Manufacturer's guarantees will not relieve the contractor of his responsibility for the suitability of any admixture. Quantity of any admixture to be used shall be limited to the quantity given in Table-9.1 subject to test and approval of the Employer. The admixtures shall be fed to the mixer directly and in the exact proportion by weight or volume.

(4) Bentonite

Bentonite is clay having high content of montmorillonite (83% or more) and shall be naturally powdered pure sodium action base with high swelling characteristics., It shall be of high grade conforming to IS: 12584-2000 (Specification for Bentonite for Grouting in Civil Employ ring Works).

(5) Water

The water to be used in the grout shall be fresh, clean and free from harmful amounts of sewage, oil, acid, alkali, salts, or organic or any other deleterious/undesirable matters subject to the quantity specified. In cases of doubt, the water is subject to the approval by the Employer . Necessary tests have to be performed by the Contractor without additional payment.

Table - 9.1
Optimum Dosage of Different Admixture

Admixture	Chemical	Optimum Dosage(% Cement wt.)	Remarks
Accelerator	Sodium Silicate Sodium Aluminates	0.5-3.0	Accelerates set

Retarder	Tartaric Acid Sugar	0.1-0.5	Also increases fluidity
Fluidities	Detergent	0.05	Entrains air
Air Entrained	Insole Resin	0.1-0.2	Upto 10%o of air entrained
Expander	Aluminum Powder	0.005-0.02	Upto 15% pre-set Expansion
	Saturated Brine	30-60	Upto 1% post set expansion
Anti-Bleeder	Cellulose Ether	0.2-3.0	Equivalent to 0.5% of mixing water.
	Aluminum Sulphonate	Upto 20%	Entrains air

9.4 DRILLING EQUIPMENT

Drilling equipment including all auxiliaries, instruments, temporary plant and installations shall be of modern, appropriate design to meet specified requirement, and shall be in perfect working conditions when brought to the site. Sufficient auxiliaries, spares, tools, etc. shall be provided and / or in stock at the site to warrant uninterrupted operation. Rotary or rotary percussion drills may be required, and only electric or air-driven tools will be accepted for work to be executed underground. Equipment with diesel or other drives shall be used only for open-air operation.

9.5 GROUTING EQUIPMENT

The grouting equipment to be use shall be of a type, capacity and mechanical condition suitable for the work to be carried out, as approved by the Employer ' and shall consist of, but not be limited to, mixer, material storage tanks' automatic pressure gauge balance, discharge meter, pressure nozzles, tools, pumps, pipes, valves, automatic recorder and all accessories necessary to maintain a continuous supply of grout, control of pressure, and keep relevant records of grouting operation.

The arrangement of the grouting equipment shall be such as to provide a supply line and a return line from the grout hole to the grout pump Provision shall be made to permit continuous circulation and accurate control of grouting pressures and grout flows into the grout holes. The equipment must maintain the required pressure for at

least 15 minutes even after refusal of grout. Stand-by equipment for immediate continuation of work in case of disturbances shall be provided. The distance between the grouting place and the pumps shall allow for continuous work without running the risk of clogged pipes.

Prior to commencement of the grouting work, during the work, if ordered by the Employer , and at the end of the work, all pressure gauges, recorders and discharge meters must be officially checked and calibrate. The corresponding data shall be submitted to the Employer daily.

9.5.1 Grout Mixers

Grout mixers shall have two vertical / horizontal, barrel type tanks namely mixing tank and Agitating tank, each of sufficient capacity and equipped with a centrifugal pump for preparation of colloidal grout mix with practically no bleeding (less than 3%). Grout mixers shall have RPM of 1200 or more. Mixers shall be provided with equipment for measuring weight and volume mix components with an accuracy of 2% and a water meter calibrated in liters with reset switch for zeroing after each delivery.

9.5.2 Agitator

The delivery end of the grout mixers shall be attached to the system of Double Drum Agitators. These agitators shall have calibrations in liters for measuring grout intake vs time and also have device for control of quantity of grout. The agitators shall be provided with a minimum of 100 RPM stirring propellers. The stirring paddle shall be of such arrangement for continuous agitation to prevent setting and also to guarantee a complete circulation of the entire sump content

9.5.3 Pumps

All pumps shall be of the electric / hydraulic type allowing independent regulation of pressure and discharge: Pump shall be equipped with- interconnecting pipes and valves in such a way as to permit a stand-by pump to be brought into immediate service.

The pumping equipment shall be capable of transporting grout into holes or grout connections in a continuous, uninterrupted flow at any specified pressure upto a

maximum of 30 kg / cm², only minimum fluctuations in pressure during pump cycle being permissible. The grouting equipment shall be arranged so as to provide a supply line and a return line from the grout pump to the grout hole. They shall enable passing a maximum discharge of 150 liter / min.

9.5.4 Grouting System Arrangements

The grouting system shall have sufficient number of manifolds with requisite fittings like couplings, nipples, unions, etc. to:

- Permit regulation of the flow of grout into a group of holes simultaneously whenever required,
- Maintain the desired allowable grout pressure,
- Allow any excess grout to be drained from the system or returned to the agitator tank for recirculation and
- Close off the hole when washing the supply line.

The grouting system shall have circulation system of grouting such that there shall be a supply line from the grout pump to the grout hole and a return line from the grout hole to the agitating tank. By opening the supply and grout hole valves, grout shall be forced into the hole as required and the pressure shall be maintained by adjusting either the supply valve or the return valve or both so that complete control of pressure shall be maintained at the hole. There shall be a pressure gauge at the delivery end of the pump. Long supply lines shall be avoided to reduce the chances of change in consistency of the grout and clogging.

9.5.5 Pipes

Standard mild steel pipes and all fittings for grouting shall be set in the rock and concrete where required. A standard coupling and wrapped nipple to facilitate removal of the pipe-ends shall be attached to the grout pipe where embedded in concrete. All grout pipes and accessories to be left embedded in concrete shall be carefully cleaned and protected against clogging and displacement while concrete is being poured. Pipes shall be cut individually to the exact length so that the outer end remains flush with the finished concrete surface. The outer end shall be provided with a screw joint to enable the connection to a grout pipe, where required. The buried end shall be cut to a flare

or provided with joint to obtain safe anchorage Both ends shall be protected to keep them from being filled with concrete during pouring. The internal diameter of the pipes shall prevent harmful solid sedimentation when pumping at a minimum capacity.

9.5.6 Packers

All packers used shall guarantee proper sealing of the respective borehole section and shall then be capable of withstanding pressure exceeding the maximum grout or water pressure to be used without leakage. This may require the use of different types and sizes of packers, such as double-tube packers, hydraulic packers, pneumatic packers or self-sealing packers, each in accordance with the rock conditions' Type of packer used is subject to approval by the Employer , and the contractor shall have all types required available on site for immediate use.

9.5.7 Pressure and Rate Gauge

Where the Employer directs the use of automatic self-recording gauges' each gauge shall be installed during grouting operations and shall be calibrated with reasonable accuracy as approved by the Employer . After usage, they shall be cleaned and recalibrated at frequent intervals. Such recorders shall be of modern and sturdy design warranting reliable operation and exact recording to measurements. No grouting is permitted without the use of such instruments unless particularly approved by the Employer.

Particular attention of the Contractor is drawn to the fact that only records from such automatic recording instruments will serve as the basis for payment of grouting. Pressure gauges of adequate accuracy shall be placed at pumps and borehole collars or wherever required.

9.5.8 Some Special Monitoring Equipment

To monitor the quality of the grout to be placed in the foundation, Grouting Equipment shall include the following monitoring equipment:

Flow Cone -The flow cone measurement shall be used in the laboratory and also in the field for determining the flow of grout mixtures by measuring the time of efflux of specified volume of grout from a standard cone.

Slurry Scale -The unit weight of grout mixtures shall be determined by using either the standard API approved mud scale balance or by a unit weight container, specially calibrated and has a set of scales and a weighting capacity of at least 100 kg.

Dosimeters -Dosimeters equipped with remote continuous readouts shall be used for measuring and controlling the densities of grout mixtures while grouting continuously. These units shall be placed in-line and ahead of the surface re-circulating system to provide a means for adjusting mixtures to designed densities.

Slump Cone -The consistency of very thick grouts shall be determined by measuring the slump in frustum of cone having base of 20 cm. top of 10 cm. and a vertical height of 30 cm. The grout shall be placed in one of the three equal layers and each layer shall be rodded 25 items. The cone shall then be removed vertically and the slump of the grout shall be measured from the top of the slump cone to the top of the grout.

Time-of-Setting Apparatus -The initial and final sets of cement grout shall be determined by use of Vicat apparatus.

9.6 EXECUTION OF DRILLING AND GROUTING

All grouting works require extensive experience and adequate techniques and shall be executed by the competent staff together with equipment, which will guarantee proper work. The execution of work of drilling and grouting shall be performed in accordance with the relevant Indian Standards and guidelines (IS 6066 &IS 4999) or equivalent internationally accepted standard and guideline.

9.6.1 Drilling Operations

Holes may be drilled with either rotary type drills or by percussion type drills and as directed by the Employer. If the holes cannot be drilled by percussion type drills satisfactorily, then rotary type drills shall be used for subsequent works.

The direction and depth of holes shall be as shown on the Drawings or as directed by the Employer who may at any time increase or decrease the number of holes or

instruct drilling to a greater or smaller depth, subject to actual rock conditions revealed by the drilling. Holes shall be drilled from positions shown on the Drawings with a tolerance of 25cm and to an accuracy of 5 degrees to the specified angle. The bit diameter for different types of drilling shall be in general as in Table-9-2.

Table-9-2.

Bit Diameter for Different Type of Drilling

S.No.	Type of Drilling Machine	Bit Diameter	Drilling Type	Purpose
1	Rotary type	66 mm	Core	Test Hole
2	Rotary type	38mm (NX hole)	Non - core	Curtain grouting

Core Drilling for tests

All core drillings shall be performed in a workmanlike manner by experienced workmen, using appropriate core barrels and taking special care to recover the maximum length of core obtainable, in the best possible condition from all holes. All core drilling shall be executed with rotary equipment, using double tube core barrels, capable of producing cores of the specified diameter. Core drilling shall be 66 mm in diameter and shall produce cores 38 mm in diameter.

Within 24 hours of completing drilling of a cored hole and before being grouted, the Contractor shall submit in duplicate a complete log of the hole in a form approved by the Employer.

The Contractor shall provide strong 1.05 m long standard metal, plastic or wooden core boxes subject to the approval of the Employer. Each box shall hold cores from 5 m of hole and they shall be provided with fasten able lids.

The Contractor shall place the core in the box in the correct sequence after extraction from the core barrel. The core at the bottom of each lift shall be marked immediately after it has been placed in the box and a corresponding mark shall be printed on the side of the core box and on the rock core. When core is not recovered, timber blocks of square cross-section shall be placed in the box by the Contractor. These timber blocks shall be cut to the same length as the core losses and placed in the positions, for which

the core was lost, If these positions cannot be determined, the blocks shall be placed at the top of the lift.

A box shall not contain cores from more than one hole. Designating marks of hole numbers and elevations shall be placed on the boxes and along the line of cores as directed by the Employer. The cores shall be delivered to the Employer at the test laboratory, in the vicinity of the Works. Color pictures shall be taken of all cores in the boxes with legible indication. The color pictures shall be submitted with the Contractor's report in three copies with negative films.

Drilling for Curtain Grouting

The curtain grouting holes for dam foundation shall be drilled with rotary type machines as shown in the drawing. The spacing, direction and order of drilling grout holes shall be based on rock characteristics revealed on an excavated foundation and the results of pressure water testing and grouting. Depth of the holes to be drilled shall be up to depth depending upon the geological formations, subject to the minimum of 6 m or as directed by the Employer. The curtain grouting shall be performed by the descending stage method of 3 m stage.

The drilling through cap or pad concrete, if any, shall be executed a minimum of 28 days after the concrete has been placed.

Generally, the primary holes shall be spaced 12 m apart and grouted before the intermediate holes at 6m spacing are drilled and grouted, and then the next intermediate holes at 3 m spacing shall be drilled and grouted. Further intermediate holes at less than 1.5 m spacing shall not be drilled and grouted unless so directed by the Employer. The spacing, pattern, numbers, sequence etc' of grout holes may be changed any time during the grouting by the Employer based on the results of grouting and requirements.

Drilling for Test Hole

Test holes will be considered to be checking grout holes and shall be drilled, washed,

Lugeon tested and grouted in accordance with the requirements for curtain grouting. The contractor shall drill test holes for grouting work at such locations and directions as shown on the Drawings or designated by the Employer. The test holes shall be not less than 66 mm in diameter and shall produce cores not less than 38 mm in diameter. All test holes shall be of core drilling.

Drilling Records

The under mentioned drilling records shall be maintained for each hole:

Location

Drilling-hole number

Type and diameter of drilling

Ground level

Immediate, intermediate and equilibrium water level with times and dates. Note on colour and losses, etc-

Description and state of weathering of rock and the levels of its boundaries

Percentage core recovery

Rock quality designation (RQD)

The results and levels of all in-situ testing

A record of the driller's observations on progress of drilling rate of penetration, type of bit and speed of rotation of bit

Water-pressure test and/or Lugeon test results

9.6.2 Water Pressure Test/ Lugeon Test

A water pressure test shall be carried out at every stage of every hole except test holes prior to grouting. While Lugeon test shall be carried out for all the test holes.

When drilling is finished, the hole shall be washed by flushing water through drill rod or hose inserted to the bottom of the hole until returning water becomes clean. The washing shall be performed under pressure by using a grout pump. The Contractor shall, prior to water pressure test/Lugeon test, conduct leakage tests of pipe system by injecting water into the pipeline using pressure not less than the maximum grouting pressure.

Water test

The water pressure tests shall generally be carried out between a packer and the bottom of the hole. To suit the variation of jointing rock, special testing might be executed between packers (double packer testing). Pressure shall be maintained for 5 minutes in grout holes and 10 minutes in test holes at each pressure stage to be specified below. The pressure shall be determined to an accuracy of 10%. Increasing or decreasing rate of pressure from a stage to next stage shall be not more than 1 kgf/cm²/min.

Water pressure tests shall be carried out in stages of 3m depths unless otherwise directed by the Employer, at a pressure not exceeding the maximum grouting pressure specified hereafter.

The water quantity shall be measured by an accurate water meter (to an accuracy of 10% for flows exceeding 1 l/min.). The pressure shall be measured at the packer otherwise at the top of the hole, but then only with the approval by the Employer ' The tests shall be run with pressures as specified in Table-9.3.

Table-9.3 Water Pressure Test in Grout Holes

Max. Grouting Pressure (kgf/cm ²)		3	5	10	15	20 or more
Water Pressure (kgf/cm ²)	1st Step	1	2	3	5	5
	2nd Step	2	3	5	10	10
	3rd Step	3	5	10	15	20

The measurement of percolation for each pressure shall be taken for about 10 minutes, keeping the pressure constant. After finishing one step in testing, pressure shall be changed to the next step smoothly, as a rule at the rate of 1 kgf/cm²/min or as directed by the Employer.

Lugeon test

After completion of core drilling of each 3m stage, in test holes, the contractor shall perform lugeon testing. The Lugeon testing is for the purpose of measuring the quantity of water percolation from hole under the pressure stipulated in the Table- 9.4.

Table-9.4 Lugeon Testing of Exploratory and Test Holes

Max. Grouting Pressure (1 kgf/cm ² /cm ²)		3	5	10	15	20 or more
Water Pressure (kgf/cm ²)	1st Step	1	2	3	5	5
	2nd Step	2	3	5	10	10
	3rd Step	3	5	10	15	20
	4th Step	2	2	5	10	10
	5th Step	1	1	3	5	5

The measurement of percolation for each pressure shall be taken for about 10 minutes, keeping the pressure constant. After finishing one step in testing, pressure shall be changed to the next step smoothly, as a rule at the rate of 1 kgf/cm²/min or as directed by the Employer.

In general, Lugeon testing shall be conducted for each 5 m stage without grouting by the descending stage method with packer set at the upper end of the stage in the hole, and when the test hole is drilled to its ultimate depth, the hole shall be grouted by the ascending stage method of 5 m stage, provided that the rock condition proves to be good. If the rock condition prove / not to be good, Lugeon testing shall be conducted for each stage with grouting by the descending stage method as directed by the Employer.

9.6.3 Grouting Operation

Before actual grouting operation is taken up, a test section of appropriate length as approved by the Employer shall be selected and trial grouting shall be carried out upto a depth equal to water head (H) or as directed by the Employer to evolve a proper methodology of grouting vis-a-vis grout pressure, grout mix and grout intake etc. The contractor shall submit a detailed report along with all relevant data upon drilling and trial grouting operation to the Employer within a week's time after completion of such tests.

Grouting shall be performed using packers to seal the corresponding borehole length. Grouting will be done in the full depth at one stage unless otherwise directed by the Employer. Grouting mix, pressures, the pumping rate and the sequence in which holes are grouted shall be in accordance with the drawing. Any change of the grouting

procedures such as mix proportion, additives, and length of stage is subject to the approval of the Employer.

The grout shall be fluid enough to allow efficient pumping, injection and good grout ability. Grout shall also be sufficiently stable to resist displacement and evasion after injection, controllable jellification time and high set strength. The principal variable affecting the properties of the grout is water-cement ratio, the amount of water determining the rate of bleeding, subsequent plasticity and ultimate strength of the grout.

Holes should be injected by direct connection to the pump. Each hole shall be provided with a packer at the surface or with a short standpipe threaded at its outer end to accept standard or control fittings, which shall be provided with a pressure gauge, bleeder valve and a valve enabling the delivery from pump to be cut-off from the hole. As far as practical, a continuous flow of grout shall be maintained at the desired pressure and the grouting equipment shall be operated to ensure continuous and efficient performance throughout the grouting operation. It shall be continued without interruption up to completion. In general, grouting of a stage shall be considered complete up to refusal or when the absorption of grout at the desired limiting pressure shall be less than 2 liters/min averaged over a period of 10 minutes. After the first hole is grouted, all the other holes shall successively be connected to the grouting header to subject them to full pressure.

Grouting shall be normally started with a thin mixture that shall be gradually thickened until about 75% of the final desired pressure is obtained with the pump's operation at normal speed. As the hole shall approach refusal, thick grout shall be replaced with thinner grout until the hole refuses. As a general principle, grout mixture shall not be thickened if pressure starts to rise after continuous injection over a period of 10 minutes. Hasty changes in mix proportions shall not be made. Response of the hole to the selected mix proportions or the pressure to be applied shall be adjudged only after observing for a period of about 30 minutes.

Grouting shall be stopped whenever pressure gauges register a sudden drop of pressure or the rate of grout absorption increases abruptly or there is any indication of upheaval, disturbance or leakage.

Refusal Criteria

Refusal shall be considered to have been reached when the intake grout at the desired limiting pressure shall be less than 2 liter / min averaged over a period of 10 minutes and the pressure greater than 3.5 kg/cm², or 10 liter/min when the pressure is below 3.5kg/cm². Each grout application shall be continued until refusal is reached except:

- When an undesirable trend develops indicating bulb formation
- When surface leakage shall be observed on the surface away from the hole or along the grout Pipe
- when the consumption shall reach a pre-determined limit
- When there will not be grout absorption at the limiting pressure specified
- When upheaval exceeds 0.5 cm for any marker within 5 m of the hole grouted.

The grouting operation shall then be resumed after 24 hours and pressure regulated carefully to avoid repetition of the phenomena leading to stoppage of grouting.

Grouting Pressure

The grouting pressure shall be adequate to achieve the desired grout, but shall be limited to avoid disturbance and upheaval of the ground. Relatively higher pressure can be sustained without damage to the foundations when pressure is built up gradually, as resistance to flow is developed by deposition of grout. It is advisable to begin with a low initial pressure say 0.10 to 0.25 kg/cm² of overburden and build up the pressure gradually. Initially the intake may be 20 liter/min to 30 liter/min. In order to avoid premature build up of high pressure, pressure be raised only when the intake rate falls below 5liter/min. However, in case of development of any surface leakage, pressure shall be immediately reduced and proper treatment provided.

Limiting values of pressure for each zone shall be established initially on the basis of the categorization of rock and shall be confirmed by trial grouting. Choice of pressure may also be established by examining water test data. The pressure limits initially established shall be further reviewed by examining trends of grout intake and pressures during initial stages of actual grouting operations.

The method of interpretation of trends of grouting pressure shall be considered as:-

Rate of Grout intake

(a) Ratio of -----Decreasing: A trend

Grouting Pressure

Rate of Grout Intake

(b) Ratio of----- Constant : B trend

Grouting Pressure

Rate of Grout intake

(c) Ratio of ----- Increasing: C trend

Grouting Pressure

Trend A signifies increase of resistance of flow as the joints/cracks/cleavages are filled up by the grout and is desirable. Trend B may be permitted since it implies a fluctuating response. Grouting with B trend may be continued till the limit of consumption is attained or refusal may be attained eventually by restricting the pressure or by thickening the grout. Under no circumstances Trend C shall be permitted since they imply hydraulic fracturing. The pressure control criteria initially chosen shall be modified on the basis of the analysis of the trends of grouting pressure and intake.

Grout Mixture

Grout mixture (ratio by weight of water and cement) ranging from 5:1 to 0.8:1 are recommended. It is only in exceptional circumstances, the mixture leaner than 10:1 need be used. The choice of grout mixture may be based on result of percolation test conducted prior to grouting.

9.6.4 Back Filling of Grout Holes

All the holes drilled for grouting operation, whether grouted or abandoned for any reason, shall be backfilled with grout having water-cement ratio of 0.7:1 with 3 percent of bentonite. A delivery pipe of minimum 25 mm diameter shall be lowered to the bottom of the hole. Grout shall then be pumped in the delivery pipe until it flows from the hole and then the delivery line shall be withdrawn slowly but with continuity of pumping. If any settlement of grout occurs after initial set, the holes shall then be backfilled with grout again.

9.6.5 Testing Efficacy of Grouting

The permeability of the grouted area shall attain its value in the range of 1×10^{-6} cm/s to 1×10^{-7} cm/s. To test the effectiveness of the grouting in the trial reaches some test holes (T-series) as desired by the Employer shall be drilled in stages in descending order and washed and thereafter water percolation tests shall be carried out. If desired efficacy is not observed any stage of the hole, the stage shall be grouted as per requirement.

9.6.6 Report on the Efficacy of Grouting

After all the grouting operations are completed, the Contractor shall submit a report on the efficacy of the grouting operations based on the permeability results of the check holes.

9.7 SUBMITTALS

At least thirty (30) days prior to commencement of the drilling for geotechnical investigations or grouting work, the Contractor shall submit to the Employer for his approval, his program of work including updated equipment list and experienced personnel to be assigned, detail on grouting operations and methods to be applied. The approved programs shall be subject to modifications if the progress of work and the findings make it necessary.

All details of the grouting operation shall be approved by the Employer and weekly working programs shall be submitted in advance for the Employer's approval. Grouting

works shall be planned in such a manner that they can be timely executed in connection with other works. The Contractor shall keep and submit to the Employer daily records and summary of all drilling, water testing and grouting for each hole. The requirements to register grouting work include the following:

- i) Type of grouting operation (such as contact/consolidation, curtain grouting);
- ii) Location, depth, orientation of holes and identification of hole
- iii) Date and time of drilling;
- iv) Packer position and length of stage;
- v) Date and time of water testing /grouting, Plot of time Vs Water / Gout pressure for each stage of test / grouting.
- vi) Lugeon unit and Lugeon map
Plot of Time Vs Grout intake for each grout mix in each stage of grouting.
- vii) Consumption of all materials used.

9.8 MEASUREMENT AND PAYMENT

Measurement for drilling shall be made in the running meter of the drilling done and payment shall be at the unit rate per meter giving in Bill of Quantitative as per contract. The unit rate shall include the cost of all tools & plants, labour and incidentals as would be required to carry out the work satisfactorily.

Measurement for grouting shall be made separately in number of cement bag consumed in the grout mixture and the payment shall be at the item unit rate giving in Bill of Quantitative as per contract. The unit rate shall include the cost of grouting and grouting materials including all tools & plants, labour , all tests e.g. core drilling/water pressure/Lugeon (before and after grouting) and incidentals as would be required to carry out the work satisfactorily.

Annexure-9.1

S.No.	Code No.	Title of code
Indian Standards		
1	IS-5529-2000 (Part-I & Part-ID	Code of Practice for in-situ Permeability Test (Part-I : Overburden, Part-II : Bed rock)
2	IS 6926 -2001	Diamond Core drilling for Site investigation for River Valley Projects.
3	IS 5313 - 1999	Guide for core drilling observation.
4	IS- 4464-2000	Code of Practice for Presentation on Drilling information and Core description in foundation investigation.
5	IS-269 - 1998	Specification for Ordinary Portland Cement (33Grade).
6	IS-383 - 1997	Specification for Coarse and Fine Aggregates from natural sources for concrete.
7	IS-12584 - 2000	Specification for Bentonite for grouting in Civil Empowering works.
8	IS-14343 -2001	Guidelines for choice of Grouting Materials for alluvial grouting.
9	IS-9103 - 1999	Specification for Admixture for Concrete.
10	IS-4999- 1991	Recommendations for grouting o f pervious soil.
11	IS-6066 - 1999	Recommendations for pressure grouting of rock foundations in river valley projects.
12	IS-11293 - 2000/2002	Guidelines for Design of Grout curtains (Part-I: Earth & Rock fill Dams, Part-II: Masonry and Concrete Dam)

SECTION 10

BITUMEN FILLER IN SETTLEMENT AND EXPANSION JOINTS

10.1 The concrete gravity dam is divided into number of individual blocks by various joints. Water under pressure may find access to downstream side through these joints. Therefore, proper sealing arrangement is necessary to prevent seepage of water through these joints.

From the point of view of utility, the joints may be classified as construction joints, contraction joints, Expansion joints and settlement joints. Construction joints are produced by placing fresh concrete against surface of hardened concrete. This type of joint, obviously does not introduce any structural discontinuity. Contraction joints are provided to eliminate tensile stresses due to shrinkage. At contraction joints, the bond is not allowed to develop between the joint faces thereby introducing a structural discontinuity. No space is left in between contraction joints. The concreting is done on one side of the joint first and after removing the form from the joint face, the concrete is placed against the already done concrete after applying a coat of sealing compound to prevent adhesion. In expansion joints a space usually 12 to 25mm is left between the concrete joint faces to permit expansion. Joint filler is secured in between the two faces of the joint. A settlement joint is provided where the adjacent structures are likely to settle differentially. The settlement joint is similar to that of an expansion joint with different sealing arrangement.

10.2 WATER PROOFING OF THE JOINTS

Generally construction joints if thoroughly cleaned and roughened at the time of pouring of concrete are tight and need no special water proofing arrangement. Some time a single metal/ PVC water stop is provided between two lifts if considered necessary. The contraction, expansion and settlement joints are always provided with proper water proofing arrangement.

Generally water proofing is done by use of double PVC water stop with asphalt seal. The asphalt seal is diamond shaped hole filled with asphalt or bituminous material in between two water stops as an additional seal against possible leak in the water stops. The asphalt seal shall be filled with hot bitumen to ensure dense filling. Steam pipes left in place during construction may be used for reheating purpose.

The contractor shall fill the bitumen filler in between the gap in expansion joint and settlement joint with proper filler material conforming to IS 1838 (part-I). The joint filler shall be coated on both faces with coal tar pitch conforming to IS 216 or bitumen of suitable grade conforming to IS 73 or Is 702. The contractor shall also ensure dense filling of asphalt seals with hot bitumen of suitable grade conforming to IS 73 or Is 702 if there is any leak developed. The steam pipes provided during construction may be used for reheating of the bitumen.

10.3 MEASUREMENT AND PAYMENT

Measurement of filler shall be made as per area of the filler in M² and payment shall be at the item unit rate given in Bill of Quantity as per contract. The unit rate shall include the cost of materials, all tools & plants, labour and incidentals as would be required to carry out the work satisfactorily.

Measurement for filling of asphalt seal shall be made separately in weight of bitumen consumed and payment shall be at the item unit rate giving in Bill of Quantitative as per contract. The unit rate shall include the cost of materials, all tools & plants, labour and incidentals as would be required to carry out the work satisfactorily.

Annexure-10.1

S.No.	Code No.	Title of code
1	IS-1838 (Part-I) :1983	Specification for preformed fillers for expansion joints in pavements and structures
2	Is 73:1992	Specification for paving bitumen.
3	Is 216:1961	Specification for coal tar pitch.
4	Is 702:1988	Specification for industrial bitumen.

SECTION 11

GRADED FILTER BELOW ROCK TOE, HEEL TRENCHES AND IN TOE DRAIN

- 11.1** The downstream toe of an earth fill dam is the most critical region in respect of seepage instability as the entire seepage tends to concentrate here if internal drainage is not provided. Rock toe and a drainage blanket or filter drains are therefore provided on the downstream of earth fill dam.

Upstream slope of the earth fill dam shall be protected against wave action. Generally the upstream slope is protected by dumped rock riprap or hand pack stone pitching. A heel trench is generally provided on the upstream slope to support the riprap and to reduce the pore pressure during construction and sudden drawdown.

Toe drain is provided at the downstream of the earth/rock fill dam to collect seepage through dam as well as to collect rain water falling on the face of the dam.

A filter or transition zone must invariably be interposed between an impervious, fine grained zone and the pervious coarse grained material adjacent to it. Thus the graded filter is must to be provided below rock toe, heel trench and in toe drains.

11.2 FILTER MATERIAL

The filter material used for drainage system shall satisfy the following criteria.

- a) Filter materials shall be more pervious than the base material
- b) Filter materials shall be of such gradation that particle of base material do not totally migrate through to clog the voids in the filter material
- c) Filter material should help in formation of natural graded layers in the zone of base soil adjacent to the filter by readjustment of particles.

In order to satisfy the above requirements, the following criteria shall be observed.

- (i) The 15 % size (D_{15}) of filter material must be more than 4 or 5 times the of the 85% size (D_{85}) of the protected soil, and

- (ii) The 15 % size (D_{15}) of filter material must be at least be 4 or 5 times the of the 15% size (D_{15}) of the protected soil to ensure adequate permeability.

Generally sand and gravel are used in layers as filter material. The material used in the filter shall be as per specifications given in the section -3 Materials.

11.3 LAYING OF FILTER

Provision of two layers of filter (coarse and fine) is usually necessary under rock toe, heel trenches and in toe drain to prevent the washing out the underlying base material. The thickness of each layers of filter shall not be less than 150mm. Filter material shall consist of gravel/metal/crushed rock or sand of medium to coarse sizes. They shall satisfy the requirement gradation criteria conforming to IS 8237:1985.

Contractor shall lay down the filter in the rock toe, heel trench and toe drains in the layers of the materials as shown in the drawing. These layers shall be laid properly and compacted as per details given in the section of earth work for embankment. The thickness of each layer shall be as per drawing.

IS-9429:1999 Code of practice for Drainage system for earth and rockfill dams shall be referred for selection of filter material and design of filter.

11.4 GUIDE BUNDS AND LINK CANALS

PREPARATION OF SHEET OF GUIDE BUND AND LINK CANALS:

All areas to be excavated for obtaining earth, and areas coming under the embankment, shall be cleared of all trees vegetation and other objectionable materials. All stumps and roots shall be excavated and removed. The cleared and grubbed areas shall be maintained free from vegetation growth during progress of the work. The area to be occupied by the Guide Bunds and link canals shall be stripped of all materials not suitable for foundation. These shall include vegetation sod, and organic silt etc. The top soil shall be stripped to such depth as may be necessary to obtain a foundation of satisfactory density and stability. Removal of all material that

may be of soft and yielding or is likely to become unstable with saturation or that may interfere with the creation of proper bond between foundation and embankment should be ensured. The material obtained from the stripping shall be suitably disposed of.

CUT OFF TRENCH: -

The cut off trench shall be excavated in the foundation parallel to the longitudinal axis of the embankment at the location indicated on the drawing and to the dimensions shown therein.

The material obtained from the excavation of the cutoff trench shall, if found suitable, be used in the embankment.

The particular zone in which it is to be used shall be subjected to the same degree of embankment control as specified for the materials obtained from borrow areas.

PREPARATION OF FOUNDATION:-

The foundation shall be prepared by ploughing, leveling and rolling, after adding water if necessary to bring it to the optimum moisture content as specified by the laboratory, so that the surface material in the foundation be as compact and well bounded with the first layer of the fill as specified for subsequent layers.

Payment:-

No separate payment shall be made for this item. The charges on this account are included in the rate of the earthwork under different categories.

BORROW AREAS:

All materials required for the construction of the embankment shall be taken from the prescribed borrow areas. The material obtained from each borrow area shall be placed only in the zone for which it has been specified in the approved plans. Borrow pits shall be worked so that the selected material as required shall be obtainable as close to the point of utilization as possible and shall not interfere with any permanent structure or disfigure any part of the work. The depth of cut for each borrow area shall be specified by the field laboratory. Borrow pits shall be finished as directed by the – Engineer-in-charge. The formation of pool shall be avoided and all borrow pit shall be

drained as necessary by ditches to the nearest outlets. It is proposed to utilize earth obtained out of excavation of the NORTH KOEL main canal up to lead of 1.5Km to 2.5Km in the impervious core of the guide bunds and the link canals.

BORROW AREA WATERING: -

The optimum moisture content for the materials in each borrow shall be determined by the field laboratory staff. The amount of additional water, if required, for the earth in borrow pits, shall be introduced well in advance of excavation operations to ensure uniformity of moisture content.

Zonal section: -

Embankment shall be constructed to the slopes, lines and grades as shown on the drawings increased by height and width suitable to allow for proper consolidation which is generally 84mm per meter height. The exact allowance to be provided in each section shall be worked out by the research station after conducting tests on the available type of earth. That allowance has to be provided without any extra cost.

Earth fill material: -

So far as practicable all suitable material from the required excavation shall be used in the embankment. Additional material shall be obtained from the specified borrow areas. The finest and most clayey material shall be placed in the cutoff trench and the central portion of the embankment. In the semi-pervious material embankment, the coarsest and pervious material shall be placed near the outer slopes of the embankment.

Placing earth fill: -

The distribution and grading of the material throughout the earth fill shall be as shown on the drawings. The fill shall be from lapses, pockets, streaks or layers of materials differing in texture or gradation from the surrounding material. To avoid sudden transition from one material to another the different soils shall be mixed within 3 m to 6 m of theoretical line of contact.

No roots sod wood or other organic matter shall be placed in the fill. Stones having minimum dimensions of more than 100mm shall not be permitted and should not be

more than 5% of the fill.

Before a new layer is laid, existing nuts or other unevenness in the surface of any lift shall be removed and the surface of the lift shall be scarified and roughened by borrowing or ploughing to obtain a band with the material to be placed.

The material shall be placed in continuous horizontal layers not more than 150mm in the thickness after being rolled. The earth fill shall be kept slightly sloping from center to the edge to avoid formation of the pools during the rains. In case the whole length of the embankment is not constructed simultaneously the incomplete embankment shall be placed at a slope not exceeding 1 in 5 to permit satisfactory bond with the portion to be constructed later.

Payment : Payment shall be made on the basis of the bank measurements after consolidation, for this purpose level shall be taken before the work in commencement and cross section plotted generally at every 30 meter interval and also at places where there are abrupt changes in level. The contractor or his authorized agent shall be required to countersign the level sheets in token of acceptance . Quantities obtained from foundation or canal excavation where separately paid for and used in the back fill shall be deducted from the measurement for the purpose of payments. All marked undulations including humps or local depressions shall be measured and got signed by the contractor before being covered up.

Weather conditions: -

The embankment material shall be placed only when the weather condition permit. If rain is apprehended the surface shall be graded and roller with a smooth road roller to facilitate run off. After rains the surface shall be scarified and moistened before resuming work.

Moisture control: Prior to and during compaction operations, the material in each layer of the earth fill shall have a moisture content of 2 to 3% less than the optimum moisture content, as determined in the lab. This moisture shall be uniform.

Compacting Earth fill:

Sheet foot rollers, other plain rollers or tampers as directed by the engineer in charge shall be used for compacting the earth fill. Such details as the thickness of the solid

layer no. of passes of roller and or below of a tamper etc. required for achieving the required degree of compaction shall be specified by field laboratory tests after experimenting on the test section built of the major type of a soil to be used for building the embankment . The dry density of the compact fill required to be achieved shall be at least 95% of the maximum dry density obtained in the laboratory on similar soil.

Payment: Payment shall be made on the same basis measurements as detailed in para

Sheep foot rollers:

Rolling with these shall generally be accepted as most certain means of security through compaction for clay type of embankment material. Pressure shall be effectible applied over small areas to that kneeling action of the foot produces density throughout the fill. The roller drums shall be of sufficient capacity to allow control of compacting pressure by varying the amount and type of ballast used. The tamper heads of feet shall be removed to allow variation in pressure and replacement of worn out parts. Tamper feet shall be properly spaced. The roller shall be tractor drawn and shall equipped with comb cleaner to remove any material sticking between the tampers. The projecting feet or knobs shall have an overall length of at 180 mm. It should be possible to get a unit pressure upto 35Kg /cm sq. (Assuming one row of foot contact).

Road Roller: -

Where sheep foot rollers are not available and when the earth fill to be compacted is sandy without appreciable cohesion, rolling with plain rollers shall be done. These roller shall be capable of producing compacting pressure approx. up to 3.5Kg/cm sq . The no of rolling for this case shall be determined in advance by laboratory experiment.

Tamping: -

In these parts of the structure which are inaccessible to the specified rolling equipment around and in contact with structures and in proximity to structures, where the rolling equipment will not be permitted to operate, compaction shall be accomplished by tamping either with hand or mechanical tampers of approved type. Rollers will not be permitted to operate within 1 meter of concrete structure and all fill within the

distance shall be hand tampered all material to be tamped shall be spread in layers not over 75 mm thick when loose. The moisture content of the material and the amount of tamping shall be such as to produce a degree of compaction equal to that specified for roller fill.

Inspection and test:

When the material used in the random section is sandy the engineer in charge shall have the discretion to dispense with compaction and limit the work to spreading, leveling and profuse water in only. All compaction operation shall be subject to control by laboratory tests. Routine field tests shall be conducted and regular inspection of the work shall be made to see if the desired results are being obtained. Laboratory will:

1. Procured all samples necessary for control of embankment operation.
2. Make necessary tests and assess the amount of water to be used for optimum requirement.
3. Carry out density tests to control maximum dry density after compaction.

Dressing slopes: -

The outside slopes of the embankment shall be mostly dressed to line as the placing or fill progresses. Compaction shall extend over the full width of the embankment and the material in slopes shall be contacted in the same way as for the rest of the structure. All bulges and hollows varying more than 150mm. From the neat lines of the embankment shall be regarded. Material used to fill depression shall be thoroughly compacted and bonded to the original surface. Slopes shall be maintained until completion and acceptance of the work. No separate payment shall be made for this.

Slope protection rip-rap:

The upstream and downstream slopes of the guide bunds shall be protected by hand packed rip-rap. The slope and Apron to receive the rip-rap shall be prepared and revetment placed on a filter bed of sand and gravel normal to the slope.

The dimensions shall be as per drawings. The stones used for revertment shall be selected as to size and shape to secure fairly large flat surfaced stones which will lay up with an even surface and minimum of voids. The stones shall be placed on edge with broadest base down and face normal to the slope. Beginning at the bottom of the

slope, the stones shall be laid compactly with broken joints and so matched and interlocked that they shall be keyed together with minimum joint space. Rock fragments and spawl shall be tightly driven into the intersection to wedge the rip-rap and in place and close direct openings to the underlying slope. Such filling shall be carried out simultaneously with the placing of stones and shall not be permitted to fall behind. The finished revertment shall present a reasonably smooth and uniform surface free of loose stones.

Graded filter under rip-rap:

Graded filter shall be laid under the rip-rap on upstream slope as indicated, on the drawings. The filter shall be placed in at least two layers. The finer material shall be placed adjacent material to be protected and the coarser material adjacent to the rip-rap. The filter material shall be clean, sound, well graded coarse sand and gravel or screened rock fragments. The requirements or grading of filter shall be established by the field laboratory. No particle of decomposed rock, debris, wood, vegetable material shall be permitted in the filter. Before placing filter, the underlying slope shall be nearly trimmed to the slopes and grades as shown in the drawings. Each layer of filter shall be uniform and free from pockets of coarse or fine material.

Slope protection on backwater side:

The slope protection for backwater side of the guide bund and lined canal consists of 1 m layer of good clayey soil. This shall be turfed as shown in the drawings. Before laying the turf, the slopes shall be dresses to lined and shall be slightly roughened to bond and hold a surface dressing consisting of blocks or strips of dense growth of dub grass or any other species of grass to be approved by engineer-in-charge. The soil shall include a mat of roots and earth at least 50 mm thick. Soil containing an excessive amount of obnoxious growth shall be excluded. It shall be carefully handled in transportation and transplantation so that minimum amount of earth shall be lost from the root mass. Those strips or blocks of soil shall be laid on the slope in close contact and then tamped between blocks. The interval of the time between cutting and laying shall be kept to a minimum. Dries soils will not be used in turfing. Immediately after placing, the sodded slopes shall be properly watered and kept moist for 10 days. It shall

be periodically moistened if necessary for sufficient period, for re-establishing the plant growth. Sod shall be transplanted only during appropriate season to be approved by the engineer-in-charge. The rate for turfing does not include 610 mm of earth filling behind it.

Drainage of stored water on downstream turfed slope:

The turfed portion of the downstream slopes of embankment are to be drained by a surface drain, running along longitudinal terrace and suitably sloped at suitable vertical interval and a drain along the bern as shown in drawing. Transverse drains constructed of stones are provided at 30 m interval between the longitudinal terrace and the bern drain to collect water into drain.

Lighting:

The Government shall arrange for lighting arrangements on main approach paths and on haul roads for carriage of materials. The contractors shall be responsible the borrow areas and the construction zone etc.

11.5 MEASUREMENT AND PAYMENT

Measurement of filter shall be made as per volume of the filter in M³ for each material layer separately and payment shall be at the item unit rate given in Bill of Quantity as per contract. The unit rate shall include the cost of materials, all tools & plants, labour and incidentals as would be required to carry out the work satisfactorily.

Annexure-11.1

S.No.	Code No.	Title of code
1	IS 8237:1985	Code of practice for protection of slope for reservoir embankment
2	IS-9429:1999	Code of practice for Drainage system for earth and rockfill dams

SECTION - 12

STONE / BOULDER PITCHING ON SLOPE OF EMBANKMENT

12.1 Embankments slopes need to be protected against wave action, rain wash, wind action, velocity of flow or over-topping of embankment by flood water. Protection against erosion due to over-topping is provided by ensuring sufficient free board and spillway capacity. Protection against erosion due to wave action, rain wash, wind action, velocity of flow can be provided by boulder pitching or riprap on upstream slope and pitching or turfing on the downstream slope.

12.2 STONE/BOULDER PITCHING

The river side earthen slopes of embankments are protected by covering them with dumped or hand placed stones/boulders pitching/riprap. This pitching is intended to remain in its laid position. The boulders shall be conforming to specifications as given in section-3 'Material'. Stone / boulder shall be hard and durable and shall not crumble on long exposure to water, frost and air. The size of stone / boulder shall be sufficient to withstand erosion action of flow and shall be determined as per provisions of IS 8408:1994 'Planning and Design of Groynes in alluvial river'. Generally, stones / boulders shall be of size 350mm and/or weighing 40 to 70 kg. The length of stones shall not exceed three times the height and breadth of the stone.

Pitching shall be placed on slope by hand. The slope of the embankment shall be well compacted and properly dressed before laying the filter layer(s) and then placing the pitching / riprap.

Since the pitching is generally poorly graded due to predominance of one size material, the provision of adequate filter is essential. Provision of two layers of filter (coarse and fine) is usually necessary under pitching to prevent the waves from eroding and washing out the underlying embankment material. The thickness of each layer of filter shall not be less than 150mm under hand placed pitching and 200mm under dumped riprap. Filter material shall consist of gravel/metal/crushed rock or sand of medium to

coarse sizes. They shall satisfy the requirement gradation criteria conforming to IS 8237:1985.

The hand pack pitching shall consist of one man stone laid on edge. It should be laid in one coarse such that the layer thickness is same as the stone size. However, at least 80% of the area of pitching / riprap should have stones weighing more than 45 kg. Such stone should be spread uniformly in the area. The minimum thickness of the pitching shall be 300mm. The tolerance on the nominal thickness of pitching/riprap enforced on the performed profile shall be +/- 10%.

Starting at bottom of the slope the stone shall be laid compactly with staggered joints and so matched and interlocked that they shall be keyed together with a minimum of joint space. Rock fragments and spall shall be driven into interstices to wedge the pitching in place. The wedging shall be done with largest chip practicable, each chip being well driven home with a hammer so that no chip can be removed by hand. Very irregular projections shall be knocked off so that pitching presents a reasonably uniform surface free of loose stones.

In case of boulder pitching, attempts shall be to place the boulder in such a way so that there shall not be very irregular projections and the filling of small boulders (limited to 15% to 20 %) into interstices are minimum.

To prevent the sliding and failure of the pitching on slope, toe is required to be protected by a key. Key shall be provided at the toe when rock or unerodible strata is available at the river bed and over lying banks are under attack and subjected to erosion. The key is in the form of stones, bricks or concrete block filled in trenches at the toe below the hard river bed for depth equal to thickness of the pitching for proper anchorage. Sole purpose of this key is to provide lateral support. This shall be treated as part of pitching while doing measurement.

12.4 MEASUREMENT AND PAYMENT

Measurement of pitching shall be made as per area of pitching laid in M² and payment shall be at the item unit rate given in Bill of Quantity as per contract. The unit rate shall include the cost of filter laid below the pitching and toe key. No separate measurement and payment for filter and toe key shall be made. The area of toe key shall also be measured with pitching area.

The unit rate include the cost of materials, all tools & plants, labour and incidentals as would be required to carry out the work satisfactorily.

Annexure-12.1

S.No.	Code No.	Title of code
1	IS 8237:1985	Code of practice for protection of slope for reservoir embankment
2	IS-9429:1999	Code of practice for Drainage system for earth and rockfill dams
3	IS 8408:1994	Planning and Design of Groynes in alluvial river – guide lines.
4	IS 14262:1995	Planning and design of Revetments - Guidelines

SECTION – 13

LAUNCHING APRON

13.1 The toe of the hydraulic works such as Barrage, regulators, flood embankments etc need to be protected from the erosion of the toe at the river bed due to deep scouring near the toe. When hard strata are available below the river bed at a reasonable depth, a toe wall may be constructed to support the pitching on the embankment slope or safe guard the toe of a hydraulic structure. But when a firm stratum is not available at a reasonable depth below the river bed, the toe protection in the form of sheet pile may be provided. Sheet piles are difficult to drive. Launching apron is, therefore, preferred and generally provided for protection of toe of the structure..

13.2 LAUNCHING APRON (STONE/ BOULDER WITHOUT WIRE CRATES)

Protection against erosion due to scouring near toe of the structure is provided by Launching apron made of boulders or stone. Boulders/stone may directly be dumped in sufficient quantity or may be filled in wire crate and then crates are dumped/placed in position.

Just beyond the inner toe of the (river side) of the structure, pervious protection comprising of the cement concrete blocks of adequate size shall be laid over loose stone. The blocks shall generally be of 1500x1500x900 mm size to be laid with gaps of 75 mm width packed with gravel, so as not to get dislodged. The length of block protection shall be equal to D_{max} , where D_{max} is depth of maximum scour below apron level.

Beyond the block protection, launching apron of loose boulder/stones or crate filled with boulders shall be provided. The launching apron shall be laid at normal water level or at as low a level as techno-economically viable. The stone in the apron should be designed to launch along the slope of the scour and provide a strong layer that may prevent further scooping out of the river bed material. Weight and size of stone shall be determined as per provisions given in IS 8408:1994 'Planning and Design of Groynes in

alluvial river – guide lines’.

The required size of the stones/boulders or crates shall be to withstand erosive action. The length of the launching apron should be minimum $2.4 D_{\max}$. The thickness of the launching apron should corresponding to quantity of stones required for a minimum thickness of 1000mm after launching on a slope of 2 H:1V. The thickness of the laid apron shall be kept 0.8 T near the toe of the structure and 1.2 T at the river end. Where T is the average thickness of the apron.

A graded filter specifying the standard criteria conforming to IS 8237:1985 ‘Code of practice for protection of slope for reservoir embankment’ should be provided below the apron also.

13.3 LAUNCHING APRON (STONE/ BOULDER FILLED IN WIRE CRATES)

For laying of launching with stone/ boulder filled in wire crate, two situations arise.

- (i) Where the crates are to be laid in deep water and have to be dumped and the joined together.
- (ii) Where depth of water is low or dry bed is available, in such cases, the crates can be laid at site.

Wherever possible, Wire crates shall be placed in position before filling with boulders. The crates shall be filled carefully hand packing the boulders or stones as tightly as possible and not by throwing in boulders or stones. The top then shall be tightly fixed with wire.

In case the crates are to be dumped due to deep water, the wire crates shall be placed and filled on a launching platform made of bamboos and then dumped in the water.

Wire crate

Wire crates shall be made from hot dip galvanized mild steel wire of diameter not less than 4mm in annealed condition having tensile strength of 300-450 MPa conforming to

IS 280:1978 (soft). The galvanized coating shall be heavy coating for soft condition conforming to IS 4826:1979. The mesh of the crtae shall not be more than 150mm. Wire crates for shallow accessible situation shall be 3m x 1.5m x 1.25m in size. If wire crates are to be deposited on a sloping surface or there is a chance of overturning, the crate shall be divided into 1.5m compartments by cross netting. For deep or inaccessible situations, the wire crates may be made smaller subject to approval of the Engineer-in-charge, so that it is easy to dump the boulder filled crate easily.

13.4 MEASUREMENT AND PAYMENT

Measurement of apron shall be made as per volume of apron laid in M³ and payment shall be at the item unit rate given in Bill of Quantity as per contract. The unit rate shall include the cost of filter laid below the apron. No separate measurement and payment for filter shall be made.

The rate for apron with and without crate shall be given separately. The unit rates for the wire crate shall be included in the item rate of apron with wire create.

The unit rate include the cost of materials, all tools & plants, labour and incidentals as would be required to carry out the work satisfactorily.

Annexure-13.1

S.No.	Code No.	Title of code
1	IS 8237:1985	Code of practice for protection of slope for reservoir embankment
2	IS-9429:1999	Code of practice for Drainage system for earth and rockfill dams
3	IS 8408:1994	Planning and Design of Groynes in alluvial river – guide lines.
4	IS 14262:1995	Planning and design of Revetments - Guidelines
5	IS 280:1978 (soft	For tensile strength of hot dip galvanized mild steel wire
6	IS 4826:1979	For galvanized coating

SECTION - 14

REHABILITATION AND REPAIR WORKS

14.1 Repairing of different types of works is required after a long period of service, to restore the strength, flexibility, durability and characteristics of the original work. Strengthening such works by different techniques is a method to increase the resistance of its elements to withstand different working conditions and to perform adequately and efficiently the functions for which it is designed. Depending on the desired resistance, the level of the damage, the type of the components, works can be repaired and for rehabilitated, or upgraded by different methods. It is of paramount importance to realize that in all repair works the instructions of the Engineer-in charge shall be followed. The Contractor shall remove and transport all refuse matter at his own cost. All soil, turf, gravel, stone, timber and other materials obtained in the excavation and clearing of the site of the works shall belong to the Employer and shall not be removed from the Works or sold without the consent of the Project Manager. The Contractor may use for the construction of the works any of the materials excavated, which the Engineer-in-charge may determine to be fit for such use.

14.2 CONSTRUCTION REQUIREMENTS

The Contractor shall ensure that certain requirements are satisfied for the repair works to be executed efficiently. The following requirements are necessary for the proper execution of the works :

- Adequacy of tools and equipments used-
- safety measures taken to avoid unnecessary damage to the existing structures.
- sequence and methodology of work adopted.
- stability of materials used and quality of workmanship.

In repairing the damaged works, the Contractor shall use simple hand tools, light devices and if necessary, mechanical means as may be required and approved by the Engineer-in-charge to avoid damages to existing structures and its surroundings.

Damaged parts shall be removed with care to avoid causing vibrations and movements of the works under repair that may cause a threat to the existing structures or its surroundings. Use of explosives or air compressors shall not be allowed.

The Contractor shall furnish all materials and supplies and complete works required for repair works under this Contract in accordance with this Specification described herein and elsewhere in the Specifications.

14.3 SAFETY MEASURES

The Contractor shall explore the Site conditions and identify the nature and scope of the works under this Contract, its limitations and risks, and shall submit to the Engineer-in-charge, the statement report indicating the arrangements, procedures and measures that shall be adopted in carrying out the repair works and handing over the site clean and neat. The provisions of clauses in Specification earlier sections shall apply in regard to safety measures needed for this kind of work. Temporary supports, scaffolding and all required shall be provided by the Contractor at his own cost to carry out the works efficiently and safely and finish the same in good condition. The Contractor shall safely dispose of all refuse matter within the haul distance as directed by Engineer-in-charge.

14.4 REPAIR TECHNIQUES FOR CONCRETE WORKS

In carrying out repair works the contractor shall use the most efficient method that is suitable to remedy a specific damage. Damaged works can be upgraded, rehabilitated and repaired by the following repairing techniques:

- Injection
- Removal and Replacement of the damaged parts.
- Jacketing.

The location, extent and type of repair work shall be indicated on the Drawings. The contractor shall resort to the appropriate type of repair technique shown on the Drawings and shall strictly follow the procedures stipulated in the specifications to

carry out the works under this item as described in the scope of the contract.

Injection

Resin or cement grout injections are to be applied only for works with slight cracks, without damaged concrete or reinforcement.

Removal and Replacement of Damaged Parts

When the concrete is heavily damaged, the steel reinforcement is exposed, abraded or completely rusted, the bonds are deteriorated and the concrete is crushed, total removal and replacement of the damaged parts must be carried out. If only repair is required, the original cross section size will be maintained. If strengthening is necessary, the area of the original cross section must increase; damaged and loose concrete must be removed, new reinforcement inserted and welded to existing sound reinforcement and new ties are placed. Special attention must be paid to achieve good bond between new and old concrete.

Jacketing

Jacketing should be applied in cases of heavily damaged concrete works or in cases of insufficient strength of concrete elements. Jacketing may be used for strengthening purposes of the concrete structures, although it can also be used for repairing. Jacketing can be performed by adding reinforced concrete, steel profiles (angles and straps) or steel encasement.

14.5 LOCAL REPAIRS IN CONCRETE

Damage types

Damage is considered "Heavy", when the concrete is heavily damaged' the-steel is exposed, abraded, or completely rusted, the bonds are deteriorated and the concrete is crushed, total removal of the damaged parts and their replacement must be carried out as an appropriate remedial measure. Damage is considered 'Moderate', when the concrete is slightly damaged without damage to reinforcement. The contractor shall qualify the type of damage and proposed repair method to the approval of the Project

Manager.

Procedures

The type of repair applied to dissipater-blocks with "Heavy" damage is the removal of the damaged parts and their replacement with new one. Where the surface concrete of the existing dissipater blocks is "Moderately" damaged without any damage to the reinforcement the concrete cover shall be chipped away, the surface roughened, dust is cleaned and the surface is treated with glue and concrete is poured to restore the block to its original condition. Then steel jacketing of the edges of the blocks is provided to strengthen the block against future stresses from floodwaters.

Dismantling and Replacement of Damaged Parts

In carrying out this type of repair work, the Contractor shall follow the stages explained below:

1. The Contractor shall refer to the Drawings to identify the type of repair and extent of the work involved. The lines, levels and alignment of the works under repair shall be followed strictly from the Drawings and shall be consistent and in harmony with those of the existing works. The Contractor shall carry out needed survey works to establish the correct grades, cross sections, centrelines and alignment of the works.
2. The Contractor shall identify and locate the dissipater blocks to be repaired and clear the area where the works is to be carried out.
3. The contractor shall demolish and chip away the damaged parts of the concrete. Chipping away the concrete surface shall be done in an irregular way down to the levels required to remove the damaged, rusted reinforcement. This can be achieved by sand blasting or by chipping with special mechanical equipment under the direct supervision of the Project Manager.
4. The Contractor shall remove the damaged steel parts and ties and replace them with new ones of the same diameter or higher.
5. The existing sound steel parts an ties shall be cleaned from rust by use of

mechanical steel brushes or sand gun.

6. The new reinforcement and ties shall be welded to the existing sound reinforcement and ties to restore the reinforcement level to its original condition before the damage.
7. prior to concreting, the rough surface shall be cleaned from dust and loose materials and shall be treated with suitable and approved bonding epoxy resin glue paint (NITOBOND or equivalent) to achieve bond between the old and new works. Grouting the surface may be used as another option provided the approval of the Project Manager is obtained.
8. Formwork for the concrete shall be placed to form blocks of the same shape, lines and dimensions as shown on the Drawings. Formwork shall comply with the relevant clauses in earlier sections.
9. Concrete of specified grade 30/20 is poured in the formwork to produce the required dissipater block. Concrete shall comply with the requirements of clauses in section-4 of the Specifications.

Jacketing with Steel profiles

In carrying out this type of repair technique, the contractor shall follow the procedures set below:

1. Same procedure as in 1 of above
2. Same procedure as in 2 of above
3. The Contractor shall remove the loose concrete and chip away the concrete cover in an irregular way by sandblasting or with a mechanical equipment under the direct supervision of the Project Manager. The surface is then painted with an approved bonding agent (epoxy resin paint-NITOBOND or equivalent) prior to concreting to restore the old concrete blocks to their original condition.
4. The concrete cover is restored to the old concrete block by use of concrete with better properties than the existing concrete. Concrete shall be of grade M-30/M-20 and shall comply with the provisions of clauses in the section 4 of the Specifications.

5. After the original shape of the concrete block is restored, the Contractor shall proceed with the process of strengthening the concrete blocks by placing steel angles of all the edges. The angles shall be painted with anti-rusting epoxy paint (ZINCRICH or equivalent) and fixed to the concrete surface by epoxy resin. Gaps between the angle profiles and the surface of the block must be filled with non-shrinkage grout or resin grout. Tight bearing between the angle profiles and the bottom of the blocks shall be achieved by an angle profile collar around the block. The Contractor shall hand in the works neat and clean.

14.6 REPAIRS IN MASONRY WORKS

Rehabilitation and repair works to existing masonry works to maintain its original functions or increase its durability and stiffness whether these works are cracked or uncracked can be achieved by the following repair techniques:

- Grouting
- Addition of vertical reinforcement concrete coverings (jackets) on both sides of the wall.
- Using steel tie bars to hold the walls together (Pre-stressing the walls).

Grouting

Holes are drilled in the wall (2 to 4 holes/m²) sufficient to ensure full penetration of grout. First water is injected in order to wash the wall inside and to improve the cohesion between the grouted mixture and the wall elements. Secondly a cement water mixture (1 cement: 1 water) is grouted at low pressure of 1 to 2.5kg/ cm² in the holes starting from the lower holes going up. Alternatively, Polymeric mortars may be used. Pressure for grouting can be obtained by gravity flow from super elevated tanks. (Grouting may also be required under slabs to fill voids. Grout shall be injected through holes drilled through the base. Grout for filling voids shall be 1 cement : 6 sand by weight.

Addition of vertical reinforced Concrete Coverings Plates (jackets)

A steel wire mesh comprising welded wire fabric of 10 x 10 mm bar diameters mesh

with a spacing of 10 x 20 cm is placed on the surface of the wall and connected by 12 mm steel bars, 50 to 75 cm apart. A 3 to 4 cm thick mortar layer of cement and sand mixture: (1 cement : 1 sand by volume or equivalent in strength) is then applied on the mesh.

Pre-stressing (Tie Bars)

A horizontal compression by horizontal tendons can increase the shear strength of walls' This also improves the connections of orthogonal walls. The easiest pre-compression is achieved by placing two steel rods on the two sides of the wall and stretching them with turnbuckles' Good effects can be obtained by slight horizontal pre-stressing.

Extensive Repair

Extensive damage may occur to masonry walls which require reconstruction of a portion of the wall. It is important to install temporary shoring promptly to support other structures connected to the heavily damaged wall.

When portion of masonry walls have permanent lateral distortion or humping at both sides of the wall, that portion of the wall must be completely removed and reconstructed. If the wall has spread or humped on one side only complete reconstruction can be avoided if the vertical face is stable enough to be used as formwork after when the bulging side is taken down. Headers are placed in the rebuilt wall using concrete or cement grout to fill all voids

Different procedures are followed in repairing damages that occur in masonry structures depending on the level of damage. For small repair works, grouting as a repair technique is used. For larger repair works where excessive stone has to be removed from the existing masonry work, Jacketing is an efficient repair technique to restore the strength of the masonry structure to its original condition.

Minor Repair

When rendering and/or repair work is required along existing masonry structure all loose stones and defective joints shall be thoroughly raked out and cleaned back to expose a sound base for application of the repair work. All such exposures shall be inspected by the Project Manager. The Contractor shall not commence any repair work before the Project Manager's approval is obtained. The stone and mortar mix used for remedial works should be consistent with the general clauses of the specifications described earlier and also with the general colour and appearance of the existing structure.

The procedure to be followed by the Contractor for cracking repair shall be as follows:

- Clean out all cracks with water. Remove old mortar from any masonry joints and clean the joints.
- Deposits in cracks can be easily removed by compressed air.
- The contractor shall not crack openings before filling with mortar.
- The contractor shall fill the cracks with mortar and finally fill the joints with mortar to replace the old mortar that has been removed from the joints.
- Then the mortar shall be trowelled smoothly after the cracks have been filled, and the joints treated.
- The areas shown on the Drawings where the masonry works are in good condition, and only small portions of the stones have to be removed and replaced by new ones, and some defects appear on masonry joints shall be repaired, the Contractor shall proceed as follows to carry out the repair works required and shown on the Drawings:
 - The Contractor shall remove all loose stones and defective joints using compressed air or a water spray, hammer and chisel. The Contractor shall clean all cavities exposed and defective joints of old mortar to establish a sound base for formation of the new repair works.

The surface under repair shall be moistened with spray water, and the Contractor shall place a new mortar bed to receive the masonry stones, and shall also apply fresh mortar to the joints between the new stones and the old ones, and filling all space available, compacting with a suitable wooden tamper. The joints shall be smoothed with suitable tool either a piece of rubber or plastic water hose. The joints width shall be within 10 - 20mm.

Major Repairs

For major repair works, where excessive Stones is required to be removed' many repair operations are involved; strengthening the wall by steel jacketing; reconstruction of the damaged portion of the wall; filling the cavities inside the wall by grouting-The Contractor shall proceed as follows:

- Prior to commencement of repair work,, the Contractor shall take the requisite requirements to ensure the stability and safety of the structure under repair and its surroundings and the safety of all persons working at the site whether employed by him or not.
- The Contractor shall completely remove the portion of the wall that has damaged stones and prepare a smooth surface to accommodate the new works.
- Then the Contractor shall supply vertical reinforced concrete covering plates as jackets to the surface of the wall by adding a steel wire mesh comprising welded steel wire fabric on surface of the wall and connected by 10mm diameter steel bars, 50 to 75cm apart' A 3 to 4 cm thick cement sand mix (1 cement: 2 sand by volume) is then applied on the mesh.
- Then the Contractor shall start reconstructing the damage portions of the wall in accordance with the clause of the Specifications described in earlier chapter.
- After completion of the rebuilt portion of the wall, the contractor shall place headers in the rebuilt wall using cement grout to fill all voids. The cement water

mixture of 1 cement:1 water shall be used.

- The work shall be given neat and clean.
- After completion of the works in the manner described above, a number of holes are drilled in the masonry wall at the rate of 3 holes per square meter. First water is injected in order to wash the wall inside and to improve the cohesion between the grouted mixture and the wall elements. Secondly, a cement and water mixture (1 cement; 1 water) is grouted at low pressure of 1 to 2.5 kg/cm² in the holes starting from the lower holes going up. In most cases the pressure needed for grouting can be obtained by gravity flow of the grout from super-elevated tanks.
- Carry out the same requisite requirements stated earlier.

14.7 REPAIRS IN HYDRAULIC STRUCTURES

Damage and loss of surface materials of waterways in different parts of the irrigation scheme is a common phenomenon, in particular in Scour Sluices aprons that are operated whenever required to flush sediments and trash accumulated at the intake. Damage and loss of surface materials of waterways associated with diversion works due to long use over a number of years, and lack of regular maintenance has hindered the smooth and efficient performance of the existing irrigation schemes.

The Contractor shall carry out the required repair works in the locations and details shown on the Drawings to restore the function of the different components of the structure to its original condition.

Cleaning and Clearing

Before setting out to start the repair works, the Contractor shall ensure that cleaning and clearing of the areas of work of all superficial obstruction has been completed and approved by the Engineer-in-charge. The damaged stone and concrete surfaces shall be repaired by removing the existing damaged surfaces and replacing with new concrete or new stone.

Tools And Supplies

The surfaces damaged and eroded by flood waters shall be completely removed with great care using simple hand tools, and light devices to avoid causing unnecessary damage to existing structure. The means used by the Contractor to remove the damaged existing surfaces shall be under the direct supervision of the Engineer-in-charge and the Contractor shall keep the Engineer-in-charge well informed on the nature and type of the-tools, devices he intends to use. In the removal of existing damaged surfaces the contractor shall obtain the Engineer-in-charge written approval for the use of any proposed mechanical equipment for demolishing the works.

Confirmation of Levels

The contractor shall make use of reference points and benchmarks to establish all levels shown on the Drawings to execute stipulated repair works to the dimensions, levels shown on the Drawings. All works executed shall comply to the provisions of the specifications in regard to survey work needed by the Contractor and his liabilities.

Sequence and Methodology of Works

The repair work shall be done by the Contractor in six "6" sequential Stages:

1. Clearing and cleaning the U/S & D/S area of superficial obstructions deposited by the spate floods.
2. Establishing reference points as benchmarks for use in completing works to the required dimensions, level, shown on the Drawings.
3. Marking out the area to be repaired, and where work starts and ends to ensure good alignment and proper execution of works.
4. Demolishing and removal of damaged unsound existing surfaces to the extent and levels shown on the Drawings, and disposal of refuse matter to haul distance.
5. Cleaning and clearing the surfaces of dust and other loose residues material

and preparing the surface for the new repair works.

6. Proceed with the type of repair work and. handing over the works in a clean and neat condition.

Procedure

Repair of damaged stone and concrete surfaces is achieved by the replacement of the existing works with new stone / concrete facing blocks to ensure smooth flow of water and rapid removal of sediments and trash through the flushing system incorporated in the diversions structures. This treatment shall be carried out by the Contractor in two stages.

First Stage: Establish bonds between the old and new works. After removal of the damaged surfaces preparation of surface for the new works is important, The existing sound surfaces shall be roughened. The contractor shall roughen the existing surface by chipping in an irregular way to the levels required to place the works as shown on the Drawings. This process can be achieved by heavy sand blasting or by chipping with any special mechanical equipment approved by the Engineer-in-charge.

- The surface shall be thoroughly cleaned with air and/ or water jets to ensure its freeness from dust, oil, grease or, any other deleterious loose materials' and treated with, a suitable bonding epoxy (NITOBOND or equivalent) or grout approved by project Manager.
- The Contractor shall provide steel dowel bars that shall be embedded in the existing sound surfaces, and in the new works as shown on the Drawings.
- By the end of this stage the existing surfaces shall be ready to accommodate and accept the new works.

Second Stage: Execution of remedial works: when the Contractor is sure that the existing surface is treated and ready to accept the new remedial measures the Engineer-in-charge shall be informed for inspection of the works completed and shall request his approval to commence the repair works. Once approval has been granted

by the Engineer-in-charge, the contractor shall Prepare the concrete bedding shown on the approved Drawings. A nominal 30 mm thick bedding of concrete shall be allowed to place stone/concrete on original exiting concrete. Steel channels 254x76x28 mm are placed back to back to provide adequate tie and strength at the designated location. The steel channel shall be well anchored to the concrete by using anchor, bolts and epoxy resin paint. The requirements of concrete preparation and mixing shall follow the provisions of the Specifications described earlier.

In all cases with the approval of Engineer-in-charge, the portions of heavily/partially damaged masonry / concrete structures are to be rebuilt with concrete filling.

14.8 DESILTING OF CANALS

Prior to the commencement of desilting work, all relevant reaches of the canals shall be marked at site and drawings prepared showing the locations of the cutting and embankment reaches. The L- section and the cross section at every 20m intervals of the canal reach shall be and plotted on a reasonable scale. The designed bed levels and dimensions of the canal i.e the final section of the canal shall be marked on these L-section and cross sections. The quantities of the silt deposited to be excavated and If there is a need to place some fill to restore the original designed section shall be shown in these drawings in the different colours. These drawings shall be submitted to the Engineer-in charge for his approval.

Reference pegs should be driven into ground at affixed distance along the centre line of the canal. The section profile as per designed sections of the canal in one metre length shall then be made manually at every 25m intervals. Then Excavation of the deposited silt may be carried out by manual labour or by excavating machines. If the work of desilting is done by machine, the silt shall be removed from the central part of the canal only. The final bed and slope cutting shall be done manually so that the final section of the canal is exactly as per approved drawings.

In the part, where the section needs some earth fill, it shall be placed in layers with

proper compaction. The earth work shall be done in nearly 60cm extra width and then the pride shall be cut manually to the proper slope. Where the canal is to be lined, the preparation of sub grade shall be done as per detailed specification given in the para for concrete lining of the canal.

The excavated silt should not be placed over the canal banks and shall be deposited on the outer slope of the canal banks to strengthen the banks. If the canal reach is in cutting, then the excavated silt should be deposited outside the canal in form of spoil banks leaving a suitable berm and cross drains or transported to a disposal area as directed by engineer-in charge. A gap of nearly 3m wide at toe may be left in spoil banks at 150m intervals for the purpose of drainage.

14.9 REPAIRS / REHABILITATION OF CANAL CEMENT CONCRETE SLABS LINING

Lining of canals with precast cement concrete slabs shall be adopted for rehabilitation of the damaged precast slab lining in canals in places as shown in the drawings or as directed by the Engineer-in charge.

PREPARING FOUNDATION

Prior to the commencement of tile lining work, all relevant reaches of the canals shall be marked at site and drawings prepared showing the locations of which repairs is needed. The complete panel shall be repaired even if the damaged is 1 m part of the panel. The old concrete slabs shall be removed from the damaged panel and model sections prepared for cement concrete lining.

MODEL SECTIONS OR TEMPLATES

Model sections or templates of cement concrete M15 shall be constructed in the bed and sides of the canal to the required sections with the top of model section level to the finished surface of the lined section of the canal portion. The spacing of the model sections shall be 15 metres in straight reaches and 7.5 metres in curved reaches. The exposed face of the model sections constructed with cement concrete M 15 or shall be

plastered with cement mortar 1:4 as shown in the drawing or as directed by the Project Manager. The dimensions of the model sections will be the given in the drawings or as directed by the Engineer-in-charge.

Suitable super elevation in curved roaches shall be given after the approval of the Engineer-in-charge.

Since the model sections are to be used as reference for excavation and trimming of sub grade for the lining and for laying, finishing the lining to the required grade and profile, it should be constructed with in a tolerance limit of 50 mm. in a length of 3 meters. Model sections beyond the permissible tolerance will be removed and redone by the contractor at his own expense.

After preparing the subgrade, casting of sleepers and laying of longitudinal drain and filter material as per required specifications given in the para of cement concrete canal lining, LDPE sheets of 200 gauge (50 micron) shall be spread over the subgrade before placing the concrete slabs for lining. The LDPE film shall be of appropriate strength, toughness and durability as approved by Employer. The film shall be spread tightly by stretching the sides/corners so that it is spread smoothly without any wave. It should be fixed in the subgrade so as to prevent displacement during the placement of the concrete. The over lapping of 100mm shall be done for jointing of the film.

PRECAST SLABS

Mix for the slab shall be cement concrete M 15 using 20 mm. hard machine broken stone aggregates. The face of the slab shall be square or rectangular. The dimensions of the slab and toe- wall block shall be as per approved drawings. The thickness shall not be less than the specified value. The slabs shall be either with all its sides at right angles to the faces or with two of its sides beveled at a particular angle to the faces or as directed by the project Manager. The beveled slabs shall be provided with tongues and grooves as per para 6.1.2.7 of I.S. 3860-1966. The slabs shall have minimum flexor strength-as specified in I.S. 4060-1968.

Manufacturing of slabs required for lining shall be done in the casting yard using concrete mixers for mixing, steel molds and table vibrators. They shall be cured in curing ponds. The casting yard with the required infrastructure shall be constructed by the contractor at his cost.

The table vibrators to be used shall conform to LS. 2514-1963. For all sizes of vibrating table, the height of the table top from the ground level shall be sufficient to allow for easy placing and removal of the moulds and shall not exceed 0.75 meter. The capacity of vibrating table shall be indicated, for the effective vibration by the maximum weight in tones of the mould plus the concrete in the mould. The frequency of vibration for the table operating at its maximum load capacity shall be between 3000 to 6000 cycles per minute. The vibration acceleration of the table operating at its maximum load capacity shall not be less than four times the acceleration due to gravity. The minimum frequency or the table under loaded state for determining the acceleration shall not be less than 3000 cycles per minutes. The reduction in amplitude of the table while operating from 'zero load' to full load condition shall not exceed 25 %.

A source for giving water, required for mixing, casting and curing concrete shall, be provided at the contractor's cost. Sufficient numbers of steel moulds, of required size with necessary base plates shall be procured by the contractor.

The payment shall be for finished work and the payment includes all materials, equipment, machinery, casting yard and all other inputs including water supply etc. complete.

CASTING AND CURING

Prior to the batching operation, steel mould and base plates shall be cleared of all dirt and well oiled on all surfaces and kept ready for placement of concrete. Cement, sand and aggregate shall be fed in to the mixer after measuring each volumetrically in required proportion. Required water shall be added while the ingredients are fed into

the drum from the hopper. The mixing time shall not be less than two minutes and unloading of the mixed concrete to the platform shall be done only after the steel mould and the table vibrator are ready to receive concrete. The concrete shall be laid in the oiled steel moulds and vibrated using vibrating table with a frequency of not less than 3000 cycles per minute and the vibrating time shall not generally be less than 20 minutes for 10 Sqm of slab of size of 5 cm thick and 30 minutes for 10 Sqm in the case of 7.5 cm thick slab.

After the specified vibration period is completed, the slab shall after finishing the top surface be allowed to cure under polythene sheet or wet sack for 24 hours. After the lapse of 24 hours the slabs shall be cured in curing ponds for 7 days. Before placing the slab in the curing ponds care shall be taken to finish the top surface smooth and after 7 days of immersed curing under water, the slabs shall be cured with sprinkling water for next 21 days covering the slab with straw, gunny etc., for keeping the surface always moist.

LAYING OF SLABS

The slabs shall be removed to the canal site for laying only after they are cured for the prescribed period. While loading, transporting and unloading at the site, care shall be taken to prevent any damage to the slab. Slabs which are with rough damaged surfaces or with broken corners or cracks or with irregular edges shall not be allowed to be used in lining.

The slabs shall be laid on finished surface true to line and grade using model sections as a guide starting from the bottom layer, the joints shall be filled in with cement mortar of mix 1:3 to the full depth of joint, the width of the joint shall not exceed 12 mm. The joint should be flush pointed in cement mortar 1:3. Curing shall be done for a period not less than 14 days. Any portion of work not in line or grade, joints not packed with mortar and not cured for the prescribed period shall be removed and redone.

14.10 MEASUREMENT AND PAYMENT

Recording of measurements for rehabilitation works are similar to the measurement of different items like concrete, masonry, centering, shuttering reinforcement and plastering / pointing etc. Similarly, the items will be paid at the rates provided for different items of work in the BOQ.

For the dismantling items required for execution of rehabilitation work, the measurement and payment shall be done separately. The payment for these items shall be done to the contractor at mutually agreed rates.

The rates shall include all cost for labour, materials, T&P, Machinery, equipments and consumables required for carrying out the following operations.

- Cleaning of surface area.
- Procurement of all materials/T & P to worksite.
- Erection of gangway and scaffolding at work site.
- Carrying out dismantling work as per instruction of Project Manager.
- Removing dismantled debris away from work site and stacking useful materials for reuse.
- Site illumination.
- Construction cofferdam if necessary and removal after completion of work.
- Any other incidental cost to complete the work.

The useful material restacked will be issued to the contractor at mutually agreed rates.

SECTION - 15

WATER BOUND MACDAMROAD

- 15.1** The scope of works under this section covers construction of single lane WBM road and PCC (Plane cement concrete) road in irrigation colonies for the lengths specified in the scope of the works as per direction of the Engineer-In-Charge. The WBM road shall consist of laying and compacting of water bound macadam with three courses of stone metal (total thickness 250 mm) overlaid a layer of 100mm thick of drainage material on a sub-grade of selected coarse-grained soil of 300 mm thickness.

The contractor shall provide all The construction plants and equipment, skilled and auxiliary personnel and material necessary to commensurate with the various tasks and requirement associated with work as per drawings, specifications and/or direction of Employer.

All materials and works for production, placing, rolling, watering, application of binding and screening materials etc. shall conform to the relevant Indian Standards, IRC and guidelines or alternately to equivalent International standard. A list is given in Annexure- 15.1.

15.2 WATER BOUND MACDAM ROAD

MATERIALS

Road section consists of three courses of Water bound macadam laid over a layer of drainage material. Material for drainage layer shall consist of sand/ moorum. Material for soling and other two road metal courses shall consist of stone aggregates from approved quarries. The aggregates for shall be of size from 90mm to 45 mm for soling course, from 63mm to 45mm for inter course and 53mm to 22.4mm for the top course. The aggregates shall be hard, durable and free from excess of flat, elongated soft, disintegrated particles, dirt, organic material and other objectionable materials. The total quantity of such deleterious material shall not exceed 5% of weight of the

aggregates. The gradation of material shall conform to the table given below.

SEIVE SIZE (MM)	% PASSING THE SEIVE		
	FOR SOLING	FOR INTER COURSE	FOR TOP COURSE
125	100		
90	90-100	100	
63	25-60	90-100	100
53	0-15	25-60	90-100
45	0-10	0-10	25-60
22.4			0-10

Screening Material

Screening material to fill voids in the coarse aggregates shall generally consist of same material as coarse aggregates. However, where permitted, non-plastic material like moorum or gravel may be used if the liquid limit and plastic index of such is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 22%.

Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Employer having plastic index value of less than 6.

CONSTRUCTION OF ROAD

The road shall be constructed in accordance with the slopes and sections shown in the drawings or as directed by Employer. After completion of earthwork on the canal embankment / colony roads, the excavation shall be done in a width of nearly 30cm more than the finish width of the road and for a depth of 350mm and sub-grade for the road shall be prepared with specified camber. The sand / mooram shall be spread over the prepared subgrade in such a quantity that the compacted layer shall be 100mm thick. The compaction shall be done by using three-wheeled power rollers of 8 to 10 tonne capacity.

Laying of WBM courses

The coarse aggregates as specified in the drawing shall be spread to the profile with a twisting motion to avoid segregation together in such a quantity that a compacted layer shall be of as shown in approved drawing. The surface of the aggregates spread shall be carefully checked with templates and all high and low spots remedied by removing or adding aggregates as may be required.

Immediately, after the spreading of coarse aggregates, rolling shall be started with three-wheeled power rollers of 8 to 10 tone capacity. Rolling shall begin from the edges gradually progressing towards the centre. First the edge shall be compacted with roller running forward and backward. Then roller shall move inward parallel to the centre line of the road, in successive uniformly lapping preceding tracks by the least one half width. During rolling slight sprinkling of water may be done, if necessary. Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings.

After the coarse aggregate have been rolled lightly to the required true shape, screening material consist of same coarse aggregates or non-plastic material like gravel or mooram shall be applied gradually over the surface to completely fill the interstices. Dry rolling and brooming shall be done while the screening is being spread so that the vibrations of the roller cause them to settle into the voids of the coarse aggregate. This operation shall continue until no more screening can be forced into the voids of the coarse aggregate.

After the screening has been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screening into voids and to distribute them evenly. The sprinkling , sweeping and rolling operations shall be continued with additional screening applied as necessary, until the coarse aggregate has been thoroughly keyed, well-bounded and firmly set in its full depth and a grout has been formed of screenings.

After the application of screening and rolling, a suitable binding material as approved by Employer shall be applied successively in two or more thin layers at a slow and uniform rate. The surface shall ,then be copiously sprinkled with water, the resulting slurry swept in with hand broom, or mechanical broom to fill the voids properly and rolled during which water shall be applied to wheels of the rollers if necessary to wash down the binding material striking to them. This operation shall continue until the resulting slurry after filling voids, forms a wave ahead of the wheels of the moving roller.

After the final compaction of water bound macadam first course, the road shall be allowed to dry and set.

When the first layer of the macadam has set properly, the above process shall be repeated for the second and third layers of the macadam courses. No traffic shall be allowed on the road until the macadam has set.

Both side shoulders shall be properly leveled with a slope of 1:100 towards the outer edge of the roads. The bricks on edge shall also be laid in a width of 500mm on either side of the WBM road. The joints shall be filled with dry sand/earth.

MEASUREMENT AND PAYMENT

The measurement WBM part of the road shall be recorded in running meter while the measurement for brick work shall be recorded in M² by measuring the length and width of the brick soling area.

Payment shall be made at the unit rate given in BOQ of the contract.

The unit rate shall be inclusive of the cost of all materials, labour, tools, equipments, land preparation, watering, supervision and all incidental works required to complete the work as verified and approved by Engineer-in-Charge.

Annex-15.1

List of Reference Standards and Codes

CODE NO.	TITLE OF CODES
IS- 217	Specification for cut back Bitumen
IS- 383	Specification for coarse and fine aggregates from natural sources
Is-2386 (part –I to VII)	Method of test for aggregates
Is- 5317	Specification for Bitumen mastic for bridge decking and roads
IS -2386(pt.v)	Soundness test for aggregates
IRC-63	Stabilized soil material for sub base

SECTION - 16

MISCELLANEOUS CIVIL ENGINEERING WORKS

- 16.1** The scope of works covered under this section shall be the execution of miscellaneous works of civil engineering, which are not covered by other sections of specifications. The scope of works also cover to provide and maintain all plants and equipment, skilled and auxiliary personnel and material necessary to commensurate with the various tasks and requirement associated with work as may be necessary for various works and requirements associated with all types of these miscellaneous works along with installation of all temporary and/or permanent supports as necessary.

The contractor shall submit his proposal with detailed specifications to Employer for his approval. The details of material to be procured needed for the works shall include the source of purchase, quantity and typical test report performed by the manufacturer shall also be submitted. No material shall be procured /ordered without prior approval of the Employer. The approval of the Employer for the material shall not relieve the contractor of his full responsibility for proper quality and performance of any material or any obligations thereto under the contract.

All materials covered under this section shall conform to the specifications as mentioned in this section or in section for material. In case where no specification is cited, Indian Standard and/ or equivalent International Standard specifications shall be applicable.

16.2 EXECUTION/SUPPLY OF MISC. WORKS

16.2.1 Water stop

Metal sealing Strips

Metal sealing strips shall be of 16 gauge thick copper or monel (trade name of copper nickel alloy). The properties of copper and Monel shall conform to the specifications mentioned in the table below unless otherwise approved by Employer.

Sl. No.	Property	Copper	Monel
1	Tensile Strength (Kg/ cm ²)	2194.09	4922.64
2	0.2% proof stress (Kg/ cm ²)	1125.18	1969.06
3	Elongation percent	55	35
4	Hardness B.H.N. (max.)	50	135
5	Fatigue limit (Kg/ cm ²)	689.17	2531.65
6	Corrosion fatigue limit in well water (Kg/ cm ²)	703.23	1476.79
7	Corrosion fatigue limit in saline water (Kg/ cm ²)	703.23	1969.06
8	Coefficient of thermal expansion (25 ⁰ -100 ⁰) cm/degree	16.6x10 ⁻⁶	13.6x10 ⁻⁶

Metal sealing strips shall be placed in joints in the structures as shown on the drawings and elsewhere as directed by Employer. The strips shall be jointed carefully together by brazing so as to form continuous water tight diaphragms in the joints. Adequate provision shall be made to support and protect the sealing strips during the progress of the work.

The sealing strips shall be properly embedded in green concrete of minimum thickness of 15cm on either face. While concreting, care shall be taken that coarse aggregate does not surround and damage the seal. Care shall also be taken to prevent U of the sealing strip from getting filled up with concrete or any other material which may restrict its functioning. Adequate provision shall be made to support and to protect the sealing strip during the progress of the work.

The contractor shall replace or repair to the satisfaction of the Employer any metal sealing strip punctured or damaged before final acceptance of the work.

Plastic Water stops

The plastic water stops shall be extruded from an elasto-metric plastic compound, the

basic resin of which shall be Polyvinyl Chloride (PVC). The characteristics of PVC stops shall conform to the specifications mentioned in Is 15058:2001 (PVC water stop at transverse contraction joints for use in masonry and concrete dams) unless otherwise approved by Employer.

Water stops should be stored in a suitable environment to avoid its damage due to adverse weather conditions. During installation, the exposed portion of water stops should also be protected against adverse weather conditions. The stops shall be jointed in straight reaches only by experienced trained personnel using a suitable device in consultation with the Employer and manufacturer.

The plastic water stop shall be 300 mm wide and 10mm thick as per specifications given in IS code- 15058:2002 with permissible tolerances on width (+_) 10mm and thickness (+) 2mm. The water stop shall be cut to proper lengths, vulcanized at bends and joints and properly fixed with the shuttering. The water stop shall be satisfactorily embedded in green concrete of minimum thickness of 15 cm. on either face. The vulcanizing shall be such as to form continuous water tight diaphragms in the joint. While concreting, care shall be taken that coarse aggregate does not surround and damage the water stop. Adequate provisions shall be made to support and protect the, water stop till it is embedded and also subsequently till the completion of work.

Measurement And payment

Measurement of water stops shall be made on the basis of linear length contained within the profile in the structures as per approved drawings. Payment shall be made on the basis of Unit rate tendered in the Financial proposal. The unit rate shall be inclusive of the cost of all materials, labour, supervision, fixing and all incidental works required to complete the work as per drawings and specifications.

16.2.2 Barbed wire fencing boundary

The residential and office complex at site shall be enclosed by providing barbed wire fencing boundary as shown in drawing or as directed by Employer. The post of steel

angle of IS 75x75x5 shall be provided at 3.0 m centre to centre distance. The height of the post above the ground shall be 1.5m. The post shall be embedded 200mm deep in concrete M10 pedestals of 250mmx250mmx250mm size casted in situ. The post shall be painted with paint as approved by Employer.

5 numbers hooks made of Ø 6mm steel bars shall be welded properly on each post 300mm apart leaving 50mm from the top. The barbed fence wire then shall be tied after stretching straight tightly with these hooks using thin steel wire. The barbed wire shall be of standard quality as approved by Employer.

The post on which door is supported shall be RCC (M 15) post of 300mm x 300mm size with sufficient size of foundation concrete block of size 600mm x 600mm x 600mm as per drawing. The gate shall be attached to RCC posts with cylindrical channels at hinges.

Measurement And payment

Measurements shall be made on the basis of linear length of the wire fencing as per approved drawings. Payment shall be made on the basis of Unit rate tendered in the Financial proposal. The unit rate shall be inclusive of the cost of all materials, labour, supervision, fixing and all incidental works required to complete the work as per drawings and specifications.

16.2.3 NP2 concrete pipes for irrigation outlets and drainage crossings

Reinforced concrete, light-duty, non pressure pipes of the sizes as shown in drawings shall be used for irrigation outlets and for construction of drainage crossings. The pipe shall be standard NP2 types as per specifications given in IS code 458:2003. The pipes shall be manufactured by spinning process or vibrated casting process. The reinforcement used for the manufacture of the pipes shall be hard drawn steel wire conforming to IS 432 (part-2). The concrete shall be as per IS 456 of compressive strength not less than 35N/mm^2 . The pipes shall be capable of withstanding a test pressure of 0.07 Mps (7 m head).

The pipes shall be straight and free from cracks except that craze cracks may be permitted. The ends of pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench, no opening between ends in contact shall exceed 3mm in pipes up-to 600mm diameter and 6mm in pipes larger than 600mm diameter. The outside and inside surface of the pipes shall be dense and hard and shall be coated with cement wash.

Outlet pipes

The internal diameter of the NP2 pipes for outlet shall be 100mm, 150mm or 200mm as per drawings and barrel wall shall be 25mm thick. The pipe shall be laid in the canal embankment with end of pipe embedded in the concrete block as per drawing. The collar shall be 25mm thick and 150mm long as per specifications given in IS code 458:2003 for NP2 pipes. The inner surface of the collar may be finished rough for better bond. The gap between pipe and collar shall be filled with cement mortar caulking.

Drainage crossing/ water courses crossing the chak roads

The internal diameter of the NP2 pipes for Drainage crossing shall be as per drawings and barrel wall shall be 70mm thick. The pipe shall be laid and embedded in the M15 concrete as per drawing. The pipes shall be jointed with collar joints. The collar shall be 50 to 60 mm thick and 200mm long as per specifications given in IS code 458:2003 for NP2 pipes. The inner surface of the collar may be finished rough for better bond. The gap between pipe and collar shall be filled with cement mortar caulking.

MEASUREMENT AND PAYMENT

Measurement and Payment for pipes shall be done on basis of linear length of the pipes and the unit rate tendered in the Financial proposal. The unit rate shall be inclusive of the cost of all materials, labour, tools, equipments, supervision required for laying the pipes in position and all incidental works required to complete the work.

16.3 GRASS TURFING

The outer earthen slopes of embankments are protected against rain water action by covering grass turfing. Top soil of about 15cm depth shall consists of fertile soil of loamy character and shall contain an amount of organic matters, which can generally expected in the vicinity of the site. The sods used shall be cut in rectangular shape 8 to 10 cm sections. Care shall be taken to retain the native soil on the roots of the sods during stripping, transporting and planting.

The sods shall be laid so that their edges are in close contact and then welded by being gently rammed till they form a level and compact mat. The area covered by sods shall be watered immediately after placing and in daily intervals for a period of not less than 4 weeks. The quantity of water shall be sufficient to keep the root of sods moist down to a depth of at least 6cm.

Sodded are shall be maintained and watered by the contractor until the date of issue of final certificate. When any portion of surface becomes gullied or otherwise damaged, the affected portion shall be repaired and reinstated to the satisfaction of the Employer.

MEASUREMENT AND PAYMENT

Measurement of sodding with top soil shall be made on the basis of area covered measured in M². Payment shall be made on the basis of Unit rate tendered in the Financial proposal. The unit rate shall be inclusive of the cost of all materials (including top soil), labour, tools, equipments, land preparation, watering, supervision and all incidental works required to complete the work.

SECTION - 17
MODEL RULES FOR THE PROTECTION OF
HEALTH AND SANITARY ARRANGEMENTS FOR WORKERS AND CONTRACTORS LABOUR
REGULATIONS

17.1 APPLICATION

These rules shall apply to all construction works in which twenty or more workers are ordinarily employed or are proposed to be employed in any day during the period during which the contract work is in progress.

17.2 DEFINITION

Work place means a place where twenty or more workers are ordinarily employed in connection with construction work on any day during the period during which the contract work is in progress.

17.3 FIRST-AID FACILITIES

- i) At every work place, there shall be provided and maintained, so as to be easily accessible during working hours, first-aid boxes at the rate of not less than one box for 150 contract labour or part thereof ordinarily employed.
- ii) The first-aid box shall be distinctly marked with a red cross on white back ground and shall contain the following equipment,
 - a) For work places in which the number of contract labour employed does not exceed 50 -

Each first-aid box shall contain the following equipment: -

- 1. 6 small sterilized dressings.
- 2. 3 medium size sterilized dressings.
- 3. 3 large size sterilized dressings.
- 4. 3 large sterilized bum dressings.
- 5. 1 (30 ml.) bottle containing a two per cent alcoholic solution iodine.
- 6. 1 (30 ml.) bottle containing salvolatile having the dose and mode of administration indicated on the label.
- 7. 1 snakebite lancet.

8. 1 (30 gms.) bottle of potassium permanganate crystals.
9. 1 pair scissors.
10. 1 copy of the first-aid leaflet issued by the Director General, Factory Advice Service and Labour Institutes, Government of India.
11. 1 bottle containing 100 tablets (each of 5 gms.) of aspirin.
12. Ointment for burns.
13. A bottle of suitable surgical antiseptic solution.

b) For Work places in which the number of contract labour exceed 50.

Each first-aid box shall contain the following equipment.

1. 12 small sterilized dressings.
2. 6 medium size sterilized dressings.
3. 6 large size sterilized dressings.
4. 6 large size sterilized burn dressings.
5. 6 (15gms.) packets sterilized cotton wool.
6. 1 (60 ml.) bottle containing a two percent alcoholic solution iodine.
7. 1 (60 ml.) bottle containing salvolatile having the dose and mode of administration indicated on the label.
8. 1 roll of adhesive plaster.
9. 1 snake bite lancet.
10. 1(30 gms.) bottle of potassium permanganate crystals.
11. 1 pair scissors.
12. 1 copy of the first-aid leaflet Issued by the Director General Factory Advice Service and Labour Institutes / Government India.
13. A bottle containing 100 tablets (each of 5 gms.) of aspirin.
14. Ointment for burns.
15. A bottle of suitable surgical antiseptic solution.

- iii) Adequate arrangements shall be made for immediate recoupment of the equipment, when necessary.
- iv) Nothing except the prescribed contents shall be kept in the First-aid box.
- v) The first-aid box shall be kept in charge of a responsible person who shall always be readily available during the working hours of the work place.
- vi) A person in charge of the First-aid box shall be a person trained in First-aid treatment, in the work places where the number of contract labour employed is 150 or more.
- vii) In work places where the number of contract labour employed is 500 or more and

hospital facilities are not available within easy distance from the works.

First-aid posts shall be established and run by a trained. The compounder shall be on duty and shall be available at all hours when the workers are at work.

- viii) Where work places are situated in places which are not towns or cities, a suitable motor transport shall be kept readily available to carry injured person or person suddenly taken ill to the nearest hospital.

17.4 DRINKING WATER

- i) In every work place, there shall be provided and maintained at suitable places, easily accessible to labour, a sufficient supply of cold water fit for drinking.
- ii) Where drinking water is obtained from an Intermittent public water supply, each work place shall be provided with storage where such drinking water shall be stored.
- iii) Every water supply or storage shall be at a distance of not less than 50 feet from any latrine drain or other source of pollution. Where water has to be drawn from an existing well which is within such proximity of latrine, drain or any other source of pollution, the well shall be properly chlorinated before water is drawn from it for drinking. All such wells shall be entirely closed in and be provided with a trap door which shall be dust and waterproof.
- iv) A reliable pump shall be fitted to each covered well, the trap door shall be kept locked and opened only for cleaning or inspection which shall be done at least once a month.

17.5 WASHING FACILITIES

- i) In every work place, adequate and suitable facilities for washing shall be provided and maintained for the use of contract labour employed therein.
- ii) Separate and adequate cleaning facilities shall be provided for the use of male and female workers.
- iii) Such facilities shall be conveniently accessible and shall be kept in clean and hygienic condition.

17.6 LATRINES AND URINALS

- i) Latrines shall be provided in every work place on the following scale namely: -
 - a) Where females are employed there shall be at least one latrine for every 25 females.
 - b) Where males are employed, there shall be at least one latrine for every 25 males.

Provided that where the number of males or females exceeds 100, it shall be sufficient if there is one latrine for 25 males or females as the case may be up to the first 100, and one

for every 50 thereafter.

- ii) Every latrine shall be under cover and so partitioned off as to secure privacy, and shall have a proper door and fastenings.
- iii) Construction of latrines: The inside walls shall be constructed of masonry or some suitable heat-resisting nonabsorbent materials and shall be cement cashed inside and outside/at least once a year. Latrines shall not be of a standard lower than borehole system.
- iv) a) Where workers of both sexes are employed, there shall be displayed outside each block of latrine and urinal, a notice in the language understood by the majority of the workers "For Men only" or "For Women Only" as the case may be.
b) The notice shall also bear the figure of a man or of a woman, as the case may be.
- v) There shall be at least one urinal for male workers upto 50 and one for female workers upto fifty employed at a time, provided that where the number of male or female workmen, as the case may be exceeding 500, it shall be sufficient if there is one urinal for every 50 males or females upto the first 500 and one for every 100 or part thereafter.
- vi) a) The latrines and urinals shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times.
b) Latrines *and* urinals other than those connected with a flush sewage system shall comply with the requirements of the Public Health Authorities.
- vii) Water shall be provided by means of tap or otherwise so as to be conveniently accessible in or near the latrines and urinals.
- viii) Disposal of excreta: - Unless otherwise arranged for by the local sanitary authority, arrangements for proper disposal of excreta by incineration at the work place shall be made by means of a suitable incinerator. Alternately excreta may be disposed of by putting a layer of night soil at the bottom of a pucca tank prepared for the purpose and covering it with a 15-cm. layer of waste or refuse and then covering it with a layer of earth for a fortnight (when it will turn to manure).
- (ix) The contractor shall at his own expense, carry out all instructions issued to him by the Engineer-in-Charge to effect disposal of night soil and other conservancy work in respect of the contractor's workmen or employees on the site. The contractor shall be responsible for payment of any charts which may be levied by Municipal or Cantonment Authority for execution of such on his behalf.

17.7 PROVISION OF SHELTER DURING REST

At every place there shall be provided, free of cost, four suitable sheds, two for meals and the other two for rest separately for the use of men *and* women labour. The height of each

shelter shall not be less than 3 metres (10 ft.) from the floor level to the lowest part of the roof. These shafts be kept clean and the space provided shall be on the basis of 0.6 sq.m. (6 sq ft) per head.

Provided that the Engineer-in-Charge may permit subject to his satisfaction, alternative accommodation to be used for the purpose.

17.8 CRECHES

- i) At every work place, at which 20 or more women workers are ordinarily employed, there shall be provided two rooms of reasonable dimensions for the use of their children under the age of six years. One room shall be used as a play room for the children and the other as their bedroom. The rooms shall be constructed with specifications as per clause 19H(ii)a, b & c.
- ii) The rooms shall be provided with suitable and sufficient openings for light and ventilation. There shall be adequate provision of sweepers to keep the places clean.
- iii) The contractor shall supply adequate number of toys and games in the play room and sufficient number of cots and beddings in the bed room.
- iv) The contractor shall provide one ayah to look after the children in the creche when the number of women workers does not exceed 50 and two when the number of women workers exceed 50.
- v) The use of the rooms earmarked as crèches shall be restricted to children, their attendants and mothers of the children.

17.9 CANTEENS

- i) In every work place where the work regarding the employment of contract labour is likely to continue for six months and where in contract labour numbering one hundred or more are ordinarily employed an adequate canteen shall be provided by the contractor for the use of such contract labour.
- ii) The canteen shall be maintained by the contractor in an efficient manner.
- iii) The canteen shall consist of at least a dining hall, kitchen, storeroom, pantry and washing places separately for workers and utensils.
- iv) The canteen shall be sufficiently lighted at all times when any person has access to it.
- v) The floor shall be made of smooth and impervious materials and inside walls shall be lime-washed or colour washed at least once in each year. Provided that the inside walls of tile kitchen shall be Semi-washed every four months.

- vi) The premises of the canteen shall be maintained in a clean and solitary condition.
- vii) Waste water shall be carried away in suitable covered *drains* and shall not be allowed to accumulate so as to cause a nuisance.
- viii) Suitable arrangements shall be made for the collection and disposal of garbage.
The dining hall shall accommodate at a time 30 per cent of the contract labour working at a time.
- ix) The floor area of the dining hall, excluding the area occupied by the service counter and any furniture except tables and chairs shall not be less than one square meter (10 sft) per diner to be accommodated as prescribed in sub-Rule 9.
- x) a) A portion of the dining hall and service counter shall be partitioned off and reserved for women workers in proportion to their number.
b) Washing places for women shall be separate and screened to secure privacy
- xii) Sufficient tables stools, chair or benches shall be available for the number of diners to be accommodated as prescribed in sub-Rule 9.
- xiii) a) 1. There shall be provided and maintained sufficient utensils crockery, furniture and any other equipment necessary for the efficient running of the canteen.
2. The furniture utensils and other equipment shall be maintained in a clean and hygienic condition.
b) 1. Suitable clean clothes for the employees serving in the canteen shall be provided and maintained.

2. A service counter, if provided, shall have top of smooth and impervious material.
3. Suitable facilities including an adequate supply of hot water shall be provided for the cleaning of utensils and equipment.
- xiv) The food stuffs and other items to be served in the canteen shall be in conformity with the normal habits of the contract labour.
- xv) The charges for food stuffs, beverages and any other items served in the canteen shall be based on 'No profit, No loss' and shall be conspicuously displayed in the canteen.
- xvi) In arriving at the price of foodstuffs, and other article served in the canteen, the following items shall not be taken into consideration as expenditure namely: -
 - a) The rent of land and building.
 - b) The depreciation and maintenance charges for the building and equipment provided for the canteen.
 - c) The cost of purchase, repairs and maintenance of equipment including furniture, crockery, cutlery and utensils.
 - d) The water charges and other charges incurred for lighting and ventilation.
 - e) The interest and amounts spent on the provision and maintenance of equipment provided for the canteen.

xvii) The accounts pertaining to the canteen shall be audited once every 12 months by registered accountants and auditors.

17.10 ANTI-MALARIAL PRECAUTIONS

The contractor shall at his own expense, conform to all anti-malarial instructions given to him by the Engineer-in-Charge including the Ming up of any borrow pits which may have been dug by him.

The above rules shall be incorporated in the contracts and in notices inviting tenders and shall form an integral part of the contracts.

17.11 AMENDMENTS

Government may, from time to time, add to or amend these rules and issue directions- it may consider necessary for the purpose of removing any difficulty which may arise in the administration thereof.

17.12 CONTRACTOR'S LABOUR REGULATIONS

17.12.1 DEFINITION

- i) Workman means any person employed by Department or its contractor directly or indirectly through a subcontractor with or without the knowledge of the Department to do any skilled, semiskilled or unskilled manual, supervisory, technical or clerical work for hire or reward, whether the terms of employment are expressed or implied but does not include any person: -
 - a) Who is employed mainly in a managerial or administrative capacity: or
 - b) Who, being employed in a supervisory capacity draws wages exceeding five hundred rupees per mensem or exercises either by the nature of the duties attached to the office or by reason of powers vested in him, functions mainly of managerial nature: or
 - c) Who is an out worker, that is to say, person to whom any article or materials are given out by or on behalf of the principal employers to be made up cleaned, washed, altered, ornamental finished, repaired adopted or otherwise processed for sale for the purpose of the trade or business of the principal employers and the process is to be carried out either in the home of the out worker or in some other premises, not being premises under the

control and management of the principal employer.

No person below the age of 14 years shall be employed to act as a workman.

- ii) **Fair Wages** means wages whether for time or piece work fixed and notified under the provisions of the Minimum Wages Act from time to time.
- iii) **Contractors** shall include every person who undertakes to produce a given result other than a mere supply of goods or articles of manufacture through contract labour or who supplies contract labour for any work and includes a subcontractor.
- iv) **Wages** shall have the same meaning as defined in the Payment of Wages Act.

17.12.2

- i) Normally working hours of an adult employee should not exceed 9 hours a day. The working day shall be so arranged that inclusive of interval for rest, if any, it shall not spread over more than 12 hours on any day.
- ii) When an adult worker is made to work for more than 9 hours on any day or for more than 48 hours in any week he shall be paid overtime for the extra hours put in by him at double the ordinary rate of wages.
- iii) a) Every worker shall be given a weekly holiday normally on a Sunday, in accordance with the provisions of the Minimum Wages (Central) Rules 1960 as amended from time to time irrespective of whether such worker is governed by the Minimum Wages Act or not.

B) Where the minimum wages prescribed by the Government under the Minimum Wages Act are not inclusive of the wages for the weekly day of rest, the worker shall be entitled to rest day wages at the rate applicable to the next preceding day, provided he has worked under the same contractor for a continuous period of not less than 6 days.

c) Where a contractor is permitted by the Engineer-in-Charge to allow a worker to work on a normal weekly holiday, he shall grant a substituted holiday to him for the whole day on one of the five days immediately before or after the normal weekly holiday and pay wages to such worker for the work performed on the normal weekly holiday at overtime rate.

17.12.3 DISPLAY OF NOTICE REGARDING WAGES ETC.

The contractor shall before he commences his work on contract, display and correctly maintain and continue to display and correctly maintain in a clear and legible condition in conspicuous places on the work, notices in English and in the local Indian languages spoken by the majority of the workers giving the minimum rates of wages fixed under Minimum Wages Act, the actual wages being paid, the hours of work for which such wage are earned, wages periods, dates of payments of wages and other relevant information.

17.12.4 PAYMENT OF WAGES

- i) The contractor shall fix wage periods in respect of which wages shall be payable.
- ii) No wage period shall exceed one month.
- iii) The wages of every person employed as contract labour in an establishment or by a contractor where less than one thousand such persons are employed shall be paid before the expiry of seventh day and in other cases before the expiry of tenth day after the last day of the wage period in respect of which the wages are payable.
- iv) Where the employment of any worker is terminated by or on behalf of the contractor the wages earned by him shall be paid before the expiry of the second working day from the date on which his employment is terminated.
- v) All payment of wages shall be made on a working day at the work premises and during the working time and on a date notified in advance and in case the work is completed before the expiry of the wage period, final payment shall be made within 48 hours of the last working day.
- vi) Wages due to every worker shall be paid to him direct or to other person authorized by him in this behalf.
- vii) All wages shall be paid in current coin or currency or in both.
- viii) Wages shall be paid without any deductions of any kind except those specified by the Central Government by general or special order in this behalf or permissible under the Payment of Wages Act 1956.
- ix) A notice showing the wages period and the place and time of disbursement of wages shall be displayed at the place of work and a copy sent by the contractor to the Engineer-in-Charge under acknowledgment.
- x) It shall be the duty of the contractor to ensure the disbursement of wages in the presence of the Junior Engineer or any other authorized representative to the Engineer-in-Charge who will be required to be present at the place and time to disbursement of wages by the contractor to workmen.
- xi) The contractor shall obtain from the Junior Engineer or any other authorized representative of the Engineer-in-Charge as the case may be, a certificate under his

signature at the end of the entries in the 'Register of Wages' or the "Wage-cum-Muster Roll" as the case may be in the following form :-

'Certified that the amount shown in column No..... has been paid to the workman concerned in my presence on at "

17.12.5 FINES AND DEDUCTIONS WHICH MAY BE MADE FROM WAGES

- (i) The wages of a worker shall be paid to him without any deduction of any kind except the following: -
 - (a) Fines
 - (b) Deductions for absence from duty i.e. from the place or the places where by the terms of his employment he is required to work. The amount of deduction shall be in proportion to the period for which he was absent.
 - (c) Deduction for damage to or loss of goods expressly entrusted to the employed person for custody, or for loss of money or any other deduction which he is required to account, where such damage or loss is directly attributable to his neglect or default.
 - (d) Deduction for recovery of advances or for adjustment of overpayment of wages, advances granted shall be entered in a register.
 - (e) Any other deduction which the Central Government may from time to time allow.
- (ii) No fines should be imposed on any worker save in respect of such acts and omissions on his part as have been approved of by the Chief Labour Commissioner.
- (iii) No fine shall be imposed on a worker and no deduction for damage or loss shall be made from his wages until the worker has been given an opportunity of showing cause against such fines or deductions.
- (iv) The total amount of fine which may be imposed in any one wage period on a worker shall not exceed an amount equal to three paise in a rupee of the total wages, payable to him in respect of that wage period.
- (v) No fine imposed on any worker shall be recovered from him by installment, or after the expiry of sixty days from the date on which it was imposed.
- (vi) Every fine shall be deemed to have been imposed on the day of the act or omission in respect of which it was imposed.

17.12.6 LABOUR RECORDS

- (i) The contractor shall maintain a **Register of persons employed** on work on contract in Form XIII of the CL (R&A) Central Rules 1971.
- (ii) The contractor shall maintain a **Muster Roll** register in respect of all workmen employed

by him on the work under Contract in Form XVI of the CL (R&A) Rules 1971.

- (iii) The contractor shall maintain a **Wage Register** in respect of all workmen employed by him on the work under contract in Form XVII of the CL (R&A) Rules 1971.
- (iv) **Register of accident** - The contractor shall maintain a register of accidents in such form as may be convenient at the work place but the same shall include the following particulars:
 - a) Full particulars of the labour who met with accident.
 - b) Rate of Wages.
 - c) Sex
 - d) Age
 - e) Nature of accident and cause of accident.
 - f) Time and date of accident.
 - g) Date and time when admitted in Hospital.
 - h) Date of discharge from the Hospital.
 - i) Period of treatment and result of treatment.
 - j) Percentage of loss of earning capacity and disability as assessed by Medical Officer..
 - k) Claim required to be paid under Workmen's Compensation Act.
 - l) Date of payment of compensation.
 - m) Amount paid with details of the person to whom the same was paid.
 - n) Authority by whom the compensation was assessed.
 - o) Remarks
- v) The contractor shall maintain a **Register of Fines** in Form XII of the CL (R&A) Rules 1971.

The contractor shall display in a good condition and in a conspicuous place of work the approved list of acts and omissions for which fines can be imposed.
- vi) The contractor shall maintain a **Register of deductions for damage or loss** in Form XX of the CL (R&A) Rules 1971.
- vii) The contractor shall maintain a **Register of Advance** in Form XXI of the CL (R&A) Rules 1971.
- viii) The Contractor shall maintain a **Register of Overtime** in Form XXIII of the CL (R&A) Rules 1971.

17.12.7 ATTENDANCE CARD-CUM-WAGE SUP

- i) The contractor shall issue an **Attendance card-cum-wage slip** to each workman employed by him in the specimen form.
- ii) The card shall be valid for each wage period.

- iii) The contractor shall mark the attendance of each workman on the card twice each day, once at the commencement of the day and again after the rest interval, before he actually starts work.
- vi) The card shall remain in possession of the worker during the wage period under reference.
- v) The contractor completes the wage slip portion on the reverse of the card at least a day prior the disbursement of wages in respect of the wage period under reference.
- vi) The contractor shall obtain the stature or thumb impression of the worker on the wage slip at the time of disbursement of wages and retain the card with himself.

17.12.8 EMPLOYMENT CARD

The contractor shall issue an **Employment Card** in Form XIV of the CL (R&A) Central Rules 1971 to each worker within three days of the employment of the worker.

17.12.9 Provisions of Employee Provident Fund and Miscellaneous Provisions Act, 1952:

The Contractor shall comply with provisions of Para 30 & 36-B of the Employees Provident Fund Scheme, 1952; Para 3 & 4 of the Employees' Pension Scheme, 1995; and Para 7 & 8 of Employees Deposit Linked Insurance Scheme, 1976; as modified from time to time through enactment of "Employees Provident Fund & Miscellaneous Provisions Act, 1952", wherever applicable and shall also indemnify the WAPCOS from against any claims under the aforesaid Act and the Rules.

17.12.10 SERVICE CERTIFICATE

On termination of employment for any reason whatsoever the contractor shall issue to the workman whose services have been terminated, a **Service certificate** in Form XV of the CL (R&A) Central Rules 1971.

17.12.11 PRESERVATION OF LABOUR RECORDS

All records required to be maintained under Regulations Nos. 6&7 shall be preserved in original for a period of three years from the date of last entries made in them and shall be made available for inspection by the Engineer-in-Charge or Labour Officer or any other officers authorized by the Ministry of Urban Development t) Ms behalf.

17.12.12 POWER OF LABOUR OFFICER TO MAKE INVESTIGATIONS OR ENQUIRY

The Labour Officer or any person authorized by Government on their behalf shall have

power to make enquires with a view to ascertaining and enforcing due and proper observance of Fair Wage Clauses and the Provisions of there Regulations. He shall investigate into any complaint regarding the default made by the contractor or subcontractor in regard to such provision.

17.12.13REPORT OF LABOUR OFFICER

The Labour Officer or other persons authorized as aforesaid shall submit a report of result of his Investigation or enquiry to the Engineer-in-Charge concerned indicating the extent, if any, to which the default has been committed with a note that necessary deductions from the contractor's bill be made and the wages and other dues be paid to the labourers concerned. In case an appeal is made by the contractor under Clause 13 of these regulations, actual payment to labourers will be made by the Engineer-in-Charge after the concerned senior authority has given his decision on such appeal.

The Engineer-in-Charge shall arrange payments to the labour concerned within 45 days from the receipt of the report form the Labour Officer or the concerned senior authority as the case may be.

17.12.14APPEAL AGAINST THE DECISION OF LABOUR OFFICER

Any person aggrieved by the decision and recommendations of the Labour Officer or other person so authorized may appeal against such decision to the concerned senior authority concerned within 30 days from the date of decision, forwarding simultaneously a copy of his appeal to the Engineer-in-Charge concerned but subject to such appeal, the decision of the officer shall be final and binding upon the contractor.

17.12.15PROHIBITION REGARDING REPRESENTATION THROUGH LAWYER

- i) A workman shall be entitled to be represented in any investigation or enquiry under these regulations by: -
 - a) An officer of a registered trade union of which he is a member.
 - b) An officer of a federation of trade unions to which the trade union referred to in clause (a) is affiliated.
 - c) Where the employer is not a member of any registered trade union, by an officer of a registered trade union, connected with the industry in which the worker in employed or by any other workman employed in the industry in which the worker is employed.

ii) An employer shall be entitled to be represented in any investigation or enquiry under these regulations by: -

- a) An officer of an association of employers of which he is a member.
- b) An officer of a federation of associations of employers to which association referred to in clause (a) is affiliated.
- c) Where the employers are not a member of any association of employers, by an officer of association of employer connected with the industry in which the employer is engaged or by any other employer, engaged in the industry in which the employer is engaged.

(iii) No party shall be entitled to be represented by a legal practitioner in any investigation or enquiry under these regulations.

17.12.16 INSPECTION OF BOOKS AND SLIPS

The contractor shall allow inspection of all the preserved labour records to any of his workers or to his agent at a convenient time and place after due notice is received or to the Labour Officer or any other person, authorized by the Government on his behalf.

17.12.17 SUBMISSIONS OF RETURNS

The contractor shall submit periodical returns as may be specified from time to time.

17.12.18 AMENDMENTS

The Government may from time to time add to or amend the regulations and on any question as to the application / interpretation or effect of those regulations the decision of the Engineer-in-Charge concerned shall be final.

SECTION – 18

HYDRO-MECHANICAL WORKS (GATES)

1.1	INTENT OF TECHNICAL SPECIFICATIONS AND SCOPE OF WORK
1.1.1	General
	i) These Specifications are part of the requirements for various items related to the work which are to be provided according to the stipulations of the contract. Hence, the instructions given herein form an integral part of, and are applicable to the Bidding Documents issued for the works. Addenda to these Specifications may be issued, as required, during bidding and construction phases.
	ii) These Specifications shall be read in conjunction with the Conditions of Contract if any and the Contractor shall comply with all provisions contained within the Bidding Documents and instructions of the Engineer Incharge.
	iii) Certain performance requirements, materials, features and design requirements are specified herein. It is not the intention in these specifications to specify in complete detail the various components of the equipment. This is left to the experience and practice of Contractor who shall furnish equipment which shall meet, in all respects, the specified requirements in regard to performance, durability and satisfactory operation. However, certain features, materials and design requirements are specified and are intended to establish minimum standards for the work & to enable the bidder to submit a well planned bid.
	iv) It is the intent of these Specifications to establish acceptable standards of quality. Deviations from these specifications shall be considered for acceptance provided that, in the opinion of the Employer / Owner, the proposed substitutions are equal or superior in quality to those specified.
	v) All works shall be executed according to the Technical Specifications and requirements issued for construction, in a professional and diligent manner and all supplies and works shall comply with the quality requirements defined in the relevant Section of these Specifications and other Bidding

	Documents. The Contractor shall endeavor to provide all such necessary efforts in order to comply with the intent of these Specifications to the satisfaction of the Employer / Owner.
1.1.2	Notes:
	The bidder shall visit and carefully examine the site of the work and the adjoining premises and shall conduct necessary investigations to acquaint himself thoroughly with the facilities for handling the specified equipment at the site. A thorough investigation shall be made of potential interferences and difficulties that may be encountered in the proper and complete execution of the work specified. No plea of ignorance of existing or unforeseen conditions, that create difficulties or encumbrances in the execution of the work, will be accepted as an excuse for any failure on the part of the Contractor to fulfill in every detail the requirements of the Contract Documents. Furthermore, a plea of ignorance will not be accepted as a basis for any claim whatsoever for.
1.1.3	Design, Drawings and Other Data to be Furnished by the Bidders in the Technical Bid
	It is required that the bidders shall carefully study the Technical Specifications and shall intimate the purchaser in case any error / omission is discovered. As a result of such interaction, if some corrections / modifications are required, the same shall be brought to the notice of all the bidders by the Client before the date of submission of the bids.
	While submitting the bid, each bidder shall append the following technical information / drawings, strictly In the order given :
	i) Basic design, estimated, 2 nd stage embedment's, Gate, hoist supporting structure, hoist capacity calculations and general arrangement drawings for each of the equipment covered under the scope of the work.
	ii) Technical particulars of the equipment and other relevant data which shall also include type, size, make and ratings of various bought out items proposed to be used including material specification for all important components.
	iii) Table listing out material specification for other important components.
	iv) Gate wise schedule covering submission of design calculations, drawings, fabrication, erection, testing and commission for each set of the Gates and

	Hoists and associated equipments covered in the scope of the work to match the completion period of the contract.
	v) Deviation from technical specifications or general arrangement of the equipment / components, if any.(Cost not be indicated in the technical bid)
	vi) In case the bidder proposes to make major changes in the design/ arrangement of the equipment to be furnished under the specifications, then he shall also submit with his bid documents, the drawings and the design calculations of his alternate arrangements / proposals. The drawings shall be complete and give all proposed changes in details. Acceptance of alternate arrangements / proposals of the bidder shall not be binding on the part of purchaser.
	vii) Erection methodology including dry and wet testing of the equipment giving minimum time period of each activity.
	viii) List of erection equipment including material handling machines/cranes available with the bidder and proposed for erection at site along with their capacities, make, year of manufacture and personnel etc.
	ix) Details of the portion of the work falling in the scope of supply which is being proposed to be sublet together with list of the sub Contractors to whom these portions of work are proposed to be sublet.
	x) Quality assurance plans both at the stage of manufacture and erection, testing and commissioning for finalization before the award of contract.
1.1.4	Details of Design, Drawings And Other Data /Documents To Be Submitted By Contractor After The Award Of Contract At Various Stages Of Contract Operation.
a)	Design calculations for all components and parts in accordance with design criteria & specifications to prove their adequacy supported by catalogues / technical literature of all bought out components with selection criteria & characteristics.
b)	General assembly and sub-assembly arrangement and detailed dimensions of the parts of the equipment to be supplied under the contract.
c)	Block out drawings, dimensions, locations of anchors and concrete outlines:

	Material list covering specifications, sizes, quantities, weight of each component from which the various parts will be made and their finishes of machine surfaces, weld details, welding rod specifications and inspection methods.
d)	Machinery imposed loads on concrete structure, location of anchors, grout pockets and checks in structures constructed by others shall be provided within 90 days of award of Contract.
e)	All handling attachments for site assembly, painting system including cleaning & application procedures, primary and final coats.
f)	The Contractor shall be required to submit quality assurance documents within four weeks after dispatch of the equipment.
g)	For guidance during the installation of the work and subsequently for guidance of the plant operating and maintenance staff, Contractor shall prepare and submit Installation, operation & maintenance manuals
h)	Any other documents specified elsewhere in the Technical Specifications or as desired otherwise by the Engineer-in-Charge which are not mentioned /specified but otherwise are necessary for execution of the work.
1.1.5	Submittals
	i) The Contractor shall provide to the Engineer-in-Charge at least four copies or as otherwise specified, of all submittals as requested for in these Specifications and other Bidding Documents. Although their extent shall be to the discretion of the Contractor, they shall be complete enough to illustrate adequately the problem of the aspect concerned for the understanding of the Employer / Owner. The drawings shall be at least in A -1 size.
	ii) At any time, the Engineer-in-Charge may call either for additional information, completion of the submittals or request the Contractor not to submit some of them.
	iii) The Contractor shall submit these documents to the Employer / Owner so that, even if not specifically expressed, reasonable time will be given to the Engineer-in-Charge to comment or approve the submittals.
	iv) All drawings shall be carefully checked by the Contractor for

	accuracy, completeness and clarity before submission to Employer / Owner for review. Contractor shall be responsible for correctness and adequacy of the design in relationship to the specifications.
	v) Approval by the Purchaser for the Contractors design and drawings shall not be held to relieve the Contractor for any part of the Contractor's obligation to meet all the requirements of the specifications or of the responsibility for the correctness of the Contractor's drawing and designs.
	vi) The requirements of any such alterations requested by Employer / Owner shall not be construed to mean that the drawings have been checked in detail, shall not be accepted as justification for an extension of time and shall not relieve manufactures from responsibility for the adequacy of the designs and correctness of the drawings.
	vii) The design of all equipment shall be such that installation, replacements and general maintenance may be undertaken with the minimum time and expense.
	viii) The following items shall broadly be covered in the drawings to be submitted by the Contractor for approval. It is essential that independent drawings are drawn as per the best drawing practice. The no. of drawings indicated against each item may increase or decrease as per the requirement of the work to completely illustrate the construction details of various parts and components of gates and hoists to enable the purchaser to check /scrutinize the same. Congestion of various views in the drawings should be strictly avoided. There should be reasonable free space for writing observation, approvals etc.
1.1.6	Schedule And Progress
	Within 15(Fifteen) calendar days after the receipt of approval of drawings, the Contractor shall submit to the purchaser for his approval the schedule of fabrication and transportation of the equipment so as to ensure its delivery within the specified period. The schedule shall clearly state all the stages of fabrication to enable the purchaser to plan his inspection accordingly as stated in these specifications. The Contractor shall also (during the course of fabrication) submit a weekly and monthly progress report along with

	photographs of fabrications done to the purchaser, apprising him of the progress of equipment for the preceding fortnight. From time to time during manufacture and installation, manufacturer shall photograph the equipment to depict the actual progress by supplying minimum 3 views per location per fortnight. The size of the print shall not be less than 18 cm × 24 cm.
	i) The schedule of completion of works as stipulated in the bid document shall be deemed to be the essence of the contract. However, certain alteration can be suggested by the bidder keeping in view of the programme of the erection, front availability and the completion date. The Contractor shall submit along with his bid a detailed programmer based on the dates indicated in the bid document or alternatively his own time schedule giving shorter delivery / erection period taking into consideration of the gate by which the erection front can be made available to him. The schedule will be in the form of a detailed PERT network within the time frame agreed above consisting of adequate number of activities covering various key phases of the works such as designs, drawings, procurement, manufacturing, shop assembly (gate wise) sand blasting and painting, shipment, field erection and testing activities. This network shall also indicate the interface facilities to be provided by the purchaser if any and the dates by which such facilities are needed. It shall also indicate the details of resources like manpower/machinery envisaged in the part and to be mobilized by the Contractor for all stages of erection.
	ii) The Contractor shall so organize his resources and perform his work as to complete it not later than the date agreed to by him. The time for completion of the works contracted for, shall be reckoned from the date of issue of the letter of award by the purchaser. During the performance of the contract, if in the opinion of the Engineer-in-charge, proper progress is not maintained suitable changes shall be made in the Contractor's operation to ensure proper progress.
1.1.7	Spares
	Wherever possible, all similar parts shall be made to gauge and shall be made interchangeable so as to enable substitution or replacement from spare parts to

	be easily and quickly made in case of wear or other failure. In particular, all bearings, bushing, sleeves, pins, sheaves, seals etc. shall where practicable, be made interchangeable. The spares have been classified into two categories as given below :
1.1.7.1	Mandatory Spares
	Certain spares have been identified by the purchaser as essential for the operation & maintenance of the equipment for a period of five years from the date of commissioning of the project. The bidder shall quote the prices of these spares in the sub price schedule for mandatory spares. The component wise requirement of mandatory spares required for different gates, hoists & associated equipment has been appended with of bid documents.
1.1.7.2	Additional Spares
	In addition to the mandatory spares, the Contractor shall also submit a list of spares which he feels shall be required for proper operation / maintenance of the equipment for a period of five years from the date of commissioning of the project. The cost of these additional spares may be given in a separate schedule. The cost of these additional spares shall not be considered for evaluation of this bid. The items and quantity of the additional items to be purchased shall be entirely at the discretion of the purchaser and the Contractor shall not be entitled for any variation in rates on this account.
	Note: The list of mandatory Spares indicated in the Price Schedule is tentative only, however, the Contractor shall also supply the complete list of such spares (mandatory and additional spares as specified above) which should be sufficient for the satisfactory operation of the gates, hoists and their associated equipments at least for a period of 5 Years from the date of commissioning of the project.
1.1.8	Responsibilities Of Contractor
	The Contractor shall be responsible for :
	a) The quality of materials and workmanship in all the item of work
	b) Strict adherence to the dimensions of parts shown on approved drawings unless deviations are specifically authorized in writing by the engineer or

	purchaser.
	c) Strength of all parts of gates, hoists and associated equipment when operated under the worst conditions of load and under conditions of closure during periods of maximum flow discharge as applicable.
	d) It is Contractor's responsibility to ensure that all components supplied in accordance with these specifications shall fit correctly to each other. In the event of any field modifications being required due to errors in shop fabrication, Contractor shall bear the full cost of such modifications. Any such changes shall be shown on the drawings and accepted in writing by Employer / Owner, before being made by Contractor.
	e) Satisfactory performance of the entire work under all operating conditions without signs of undue strain, and without damage, breakdown or deterioration of any of the parts due to faulty or incorrect or unsuitable material, workmanship or design.
	f) The operation of gate and hoist shall be free from vibrations of any part or parts under the most severe operating conditions
	g) The gate shall be leak proof with in the permissible leakage as per I S code
	h) The strength, accuracy and adequacy in all respects.
	The contract documents and specifications do not specify in complete detail the various components of the equipments. The Contractor shall supply and erect all equipments in a complete shape, which will meet the requirements regarding performance, durability and satisfactory operation.
	The principal parts of the equipment are mentioned in these specifications which outline the general features to be adopted in design. Any deviations from the specified requirements shall be done only with the approval of the purchaser.
1.1.9	Standards And Codes
	a) General
	i) All Works & supplies shall conform to the Indian Standards. Authoritative Standards and Codes other than IS or those specified in the Bidding Documents, which ensure an equal or higher quality, may also be

	acceptable.
	ii) All standards and codes referred to shall be the latest current issues.
	iii) In case of discrepancies between these Specifications and National or international Standards and codes, these Specifications being part of Bidding Documents shall govern, unless otherwise directed by the Engineer-in-Charge in each particular case.
	b) National Standards, Codes, Laws and Regulations
	i) Throughout the duration of the Contract, the materials, equipment, services, design and workmanship shall conform to the applicable national codes, standards, laws and regulations in force in India, if not otherwise specified.
	ii) It is the Contractor's duty to acquaint him self with all national codes, standards, laws and regulations related to the Works in any way and he shall procure and keep at his works on the Site a copy of each of such applicable documents.
	c) International Standards and Codes
	i) The International Standards / codes may be adopted provided that :
	The Standards / codes proposed are at least as stringent as the equivalent national ones relevant to the works, or if there is no applicable national Standard / code for the specific item concerned.
	The Contractor shall state, prior to starting the works, the international standard / code he proposes to apply, giving full identification of each of them. These proposals are subject to the approval by the Employer / Owner.
	ii) Where reference is made in the Bidding Documents to the Standards / codes of the country of origin for a supply item, it shall be a recognized national Standard / code of the country where the specific supply item is manufactured. To be acceptable under these Specifications, such Standards / codes must comply in all respects with the quality requirements of above mentioned international Standards / codes and must be approved by the Employer / Owner.

1.1.10	System of Units
	The metric/SI system of units has been used throughout these specifications and this system of units shall be used consequently throughout the duration of Contract for all technical or contractual purposes.
1.1.11	Wastage of Steel Sections
	The wastage of steel sections, received from main producers, shall not be compensated to the Contractor under price variation clause. The price variation will be reimbursed for the net weight of the gate, hoist components based on the sectional unit weight as per the table of standard sections (supplied by SAIL) and used in the gates. The weight of nuts, bolts, rivets, welding, etc. will not be considered in the net weight of gate. All the wastage of steel sections supplied by the main producer will be at Contractor's account and the Contractor should consider this aspect in his bid.

1.1.12 DESIGN AND DESCRIPTION		
1.1.12.1	Construction sluice gate with spillway gantry crane	
	Construction Sluice Gates (2.5m x 3.0m – w x h)	
	Two number fixed wheel gates have been proposed at the construction sluices. Each gate shall be operated by a spillway gantry crane of 45T (Tentative) which is also used for an operation of emergency gate for maintenance of Low level sluice gate and Irrigation sluice gate and intake maintenance gate. A separate lifting beam is attached with the gantry crane for operation of above said gate. Gantry crane shall be installed on the top of deck at EL 372.00m. The gate leaf is designed as vertical lift roller gate. Gate element is fitted with 4 rollers working on self aligned spherical roller bearing mounted on stainless steel pin. The roller pin is made with eccentricity of 5mm for fine adjustment at later stage if required. The U/S skin plate is fitted with Bulb type of rubber seals for sides & top and Flat type of rubber seals for bottom for water tightness. The design requirements for the gate and hoist are broadly appended below :	
	i) Type of Gate	Fixed Wheel Type
	ii) Sill level	EL. 305.50 m

	iii) Design head (Against EL. 332.00)	28.00m
	iv) FRL	EL. 341.00 m
	v) Max. Water Level	EL. 355.00 m
	vi) Deck Level	EL. 372.00 m
	vii) C/C of side seal	2700 mm
	viii) C/C of track	3000 mm
	ix) Design loading conditions : Gate will be designed for FRL conditions and check for MWL conditions	
	x) Operation : Lowering : Closing under flowing water conditions	
	xi) Operating loading conditions: Gate will be lowered under unbalanced head conditions with the help of a spillway gantry crane.	
	xii) Type of Wheel Assembly: Wheel with spherical roller bearing mounted on pin. The wheels shall have line contact with track. The Wheel assembly should be designed at folding arrangement along with the end vertical girder plate for the purpose of their repair/replacement in case of defects occurred during operation of the gates.	
	xiii) Minimum thickness of skin plate.	12 mm
	xiv) Minimum thickness of stainless steel track plate. (after machining).	10 mm
	xv) Minimum thickness of stainless steel seal seats. (after machining)	10mm
	xvi) Type of seals : The seals shall be Teflon clad rubber seals (moulded as per para 6.1 of IS:15466) for sides & Top and wedge type rubber seals for bottom. Sealing arrangement shall conform to IS: 11855. The seals shall be fixed to the gates by means of either counter sunk screws or bolts & nuts, Screws/ bolts shall be designed to withstand the full shear likely to develop during raising or lowering cycle of the gate under maximum hydrostatic head between the seals and seal seat plates due to frictional forces. In case the screws are used for fixing the seals, these shall be tightened for designated torque with torque wrench, and locked by punch mark. Minimum threaded length equivalent to 1.50 times the diameter of screws shall be provided. The seal interference of side seals as well as the compression of	

	bottom seal shall be 6.0 mm. Suitable chamfer at the bottom of skin plate and clamp plates to accommodate the compression of bottom wedge seals. Co-efficient of friction between Teflon and steel (machined stainless steel) should be adopted considering the wear of Teflon as 1.5.	
	xvii) Numbers required – No. of opening (s) – No. of gate (s) – Sets of 2 nd stage embedded parts.	2 (Two) 2 (Two) 2 (Two)
	xviii) Governing Indian Standard	IS : 4622 (Latest Edition)
	xix) Permissible mono-axial stresses in structural components for gate and embedded parts shall be in accordance with Annex-B of IS : 4622 (latest Edition). The gate shall be designed for wet and inaccessible conditions and embedded parts shall be designed for wet and inaccessible condition. In case of normal loading, the hydrodynamic loading due to earthquake shall be combined. The allowable stress in loading combined with earthquake shall be limited to 80% of yield point.	
	xx) Permissible deflection of gate.	– Span (C/C of wheel) /800
	xix) Permissible bearing and shearing stress in concrete	As per IS : 456 (Latest Edition)
	xxi) Grades of concrete to be used	– Second stage concrete M-25
	xxii) Lubrication arrangement	Through non-return grease nipple
	xxiii) Material for fabrication	As per relevant IS
1.1.12.2	Low Level Sluice Gates Equipment and Hydraulic Hoist with bonnet cover	
	Low Level Sluice Gates (2.0m x 3.0m – w x h)	
	Two number fixed wheel gates, suitable for a clear vent opening of size 2000mm × 3000 mm (w × h) have been proposed at the Low Level sluices. These gates are shall be of regulating type and the double acting hydraulic hoist shall be designed for this. Each gate shall be operated by an independent hydraulic hoist, which shall be installed in the gate operation chamber at EL. 332.50m. The gate leaf is designed as vertical lift roller gate. Gate element is fitted with 4 rollers working on self aligned spherical roller bearing mounted on stainless steel axle. The axle is made with	

	eccentricity of 5mm for fine adjustment at later date if required. The U/S skin plate is fitted with Bulb type of moulded rubber seals for sides & top, flat type of rubber seals for bottom for water tightness. The gate is being operated with double acting type hydraulic hoist of 50T (Tentative) capacity. The design requirements for the gate and hoist are broadly appended below :	
	i) Type of Gate	Fixed Wheel Type
	ii) Clear width of opening	2000mm
	iii) Clear height of opening	3000mm
	iv) C/C of seal	2200 mm
	v) C/C of tracks	2500 mm
	vi) Sill elevation	EL. 318.00 m
	vii) FRL	EL. 341.00 m
	viii) Max. Water Level	EL. 355.00 m
	ix) Deck Level	EL. 372.00 m
	x) Design loading conditions: Gate will be designed Head against MWL.	
	xi) Operation: Lowering : Closing under flowing water conditions Raising: Opening under unbalanced head conditions.	
	xii) Operating loading conditions : Gate will be operated under unbalanced head conditions with the help of double acting type hydraulic hoist.	
	xiii) Type of Wheel Assembly: Wheel with spherical roller bearing mounted on pin. The wheels shall have line contact with track. The Wheel assembly should be designed at folding arrangement along with the end vertical girder plate for the purpose of their repair/replacement in case of defects occurred during operation of the gates.	
	xiv) Minimum thickness of skin plate.	12 mm
	xv) Minimum thickness of stainless steel tack plate. (after machining).	10 mm
	xvi) Minimum thickness of stainless steel seal seats. (after machining)	10mm
	xvii) Type of seals : The seals shall be fluorocarbon clad rubber seals (moulded as per para 6.1 of IS:15466) for sides & top and wedge type rubber seals for bottom. Sealing arrangement shall conform to IS: 11855. The seals shall be fixed to the gates by means of either counter sunk screws or bolts & nuts, Screws/ bolts shall be	

	designed to withstand the full shear likely to develop during raising or lowering cycle of the gate under maximum hydrostatic head between the seals and seal seat plates due to frictional forces. In case the screws are used for fixing the seals, these shall be tightened for designated torque with torque wrench, and locked by punch mark. Minimum threaded length equivalent to 1.50 times the diameter of screws shall be provided. The seal interference of side seals as well as the compression of bottom seal shall be 3.0 mm. Suitable chamfer at the bottom of skin plate and clamp plates to accommodate the compression of bottom wedge seals. Co-efficient of friction between Teflon and steel (machined stainless steel) should be adopted considering the wear of Teflon as 1.5.	
	xviii) Numbers required – No. of opening (s) – No. of gate (s) – Sets of embedded parts.	2 (Two) 2 (Two) 2 (Two)
	xix) Governing Indian Standard	IS : 4622 (Latest Edition)
	xx) Permissible mono-axial stresses in structural components for gate and embedded parts shall be in accordance with Annex-B of IS : 4622 (latest Edition). The gate shall be designed for wet and inaccessible conditions and embedded parts shall be designed for wet and inaccessible condition. In case of normal loading, the hydrodynamic loading due to earthquake shall be combined. The allowable stress in loading combined with earthquake shall be limited to 80% of yield point.	
	xxi) Permissible deflection of gate.	Span (C/C of wheel) /800
	xxii) Permissible bearing and shearing stress in concrete	As per IS : 456 (Latest Edition)
	xxiii) Grades of concrete to be used	First stage concrete M-20 Second stage concrete M-25
	xxiv) Lubrication arrangement	Through non-return grease nipple
	xxv) Material for fabrication	As per relevant IS
1.1.12.3	Irrigation Sluice Gates Equipment and Hydraulic Hoist	
	Irrigation Sluice Gates (2.0m x 3.0m – w x h)	

	Four number fixed wheel gates, suitable for a clear vent opening of size 2000mm × 3000 mm (w × h) have been proposed at the irrigation sluices. These gates are shall be of regulating type and the double acting hydraulic hoist shall be designed for this. Each gate shall be operated by an independent hydraulic hoist, which shall be installed in the Gate Operating Channel at EL 339.50 m. The gate leaf is designed as vertical lift roller gate. Gate element is fitted with 4 rollers working on self aligned spherical roller bearing mounted on stainless steel axle. The axle is made with eccentricity of 5mm for fine adjustment at later date if required. The U/S skin plate is fitted with Bulb type of moulded rubber seals for sides, flat type of rubber seals for bottom for water tightness. The gate is being operated with double acting type hydraulic hoist of 35 T (Tentative) capacity. The design requirements for the gate and hoist are broadly appended below :	
	i) Type of Gate	Fixed Wheel Type
	ii) Clear width of opening	2000mm
	iii) Clear height of opening	3000mm
	iv) C/C of seal	2200 mm
	v) C/C of tracks	2500 mm
	vi) Sill elevation	EL. 332.00 m
	vii) FRL	EL. 341.00 m
	viii) MWL	EL. 355.00 m
	ix) Deck Level	EL. 372.00 m
	x) Design loading conditions ; Gate will be designed for head against MWL.	
	xi) Operation: Lowering : Closing under flowing water conditions Raising: Opening under unbalanced head conditions.	
	xii) Operating loading conditions : Gate will be operated under unbalanced head conditions with the help of double acting type hydraulic hoist.	
	xiii) Type of Wheel Assembly ; Wheel with spherical roller bearing mounted on pin. The wheels shall have line contact with track. The Wheel assembly should be designed at folding arrangement along with the end vertical girder plate for the purpose of their repair/replacement in case of defects occurred during operation of the gates.	

	xiv) Minimum thickness of skin plate.	12 mm
	xv) Minimum thickness of stainless steel tack plate. (after machining).	10 mm
	xvi) Minimum thickness of stainless steel seal seats. (after machining)	10mm
	xvii) Type of seals ; The seals shall be fluorocarbon clad rubber seals (moulded as per Para 6.1 of IS:15466) for sides & top and wedge type rubber seals for bottom. Sealing arrangement shall conform to IS: 11855. The seals shall be fixed to the gates by means of either counter sunk screws or bolts & nuts, Screws/ bolts shall be designed to withstand the full shear likely to develop during raising or lowering cycle of the gate under maximum hydrostatic head between the seals and seal seat plates due to frictional forces. In case the screws are used for fixing the seals, these shall be tightened for designated torque with torque wrench, and locked by punch mark. Minimum threaded length equivalent to 1.50 times the diameter of screws shall be provided. The seal interference of side seals as well as the compression of bottom seal shall be 6.0 mm. Suitable chamfer at the bottom of skin plate and clamp plates to accommodate the compression of bottom wedge seals. Co- efficient of friction between Teflon and steel (machined stainless steel) should be adopted considering the wear of Teflon as 1.5.	
	xviii) Numbers required – No. of opening (s) – No. of gate (s) – Sets of embedded parts.	4 (Four) 4 (Four) 4 (Four)
	xix) Governing Indian Standard	IS : 4622 (Latest Edition)
	xx) Permissible mono-axial stresses in structural components for gate and embedded parts shall be in accordance with Annex-B of IS : 4622 (latest Edition). The gate shall be designed for wet and inaccessible conditions and embedded parts shall be designed for wet and inaccessible condition. In case of normal loading, the hydrodynamic loading due to earthquake shall be combined. The allowable stress in loading combined with earthquake shall be limited to 80% of yield point.	
	xxi) Permissible deflection of gate.	Span (C/C of wheel) /800

	xxii) Permissible bearing and shearing stress in concrete	As per IS : 456 (Latest Edition)
	xxiii) Grades of concrete to be used	Second stage concrete M-25
	xxiv) Lubrication arrangement	Through non-return grease nipple
	xxv) Material for fabrication	As per relevant IS
1.1.12.4	Emergency Gates Equipment for Irrigation & Low Level Sluices with Spillway Gantry Crane	
	Emergency Gate (3.32 x 5.0m – w x h)	
	One number slide type gate, suitable for a clear vent opening of size 3320mm × 5000 mm (w × h) has been proposed at the face of dam for the maintenance of Irrigation sluice gate and Low level sluice gate. The gate shall be operated by a spillway gantry crane of 45 T (Tentative) capacity with hoist mounted on a cross travel trolley through a lifting Beam, which is also used for an operation of construction sluice gate and intake maintenance/bulkhead gate. Gantry crane shall be installed on the top of the structure at deck level EL.672.00m. The gate leaf is designed as vertical lift slide gate. The D/S skin plate is fitted with Bulb type of moulded rubber seals for sides, flat type of rubber seals for bottom for water tightness. The design requirements for the gate and gantry crane are broadly appended below :	
	i) Type of Gate	Slide Type
	ii) Clear width of opening	3320mm
	iii) Clear height of opening	5000mm
	iv) C/C of seal	3470 mm
	v) C/C of tracks	4070 mm
	vi) Sill elevation	EL. 318.00 m & EL. 332.00 m
	vii) FRL	EL. 341.00 m
	viii) MWL	EL. 355.00 m
	ix) Deck Level	EL. 372.00 m
	x) Design loading conditions ; Gate will be designed for head against MWL.	
	xi) Operation: Lowering : Closing under flowing water conditions Raising: Opening under balanced head conditions.	
	xii) Operating loading conditions: Gate will be operated under balanced head	

	conditions with the help of filling valve and gantry crane with lifting beam.	
	xiii) Minimum thickness of skin plate.	12 mm
	xiv) Minimum thickness of stainless steel tack plate. (after machining).	10 mm
	xv) Minimum thickness of stainless steel seal seats. (after machining)	10mm
	Type of seals ; The seals shall be fluorocarbon clad rubber seals (moulded as per Para 6.1 of IS:15466) for sides & top and wedge type rubber seals for bottom. Sealing arrangement shall conform to IS: 11855. The seals shall be fixed to the gates by means of either counter sunk screws or bolts & nuts, Screws/ bolts shall be designed to withstand the full shear likely to develop during raising or lowering cycle of the gate under maximum hydrostatic head between the seals and seal seat plates due to frictional forces. In case the screws are used for fixing the seals, these shall be tightened for designated torque with torque wrench, and locked by punch mark. Minimum threaded length equivalent to 1.50 times the diameter of screws shall be provided. The seal interference of side seals as well as the compression of bottom seal shall be 6.0 mm. Suitable chamfer at the bottom of skin plate and clamp plates to accommodate the compression of bottom wedge seals. Co- efficient of friction between Teflon and steel (machined stainless steel) should be adopted considering the wear of Teflon as 1.5.	
	xvi) Numbers required – No. of opening (s) – No. of gate (s) – Sets of embedded parts.	6 (Six) 1 (One) 6 (Six)
	xvii) Governing Indian Standard	IS : 5620 (Latest Edition)
	Permissible mono-axial stresses in structural components for gate and embedded parts shall be in accordance with Annex-B of IS : 5620 (latest Edition). The gate shall be designed for wet and inaccessible conditions and embedded parts shall be designed for wet and inaccessible condition. In case of normal loading, the hydrodynamic loading due to earthquake shall be combined. The allowable stress in loading combined with earthquake shall be limited to 80% of yield point.	

	xviii) Permissible deflection of gate.	Span (C/C of wheel) /800
	xix) Permissible bearing and shearing stress in concrete	As per IS : 456 (Latest Edition)
	xx) Grades of concrete to be used	Second stage concrete M-25
	xxi) Lubrication arrangement	Through non-return grease nipple
	xxii) Material for fabrication	As per relevant IS
1.1.12.5	Intake Service Gates Equipment and Hydraulic Hoist	
	Intake Service Gates (2.40 m x 3.066 m – w x h)	
	Two numbers fixed wheel gates, suitable for a clear vent opening of size 2400mm × 3066 mm (w × h) have been proposed at the Intake bays. These gates are shall be of regulating type and the double acting hydraulic hoist shall be designed for this. Each gate shall be operated by an independent hydraulic hoist, which shall be installed on the top of deck at EL 372.00 m. The gate leaf is designed as vertical lift roller gate. Gate element is fitted with 6 rollers working on self aligned spherical roller bearing mounted on stainless steel axle. The axle is made with eccentricity of 5mm for fine adjustment at later date if required. The U/S skin plate is fitted with Bulb type of moulded rubber seals for sides, flat type of rubber seals for bottom for water tightness. The gate is being operated with double acting type hydraulic hoist of 25 T (Tentative) capacity. The design requirements for the gate and hoist are broadly appended below :	
	i) Type of Gate	Fixed Wheel Type
	ii) Clear width of opening	2400mm
	iii) Clear height of opening	3066mm
	iv) C/C of seal	2600 mm
	v) C/C of tracks	2850 mm
	vi) Sill elevation	EL. 331.379 m
	vii) FRL	EL. 341.00 m
	viii) MWL	EL. 355.00 m
	ix) Deck Level	EL. 372.00 m
	x) Design loading conditions ; Gate will be designed for head against MWL.	
	xi) Operation: Lowering : Closing under flowing water conditions	

	Raising: Opening under unbalanced head conditions.	
	xii) Operating loading conditions : Gate will be operated under unbalanced head conditions with the help of double acting type hydraulic hoist.	
	xiii) Type of Wheel Assembly ; Wheel with spherical roller bearing mounted on pin. The wheels shall have line contact with track. The Wheel assembly should be designed at folding arrangement along with the end vertical girder plate for the purpose of their repair/replacement in case of defects occurred during operation of the gates.	
	xiv) Minimum thickness of skin plate.	12 mm
	xv) Minimum thickness of stainless steel tack plate. (after machining).	10 mm
	xvi) Minimum thickness of stainless steel seal seats. (after machining)	10mm
	xvii) Type of seals ; The seals shall be fluorocarbon clad rubber seals (moulded as per Para 6.1 of IS:15466) for sides & top and wedge type rubber seals for bottom. Sealing arrangement shall conform to IS: 11855. The seals shall be fixed to the gates by means of either counter sunk screws or bolts & nuts, Screws/ bolts shall be designed to withstand the full shear likely to develop during raising or lowering cycle of the gate under maximum hydrostatic head between the seals and seal seat plates due to frictional forces. In case the screws are used for fixing the seals, these shall be tightened for designated torque with torque wrench, and locked by punch mark. Minimum threaded length equivalent to 1.50 times the diameter of screws shall be provided. The seal interference of side seals as well as the compression of bottom seal shall be 6.0 mm. Suitable chamfer at the bottom of skin plate and clamp plates to accommodate the compression of bottom wedge seals. Co- efficient of friction between Teflon and steel (machined stainless steel) should be adopted considering the wear of Teflon as 1.5.	
	xviii) Numbers required	
	– No. of opening (s)	2 (Two)
	– No. of gate (s)	2 (Two)
	– Sets of embedded parts.	2 (Two)
	xix) Governing Indian Standard	IS : 4622 (Latest Edition)

	xx) Permissible mono-axial stresses in structural components for gate and embedded parts shall be in accordance with Annex-B of IS : 4622 (latest Edition). The gate shall be designed for wet and inaccessible conditions and embedded parts shall be designed for wet and inaccessible condition. In case of normal loading, the hydrodynamic loading due to earthquake shall be combined. The allowable stress in loading combined with earthquake shall be limited to 80% of yield point.	
	xxi) Permissible deflection of gate.	Span (C/C of wheel) /800
	xxii) Permissible bearing and shearing stress in concrete	As per IS : 456 (Latest Edition)
	xxiii) Grades of concrete to be used	Second stage concrete M-25
	xxiv) Lubrication arrangement	Through non-return grease nipple
	xxv) Material for fabrication	As per relevant IS
1.1.12.6	Bulkhead Gate Equipment for Intake gates with Spillway Gantry Crane	
	Bulkhead Gate (2.67m x 4.59m – w x h)	
	One number slide type gate, suitable for a clear vent opening of size 2670mm × 4590 mm (w × h) has been proposed for maintenance of Intake service gate. The gate shall be operated by a spillway gantry crane of 45 T (Tentative) capacity with hoist mounted on a cross travel trolley through a lifting Beam, which is also used for an operation of emergency gate for irrigation and low level sluice. Gantry crane shall be installed on the top of the structure at deck level EL.672.00m. The gate leaf is designed as vertical lift slide gate. The D/S skin plate is fitted with Bulb type of moulded rubber seals for sides, flat type of rubber seals for bottom for water tightness. The design requirements for the gate and gantry crane are broadly appended below :	
	i) Type of Gate	Slide Type
	ii) Clear width of opening	2670mm
	iii) Clear height of opening	4590mm
	iv) C/C of seal	2820 mm
	v) C/C of tracks	3170 mm
	vi) Sill elevation (with supporting	EL. 329.60 m

	structure)	
	vii) FRL	EL. 341.00 m
	viii) MWL	EL. 355.00 m
	ix) Deck Level	EL. 372.00 m
	x) Design loading conditions ; Gate will be designed for head against MWL.	
	xi) Operation: Lowering : Closing under flowing water conditions Raising: Opening under balanced head conditions.	
	xii) Operating loading conditions: Gate will be operated under balanced head conditions with the help of filling valve and gantry crane with lifting beam.	
	xiii) Minimum thickness of skin plate.	12 mm
	xiv) Minimum thickness of stainless steel tack plate. (after machining).	10 mm
	xv) Minimum thickness of stainless steel seal seats. (after machining)	10mm
	Type of seals ; The seals shall be fluorocarbon clad rubber seals (moulded as per Para 6.1 of IS:15466) for sides & top and wedge type rubber seals for bottom. Sealing arrangement shall conform to IS: 11855. The seals shall be fixed to the gates by means of either counter sunk screws or bolts & nuts, Screws/ bolts shall be designed to withstand the full shear likely to develop during raising or lowering cycle of the gate under maximum hydrostatic head between the seals and seal seat plates due to frictional forces. In case the screws are used for fixing the seals, these shall be tightened for designated torque with torque wrench, and locked by punch mark. Minimum threaded length equivalent to 1.50 times the diameter of screws shall be provided. The seal interference of side seals as well as the compression of bottom seal shall be 6.0 mm. Suitable chamfer at the bottom of skin plate and clamp plates to accommodate the compression of bottom wedge seals. Co- efficient of friction between Teflon and steel (machined stainless steel) should be adopted considering the wear of Teflon as 1.5.	
	xvi) Numbers required	
	– No. of opening (s)	2 (Two)
	– No. of gate (s)	1 (One)

	– Sets of embedded parts.	2 (Two)
	xvii) Governing Indian Standard	IS : 5620 (Latest Edition)
	Permissible mono-axial stresses in structural components for gate and embedded parts shall be in accordance with Annex-B of IS : 5620 (latest Edition). The gate shall be designed for wet and inaccessible conditions and embedded parts shall be designed for wet and inaccessible condition. In case of normal loading, the hydrodynamic loading due to earthquake shall be combined. The allowable stress in loading combined with earthquake shall be limited to 80% of yield point.	
	xviii) Permissible deflection of gate.	Span (C/C of wheel) /800
	xix) Permissible bearing and shearing stress in concrete	As per IS : 456 (Latest Edition)
	xx) Grades of concrete to be used	Second stage concrete M-25
	xxi) Lubrication arrangement	Through non-return grease nipple
	xxii) Material for fabrication	As per relevant IS
1.1.12.7	Embedded parts construction for Construction Sluices, Emergency gate, Low Level Sluices, Irrigation Sluices, Bulkhead gate for Intake and Intake service gate.	
	The embedded parts shall be designed to suit the block outs and first stage anchors. The embedded parts for each gate shall comprise of embedded gate frames having wheel tracks, side and bottom seal seats and sill beam with seal seat, Groove liners, bonnet assembly and bonnet cover, Corner angles of size 130 × 130 × 12mm with necessary anchorages shall also be provided at the top of all shafts for Weir Vertical gate at deck level. The track shall be designed for line contact. Design of all embedment's shall conform to IS: 4622 (Latest Edition). Minimum sizes and tolerances of all components specified in IS: 4622 (Latest Edition) shall be adhered to. The concreting in the block outs shall be done after erecting the embedded parts, aligning and checking them and ensuring their correct position and place. Suitable struts, supports etc., required shall be provided by the contractor to prevent disturbance in the parts during concreting. The contractor shall be responsible for correct erection of the embedded parts in position and maintaining the dimension and accuracy as per approved drawings.	

1.1.12.9	Hydraulic Hoist and Hoist Supporting Structure for Low Level Sluices , Irrigation Sluices and Intake service gate
	Each gate will be operated by independent double acting hydraulic hoist. Each hydraulic hoist shall be designed for operation of the gate (regulating type), both for lowering, raising and holding the same at any intermediate position during its travel under unbalanced head of water. The hoist capacity shall be computed by determining the force required to operate the gate under worst combination of loads acting and adding 20% towards reserve capacity of the hoist. The hydraulic hoist shall comprise of hydraulically operated piston and cylinder with the use of hydraulic oil as the fluid. Each hoist cylinder shall be installed on a supporting structure. It is fixed with a piston equipped with sealing arrangements. A piston rod with its upper end attached to the piston passes down through the gland fitted openings in the bonnet cover and is connected to the gate lifting lug with lockable corrosion resistant steel pins. The intake service gate hydraulic hoist is connected to the gate by providing link rods and link rod couplings with lockable corrosion resistant steel pins. The link rods with couplings shall be provided in such a manner, when the gates are removed for maintenance these shall be dismantle easily by accessing the maintenance floor provided above the gate opening.
	All parts and components of hydraulic hoists seals, gaskets, pumps, valves and hoses that are normally or may accidentally come in contact with hydraulic fluid shall be compatible with the hydraulic fluid employed. Hydraulic arrangement shall ensure that the cylinders and piping are permanently and completely full of hydraulic fluid under normal working conditions at all times, to avoid internal corrosion effects of moisture and other corrosive agents contained in the air. Hydraulic arrangement so far as possible shall ensure a positive fluid pressure within cylinders and piping, so that in the event of any lack of tightness, no air or water shall enter the hydraulic system. Shut off valves shall be provided in all hose connections and other suitable locations in the hydraulic system to enable convenience of hose replacement and other parts so that there will be no need to drain all oil through the system.
	The hoist shall be provided with a gate position indicator at the cylinder. The hoist is operated by a motor and a pump arrangement with directional flow of oil controlled by valves which are actuated by electric contacts.

	The H.M. Agency shall furnish all details of the method of erection at the time of submission of drawings and designs for approval by the purchaser.
	The operation of a four way valve in the control cabinet shall enable actuating the pump and the motor and to lift, lower or stop the gate in its travel. It shall be possible to stop the gate at any intermediate position and to further move from the stopped position for lifting or lowering the gate. Suitable limit switches shall be provided to stop the gate in its travel at the fully opened, fully closed or any other positions which so ever required. A hand pump shall also be provided for raising or lowering the gate.
	The hydraulic hoist cylinder and other parts of hoist shall be in accordance to their provisions in IS: 10210 and these specifications.
1.1.12.9.1	Hoist Cylinder
	a) The cylinder shall be made of forged steel, or boiler quality steel plate bent to cylindrical shape and welded with not more than two longitudinal welds. All butt welds in the cylinder and cylinder heads shall be tested by radiographic testing and it shall be ensured that the welding is good and free from defects. The cylinder shall be annealed i.e. stress relieved before machining. The cylinder shall be straight and true and shall be of sufficient wall thickness to resist maximum operating pressure and bending forces that could be imposed upon it. The fabrication on the cylinder, welding, stress relieving etc., any repairs to be done after testing, the testing shall be done in accordance with the provisions in code for unfired pressure vessels IS : 2825 or equivalent ASME code.
	b) Interior Surface Finish ; Interior surface of the cylinder tube that comes in contact with piston seals shall be continuous and without detectable offsets. Surface shall uniformly honed to a surface finish commensurate with the specified maximum leakage limit and long seal life. In any case, the finish shall not be coarser than 0.33 microns.
	c) Exterior Surface Finish Outer surface of cylinder shall be sand blasted and protected in accordance with standard practice for surface protection. The H.M. Agency shall mention in his quotation, the protection he will be providing.

	d) Ports Ports shall preferably be located in the cylinder heads. If located on the cylinder tube, their edges shall be kept at least 6mm far from the piston seal contact line in all positions of the piston.
	e) The cylinder shells shall be subjected to a hydraulic pressure test at the manufacturer's works using a pressure of 150% of normal working pressure. Test certificates shall be furnished by the H.M. Agency.
1.1.12.9.2	Cylinder heads
	a) Each cylinder assembly shall have a blind end cap and a rod end head each fastened to the cylinder tube by bolted connection. Cylinder heads shall have machined contact surfaces for resisting the thrust of the piston and rod assembly without exceeding normally allowable stresses, in the event of a limit switch failure or other malfunction.
	b) A gland shall be provided in the rod-end head. The gland shall include a piston rod guide bushing, piston rod guide bushing seal and a heavy duty scraper/wiper ring which shall prevent the entry of foreign material into the cylinder. Guide bushing shall be of fibre-reinforced phenolic material.
	c) Design of the rod end head shall permit servicing of the piston rod seal(s) without disassembling the cylinder and while the cylinder remains in its normal working position.
	d) Water exclusion seals shall be provided as necessary to prevent the entry of water into the cylinder.
1.1.12.9.3	Piston
	The piston shall be of cast steel or forged steel. It shall be nickel chrome plated to atleast 0.5mm thickness in accordance with standard specification IS: 1068 and shall be finished to suit the inside diameter of the cylinder. It shall have grooves for the piston rings and provision for fixing suitable seals. The piston shall have square threads for connecting to the piston stem or rod. Suitable seals are to be provided to prevent leakage of oil through the stem threading at lower end and upper portion engaging the hanger stud.
1.1.12.9.4	Piston rings

	Piston rings shall be single piece bronze conforming to the Latest Edition of IS : 305 or IS : 318. The rings shall be suitable for hydraulic service at the normal working pressure. The piston ring joint shall be angled or overlapped type allowing the minimum leakage through the joint and provide an effective seal.
1.1.12.9.5	Piston Rod or Stem
	Stem shall be solid nickel chromium plated stainless steel having at least 18 percent chromium content conforming to 15C16Ni2 of IS : 1570.
	The piston rod shall be perfectly straight, of uniform circular cross section correctly machined, ground honed and polished. The assembled piston rod shall be concentric with the piston and shall be truly normal to the piston faces. One end of the piston rod shall be suitably threaded for fitting Clevis with the gate leaf through pin connection.
1.1.12.9.6	Seals
	Piston seals and piston rod seals shall be of the chevron type packing seals for piston and for piston rod, mechanically locked in place. Seals shall resist roll, turn and extrusion. The hoist cylinders shall be designed for fluid pressure acting from either side, therefore a separate set of piston seals shall be provided on each side.
1.1.12.9.7	Hanger stud
	The hanger stud or stem locking device shall be of mild steel. The upper end shall be screwed into and locked with the piston. It shall be in accordance with provisions in IS : 10210. Suitable wrench facing shall be provided on the stud near the minimum cross section.
1.1.12.9.8	Packings
	Packings or static seals such as rings shall be provided between all connected parts where leak-tight joints are required, such as between cylinder tube and heads or between piston and piston rod.
1.1.12.9.9	Speed Limiting Orifice
	Cylinder shall have a permanently mounted speed limiting orifice to limit the downward speed of the gate, in case of rupture in the connecting pipes.
1.1.12.9.10	Bosses, Drains, Vents and test Connection
	a. Bosses: If bosses are provided at the hydraulic cylinder ports, they shall be

	welded.
	b. Drains: All necessary drains shall be provided.
	c. Air Bleed Valves: Cylinder shall be furnished with at least 2 air bleed valves for complete removal of trapped air. All air bleed valves shall be of stainless steel.
	d. Test Connections: Cylinder shall be furnished with one test connection in each of the fluid ports for attaching a pressure gauge or transducer. Additional test connections shall be provided on the cylinder as required. All test connections shall be provided with corrosion resistant steel minimus type connectors equipped with check valves; no shut off valves shall be used.
1.1.12.9.11	Cylinder Mounted Components
	Except for pipe connectors, pipe supports, air bleed valves, test connections, plugs and the necessary pressure piping, no other components shall be mounted on the hydraulic cylinder. However, from safety consideration, a control plate with at least one shut off valve, lock valve and pressure release valve may be flanged on to the cylinder directly.
1.1.12.9.12	Handling Eyes
	Each cylinder shall be equipped with handling eyes to facilitate easy handling during transportation and erection.
1.1.12.9.13	Proximity Switches
	Each cylinder shall be equipped with proximity switches, one at each end to switch off the power unit at the end positions of the gate. Connection between the proximity switches and the control wiring shall be weatherproof. The conduit (including flexible conduit) up to the terminal board shall also be weatherproof.
1.1.12.9.14	Position Transducer
	Each gate cylinder shall be equipped with an electronic position transducer. The piston rod shall be drilled as necessary to accommodate the lower transmitter body.
1.1.12.9.15	Wiper Scraper
	This shall consist of a corrosion resisting metal scraper and a rubber wiping member assembled in tandem position and securely clamped and enclosed in a steel shell. The scraper shall have a snug fit on piston stem, and have sufficient play within the

	shell to permit alignment under normal tolerances. It shall be fixed in the lower cylinder head gland, by simple press fit for removing foreign materials sticking to the stem. It shall be effective in the upward stroke only and wiping member shall remove any particles that pass the scraper.
1.1.12.9.16	Connecting Piping
	a. All piping on the hoist control module and between hoist control module and hydraulic cylinder and on the hoist cylinders shall be of stainless steel & conform to the requirements specified in subsequent paragraphs. Insulators shall be used to isolate all dissimilar metals at the connection points.
	b. The piping and appurtenances shall conform to the applicable requirements of ANSI-B31.1 or equivalent standard.
	c. All piping in the hoist control module shall be completely installed in the shop before shop testing and shipping. The piping between the hoist control module and hoist cylinder shall be finished in the shop to obtain transportable (in no case longer than 6m) sections with all bolting flanges or couplings welded to the sections. Piping sections, where dimensions may require adjustment at field installation, shall be prepared in the shop without welding the flange or coupling on one or both ends of the piping section and cutting the pipe to 200mm over length at each of these ends.
	d. All pipe sections to be connected in the field shall be flanged using shop or field welded flanges or shall be designed for connection in the field with socket welded couplings. Pipe section shall not be designed for butt welding in the field.
1.1.12.9.17	Piping Arrangement
	a. The general arrangement of all piping shall be in accordance with the space and clearances available from gate and operation chamber.
	b. The piping shall allow easy removal and reinstallation of the hydraulic cylinder and hoist control module. For this purpose, all hydraulic lines connecting the hydraulic cylinders to the hoist control modules shall be provided with flexible connections at the cylinder and if necessary at the control modules. Both ends of all flexible connections shall be connected with corrosion resistant steel

	shut off valves so that the piping, cylinder, and hydraulic power unit can be shut off when the connections are removed.
	c. Manual vent valves shall be provided at all high points and elsewhere required in the system for the complete removal of trapped air. The valves shall have threaded female ends and shall be of corrosion resistant steel or bronze. The outlet ports of all vent valves shall be plugged with threaded bronze plugs.
	d. Rigid piping installed on the cylinders shall be kept to an absolute minimum. The same shall be of corrosion resistant steel and shall not be welded to the cylinder. Also no compression fitting shall be used. All connections shall be screwed connections.
	e. Piping shall not be embedded in concrete.
	f. Piping in the hoist control module shall be laid out such that it shall not obstruct access to, or removal of hydraulic components for maintenance or inspection.
	g. Piping shall be adequately sized to permit fluid flow and functioning of the system without significant pressure drop between the power unit and the farthest cylinder. The minimum size of the piping for pressure and return piping shall be 16mm inside diameter.
1.1.12.9.18	Fittings and Flanges
	a. All pipe fittings shall be of the socket welding type conforming to the applicable requirements of ANSI B 16.11 or equivalent.
	b. All pipe flanges shall be of the weld neck type conforming to the applicable requirements of ANSI B 165 or equipment.
1.1.12.9.19	Flexible Connections
	The flexible connections shall allow reconnection of the hydraulic power unit or hoist cylinder without realignment and shall also permit the necessary freedom of movement of the hoist cylinder in its mounting.
1.1.12.9.20	Flexible Hoses
	a) All flexible hoses shall be of rubber, suitable for system pressure of the equipment.
	b) All flexible hoses shall be furnished with factory installed fittings which shall be

	of corrosion resistant materials.
1.1.12.9.21	Pipe Supports
	All pipe supports such as pipe hangers, anchors, guides, clamps, etc. shall conform to the applicable requirements of ANSI B 31.1 MSS SP-58 and MSS SP-69.
1.1.12.9.22	Hoist Control Module
	a. The hoist control module shall be furnished complete with all appurtenances to provide pressurized hydraulic fluid for the operation and control of the hydraulic hoist cylinders.
	b. The hoist control module shall include a hydraulic power unit and an electrical control cabinet. These parts shall form a single integrated equipment package mounted on a common frame and installed in a single housing. The hoist control module shall also include all interconnecting wiring between these two sub assemblies, the required housings and all other appurtenances.
	c. A common hoist control module shall be provided with so that either of the two gates can be operated at any time on a common hydraulic reservoir and separate sets of electrical control components for each gate built in an independent electrical control cabinet.
1.1.12.9.23	Hydraulic Power Unit
	The hydraulic power unit shall include a hydraulic reservoir, two electric motors driven pumps, manual pump, automatic controls, pressure relief, check, flow control and directional control valves, pressure and temperature gauges, fluid level switch, filters and strainers, piping and all accessories, appurtenances and wiring required to provide an operational fluid power system for the operation of the hoist according to the requirement of these specification. All of the components shall be mounted on the hydraulic reservoir.
	a. Hydraulic System Layout
	i) Motor Driven Pumps: The number of electric motor driven pumps for each hydraulic hoist shall be two (one + one standby).
	ii) Manual Pump: One manual pump shall be provided for the hoist. The manual pump shall be arranged in parallel with the motor driven pump.
	iii) Suction Strainers: Suction strainer shall be provided and fitted in such a way

	that motors do not need to be removed for its replacement.
	iv) Pressure Filters: All hydraulic fluid being discharged from each pump shall pass through its own pressure filter before entering the rest of the hydraulic system. Pressure filter shall have 100% spare capacity.
	v) Return Line filters: Hydraulic fluid returning from the system to the hydraulic reservoir shall pass through a return line filter.
	vi) Check Valves : one check valve shall be provided in the pressure line of each pump between the pressure line filter and the rest of the system to prevent back pressure on the pumps when they are not in operation. Other check valves shall be arranged in the hydraulic system as required.
	vii) Pressure – Relief Valves ;
	– One pressure relief valve, sized to pass the full discharge of one motor-driven pump, shall be arranged in the pressure line of each other driven pump.
	– Pressure relief valves to limit pressures due to heat expansion or to limit hoist capacity in one direction shall be provided as required.
	viii) Pressure Gauges : One pressure gauge shall be provided on the common pressure line of one or more pumps and on the hoist cylinder pressure and return line between the hoist cylinder and hydraulic control components within the hydraulic power unit. Additional pressure gauges shall be provided as per standard practice or as otherwise required.
	ix) Test Connections: Test connections shall be provided suitably.
	x) Pressure Switch: This shall be of the type suitable to operate a mercury switch having rating of at least 5 amps at 230 volts A.C. The switch shall have independent adjustments with locking devices for setting the cut-in and cut-out pressure and with pressure settings indicated on a dial. It shall have suitable provisions at the back for pressure connection and electrical conduit connection. The switch shall have a capacity to withstand a pressure of at least two times the maximum operating pressure in the control system.
	b. Fluid Reservoir:
	The hydraulic fluid reservoir shall conform to IS-10210. A single reservoir with compartments for separate fluid supply for the operation of each gate shall be

	provided. Also provision shall be made so that the two compartments can overflow into each other. Each compartments shall be provided with baffle plates and an access opening at each end for clean out. The reservoir shall be equipped with a sight fluid level gauge, minimum oil level indicating device, dial type thermometer to indicate fluid temperature, valves drain connection, a magnetic plug type drain arranged to permit complete drainage, a filler pipe provided with a strainer, a desiccant filled breather cap with filter, and pipe connections for a fluid purification device. The fluid purification device shall also be supplied by the H.M. Agency for this work. The desiccant breather cap shall be of the silica gel type and shall be mounted directly on the fluid reservoir. The breather shall function as an air filter to eliminate moisture and particulate contamination within the reservoir. The reservoir shall be provided with lifting and jacking lugs as required for its handling. The bottom of the reservoir shall be inclined towards the drain plug for easy removal of water and contamination.
	c. Motor driven pumps:
	The motor driven hydraulic pumps shall be of the self priming positive and constant displacement type. The pumps shall be driven by direct coupled electric motors and shall be equipped with individual 'Manual/Auto' switches and 'Start', 'Stop' push buttons for operating the pump in the 'Manual' mode.
	d. Manual Pump:
	The manual pump shall be of the lever operated piston type. The pump shall be mounted on the front of the hydraulic fluid reservoir, shall be operable from a standing position, and shall not require more than 14 kg of force on the pump lever to reach nominal design system pressure.
	e. Hydraulic control Panel:
	The common Hydraulic hoist control module and the hydraulic control panel shall be located in the gate cum ventilation gallery at El: 1636.00m, in such a way that oil almost travels equal distance, for both the gates. All hydraulic components which need to be accessible for manual operation and all gauges shall be mounted on the hydraulic control panel. Strainers and filters shall also be easily accessible for maintenance, their location shall be such that the

	draining oil during exchange of the filter elements shall not spoil the instrumentation including pressure gauges and pressure switches and other critical items. All components shall be arranged in an orderly and functional manner, and they shall be removable without removing the surrounding components and piping.
	f. Hydraulic valves
	1. General: All valves shall have JIC or equivalent pressure ratings not less than the maximum system pressure. All pressure relief and flow control valves shall be preset in the shop to their operational setting. All electrically operated valves shall be furnished with suitable provisions for standby manual operation. Each valve shall be furnished with a corrosion resistant tag suitably engraved or stamped to identify the valve according to its designation on the hydraulic circuit drawing and according to its function in the system.
	i) Shut-off Valves: All shut-off valves shall be ball valves.
	ii) Check Valves: All check valves shall be spring loaded for closure with minimum shock unless otherwise specified. Pilot operated check valves shall be provided where the check valve has to open against pressure.
	iii) Directional Control Valves: All directional control valves shall be of standard manufacture and nominally rated for zero leakage.
	iv) Pressure Relief Valves: All Pressure relief valves shall be of the hydraulically operated type. The valves shall be adjustable and shall maintain the pressure within 5% of the preset valve.
	v) Flow control Valves: All flow control valves shall be of the adjustable pressure and temperature compensated type with an integral check valve for free return. All valves shall be shop tested to pass the required flow within 5%.
	g) Filters and Strainers
	i) Filters shall be of the disposable, replaceable element type. Strainers shall be of the cleanable, replaceable element type. Elements of all filters and strainers shall be stainless steel or Monel woven or wound wire.
	ii) All filters shall be constructed and installed to permit servicing of the filter elements without disturbing the piping and without draining the hydraulic

	system and the fluid reservoir. Shut off valves shall be provided where necessary.
	iii) Each filters shall be furnished with a bypass valve which shall open to pass the flow when the pressure drop across the filter element exceeds the allowable limit.
	iv) Each filter shall be provided with a means to indicate the condition of the filter element by visual inspection.
	v) Each filter and strainer shall be furnished with a differential pressure or minimum pressure switch to energize a warning light when the pressure drop across the filter or strainer reaches a predetermined value.
	vi) Filter Media Rating Requirements : Filter elements shall be screw on type and shall be furnished with the following absolute ratings :
	– Low pressure line strainers : 160 microns – Pressure filters : 10 microns – Return line filters : 40 microns
	vii) Pressure Drop Requirements: The maximum pressure drop across any clean filter or strainer at normal flow shall not exceed the following values in the normal operating temperature range.
	0.0703 kg/cm ² (1 psi) for low pressure line strainers.
	0.3515 kg/cm ² (5 psi) for pressure filters.
	viii) By-pass Valves : The filters shall be provided with bypass valves which shall be set to open when the pressure drop across the filter elements exceeds 1.0545 kg/cm ² (15 PSI)
	h) Pressure Gauges :
	All pressure gauges shall be of the Bourdon tube type with glycerine filled housing. The accuracy of pressure gauges shall conform to Grade A of ANSI B 401. All pressure gauge dials shall be at least 100mm diameter and shall have dial graduations equal to their accuracy. The total measuring range of the gauge shall be between 0 and 200% of the maximum pressure expected. All pressure gauges shall be provided with corrosion resistant shut off valves and numbers.

	j) Test Connections :
	The power unit shall be furnished with test connection at appropriate locations for attaching a pressure gauge or transducer. Each test connection shall be provided with a corrosion resistant steel minimum type connector equipped with check valves ; no shut off valves shall be used.
1.1.12.9.24	Electrical Connections
	All electrical wiring and equipments, unless otherwise called for in these specifications or in the drawings shall conform to the latest Indian standard specifications and all electrical works shall be carried out conforming to latest rules under Indian Electricity Act or other applicable legislations.
	All internal wiring required for the electrical equipment of the hydraulic power unit shall be provided. All wiring shall be installed in conduits. Wiring and conduits shall be installed so as not to interfere with access and maintenance of any part of the power unit.
	The hydraulic power unit and the electrical control cabinet shall be completely wired to terminals in the shop for field interconnection to others.
	The equipment is to be designed for the power supply 400/440 volts 50 cycles 3 phase AC and 230/250 volts 50 cycles single phase AC. All control circuits are to be designed for 230/250 volts 50 cycles supply.
	Electrical items such as motors, starters, relays, circuit breakers etc. likely to be subjected to arcing shall be kept separately eliminating fire hazards.
1.1.12.9.25	Electric Motor
	The electric motor shall be directly coupled to the oil pump and shall be of sufficient capacity to carry continuously the maximum load likely to develop under all conditions of operation of gates and shall have nominal speed to match the requirements of the oil pump.
	The motor shall be of totally enclosed fan cooled squirrel cage induction motor continuous duty type with insulation F type and suitable for 400/440 V, 3 phase 50 cycles AC, non-reversing type with high starting torque characteristics, and shall conform to IS: 325. The electrical insulation shall be moisture resistant for use with motors which may be either continuously running or may be idle for long periods

	under highly humid atmospheric conditions. All the motor bearings shall be self lubricating and shall be either ball or roller type, properly sealed against loss of lubricant or entrance of dust.
	To prevent condensation, the electric motor shall be equipped with suitable arrangement like a heater element mounted as an integral part of motor or 230/250 volts single phase heater mounted in or on the frame. The leads of the electric motor and the ant condensation heater shall be brought out in a terminal box on the motor having suitable cable entry lugs.
	The motor shall be suitable for outdoor type duty and the break down torque shall not be less than 200% of normal running torque. The motor shall be of standard make approved by the purchaser and horizontal foot / vertical mounted construction.
1.1.12.9.26	Wiring
	All wirings of power control cabinets shall be single conductor, tinned annealed copper wire with PVC insulation and shall be neatly installed, connected and securely anchored in plates in a workman like manner. Electric connections shall be neat, mechanically tight and secure and shall be made at appropriate terminals and terminal blocks. Terminals for field connection shall be accessible easily. The insulation of control wiring shall be polyvinyl chloride or similar synthetic insulation of 650 volts grade and oil vapour proof. All wiring shall be water proof and suitable for tropical climate and highly humid atmosphere. Wherever necessary the wiring shall be carried in heavy gauge hot dip galvanised metal conduits. Conduits shall conform to Indian standard 'Rigid Steel Conduits (With amendment No. 1)' IS : 9537 (Part-II, Latest Edition) and Indian Standard 'Rigid Plain conduits of Insulating Materials' IS : 9537 (Part-III, latest Edition).
1.1.12.9.27	Flexible coupling
	The flexible coupling between the motor and the pump shall be an all-metal type suitable for accommodating radial and angular misalignment. The coupling shall be of adequate capacity to drive the pump and shall be accurately bored. Suitable keyway shall be provided to ensure proper fitment on motor and pump shaft and permit minor adjustments for alignment purpose.
1.1.12.9.28	Circuit breaker

	One air insulated tripe pole breaker shall be provided for the control of each oil pump motor. It shall be suitable for use as back up protection against short circuit current and in accordance with Indian Standard Specifications for Alternating Current Circuit Breakers., Requirements and Tests, Section-I, Voltages not exceeding 1000 V AC or 1200 V DC (First Revision) (With Amendment No.1), IS : 2516 (Part-I & II/Sec-I, Latest Edition).
	The circuit breaker shall be provided with thermal overload release. The breaker interrupting capacity shall not be less than 50-0 amperes. Provision shall exist on the circuit breaker for the adjustment of triple setting to suit the requirements of electric motor.
	For each oil pump motor, one magnetic motor starter of suitable capacity rated for 400/440 volts, 3 phase, 50 cycles, AC and direct on line starting service shall be provided. The starter shall be suitable for working in conjunction with the control relay for thermal overload and single phasing protection and shall have a no volt release coil.
1.1.12.9.29	Control Switch
	For raising and lowering a gate spring loaded control switch of self resetting type shall be provided. The switch shall provide momentary contact with its handle is operated to positions corresponding to raising and lowering the gate. The control switch shall be of heavy duty type having silver plated contacts and suitable for flush mounting on a panel. The rating shall be 5 amperes, 230/250 volts and 50 cycles A.C. supply.
1.1.12.9.30	Push Button
	The gate moves when the push button is pressed and stops in any position when the push button is not pressed, the push buttons shall be of spring loaded oil tight, heavy duty type, having silver plated contacts and suitable for flush mounting on the panel. The push button shall have normally closed contacts. The rating shall be 5 amperes, 230/250 volts, 50 cycles, AC supply.
1.1.12.9.31	Indicating lamps
	To indicate the gate at extreme positions and other positions, indicating lamps shall be provided as under :

	1. Gate fully opened
	2. Gate fully closed
	3. Gate in intermediate position
	4. Gate in moving position
	The indicating lamps shall be water tight, heavy duty type rated for 230/250 volts, AC and suitable for flush mounting on a control panel.
	While the gate starts opening or closing, the amber lamp will be lighted and shall remain lighted during gate movement. Provision shall also be made for red lamp or green lamp to flicker to indicate the direction of movement of the gates. Once the gate is moved to fully open or closed position the red or green light as the case may be, shall become stable and stop flickering and amber light shall switch off automatically.
1.1.12.9.32	Heater Switch
	Single pole disconnecting heater switch rated for 5 amperes, 230/250 volts, 50 cycles, AC supply shall be provided for the heater in each electric motor and in the control cabinet. The switch shall be oil tight and suitable for flush mounting on a panel.
1.1.12.9.33	Control relay
	For overload and single phasing protection of the motor, a 3 phase control relay shall be provided. The overload device shall be set or adjusted to trip the starter between 115 to 120% of the rated normal, full load running current of the motor. The relays shall be capable of resetting manually.
1.1.12.9.34	Limit Switches
	Limit switches are to be provided to take the gate to its position in the event of its creeping down. When the gates is left in any position for a long time and creeps up to 150mm under the weight of parts due to oil from the rod end side of piston leaking past the piston to the top, one of the limit switches shall be operated to move the gate up and restore to the original position. If it is not possible to restore the original position and the gate creeps to an extent of 175mm and more another limit switches shall be operated to sound an alarm.
	It should be arranged that the gate moves up only when the relevant push button is

	pressed & will be left in an intermediate position when once the push button is not pressed.
1.1.12.9.35	Hoist Electrical Control Cabinet
	a. One control cabinet shall serve two number gates installed in different gate chambers. The electrical control cabinet shall contain all relays, time delay, relays, motor starters, disconnecting switches, control transformer contactors, convenience outlet and lighting receptacles, and any additional electrical equipment required to provide proper and safe operation of the hoists. The convenience outlet shall be installed outside the cabinet, on the side wall. All other electrical control components shall be mounted inside the control cabinet. A main disconnected switch shall be mounted in each control cabinet. The controls may be conventional (hard wiring), or an electronic programmable logic controller may be used.
	b. Gate shall operate in the opening or closing direction continuously until stopped by either the stop push button or applicable limit switch.
	c. The control cabinet shall be fully wired in the shop. The only wiring required in the field shall be the wiring between the cabinet terminal blocks and the components located outside the cabinet.
1.1.12.9.36	Enclosures
	a. The enclosure of the local control cabinet shall be NEMA type 4 IP66 or equivalent cabinet constructed of heavy gauge steel not less than 3mm thick. This cabinet shall be provided with hinged and gasketed doors on the front for full access to the equipment. Tamper-proof locks shall be provided on the doors of the enclosure.
	b. The control cabinets shall be provided with spaces for conduits entering from below as required.
1.1.12.9.37	Contactors
	a. Contactors for the control system of each of the gates shall be provided in each control cabinet.
	b. Contactors shall be of 1, 2, 3 or 4 poles and of appropriate current and voltage rating for the application. The contactors shall be of the normally open,

	magnetically held type.
	c. The contactors shall be rated in amperes for all classes of loads. Interrupting capacity shall be 6 times rated current. No derating shall be necessary when used on high inrush current loads. Each pole of the contactors shall be furnished with magnetic blowouts.
	d. Contactors shall be Asco Bulleting 1035, or equal.
1.1.12.9.38	Control Panel
	The control panel shall contain all the push-button, indicating lights, selector and transfer switches, meters, and other indicating devices required for proper and complete operational control of the hoist. All control items shall be functionally in appropriate locations. Although the main control panel for operation of two gates shall be located in the gate cum ventilation gallery at El: 1636.00m. However provision shall also be made so that each gate can be independently operated from its gate chamber also.
1.1.12.9.39	Control Cabinet Lighting and Outlets.
	a. Lighting: The control Cabinet shall be provided with lighting to facilitate operation and maintenance. The lighting circuit shall include an ON-OFF switch.
	b. Outlets: One duplex convenience outlet shall be provided with each control cabinet for maintenance tools. They shall be rated 15-A, 2 pole, 3 wire. The outlet shall be installed, complete, outside the cabinet, mounted on the side wall of the cabinet.
	c. Lighting and outlet circuits shall be obtained from separately fused circuits derived from the common control transformer.
	d. Common Control Transformer: A control transformer shall be provided in each of the control modules. The control transformer shall have sufficient volt-ampere capacity to continuously carry the control circuit load required for the control module plus the load for space heaters lighting and outlets. A fuse shall be provided in each ungrounded legs of the control transformer secondary and primary. The minimum control transformer rating shall be of 2500 VA.
	e. Grounding: Control assemblies shall include a 1/4 inch by 2 inch copper ground

	bus. The housing framework and other noncurrent-carry metallic parts of all equipment shall be securely connected to the ground bus. Holes shall be drilled at each end of the bus to accommodate equivalent standard 2-bolt lugs.
	f. Instruments: instruments shall be calibrated in the IS customary system of units.
1.1.12.9.40	Name Plates and Wire Identification
	a. The control panel for each gate shall be furnished with a large permanent main nameplate affixed to the control cabinet in a conspicuous location, showing the purchaser's identification number and designation of the hoist and the year of manufacture.
	b. Additional name plate shall be provided to indicate main operating instructions, caution or warning for personnel, and operational, safety. In addition, each panel – mounted instrument, pressure gauge, position indicator, push-button, switch, light, and other device related to the gate operation shall be identified by a permanently affixed nameplate describing the control functions. Each item of the control panel and each pump, motor, relief valve, flow and directional control valve, check valve, and so on shall be assigned a designation (to be shown on the supplier's control panel drawing) and labelled accordingly clearly identifying the gate to which it belongs. Electrical wiring and instruments including relays shall also be labelled to correspond to the number assigned on the electrical control schematic.
	c. Each major and auxiliary component of the control system shall have a name plate permanently affixed thereto showing in a legible and durable manner the serial number, name and address of the manufacturer, rated capacity, speed, setting, electrical characteristics, and other significant information as applicable. Name plates of distribution agents only will not be acceptable.
	d. In addition to the hoists, other items of the gate equipment shall also be provided with nameplates containing operating instructions, warnings, or other information essential to the proper use of the equipment.
	e. The above general name plate requirements are also for use in preparing name plate lists and drawings to be submitted for review. Drawings for nameplates, as they will appear on the finished equipment shall be submitted

	for review.
	f. All name plates shall be in English and shall be suitably engraved and shall be weather resistant. All name plates shall be permanently attached to the respective parts, components, or equipment items in clearly visible locations. Name plates for control equipment shall be screw mounted laminated plastic, white with black cores, with engraved capital letters of 6mm minimum height.
	g. Cable and wire markers shall be identified with adhesive, self laminating type markers. The markers shall be printed with the cable designation or with the conductor designation shown on the drawings. The clear laminate shall overlap the leend and shall be resistant to oils, abrasion, and high temperature.
1.1.12.9.41	Transducers
	a. Transducers shall be suitable for accurately measuring 50-Hz quantities. Transducer outputs shall be a dc current signal ranging from 4 to 20 mA full scale, suitable for termination in a load resistance Upto 500 ohms. If the standard transducer has an output different from 4 to 20 mA, suitable instrumentation shall be provided to achieve an output of 4 to 20 mA.
	b. Unless specified otherwise, the maximum allowable error shall not exceed plus/minus 0.25% of full scale at 25 degree C., and the error resulting from a temperature variation between – 20 degree C and 60 degree C. shall not exceed plus/minus 0.5% of full scale. AC output ripple shall not exceed 1%. The units shall be provided with a 10% full scale calibration adjustment, and the response time shall be 400 ohms or better from 0 to 99%. There shall be electrical isolation between input, output, external power supply if used, and the case ground connection. All transducers shall satisfy the requirements of ANSI C37 90a and shall have a dielectric test voltage rating of 1500 V AC rms for one minute.
	c. Transducer components shall be totally enclosed in steel cases with integral brackets for surface panel mounting. External electrical connections shall be made using screw type barrier terminal blocks. A separate terminal connection shall be provided for grounding the output cable shield.
1.1.12.9.42	Hydraulic fluids

	1. Hydraulic working fluid :
	2. Flushing Fluids
1.1.12.9.43	System Cleanliness
	1. Before filling the system with hydraulic fluid the system cleanliness shall conform to NAS 1638, class 8 or equivalent.
	2. Piping: The piping supplied for field installation shall be free of all scale, dirt, grit, and other foreign matter. The piping shall be cleaned at the source of its fabrication and then sealed to prevent accumulation of foreign matter during transportation to the site. The suppliers installation instructions shall state that the piping shall remain sealed during storage at the site, that the seal shall be removed just prior to installation, and that after installation has been completed, the entire system shall be free of chips of wood, dirt, grit, waste and other foreign matter.
	3. Other : The cylinders, hydraulic power units, and manifolds shall be clean and free of all foreign matter which occurs as result of manufacture, assembly, and transpiration to and storage at the site.
1.1.12.9.44	Flushing
	1. Procedures for flushing the hydraulic system (including the list of equipment to be supplied for this purpose and method to ensure cleanliness) shall be submitted as part of the installation instructions. The instructions shall conform to ASME LOS-5CI and shall include the criteria specified below.
	i) Flushing Of Hydraulic Cylinders : Hydraulic cylinders need not be flushed at site. They shall be delivered to job site filled with hydraulic oil in a faultless and clean condition. Oil shall be new and conform to the requirement of relevant specifications to be approved by the Engineer-in-charge. The cylinders must not be connected to the hydraulic system until the Engineer is satisfied that the cylinders have been cleaned of foreign matter. Oil used in flushing must not be used to fill the hydraulic system.
	ii) Flushing Of piping : Before installation of hydraulic power unit, cylinders and manifolds, all hydraulic piping must be flushed. By-pass loops of piping must be installed in place of cylinders, manifolds, and the power units. Hydraulic oil

	must be circulated through each and every pipe until returning oil meets NAS 1638, Class 8 requirements or equivalent.
	iii) Flushing Of Hydraulic Power Unit: After cleaning and prior to shipment, each hydraulic power unit shall be flushed in the suppliers shops. The hydraulic tank shall be filled with hydraulic oil as specified and the oil filtration system actuated with a 10 micron element in the filter. The oil shall be circulated and filters changed as they become clogged. The power unit shall be flushed until the filter stays clean. After flushing of the fluid in the tank is complete, a bypass loop with filter shall be installed on the pressure and tank lines of the unit and the pumps shall be run alternately until the return oil line has no foreign particles greater than 10 microns in size.
	iv) Flushing Of Valve Manifolds: After cleaning and prior to installation, each valve manifolds must be flushed by circulating hydraulic oil through all ports until the cleanliness of the return meets NAS 1638, Class 8 requirements.
1.1.12.10	Gantry Crane and Lifting beam for operation of Construction sluice gate, Emergency gate and Intake bulkhead gate
1.1.12.10.1	DESIGN, MATERIAL AND WORKMANSHIP, REQUIREMENTS OF COMPONENTS Design The design of gantry cranes, hoists and lifting beams shall conform to the most up to date practice for equipment of this class. Materials and design shall be determined in view of ease of operation and low maintenance cost. The Contractor shall take into consideration the fact that lubrication will be carried out twice yearly. The Contractor shall provide smooth surfaces wherever possible, to ensure ease of application and renewal of rust protection. For the determination of the travelling capacity, all friction and dynamic forces and wind load shall be considered. The crane shall be statically stable with and without any load up to wind pressures of 150 kg/m² acting on vertical surfaces in any direction. Operating shall be possible up to wind velocity of 90 km/h. The capacity of the control mechanism for the engagement hooks of the lifting beam shall be as required by the design. It shall be equipped with a torque limiter that limits the tension on the control wire rope, thus avoiding damage to the operating mechanisms of the lifting beam.
	GANTRY DRIVE

	a) Long Travel Drive - The gantry crane / cross travel trolley of hoist motion shall be effected by means of motors and shall be designed to move the crane at a rated speed while supporting the rated hook load. Not less than 50% of the wheels on each track shall be connected for driving. Each motor shall be mounted at one end of the gantry crane / cross travel trolley of hoist and shall be arranged to drive on track on each side of the crane through gears. The drive motor shall have same characteristics and operated by common switches so that there is no skew in the movement of gantry. The general arrangement is shown in the drawing. The drive shall be free from vibrations while moving and in no case, there shall be any tendency for gantry crane structure to get misaligned. b) Cross Travel Drive - Cross travel motion of the hoist shall be affected by means of a geared motor or a motor with a worm reducer, in combination with other gearing system (if required). The system shall be designed for a rated speed of 0.5 meter / min. while supporting the full load plus dead weight of the equipment. - Automatic electromagnetic brakes shall be provided in this motion in addition to limit switches to arrest the motion of fully loaded crab safely to rest least possible jerk.
	Design Stresses The maximum vertical deflection of the crane bridge caused by the nominal load shall not exceed 1/1000 of the span. Wire ropes and mechanical parts shall be so designed to conform to permissible deformations according to their utilization. The greatest attention shall be paid to notching encountered, as given in the corresponding design rules. The fatigue strength of the material shall determine the reduction of permissible stresses, in the presence of dynamic or alternating loads. The capacity of the gantry crane shall be designed for an overload capacity of 110% of rated capacity. To meet earthquake loading conditions, the design shall take into account an acceleration of 0.16 g in any horizontal direction and two thirds of the horizontal coefficient in vertical direction.
	Material All materials to be used shall be up to standard, particularly as to weldability, brittle fracture, aging, wear and tear, rust resistance etc. For the main load-bearing systems, materials with guaranteed tensile strength, yield point and strain at failure

	shall be provided. For parts, which are most likely exposed to tensile stress or varying stress fine-grained steel with guaranteed notch impact resistance must be used. For parts under low stress low-grade steel may be used. For rotating or sliding mechanical members, only stainless steel shall be used, unless they are completely sealed and lubricated. Sliding shall be adjusted with great precision. The hoisting wire ropes and the lifting beam action wire rope shall be galvanized.
1.1.12.10.2	CORROSION PROTECTION
	General The rust protection of the work shall be executed. All structures shall receive the complete corrosion protection before leaving the workshop, unless otherwise specifically stated in the following sections of the PTS. Site weld zones shall be completed and defects repaired after erection. All painting shall be effectuated in accordance with IS. Paint System A For Gantry Crane, lifting beam and rails (runway). Hot-Dip Galvanizing For handrails, seal clamp bars and other small parts, such as washers, bolts, nuts (if not of stainless material), etc.
	Tolerances The tolerances of machined parts shall be marked in the drawings to be submitted. They shall be determined by the Contractor in such a way as to maintain low wear and tear during operation. Clutch bolts, axles, press guides, etc. shall not be overstressed by forcing due to erection inaccuracies. The erection tolerances are to be determined according to these considerations. For steel bearing parts, the Contractor is responsible for limiting the deviation from the theoretical sizes in such a manner that he can ensure a trouble-free and safe operation of the cranes.
1.1.12.10.3	SPECIFIC REQUIREMENTS OF COMPONENTS

	General Preferably all shafting to which gears, pinions and other similar parts are fitted shall be provided with a raised portion and/or a shoulder where such parts are carried. Any change of section of shaft shall be effected with fillets of ample radius. All gearing other than the final drives to the main hoist drums, shall be enclosed in gear boxes with automatic oil circulation, oil filling and drain connections, oil level indicators and inspection covers. The gear boxes shall be fitted throughout with ball or roller bearings. The interiors of all gear boxes shall be painted with oil resistant paint. All bearings and other wearing surfaces shall be provided with means for lubrication, preferably by automatic circulation. Points for lubrication by grease gun shall be suitable for the same make and grade of grease nipple of the all steel, one piece button-head type. All grease nipples shall be readily accessible and grouped together wherever possible. Removable sheet steel covers and lubricant drip trays shall be provided for open gearing. All gear boxes, motors, bearings and similar shall be positively located, after alignment, other than by their holding-down bolts.
	Hoist The hoist shall be of a wire-rope type, designed to function in the open air, suitably mounted for raising and lowering the lifting beam with a coupled single stoplog/bulkhead unit. The hoist shall consist of structural-steel framework, mechanical equipment including torque shafts, bearings, sheaves, gear reducers, couplings, rope drum, wire ropes, mechanical position indicators, motor brakes, torque limiters, limit switches, slacks-rope switch and all other necessary components. The hoists shall be arranged so that the line of action of the lift maintains its alignment with the stoplog/ gates guides when handling the panels. The hoist ropes shall have fibre cores with internal lubricant and shall be hot-dipped galvanized. The hoist drums shall be fitted with ball or roller bearings and shall operate on shafts, arranged in such a way that a drum and shaft can be readily removed together. The hoist drums shall be of cast iron or fabricated steel construction and shall incorporate accurately machined grooving designed to accommodate the hoisting ropes in a single layer. A self-aligning brake shall be fitted to the motor/gear box coupling of the hoists and shall operate automatically as soon as the power supply to the motor is interrupted. All working parts of the mechanical and electrical components shall be protected

	from the weather. Easy access shall be provided to facilitate inspection and repair. Access ladders shall be provided.
	Supporting frame The supporting frame shall be of fabricated construction. Wherever possible, frame steelwork shall be arranged to support chequer plate walkways for convenient and safe access to all equipment on the frame. Lifting lugs shall be incorporated to facilitate handling the assembled frame. The frame shall be totally enclosed by a robust weatherproof machinery housing constructed from galvanised steel sheet with a steel frame. The machinery housing shall be hinged to allow access to the hoist machinery, and shall be readily handled by one man. All handrails, flooring, and covers shall be hot dipped galvanized.
	Brake
	a) Main Hoist brake / hoist cross travel trolley brake 1) The Main hoist / cross travel trolley of hoist shall be provided with an automatic electro-magnetic brakes of suitable capacity. The brakes shall be mounted on the same base as the hoist motor. The electromagnetic brakes shall be of spring set, shoe type solenoid operated and of continuously rating. These shall be equally effective in both directions of travel and shall be capable of overcoming at least 150% of the full load torque exerted by the motor. 2) The brake shall set automatically, when the current is cut off from the motor and shall be electrically released, when the current is applied to the motor. The terminals of the brake magnet shall be protected from accidental contact. The connections and winding shall be effectively protected from mechanical damage. The magnet shall be provided with an efficient cushioning device. In case the gearbox selected does not have self-locking characteristic. One additional electro-hydraulic. Thruster brake shall be provided between the winding drum and the source of power for safety. The additional brake shall have same rating and shall be designed to prevent the load from moving downward unless the hoist motor are revolving under power in the lowering direction. The additional brake shall also be provided to control the hoist cross travel trolley in both directions of motion. These

	shall be arranged in such a way that service brake shall apply first and additional brake tag in application. The mechanical brake shall preferably be of suitable multiple disc type & shall run in a bath of oil. The casings shall have sufficient heat dissipating capacity to maintain the temperature of bath below 93 degree centigrade when lowering the rated load with the electric brake in operation, and if required, an external cooling device shall be provided to prevent this maximum temperature from being exceeded. 3) The electro-magnetic brake shall be of DC type complete with rectifier equipment to covert the available AC supply. However, the electro-hydraulic thruster brakes shall be of AC type. 4) The brake shall be rated on continuous duty basis and shall be capable of withstanding not less than four operations per minute. The brake shall be equipped with manual release, which must be held by hand and can not be left in the released position or one which will automatically reset at all times when the power is disconnected. A weather proof cover complete with heaters to prevent the condensation on moving parts. b) Gantry long travel motion and parking brakes 1) A shoe type mechanically or hydraulically operated brake controlled through a foot pedal in the operator's cabin shall be provided to control the crane long travel in both directions of motion. The brake shall have a capacity equal to one and a half times rated full load torque of driving motors and shall be so designed that it may be secured in the set position. The foot brake shall require a force not more than 25 kgs. At pedal and the pedal stroke shall not exceed 250mm. Electromagnetic brakes shall be provided for parking of crane / hoist cross travel trolley, which shall apply automatically when the current supply to the mains is switched off. Suitable anchoring arrangement shall also be provided to hold the crane during storm wind.
	Traverse Brakes All brakes shall have non-asbestos lining material and shall be capable of being replaced without removing other components. Self-aligning brakes shall be fitted to the motor/gear box coupling of the traverse drive units of the hoist. The traverse brakes shall be released as soon as the respective hoist button is activated and shall operate only when that button is released by tripping of the respective traverse limit switch or any other operation that causes that circuit to open.

	Load Limiting System The hoist shall incorporate a load limiting device, electrically or hydraulically operated, which effectively stops the hoist once a pre-selected load is reached. The device shall be adjustable within the limits of plus 10 per cent and minus 20 per cent of rated capacity and with accuracy relative to the set point of ± 5 per cent.
1.1.12.10.4	Electrical Equipment
	General All electrical equipment and controls shall comply with BS 466, the IEE Wiring Regulations. The Contractor's attention is drawn to the likely presence of hydrogen sulphide and methane gases in the area during spillway operation. Anti-condensation heaters as, shall be provided in enclosures for electrical equipment. Power Supply to the Hoist The Contractor shall provide and install one lockable hoist main disconnecting switch. The main disconnecting switch shall be provided with two gland plates, one plate shall be used to gland the cable connecting the main disconnecting switch to the hoist, while the other plate shall be allocated to gland the power supply incoming cable from the main distributing panel. The isolator cabinet shall be suitable for outdoor use.
	Limit Switches Series 'power circuit', whole current over-hoisting limit switches shall be fitted to the hoist of the crane. In addition, shunt-type limit switches shall be fitted to the hoist to control the limits of travel in the 'lower' direction and to supplement the whole current over-hoisting limit switch in the 'raise' direction. Shunt-type limit switches shall be provided for the travel motions. All limit switches shall be self-resetting and shall be electrically connected in a manner permitting 'backing-out' after tripping. The limit switch strikers for the travel shall be so positioned that should 300 mm over-travel occur after actuation of a limit switch, buffers on the end bogies will engage end stops. Slack rope detection limit switches shall be provided for the hoist.
	Motors

	Motors shall be to IEC 60034 or IS: 4722 and of duty type not less than S3 when without electrical braking or not less than S5 when with electrical braking. The method of motor control shall give smooth automatic acceleration and deceleration of the driven motion. All hoist and winch motor protection shall include single phase failure.
	Control and Protection The control boards shall include but not be confined to: • A triple-pole switch-disconnector, • Triple-pole magnetic overload relays for each motor, • Single phasing protection for each hoist motor, • 'Power on' indicator light, • Control circuits in accordance with the requirements of this specification. A control and protection panel housed in an enclosure of dust-proof, sheet metal construction, incorporating a hinged door and hinged panel, shall be mounted within the bridge member and shall be accessible from the fixed platform. The equipment fitted to the hinged panel shall be back connected wherever possible and shall include an externally operated, triple-pole switch-disconnector; triple-pole main contactor; and all necessary fuses, controls, circuit-breakers, relays, switches and wiring.
	Lighting Two (2) 1,500 W narrow beam floodlights shall be fitted and aligned for illumination of the stoplog / gates slots. Luminaries for the hoist shall be of the floodlight type with corrosion resistant weatherproof aluminium alloy housing and toughened front glass. Floodlights shall be adjustable in both the horizontal and vertical planes. All luminaries shall use colour corrected high pressure mercury vapour or metal halide lamps. Control gear if not integral with the luminaries shall be housed in corrosion resistant weatherproof aluminium alloy housings. The power factor of any luminaries shall be not less than 0.85 lagging.
1.1.12.10.5	INSPECTION AND TEST
	Material Test The extent of the test of material, the test procedures and limits of acceptance are listed below. Based on these requirements the Contractor shall prepare a list

	enumerating all components of the supply to the tested and the corresponding test to be carried out. The Engineer-in-charge, however, reserves the right to request further test, if he deems such necessary. Test shall be carried out on the materials of the following parts and supported by certificate test reports Wire ropes: Breaking test Welding: All welders and welding operators assigned to weld important steel structures of the cranes, as main girders, etc., shall pass a qualification test. All butt welds on web plates and flanges in the middle part of the main girders (at least 1/3 of span) shall be subjected to 100% ultrasonic and 10% X-ray test. All butt welds on the remaining parts of the cranes, as well as fillet welds exposed to stresses exceeding 1000 kp/cm^2, shall be subjected to non-destructive test, i.e. 100 % ultrasonic examination with radiographic spot-checks in case of doubtful Ultrasonic indications. Radiographically tested welds shall comply with the colour-class “blue” of the latest edition of the collection of reference radiographs of welds as issued by the “International Institute of Welding”.
	Shop Assembly and Shop Test All parts of the equipment, as far as practicable, shall be assembled at the Contractor’s work shop to the extent necessary for the purpose of inspections, testings and otherwise ensuring that they will function satisfactorily. Exceptions to this rule may be permitted by the Engineer-in-charge. All parts shall be correctly dowelled and match-marked to facilitate assembly at site. In particular, the following inspections shall be carried out under the supervision of the Engineer-in-charge. • Checking of the main dimensions • Operational test of all devices, including measuring of the operating speeds and of the load switches • Function test of the complete control system. All the test equipment shall be provided by the Contractor.

1.1.12.10.6	TEST ON COMPLETION
	Pre-Commissioning The following verifications and test shall be made: • Verification of perfect alignment of the cranes and runways. • Check of all important clearances Electrical testing of correct wiring and cabling of all control and monitoring circuits. • Testing and setting of all relays, limit switches, etc. • Functioning test with coupled lifting beam, handling of stoplog/ bulkhead elements, trial or dogging device. Commissioning (Operation and Performance Test) The following test shall be made: • Testing of the correct functioning of the cranes, including travelling and hoisting ranges (without load) • Static and dynamic load test • Working of the lifting beam under water All testing equipment, including test loads, test load carrying structures, ropes, etc. shall be provided by the Contractor.
	TRIAL OPERATION After successful termination of all operational test, cranes shall be subjected to a trial-operation period under the Contractor's supervision and responsibility. During this period the Client's staff shall be fully acquainted with the operation and routine maintenance of the equipment. The trial operation period shall last 2 months. The Taking-Over Certificate will be issued after satisfactory trial operation period.
1.1.12.10.7	Miscellaneous equipment details :
	a. The following specifications, referring to miscellaneous design details shall be applied to all equipment specified in the contract Documents.
	b. Locking of Bolted Connections: All screws, bolts, and nuts shall be provided with a locking device. Selection of means shall consider service conditions according to the following guidelines :

	i) On parts which may be subject to vibration and on connections which require repeated adjustment or which are not readily accessible (such as bolts or nuts inside of a hoist cylinder), a positive and reusable locking device shall be provided on all bolts, such as a castellated nut with cotter pin or a soft copper locking plate or washer bent over the nut and a fixed point on the structure.
	ii) On all other parts, either a positive reusable locking device or spring steel lock washers shall be used on all bolts. Lock washers shall be used in combination with a chemical thread locking compound when required. The selection of the compound shall consider the requirements for disassembly and maintenance.
	c. Handling Provisions: All parts, components, and assemblies which are heavier than 12 kg. shall be provided with suitable provisions for handling, such as eyebolts, lugs, hooks, tapped holes for eyebolts, or holes with rounded corners for passing slings.
1.1.12.10.8	Automatic Lifting Beam For Construction Sluice Gate, Emergency gate (Irrigation and Low level Sluice Gate) and Bulkhead Gate (Intake service gate)
	Separate Automatic lifting beam shall be provided for operation (both for raising & lowering) of Construction Sluice Gate, Emergency gate (Irrigation and Low level Sluice) and Bulkhead Gate (Intake bay) which shall be treated as part of these specifications. The criteria for design of lifting beam in general shall be as per IS: 13591 (latest revision).
	General (i) Automatic lifting beam shall mainly comprise of the following components, details of which are given as under: (ii) Two side guide shoes shall be provided on each side of the lifting beam. Guide shoes on the same side shall be adequately separated from each other to prevent any tilt of the lifting beam during operation. The centre to centre distance of side guide shoes shall not be less than one tenth of the length of the lifting beam or 500mm whichever is more. (iii) Hooks: Lifting beam hook mechanism shall provide for automatic engagement and release of the equipment to be handled. The two hooks shall be

	mechanically linked together for simultaneous operation. (iv) Hook profile shall be such that with the consideration of the guide plate location and of the clearance provided on the gate equipment to be handled, the hook shall work properly even in the worst condition of alignment due to guide shoes and manufacturer's deviation from design dimensions. (v) The hooks and lifting lugs provided with lifting beam shall be located at centre of gravity of the gate equipment to be operated when the lifting beam guide rollers are engaged in the guide. (vi) The engaging surface of the hooks profile shall be hard faced to a maximum of 10mm depth and shall be machined smoothly for uniform bearing of pin. (vii) In case of curved shaped hooks, the design shall be done as curved beam with appropriate structural design method. (viii) The lifting beam shall be counter weighted as required to hang plumb and level when suspended. (ix) All rotating parts of the lifting beam shall be provided with corrosion resistant steel pins and aluminum bronze bushing bearings. All nuts, bolts and washers and retaining devices for pins shall be of corrosion resistant steel. (x) The lifting beam shall be provided with suitable stoppers which shall rest on the gate equipment to be handled /engaged in spear rods provided on gates when it is lowered and pull of the hoist is completely released. (xi) Seating brackets shall be provided to store the lifting beam on the floor without damaging the hook. The bracket shall be retractable when required to avoid interference with gate equipment when lifting beam is in operation.
	Mandatory Features (i) General features indicated in the specification drawings shall be adopted without change or substitution. Alternative arrangement and alternative features for those indicated on specification drawings shall be accepted only if in the opinion of the employer, the same are superior to the arrangement and details indicated in the specification drawings. Mandatory features shall be as under:- a) All features referred to in these specifications and as shown in the specification drawings. b) Features related to civil construction and equipment to be finished by other

	agencies such as civil works out line dimensions and gantry. c) General layout and arrangement of the equipment to be handled and the dimensions defining the location of equipment relative to civil work. d) Dimensions, clearances, measurements etc. designated by "Maximum" & "minimum" to be applied as upper or lower limit for design. All tolerances mentioned in the drawing/related Indian Standards and as recommended by the employer. e) All machining involved and designation of surface finish qualities. f) All indications referring to manufacturing processes (such as "Machine after welding" or "Drill during shop assembly") as contained in specification drawings and related I.S. standards. g) All applicable Indian Standards shall be as specified by the employer. (Request regarding adoption of particular standard only, from contractor shall not be binding on the employer). h) If lifting frame is used, the height of the frame should not be less than 1/12 of span or 1m whichever is more. i) While computing the lifting beam deflection, it should be ensured that due to the deflection of beam, side guide shoes do not develop excessive gap between guide tracks. This check has to be ensured and rigidity of the beam shall cater for this also along with that of beam itself.
	Design Loading (i) General The lifting beam shall be designed to comply with the specified structural and mechanical requirement when subjected to each one of the loading conditions listed in the subsequent paras. Calculations may be limited to critical loading cases if it is evident that only those cases are critical. If the selection of critical cases is not evident or if so requested by the employer, the manufacturer shall furnish the technical demonstration to justify its selection. All load combinations shall be made as specified in these specifications and related Indian Standards. Whenever any particular load specification is not specified, the method of calculations shall be submitted to employer for his approval. The overall design loading shall be such that with unfavorable load combinations, greater factor of safety is achieved in design.

	(ii) Design Load The lifting beam shall be designed to comply with the specified structural and mechanical requirements. The lifting beam and their connections with Gantry Crane and gate shall be designed for following conditions:- - Hook loading arrived from appropriate Crane capacity with impact factor of 1.3 under the normal conditions. - Breakdown Torque conditions of Gantry Crane motor as revealed from rope tensions due to gantry Crane hoist breakdown, impact factor need not be considered here. - Loading caused by the guiding system shall be calculated and accounted for in (a & b) above as under:- - When gate is not submerged, the effort required to counteract gate swinging shall be considered as higher of either 5% of the weight of gate or surface loading of 20 kg/sq.m. Gate area to be considered in either direction, shall be projected area of gate outline. - Water turbulence shall be considered as force acting on projected area of the lifting beam of the intensity of 200 kg/sq.m - Additional friction and/or blocking forces originating in the guiding devices and seals of the gate when the hoist exerts a force equal to the rated hoist capacity, instead of the normal hoisting force. - Dead weight of the lifting beam along with its hooks, spring loaded guide shoes, links etc. shall be combined with all operating loading conditions. (iii) Structural Design The structural design of the lifting beam/frame shall conform to IS:13591 (Latest Revision) (Criteria for Design of Lifting Beams) and IS:800 (Latest Revision). Various provisions as mentioned in IS: 13591 (Latest Revision) and IS: 800 for structural components shall be met with allowable stresses as specified in these specifications. Whenever specific value of stress or design factor is not specified, decision of employer shall be final.
1.1.12.9	Life Expectancy
	Mechanical computations based on life expectancy shall consider an equivalent service of 5,000 hr referred to nominal (rated or design) loads, 10,000 starts shall be

	the basis of design for those parts whose design is governed by the number of starting and stopping operations.
1.1.12.10	D.G. Set
	One no. three-phase synchronous type diesel generating set of 300 KVA (or above) are envisaged for the emergency operations of the hydro mechanical equipments at the weir site.
1.1.12.11	Inspection and Testing
	i) Shop Tests :
	All equipment shall be checked by the Contractor as per QAP in order to ascertain its correct functioning and shall be witnessed by the Employer / Owner.
	ii) Site Tests :
	Tests to be performed shall include, but not be limited to, the following :
	a) Checking of sensitivity of all Equipment,
	b) Checking of correct functioning and correct calibration of all Equipment.
1.1.12	MATERIALS
	All members and components listed under these specifications shall be fabricated out of unused high grade materials free from any kind of defects and imperfections. All the materials shall conform to the standards specified in these specifications, however, if for any reasons the contractor desires to deviate from these standards, he shall submit a statement stating the exact nature of deviations or substitutions along with complete and detailed specifications and test reports of the materials which are proposed to be used as substitution or deviation, for the approval of the Employer, prior to the fabrication work is taken up in hands. All such materials or articles or supplies, which are not manufactured by the contractor, shall be the product of recognized and reputed manufacturer. The contractor shall furnish a list of names of the manufacturer(s) for the bought out items equipment, which are contemplated for incorporation in the work, together with their performance characteristics and other pertinent reports along with the samples of the materials, shall be submitted for approval of the purchaser. However the approval of purchaser shall not relieve the manufacturer from the

	responsibility of supply of suitable materials. Any material or equipment used or installed with no prior approval of the purchaser shall be at risk and cost of the contractor. Recommended materials for some of the components of different type of gates & hoists involved are given below :		
1.1.13.1	Fixed Wheel Gate		
	S. No. Component	Recommended Materials	Reference
	1. Skin plates, Stiffeners	Structural Steel	IS-2062 Grade E250, Quality B
	2. Main horizontal girders, Vertical girders etc.	Structural Steel	—— do ——
	3. Seal bases, Track bases, Seal seat bases Seal clamps guide shoes	Structural Steel	—— do ——
	4. Anchor plates, Anchorages etc.	Structural Steel	—— do ——
	5. Side guide tracks	Structural Steel	—— do ——
	6. Seal seats	Stainless steel, X04Cr18Ni10	IS-1570 (Part-V)
	7. Wheel tracks	Corrosion resistant steel plates X30Cr13 (BHN of wheel track should be more by minimum 50 points than that of wheel)	IS-1570 (Part-V)
	8. Wheel	Cast steel/Forged Steel	IS-1030/IS-2004/1875
	9. Wheel pin	Stainless Steel	IS-1570 (Part-V)
	10. Bearings in Wheels	Spherical Roller SKF or equivalent Bearing	
	11. Side and top Rubber Seals	PTFE clad solid bulb music note and double	IS-11855, IS-15466

		stem type respectively	
	12. Bottom seal	Wedge type rubber seal	IS-11855,IS-15466
	13. Bonnet Assembly & Cover	Structural steel	IS-2062 Grade E250,Quality B
	14. Steel liner	Structural steel	IS-2062 Grade E250,Quality B
1.1.13.2	NOTES		
	The above details shall be read in conjunction with the following notes.		
	i) In all the reference cited above the latest revised edition of Indian standards or equivalent shall only be followed. In case the contractor proposes to use materials different from those mentioned above, he should mention the same in his tender and indicate the exact extent to which he proposes to use, furnishing necessary details for approval of the purchaser. Materials conforming to international standards like ASTM, DIN, which are equivalent to those mentioned above, can be used with the approval of the purchaser.		
	ii) The sizes, ratings, capacities, and dimensions of the various standard equipment items listed in the contract Documents are based on currently available standard products. Reasonable deviations will be allowed to permit supply of standard equipment. In no case the capacity furnished shall be less than that specified, unless approved.		
	iii) Threaded fasteners, pipes, anti-friction bearings and gears : – All bolts, nuts, screws, rivets, threads, pipe, ball and roller bearings, gauges and gears shall confirm to US/BIS/DIN Standards. Screw threads for screws, bolts, nuts and other threaded hardware shall conform to ANSI B 1.1.		
	iv) Asbestos: Equipment and materials such as, gaskets, packing, brake pads etc. shall contain no asbestos products.		
1.1.14	LIST OF SOME REPUTED MANUFACTURERS OF MECHANICAL AND ELECTRICAL ITEMS TO BE USED IN HYDROMECHANICAL INSTALLATION FOR REFERENCE		
	S. No. Item	Make	
	1. Bearings	KOYA, NBC , NACHI, SKF, FAG, NSK, NTN etc.	
	2. Welding electrodes	Modi, Adore, D&H, L&T , Esab etc.	

	3. Hydraulic Cylinder	Rexroth Hydrodyne, Hunger, Montan
	4. Hydraulic Power Packs	Rexroth, Vickers, Montan
	5. ARMAC/Remote Control System Type : PLC	Allen Bradley, Rockwell, Siemens, ABB, Schneider Electric
	6. Gasoline Engine for Portable Power Pack	Kohler, Honda, Yamaha
	7. D.G. Set	Caterpillar, Kirloskar, Cummins, Greaves Cotton
	8. Hydraulic Oil Cleaning Unit for Hydraulic Hoists	KLAROL Oil Cleaning Systems
	9. Reduction Unit	New Allenberry, Allen-max, Allmax, Shanti, Allroyd, David Brown, Elecon etc.
	10. Flexible coupling	New Allenberry.
	11. Motors	Siemens, Kirloskar, NGEF, GEC, Crompton Greaves, etc.
	12. Brakes	Bhartia Cutler Hammer, Electromag, Strom Kraft, Elmar AEC Sterling etc.
	13. Steel wire ropes	Usha Martin, Fort William, Bombay wires, Winkel GMBH, Bharat wire ropes, etc.

1.1.15	METAL WORK FABRICATION, MACHINE WORKS, WELDING, PAINTING AND MISCELLANEOUS
	All the works shall be performed and completed in a thorough workman like manner as per the best modern practice in the manufacture and fabrication of materials of the types covered by these specifications. The work shall in all cases be of high grade and carefully performed to the satisfaction of the authorized representative of the purchaser. The bidder shall warrant all materials and workmanship furnished by him to be free from injurious and defective materials or defective workmanship and shall bear all cost of the repair in case of any error for which he is responsible. Workmanship shall conform to the relevant

	standards laid down by the Bureau of Indian standards. All sharp corners, which can damage the matching parts, shall be rounded and shall be chamfered.
1.1.15.1	TOLERANCES
	Where tolerances or fits are not specified on the drawings the bidder shall follow the best modern shop practice for apparatus of the type covered by these specifications and drawings, due considerations being given to the special nature of function of the parts and to the corresponding accuracy required to secure proper operation.
1.1.15.1.1	Fabrication Tolerances
	All components shall be fabricated in accordance with the relevant I.S. codes on gates & hoists except as noted below : All dimensions under 400mm shall be ± 0.8 mm unless otherwise specified and are non cumulative. All other dimensions shall be ± 1.5 mm.
	The machined sealing surface of the sill shall be straight within 0.5mm and level within 1.0mm over the whole length with a straight edge.
1.1.15.1.2	Installation Tolerances
	Installation tolerances shall not exceed 1.5 times the corresponding fabrication tolerances or the tolerances specified in relevant codes on gates and hoists, whichever is the more stringent. Design and fabrication of the gates, hoists and embedded parts shall be suitable for the achievement of such tolerances during installation.
1.1.15.2	MACHINE FINISH
	Where finished surfaces are not specified on the drawing, the type of finish shall be that most suitable for the part to which it applies and shall be as per IS: 3073 (latest edition).
	A smooth finish ($\nabla \nabla$, i.e. roughness value Ra between 1.6 to 6.3 microns) will be required for all surfaces in sliding or rolling contact and for surfaces in permanent contact, where a tight joint is required. A finish (single delta, i.e. roughness value, Ra, between 12.5 to 25 microns) shall be given to all other machined surfaces specified on the drawings or otherwise required. The parts shall be ground, if necessary, to obtain the limiting tolerances.

1.1.15.3	CASTINGS
	All castings shall be true to pattern, of workman like finish and of uniform quality and condition, free from injurious blow holes, porosity, hard spots, shrinkage defects, cracks or other defects as determined by visual inspection and shall be satisfactorily cleaned for their intended purpose and the thickness of metal shall not vary at any point by more than 5mm from that shown on the drawings. The surfaces of castings which do not undergo machining, particularly those in contact with water, shall be dressed smooth with all joints blended into adjacent surfaces and shall be free from foundry irregularities, such as projections, ridges, hollows, honeycombing, pock marks or chip marks, so that they will not require surface smoothing operations prior to painting.
	All defects shall be fully explored and casting shall not be repaired, plugged or welded without permission from the Engineer-in-charge. Such permission will be given only when the defects are small and do not adversely affect the strength, use or machine ability of the castings.
	All joints shall be machined, all bolts heads and nut location shall be spot or back faced, Castings shall be machined on all surfaces which act as bearing surfaces.
	No major welding shall be carried out after the casting is finally annealed. No defect shall be removed and the paint or oil be applied to the surface of any casting until it has been inspected by the purchaser or his authorized representative. An excessive segregation of impurities or alloys in a casting may be the cause for its rejection. Large fillets compatible with the design shall be incorporated whenever change in section occurs. The casting mould and casting practice shall be designed to minimize the occurrence of hot tears or shrinkage cavities. Casting moulds shall be designed to allow free contraction upon cooling to minimize the concurrence of high stresses caused by the mould or chills. Casting repair welds shall be carried out in accordance with relevant IS Standards.
	Test coupons from which test specimens are prepared shall be attached to all castings weighting 250 Kg or more. The number, size and location of the test coupons shall meet with the Engineer-in-charge's approval. Heat numbers shall be stamped permanently on the casting.
	Repair welding on steel castings, if approved, other than repair welding of minor

	defects, shall be done by the metallic arc process followed by thermal stress relieving. Repair welding on iron casting will not be permitted.
1.1.15.4	FORGINGS
	Forgings, unless otherwise specified, shall be in accordance with IS 2004. The ingots from which the forgings are made shall be cast in metal moulds. The workmanship shall be first class in every respect and the forgings shall be free from all defects affecting strength and durability, including seams, pipes, flaws, cracks, scales, fins, porosity, hard spots, excessive non-metallic inclusions and segregations.
	All forgings shall be given such uniform heat treatment as required to produce materials conforming to the requirements of these specifications, and shall be annealed or normalized and tempered as final heat treatment. In the case of shafts forged solid, which are required to be bored, the final heat treatment shall be performed after the forging has been rough bored.
	In each heat treatment, the forging shall be held at the desired temperature for a sufficient length of time to ensure penetration of the heat and proper grain refinement throughout the whole forging. A record of the heat treatments to which the forgings have been submitted shall be supplied to Engineer-in-charge.
	In case of shafts forged solid which require boring the final heat treatment shall be performed after the forging has been rough machined. The largest fillets compatible with the design shall be incorporated wherever a change in section occurs. Tool marks or tearing of the metal by the finishing tool will not be acceptable on the surface of fillets. Such marks, if they occur, shall be removed by grinding or polishing. All finished surfaces or forgings shall be smooth and free from tool marks.
	All important forgings like gate wheels, wheel pins, hoist drum, gears, crane wheels etc. shall be ultrasonically tested. The acceptance limit of ultrasonic testing of forging shall be as per SA 388 of ASME Section-5.
1.1.15.5	RUBBER SEALS
	Rubber seals shall be of the molded type only. The materials used for rubber seals shall be compound of natural rubber or a copolymer of butadiene and

	styrene, or a blend of both, and shall contain reinforcing carbon black, zinc oxide, accelerators, anti-oxidants, vulcanizing agents and plasticizers. The contractor shall provide all seals with test certified for adequate temperature and age resistant properties which will provide, in the molded form, suitable sealing properties.		
	The seals shall meet the following properties when tested in accordance with the ASTM /IS Standards :		
	Properties	Limit	Test Method
	Shore A durometer hardness	65 ± 5	IS-3400(Part-23):2002
	Tensile strength	14.5N/mm ² minimum	IS-3400(Part-1):1987
	Water absorption in seven days percent max.	10 percent by weight maximum	IS-3400(Part-6):1983
	Compression set	30 percent maximum	ASTM D395
	Aging	Min 80% of tensile strength before aging	IS-3400(Part-1):1987 & IS-3400(Part-4):1987
	All corners shall be pre moulded and have a suitable radius on the inside edge. All joints, both shop and field, shall be located at a reasonable distance from the corners and shall meet the following requirements :		
	All shop joints shall be vulcanized. Joint geometry shall be such as to avoid feather edges on the sealing surfaces.		
	Field joints shall be kept to a minimum and shall be accurately machine cut and carefully butted during assembly to an interference fit. The field joints shall be held with double fasteners on each side of the joint.		
	Vulcanized joints shall not break or tear when bent 180 degrees around a mandrel of a diameter equal to the maximum cross section thickness of the seal.		
	The longitudinal strength in tension of vulcanized joints shall be not less than 71.4 kg/cm ² as verified by tests on a tensile specimen prepared from one joint in accordance with ASTM D15 Part C. The joint tested shall be located at the midpoint of the test specimen and its strength determined in accordance with		

	ASTM D412.
	The joints in the rubber seal shall be vulcanized butt joints and at right angle to the rubber seal. Oblique joints at the corner shall not be permitted in the rubber seal. Vertically placed strips of rubber seals shall be formed in one piece and no joints of any sort shall be permitted in them.
	Sufficient quantity of seal jointing compound shall be supplied along with rubber seals for site requirements.
1.1.15.6	FABRICATION OF STRUCTURAL STEEL
	Structural steel work shall conform to the requirement hereinafter specified, unless otherwise called for in these specifications or on the drawings. Finished members shall be free from twists, bends and open joints. Compression joints depending upon contact bearing shall have surfaces truly faced so as to have full contact bearing when aligned and riveted or bolted.
1.1.15.7	Gates
	i) The gates shall be of welded steel construction with dimensions as shown in drawings. All parts of the gates shall be fabricated in strict accordance with the Standard as per specifications. Special care shall be taken in fabrication of parts affecting the strength, rigidity or water tightness of the gates. All pockets or depressions shall be provided with drain holes to prevent collection of water.
	ii) The structural members of gates shall be securely connected by welding or by fit bolts. Highly important joints and connections, which will be heavily stressed under load, shall be made without flaw. These joints shall include the connection between horizontal girders and end girder box, splicing joints in gates and stop logs. For welding of such connections only, the best-qualified welders shall be assigned. The splicing arrangement shall be designed to allow flexibility in the gate assembly to facilitate installation. All splices shall be designed with watertight sealing arrangements. The welding procedure for the gate body shall be planned to control and minimise distortion. All welded connections shall be fully welded.
	iii) Care shall be taken that the side seals of gates bear evenly and with uniform pressure throughout their length on the side seal seats embedded in the faces of

	the piers and that the bottom seals bear evenly on the bottom seal seat (sill) embedded in the crest. Elsewhere welded plates thicker than 28 mm will also be stress relieved. The roller axle supports and lifting connection shall be accurately line bored and machine faces maintained in proper location, alignment and tolerance so that the axis of all such holes be perpendicular to the vertical centre line of the gate and shall lie in a common plane which shall be parallel to the finished surface for the seal bases. The wheel pins shall be machined very accurately. Boring of main roller axle support hole shall be done on the assembled gate section. The sealing faces for the vertical seals, bearing bars and lintel seal shall be machined on the assembled gate to ensure the gauge distance and alignment are maintained. Slide type gate seal bases and thrust pads shall be machined after the gate assembly (i.e. welding of all components) for which suitably shop welded full strength joint shall be provided in the gates. The bolt holes for guide rollers shall be bored only after the gate has been completely field assembled and position of guide rollers located in stop logs/gates. Seal bases and thrust pads for slide gate, seal bases for gates shall be machined after the plates have been welded to gate units and stress relieved if required. The machined surfaces of the seal bases/thrust pads shall be in the same plane within a tolerance of plus or minus 0.5 mm without offsets at the joints.
1.1.15.8	Embedded Parts
	i) All structures, parts of the gate frames and anchorages shall be straight and free from twist. The bottom sill beam, seal seats etc., shall be fabricated from steel plates/structural sections and shall be provided with suitable anchorages for rigid connection to the crest and the piers. ii) Both faces of the track flanges carrying the track shall be truly perpendicular to the web. The flange face shall be machined to provide a truly plane surface for the track. The faces of the seal seats shall be machined so as to lie in one plane within permitted tolerances. The crowns of the track shall lie a true vertical plane. iii) The faces of the corrosion resistance metal shall have the scale removed and passivated. All areas of corrosion resistant metal, which are subsequently worked in any manner, which tends to destroy the original passivated condition, shall be again passivated. After passivating, surfaces shall be free from pits and surface

	defects.
1.1.15.9	Straightening of materials
	Before being laid off or worked, rolled material shall be straight and shall be cleaned of all rust and dirt. If straightening is necessary, it shall be done by methods that will not become a cause for rejection of the material.
1.1.15.10	Shearing and cutting
	Shearing and cutting by torch shall be performed carefully and in all work which will be exposed to view after completing shall be finished neatly. Sheared or cut edges of plates more than 16mm thick which carry computed stresses shall be planed to a depth of 6mm. Re-entrant cuts shall be filleted before cutting.
1.1.15.11	Holes
	Hole in structural steel members carrying calculated stresses shall be sub punched to 3mm less than the nominal diameter of the rivet and reamed to full size or drilled after assembly. All other members may be punched to full size. Main members shall be assembled in the shop prior to reaming or drilling holes for field connection.
1.1.15.12	Punching
	For sub-punching and for punching to full size, the diameter of the punch shall be 5mm smaller and 1.6mm larger, respectively, than the nominal diameter of the rivet. The diameter of the hole shall not be more than 2.5mm larger than the diameter of the punch. All holes shall be clean cut and without torn or ragged edges. If any hole must be enlarged to admit the rivet, it shall be reamed.
1.1.15.13	Accuracy of punched holes
	Holes shall be punched so accurately that after assembling the component parts of a member, a cylindrical pin 3mm smaller in diameter than the nominal diameter of the punched hole may be entered perpendicular to the face of the member, without drifting in not less than 75 percent of any group of continuous holes in the same plane. All holes shall punch a pin 5mm smaller in diameter than the nominal diameter of the holes.
1.1.15.14	Reaming
	Reamed holes shall be cylindrical, perpendicular to the member, and not less

	than 1.5mm nor more than 2.5mm than the nominal diameter of the rivets. Built up members shall be assembled and firmly bolted together before any reaming is done. Reamed parts shall not be interchanged. Burrs and savings from reaming shall be removed and, if necessary, reamed pieces shall be taken apart before being rivetted and the shavings removed.
1.1.15.15	Drilling
	Drilled holes shall be cylindrical perpendicular to the member and 1.5mm larger than the nominal diameter of the rivet.
1.1.15.16	Accuracy of reamed and drilled holes
	Holes shall be drilled and reamed so accurately after assembly that not less than 85 percent of any group of continuous holes in the same plane shall not show off-set greater than 0.8mm between adjacent thickness of metal.
1.1.15.17	Removal of burrs
	Burrs resulting from reaming or drilling shall be removed with a tool making a 1.5mm level.
1.1.15.18	WELDING
	a) Welding Technique :
	Members to be joined by welding shall be cut accurately to size, and where required, shall be rolled or pressed to proper curvature in accordance with the approved drawings. The dimensions and shape of edges to be joined shall be such as to allow thorough fusion and complete penetration and plates shall be planed if necessary, to accomplish this result. Members to be welded together shall be in sufficient intimate contact at the time of welding so that members will not be forced more closely together with the cooling of the weld, thus, setting up additional strains and distortions in the weld and parent metal. The surfaces of plates to be welded shall be free from dust, grease and scale for a distance of 12mm back from the welding edge at the time of welding. Flame cutting may be used in the preparation of the various members provided the operation is performed carefully, and the edge so cut are cleaned thoroughly after being cut so as to expose clean metal thoroughly. Any contour irregularities at points of critical stress shall be removed by grinding.

	Care shall be taken in designs that the welds, when being made, are well accessible. Overhead welding is to be avoided, if possible and flat position is to be strived for. Drawings should clearly indicate the joint position, shop or field welding, kind of welding, method of welding, welding sizes and other required points. The location of joints to be tested shall also be indicated on the drawing. Symbols to be shown on the drawings should conform to relevant Indian Standards.
	All welding shall be done by the electric arc method by a process which will exclude the atmosphere from the molten metal, except where otherwise specifically permitted. The welding electrode required shall be furnished by the contractor. Correct selection of electrodes shall be done taking due care of welding method and base metals of components. The welding electrodes shall be of the heavily coated type designed for all position welding. The make, type and size of all welding electrodes shall be subjected to the approval of the purchaser.
	In assembling and during welding the component, parts of built up members shall be held in place by sufficient clamps or other adequate means to keep all parts in proper position. The surface to be welded shall be cleared of scale, slag, rust, paint, and other foreign matter, except that thin coat of linseed oil need not be removed before welding. Where weld metal is deposited in two or more layers, each layer shall be brushed with a wire brush or otherwise cleaned before the subsequent layer is deposited. In welding, precautions shall be taken to minimize stresses due to heat by using the proper sequence in welding.
	Upon completion, the welds shall be brushed with wire brush and shall show uniform section smoothness of weld metal. Edges and ends of fillets and butt joint welds shall indicate good fusion and penetration into base metals.
	All shop and field welding performed on the work shall be subject to inspection by Engineer-in-charge when welding plates, of which one or both exceed 25mm in thickness, continuous areas of plates around the welding operation shall be preheated to not less than 70 degree C and kept at a substantially uniform temperature throughout the process. The temperature shall be measured by Tempsticks or other approved means. Low hydrogen electrodes shall be used wherever necessary, particularly if the temperatures are below 10 ⁰ C. Peening of

	multiple pass welds to control distortion or to minimize residual stresses may be carried out with light blows from a power hammer using an elongated round nosed tool. Peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling, flaking or rupturing of weld and base metal from over peening. Neither the first nor the last pass of a multiple pass weld shall be peened.
	All welds on stress-carrying members shall be done in manufacturer's shop unless otherwise agreed by Engineer-in-charge. In general, only non load-carrying seal welds will be permitted in the field. All field welding shall have prior agreement of Engineer-in-charge. Tack welds shall be permitted only as temporary weld required for assembly purpose.
	The welding sequence shall be planned to control and minimize distortion and, where necessary, shall include stress relieving to minimize residual stresses. Minimum stress-relieving requirements are specified in the appropriate sections of these specifications.
	Welded components subject to vibration and stress reversals shall be fabricated with full-penetration welds.
	Radiographic tests shall be carried out for all critical full strength butt welds. Welded joints requiring radiographic testing shall be decided by the purchaser.
	Specific requirements for butt joints and fillet joints are given below:-
	Butt Joints
	In principle, butt joints should be made with back-run. Should it be not possible to do the back-run, either a backing strip should be placed and welding should be so made that the melted metal fully penetrates to the backing strip or the side butt welding should be executed so that the melted metal reaches the back of the groove and a full penetration is achieved. Dye-penetration test shall be carried out after each pass of the weld.
	Fillet Joints
	All fillet welds shall be continuous. For the main members, no fillet welding should be made on members whose thicknesses differ substantially. Fillet weld at 'T' Joints should be made, as a rule, on each side of the joint, unless it is otherwise

	agreed due to some practical reasons. They shall be tested ultrasonically or by dye-penetrant test for soundness.
	b) Qualification of Welding Process
	A specification of the welding process, that is proposed to be used, shall be established and recorded and, if required, a copy of such specification together with a certified copy of report of results of tests made in accordance with the process and specifications shall be furnished.
	The qualification of the welding process shall be at least equal to that required by 'Standard Qualification Procedure' of the Indian Standards and the minimum requirement of the tests shall be at least as stated in the said 'Standard Qualification Procedure'.
	The contractor shall be responsible for the quality of the work performed by his welding staff. All welders assigned to the work shall have passed qualification tests for welders. If at any time the work of any welder appears questionable, the welder shall be required to pass additional qualification tests to determine his ability to perform the type of work on which he is engaged.
1.1.15.19	PAINTING AND SURFACE COATING
1.1.15.19.1	General
	All paints, painting materials and accessories for painting shall be supplied by the contractor and shall be included in the price bid. The paints proposed by the contractor must be approved by the purchaser or his authorized representative before application of the same. The analysis in respect of paint properties, paint composition and performance requirements of the paints shall be submitted by the contractor for examination and approval. The painting and surface preparation shall also conform to the relevant Indian standard Specifications on the subject. Decision of purchaser for the recommendation of such standard shall be final and binding on the contractor.
1.1.15.19.2	Preparation of Surfaces
	The preparation of surfaces prior to painting or coating shall be done as outlined below :
	Weld spatter or any surface irregularities shall be removed by suitable means

	before cleaning.
	All oils, grease and dirt shall be removed from the surfaces by the use of clean mineral spirits, xylol, white gasoline (lead free) and clean wiping materials.
	Following solvent cleaning, the surfaces to be painted shall be cleaned of all rust, mill scale, or other lightly adhering foreign objectionable substances by sand blasting or grit blasting to uniform bright base metal. Any grit or dust remaining after the cleaning operation shall be completely removed from the surface by wire brushing, air blowing, suction or other effective means.
	Surfaces of stainless steel, bronze, nickel and machined surfaces adjacent to the metal work being painted or cleaned shall be protected by masking or other suitable means during the cleaning and painting operation.
	Primer shall be applied as soon as surface preparation is complete and prior to the development of surface rust. The time gap between the application of primer and surface preparation shall normally not exceed six hours. In case there is considerable time gap, the surface should be re-blasted prior to priming. Surface preparation of various component shall be done as under ;- a) Gates- As per class A of clause 4.2.1of IS-14177 b) Exposed embedded parts -As per class A of clause 4.2.1of IS- 14177 c) Embedded parts in contact with concrete- As per class D of clause 4.2.1of IS-14177 d) Hoist and supporting structure- As per class B of clause 4.2.1of IS-14177
1.1.15.20	Shop Painting
1.1.15.20.1	Gates and Embedded Parts
A.	Primer coats After surface preparation the following coats of primer paints shall be applied.
	a) Embedded parts in contact with concrete
	All surfaces of embedded parts of gates and hoists, which are in contact with concrete shall be cleaned as given in para 4.2.1.4 of IS: 14177 - 1994 to meet the requirement of class D and shall be given a coating of cement Latex to prevent rusting.

	Exposed machined surfaces of ferrous metal, which are to be in rolling and sliding contact shall not be painted but shall be coated with heavy gasoline soluble rust preventive compound in all exposures, where metal will be partially embedded in concrete. In all exposures, where metal will be partially embedded in concrete, the protective coating shall be extended on the non-embedded portion a short distance into the area later to be embedded, thus eliminating problem at the junction point.
	Exposed embedded parts
	Over the prepared surfaces one coat of Inorganic Zinc Silicate primer preferably with the help of airless spraying equipment giving a dry film thickness of 70 ± 5 microns should be applied. Alternatively, two coats of zinc rich primer, which should contain not less than 85% zinc on dry film, should be applied to give a total dry film thickness of 75 ± 5 microns.
	Gates
	Over the prepared surfaces one coat of Inorganic Zinc Silicate primer preferably with the help of airless spraying equipment giving a dry film thickness of 70 ± 5 microns should be applied. Alternatively, two coats of zinc rich primer, which should contain not less than 85% zinc on dry film, should be applied to give a total dry film thickness of 75 ± 5 microns.
	Finishing coats
	Exposed embedded parts
	Finishing coat shall consist of two coats of solvent-less high density coal tar epoxy paint. These shall be applied at an interval of about 24 hours. Each coat shall give a dry film thickness of 150 ± 5 microns. The total dry film thickness of all the coats including primer coating shall not be less than 350 microns.
	Gates
	Finishing coat shall consist of two coats of solvent-less high density coal tar epoxy paint. These shall be applied at an interval of about 24 hours. Each coat shall give a dry film thickness of 150 ± 5 microns. The total dry film thickness of all the coats including primer coating shall not be less than 350 microns. Over and above aluminium epoxy paint of dry film thickness of 50 microns shall be provided for

	surfaces of the stop log units exposed to sun. Time interval between the coats shall be 24 hours.
1.1.15.20.2	Hoists And Supporting Structure
A.	Primer coat
	Structural components
	Two coats of zinc phosphate primer shall be applied to give a dry film thickness of 40 ± 5 microns per coat.
	Machinery
	Except machined surfaces, all surfaces of machinery including gearings / housing, shafting, bearing pedestals etc. shall be given one coat of zinc phosphate priming paint to give a minimum dry film thickness of 50 microns. Motors and other bought out items shall be painted, if necessary.
	Unmachined surfaces
	All unmachined surfaces shall be given one primer coat of chlorinated rubber based zinc phosphate primer to give a dry film thickness of 50 ± 5 microns.
B.	Finishing coats
	Structural components The finishing coats of paint shall consist of one coat of alkyd based micaceous iron oxide paint to give a dry film thickness of 65 ± 5 microns followed by two coats of synthetic enamel paint conforming to IS: 2932 - 1974 to give a dry film thickness of 25 ± 5 microns per coat of synthetic enamel paint. The interval between each coat shall be 24 hours. The total dry thickness of all paints including the priming coat shall not be less than 175 microns.
	Machinery The finishing coat of paint shall consist of three coats of Aluminium paint conforming to IS: 2339 or Synthetic Enamel paint conforming to IS: 2932 - 1974 to give a dry film thickness of 25 ± 5 microns per coat.
	Unmachined surfaces The un-machined surfaces of supporting structure for Hoist shall be cleaned and given three coats of vinyl resin / chlorinated rubber to give a dry film thickness of 30 ± 5 microns per coat to obtain a minimum dry film thickness of 125 microns

	including priming coat.
	Machined surfaces All machined surfaces of ferrous metal including screw threads which will be exposed during shipment or installation shall be cleaned by suitable solvent and given a heavy uniform coating of gasoline soluble removable rust preventive compound or equivalent. Machined surfaces shall be protected with the adhesive tapes or other suitable means during the cleaning and painting operation of other components.
1.1.15.21	Field Painting
	The painted metal work shall be handled with suitable handling equipment and reasonable care so as to keep abrasion and damage of the shop coats at a minimum during loading, unloading and during installation. The area of the shop paint, which has been damaged during transport shall be cleared to base metal and repainted. Paint applied to such areas shall be of the same type as used originally in shop painting. After erection and testing is complete all exposed unfinished surfaces of embedded parts and gates shall be given a finishing paint of Aluminium epoxy paint with minimum 25 microns dry film thickness so as to obtain shining surface of pleasing colour. This finishing coat should be able to reflect light and limit the heat absorption when exposed to sun.
1.1.15.21.1	Surfaces Not To Painted
	The following surfaces are not to be painted unless or otherwise specified: Machine finish or similar surfaces, however, such surfaces should be protected with a corrosion preventive compound. The surfaces, which are in contact with concrete Stainless steel overlay surfaces Surfaces in sliding or rolling contact Galvanized surfaces, brass and bronze surfaces Equipment name plates and instructions etc. Bare electrical conductors and insulating materials Aluminium alloy surfaces
1.1.15.21.2	Measures during Painting
	Any bare spots or holidays shall be recoated with additional application of

	primer.
	All runs, sags, floods, or dips shall be removed by scrapping and cleaning. The cleaned area should be retouched or all such defects shall be remedied by re-blasting or re-priming.
	Special attention should be given to good coverage on rivets, welds and sharp edges and covers.
	Suitable measures shall be taken to protect the applied primer from contact with rain, fog, mist, dust or other foreign matter until completely hardened and next coat is applied. The air temperature at the time of application of paints must not below 10°C and relative humidity must not be above 90%.The contractor shall keep suitable thermometers and other instruments in his paint shop to establish that the above conditions are properly maintained/met with.
1.1.15.21.3	Application Procedure
	All paints and coating materials shall be in a homogeneously mixed condition at the time of application and shall not be thinned except as hereinafter specifically provided. Warming of the paint shall be performed by means of hot water bath.
	All surfaces to which paint shall be applied immediately after cleaning, and except otherwise specifically provided, shall be applied by either brushing or by airless spray. When paint is applied by spraying, a mechanical agitator type of paint pot shall be used. Means shall be provided for removing all free oil and moisture from the air supply line of all spraying equipment. Each coat of paint shall completely cover the surfaces and shall be free from runs, sags, pinholes and holidays. Each coat of paint shall be allowed to dry or harden thoroughly before the succeeding coat is applied.
	All paints shall be applied by skilled workers in a workman like manner. Paint shall not be applied during damp weather and on the surfaces which are not entirely free from moisture. Rust preventive compound shall be applied by any convenient method to ensure complete coverage of heavy coating. After the final application, the paint film shall be allowed to cure at least for 7 days.
1.1.15.22	INSTALLATION, OPERATION & MAINTENANCE MANUAL

	For guidance during the installation of the work and subsequently for guidance of the plant operating and maintenance staff, contractor shall prepare manuals.
	The manuals shall include a separate and complete section describing the normal and emergency operating procedures for the gates and control equipment and shall include easily readable diagrammatic drawings of the equipment to facilitate understanding of the descriptive information.
	The manuals shall describe and illustrate the procedure for assembling, adjusting, operating and dismantling of each component and control system. The maintenance of each component shall be described, including the recommended frequency of inspection and lubrication.
	Manuals shall also describe and illustrate procedures for installation, storage, handling, unloading, reloading, unpacking and up keeping of each component and of the system.
	Four (4) copies of the manuals shall be submitted in English in draft form for approval of purchaser within 3 months after the final approval of the equipment. Six (6) suitably bound copies shall be provided to Engineer-in-charge not later than 30 days after receipt of approval.
	If revision of the manuals becomes necessary, as a result of information gained during installation and initial operation, Manufacturer shall make the necessary revisions and furnish six (6) copies of the revised sections.
	The manuals shall include a complete list of all drawings prepared by Manufacturer, a list of spare parts and a list of parts for each component or item of equipment. The parts list shall include manufacturer's name and serial numbers.
	Manufacturer shall ensure that his installation supervisor has a copy of all approved drawings and the manuals in his site office.
1.1.15.22.1	Inspection and Test Records
	For seeking owner's approval for transportation of any equipment / materials / components, the manufacturer shall submit Four (4) copies of all relevant inspection and test records, duly signed and accepted by manufacturer's Quality assurance group and by purchaser's representative, when-ever required to be

	associated.
1.1.15.23	INSTRUCTION PLATES
	All gauges, meters and other instruments etc. shall have dials or scales calibrated in metric system. All name plates, instruction plates, warning signs, etc. shall be in English as well as in Hindi. All equipment shall be provided by a securely fastened name plate showing the maker's name, model, serial numbers, year of manufacture, main characteristics data of the respective equipment and further relevant information specified in the applicable standards or necessary for the proper identification of the equipment involved.
	The manufacturer shall supply and also install all label plates and other labelling (of the screw-on type) on control boards, control desks, panels and other places where required for operational, functional and safety reasons. The labellings, size of the plates and their locations shall be subject to approval by the Engineer-in-charge. A sample of label plates (with indication of the material used) with lettering shall be submitted for this purpose. The number and sizes of the plates shall be optimum.
1.1.15.24	SHOP ASSEMBLY AND TESTS
	The sub-assemblies and parts shall be assembled and tested in shop to ensure that parts are correctly fabricated and properly aligned. Prior to shop assembly and testing, the manufacturer shall submit for review an outline of the procedures and tests which are planned to be performed to demonstrate the fulfilment of the requirement of these specifications. The cost of carrying out the test, (including the cost of inspection by the purchaser's personnel) shall be borne by the contractor and included in the lump sum price bid in the schedule. However, shop assembly testing and test of bought out items would be carried out at the instruction and discretion of the purchaser or his authorized representative.
	In the event it is not possible to complete the assembly of gate leaf, accessories or such other components in the shop, they will be accurately assembled in the shop using temporary connections and various critical dimensions shall be verified.
1.1.15.24.1	Embedded parts

	The assembly of each wheel track, side guide tracks, seal seat and sill beam assemblies should be made for full length. The dimensions, finish and accuracy of machining shall be checked in the shop. The side seal seat assemblies and top seal seat assembly shall be assembled in shop to ensure that the seal seats are in plane as required and conforms with the designed dimensions, fits, tolerances, surface finishes, clearances etc.
1.1.15.24.2	Pulley Assembly
	Pulleys, shafts, shaft bracket, bushing/bearing assembly shall be carried out in the shop and checked for dimensional accuracy, fits and tolerances of mating components.
1.1.15.24.3	Fixed Wheel Gate
	Each gate shall be completely assembled in the shop for inspection & to ensure that all parts fit properly & that dimensions, clearances and tolerances required in the specifications and drawings have been achieved. The gate shall be assembled in a vertical position and holes for field connections carefully drilled or reamed. Connections which have to be disassembled for shipment shall be made by the use of erection pins, one size less in diameter than the designed size or temporary machine bolts. Proper functioning and operation of filling in valves & lifting beam automatic engaging/disengaging mechanism shall be checked during shop assembly. The shop assembly must also be checked for correctness in all respect, such as quality or workmanship, freedom from defects, free rotation of rollers/wheels etc. The surfaces of seals on sides and top shall be in same vertical plane.
1.1.15.25	PREPARATION FOR DISPATCH
	No assembly or its parts shall be shipped from the manufacturer's shops until it has been inspected or inspection has been waived off in writing by the purchaser on an item basis.
	Each part of the gate, hoist and embedded parts, which is to be transported as a separate piece, shall be marked to show the unit of which it is a part and match marked to show its relative position in the unit to facilitate assembly in the field. Unit marks and match marks shall be made with heavy steel stamps and paint. Each piece, sub-assembly or package transported separately shall be labelled or

	tagged with transport designation consisting of the specifications number, the marks number of such pieces and number of parts grouped of such sub-assemblies contained in package.
1.1.15.25.1	Weights
	Before dispatch the contractor shall determine (by the most accurate means available) the net weight of each piece of assembly that is to be shipped as a unit exclusive of boxes, crates or kits. These copies listing the net weight shall be painted on the respective pieces of assemblies or stated on the tags attached thereto.
1.1.15.25.2	Packing
	After the workshop assembly and shop inspection and tests including witness inspection by the Engineer-in-Charge or his authorized representative wherever specified and prior to dismantling for shipment to the Site, all items shall be carefully marked to facilitate site erection. Wherever applicable, these markings shall be punched or painted so that they are clearly visible.
	Dismantling shall be done into convenient sections, so that the weights and sizes are suitable for transport to Site and for handling at the Site under the special conditions of the Project.
	(iv) Marking shall be done preferably by punching the marks into the metal before painting, galvanising, etc., and shall be clearly legible after painting, galvanising etc. In labelling, the Contractor shall endeavour to use as few designations as possible and each part of identical size and detail shall have the same designation, regardless of its final positioning the plant. All parts of the Works shall be packed at the place of manufacture; the packing shall be suitable for all special requirements/limitations of the transportation to Site. Where necessary, double packing shall be used in order to prevent damage and corrosion during transportation, unloading, reloading or during intermediate storage.
	All parts including electrical parts shall be suitably protected against corrosion, water, sand, heat, atmospheric conditions, shocks, impact, vibrations, etc. by packing them in heavy duty polyethylene foil.
	The Engineer-in-Charge reserves the right to inspect and approve the packing

	before the items are despatched but the Contractor shall be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not exonerate the Contractor from any loss or damage due to faulty packing.
	(V) All packing costs shall be included in the scope of Work.
	All parts shall be prepared for despatch and the slings shall be fixed to the boxes so that the same could be moved / handled safely. Where it is unsafe to attach slings to the box, parts shall be packed with slings attached to the part and slings shall project through the box or crate so that attachment can be made easily. All parts shall be properly secured and packed to withstand handling during transportation. All packing shall allow for easy removal and checking at sites. Special precautions shall be taken to prevent rusting of steel and iron parts during transit.
	Suitable methods proposed to be adopted for protection against moisture shall be subject to the prior approval of the purchaser. Each bale or package is to contain packing note quoting number and date of contractor's order and the name of office placing the order.
	After delivery of material at site, all packing shall become property of the purchaser. Notwithstanding anything stated in this clause the contractor shall be entirely responsible for loss, damage or depreciation to the stores due to faulty and insecure packing. The equipment shall be insured for loss or damage during transit at the cost of the contractor.
1.1.15.25.3	Marking
	The Contractor shall mark all containers with the implementing document number pertinent to the shipment. Each shipping container shall also be clearly marked on at least two sides as follows: i) Consignee: ii) Contract No.: iii) Port of destination: iv) Item number (if applicable): v) Package number, in sequence: vi) Quantity per package: vii) Description of works: viii) Net and gross weight, volume:

1.1.15.26	TRANSPORT
	Shipping, transportation, loading and storage shall be performed by or under the responsible direction of the Contractor. An appropriate period for transportation shall be considered. The general co-ordination of storage and erection work will be done by the Engineer-in-Charge. The delivery dates, transportation and erection periods indicated in the Contract Documents shall be strictly adhered to. From the time of manufacturing until commissioning, all parts shall be protected against damage of any kind. Parts, which are damaged during transportation, shall be replaced at the Contractor's expense. The Contractor shall provide the Engineer-in-Charge with complete packing lists of each performed shipment
1.1.15.27	STORAGE
	The Contractor shall also be responsible for obtaining from the railway or highway authorities any permit that may be required for the transport of loads exceeding the normal gauges. The Contractor shall be responsible for all Custom clearance of the consignments from the Indian port if by sea and or from airport by shipped as air cargo, local storage and further transportation to site. The Contractor shall provide means for all unloading and reloading for all consignments of the plant, during transport to Site. Unloading on the Site will be provided for by the Contractor. Consignments shall be unloaded immediately on arrival at Site. The Contractor is required to take the necessary steps in order to provide the carriage, special supporting structures for heavy loads, etc. If large parts are in the open air, they shall be provided with weather resistant and fire-resistant covers. Electrical parts, should be packed in heavy-duty polyethylene foil and those whose packing has been damaged shall be kept at insatiable places from the moment of storage to the moment of installation. All insulation materials which will be taken from the warehouse for installation and which are stored temporarily in the station shall be protected from weather or humidity
1.1.16	ERECTION
	The equipment covered by these Specifications shall be furnished and erected by

	the contractor completely at the project site. The contractor shall be required to furnish all erection drawings. The contractor shall prepare a complete erection procedure, which shall describe the sequence of operations to be carried out, the method to be used, the measurements to be taken and the tolerances to be met in the erection and alignment of the equipment. Such procedure shall have the approval of the purchaser prior to the commencement of fabrication and when approved, shall form a part of the specification furnished by the contractor.
1.1.16.1	Installation of 2nd stage Embedded Parts
	Gate and stop log frames, guides, tracks and seal seats, etc. as applicable shall be assembled and installed, brought to line, grade and plumb within the erection tolerances and secured in place by anchorages as shown on the drawings or otherwise according to the best method in practice and as may be necessary for successful functioning of these units. The erection tolerances for the frames and guides shall be as indicated on the drawings as per latest relevant Indian Standards. Extreme care shall be taken to ensure that their surfaces be in a true plane within the tolerances throughout their entire length. The 2 nd stage anchorages shall be strong enough to hold the frames and guides securely in position while concrete is being placed.
1.1.16.2	Installation of Gates , Hoists and their accessories
	All the components of the gates, hoists, shall be erected perfectly giving due cognizance to the unit and match marks on the components. All components shall be designed and assembled to fit snugly and shall be water tight. In case of gates which are exposed to floods it is desirable to avoid the flood period to perform erection of gate. Should it be necessary to do so, due precautions should be taken for measures against floods, since the gate may be submerged in water sustaining damages or the half erected gate may disturb the water flow causing damages to the civil structure. One of the measures may be that the hoists should be erected first, and when the flood broadcast is made, the half executed gates should be hoisted above the flooding water.
1.1.16.3	Guidelines for field erection
	i) The equipment shall be erected by the contractor in accordance with these specifications to the satisfaction of the purchaser using most modern

	techniques under the directions of the supervisory erection personnel to be provided by the contractor and agreed by the purchaser.
	ii) Any required tool or equipment which is not normally available at the work site as well as any jigs or fixtures required for proper erection shall be furnished by the contractor. A list of such tools shall be supplied by the contractor.
	iii) Erection tolerances shall conform to Indian Standards and / or those values specified by the purchaser.
	iv) Erection bolts, nuts, washers and other fasteners shall be furnished in the amount of 15 percent or ten bolts, nuts, washers and other fasteners whichever is greater, in excess of the nominal numbers of each size and length required for complete installation of equipment.
	v) Bolts in tension shall have a net section at root of thread 15 percent in excess of the net section required in tension.
1.1.16.4	Erection Personnel
	Skilled as well as unskilled personnel shall be arranged by the contractor for erection of the equipment covered in these specifications.
1.1.16.5	Tools & Tackles
	The contractor shall submit with his bid a list of all tools and tackles that he proposes to supply for erection, testing & maintenance of his equipment.
1.1.16.6	Transportation and Erection Limitations
	The contractor should visualize the accessibility for erection from civil data provided in these Technical Specifications. Apart from this the contractor shall make his own survey for transportation/erection limitations to site. The weights and dimensions of gates, hoists and associated equipment covered under these specifications should be taken into consideration while planning the gate/hoist components and suitable splicing/site assembly and jointing provided to enable transportation upto site. The contractor shall be held responsible for damage and security of the equipment during transportation.
1.1.16.7	Notification
	The purchaser will notify the contractor thirty (30) days prior to date on which

	erection and installation of the equipment is to commence.
1.1.17	QUALITY ASSURANCE, INSPECTION, TESTING AND FINAL ACCEPTANCE
1.1.17.1	Quality Assurance
	The Contractor shall submit and finalize manufacturing Quality Assurance Plans for all the major components and equipments. These Quality Plans will detail out various tests/inspections to be carried out as per the requirement of these specifications and standards mentioned therein and quality practices and procedures followed by Contractor's Quality Control Organization, acceptance norms etc. during all stages of material procurement, manufacture, assembly and final testing / performance testing.
	The Contractor shall also furnish copies of the reference documents/plant standards/acceptance norms/test and inspection procedure etc. as referred in Quality Plans along with Quality Assurance Plans. These Quality Assurance Plans shall be approved before signing of the contract. The other reference documents/standards etc. will be subject to purchaser's approval without which manufacturer shall not proceed. Purchaser reserve the right to add any inspection or test which is felt necessary for completion of the work. These approved documents shall form a part of the Contract. In these approved Quality Plans, purchaser shall identify Customer Hold Points (CHP's) i.e. testing checks which shall be carried out in the presence of the purchaser's Engineer or his authorized representative and beyond which the work will not proceed without consent of purchaser/authorized representative in writing. All deviations to these Specifications, approved Quality Plans and applicable standards must be documented and referred to purchaser along with technical justification for approval and dispositioning.
	The Contractor shall also submit and finalize field quality plans which will detail out for all the equipments, the quality practices and procedures etc. to be followed by the Contractor's site Quality Control Organization during various stages of site activities from receipt of material/equipment at site. The field Quality Plans shall also be approved by the purchaser.
	No material shall be dispatched from the manufacturer's works before the same is accepted subsequent to pre-dispatch /final inspection including verification of

	records of all previous tests/inspection by purchaser's Engineer or his authorized representative and duly authorized for dispatch.
1.1.17.2	DOCUMENTS TO BE SUBMITTED WITHIN FOUR WEEKS AFTER DESPATCH OF THE EQUIPMENT
	All materials used or supplied shall be accompanied by valid and approved material certificates and tests and inspection reports. These certificates and reports shall indicate the heat numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it.
	The Contractor shall be required to submit six copies of the following quality assurance documents within four weeks after dispatch of the equipment :
	a) Material mill test reports on components as specified in Quality Plan.
	b) Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
	c) Non-destructive examination results reports including radiography interpretation reports.
	d) Factory test result for testing required as per applicable codes and standards referred in the Specifications.
	e) Inspection reports duly signed by the authorized Engineering representative of the purchaser and Contractor for the agreed inspection hold points.
	f) All the accepted deviations shall be included with complete technical details.
1.1.18	Sub-letting
	All the vendors/sub-vendors proposed by the Contractor for procurement of major bought out items including castings, forgings, semi-finished and finished components/equipments list of which shall be drawn up by the Contractor and finalized with the purchaser shall be subject to purchaser's approval. The Contractor's proposal shall include vendor/sub-vendor's facilities established at the respective works, the process capability, process stabilization, Quality control system followed, experience list etc. along with his own technical evaluation of vendor/sub-vendors and shall be submitted to the owner for approval prior to any procurement. Such vendor/sub-vendors approval shall not relieve the Contractor

	from any obligation, duty or responsibility under the contract. This action would, however, not involve purchaser in any complications arising between the Contractor and his sub Contractor (s) / vendor/sub-vendors or any other liabilities. The Contractor shall also obtain Quality Plans from approved vendor/sub-vendors from whom he proposes to procure the material and submit these Quality Plans for purchaser's approval.
	Normally no request for change of vendors/sub-vendors shall be entertained by purchaser. But in the peculiar circumstances if the request for change of vendors/sub-vendors is found reasonable and justified then the same shall be entertained and the decision of purchaser in this respect shall be final and binding. The time consumed for the change of vendors/sub-vendors shall not be excluded from the stipulated time of the completion of the contract. This change shall not relieve the Contractor from the responsibility to complete the work within stipulated time in any manner.
	Purchaser reserves the right to carry out quality audit and quality surveillance of the system and procedures of the Contractor / sub-Contractor. Contractor shall provide all necessary assistance to enable the purchaser to carry out such details & surveillance including Quality Manuals.
	For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.
	Repair/rectification procedures to be adopted to make the job acceptable shall be subjected to the approval of purchaser/authorized representative.
	Before subcontracting any portion of work the Contractor will take prior approval of purchaser.
1.1.19	Place of Manufacture & Inspection
	The bidder shall state in his bid the place of manufacture, testing and inspection of various portions of the work included in the contract. Authorized representatives of the purchaser may be present at the time of any or all tests and the bidder shall provide all necessary facilities for the same. Representatives of the purchaser shall also be entitled to access to bidder's / sub-Contractor's work at any time during the manufacture of equipment and materials.

	All material entering into the work shall be subject to inspection by Employer / Owner and all purchase orders for materials and supplies shall carry a notation to this effect. Copies of all purchase orders and subcontracts shall be submitted to Employer / Owner at the time of placing the order. Waiving of inspection by Employer / Owner shall not relieve Manufacturer from the responsibility of supplying material and workmanship acceptable to Employer / Owner. Manufacturer shall be responsible for proving quality of material and workmanship either by records of inspection or by immediate inspection.
1.1.19.1	Inspection
	All supplies (which include, without limitation, raw materials, components, intermediate assemblies and end products) shall be subject to inspection and test by the purchaser to the extent practicable at all times and places. Inspection shall be carried out in accordance with relevant Indian Standards. If any inspection or test is made by the purchaser in the premises of the Contractor or sub-Contractor, the Contractor without additional charge shall provide all reasonable facilities and assistance for the safety and convenience of inspectors in the performance of their duties. If on the request of the purchaser, inspection or test is made at a point other than the premises of the Contractor or sub-Contractor of the Contractor, it shall be at the expense of the purchaser except as otherwise provided in the contract, provided that in case of rejection, the purchaser shall not be liable for any reduction in value of samples used in connection with such inspection and test. All inspections and tests by the purchaser shall be performed in such a manner as not to unduly delay the work. The purchaser reserves the right to charge the Contractor any additional cost of inspection and test when supplies are not ready at the time of such inspections and test. Acceptance or rejection of the supplies shall be made as promptly as practicable after delivery except as otherwise provided in the contract but failure to inspect and accept or reject supplies shall not relieve the Contractor of the responsibility for such supplies to be in accordance with the contract requirements. All the expenses (i.e.- travel, lodging, etc.) for pre inspection for materials at manufacturer premises for engineer-in-charge and clients personnel's shall be borne by the contractor.

	The inspection and test by the purchaser of any supplies or lots thereof does not relieve the Contractor from any responsibility regarding defects or other failure to meet the contract requirements which may be discovered prior to the acceptance. Except as otherwise provided in the contract, acceptance shall be conclusive except as regards latent defects, fraud or such gross mistakes tantamount to fraud.
	The Contractor shall provide and maintain the inspection system acceptable to the purchaser covering the supplies hereunder. Records of all such inspection work shall be kept complete by the Contractor and made available to the purchaser during the performance of the contract and for such longer period as may be specified elsewhere in the contract.
1.1.19.2	Guidelines/Recommendations For Inspection, Testing & Maintenance Of Gates And Hoist
	The guidelines/recommendations for inspection, testing & maintenance of gates and hoists as contained in the relevant Indian Standards viz. IS-7718, IS-13053, IS-3177,IS-14177etc. but not limited to, shall be applicable at different stages of the work viz. at the manufacturer's stage at the time of erection as well as after erection.
1.1.19.3	Witnessing Shop Test And Inspection
	The Purchaser will depute engineers for witnessing shop, inspection & testing
	The purchaser shall be free to even use third party inspection for witnessing tests and Inspection.
	The purchaser or his representatives shall have free access to the software (s) used or being utilized by the Contractor for Planning and Design of Gates and Hoists both at his office premises and at his shop premises. The purchaser or his representative shall be free to check the design & drawings etc. on his software at any time.
1.1.19.4	Operational Tests For gates
	The Contractor shall note that before conducting any field trial or test, complete procedure for the respective tests shall be drawn and submitted to the purchaser for his approval. Entire testing shall be conducted as per approved test

	procedures. The Contractor shall carry out in the presence of project authorities such tests on the equipment to determine that the equipment fulfils the functions for which it has been designed. Tests shall be repeated, if necessary, until successfully carried out to the satisfaction of the purchaser. Leakage tests and operational tests shall be carried out at the convenience of the project authorities after completion of other portions of the work & when the reservoir is at its full level.
1.1.19.4.1	DRY TEST
	Operational tests in dry conditions shall be carried out as soon as possible after completion of erection when all controls & permanent power supply have been connected. The tests shall include at least two complete traverses from the maximum raised position to the full closed/seating position. All adjustments, clearances, brakes etc. shall be checked for proper operation.
1.1.19.4.2	WET TEST
	These tests should simulate the actual operating conditions as closely as possible. At least two complete traverses will be made from the fully closed position at the normal raised position as follows :
	a) When gate/stop log is closed, raise gate/stop log to its normally open position in steps and observe the performance including vibrations.
	b) Lower the gate/stop log to the fully closed position in steps and observe the performance of the gate/stop log including vibrations.
	c) Check-up of proper operation of limit switches.
1.1.19.4.3	LEAKAGE TEST
	Leakage tests shall be carried out with the gate lowered on to the sill. The gate /stop log shall be reasonably water tight. Before measuring the leakage, the gate shall be raised and lowered several times by a metre or so in order to dislodge any debris that may have lodged in the side seal seats. The leakage shall then be measured and recorded. The maximum permissible leakage shall not exceed 5 litres per min. per metre length of periphery of sealing surface. The figure of permissible leakage is the upper limit before which the remedial measures shall be required to rectify the defects.

1.1.19.5	Non-Destructive Tests
	The non-destructive tests shall be carried out as specified in SNT-TC-IA "Recommended practice for non-destructive testing, personnel qualifications and certification" of the American Society for Non-destructive Tests or other similar International Standards.
1.1.19.5.1	RADIOGRAPHIC EXAMINATION
	a) For gates and other equipment the radiographic examination of at least 10 percent of total length of butt welds for plates greater than 6mm but not exceeding 20mm in thickness for the gate and the stop log shall be carried out by the manufacturer. The selection of the 10 percent of total length of butt welds for radiographic examination shall be done at random and shall represent each Welder's work. The radiographic examination of 100 percent length of all butt Welds for plates exceeding 20mm in thickness for the gate and the stop log shall be carried out by the manufacturer.
	b) Whenever dissimilar materials are butt welded together at least one x-ray radiographic examination for each component of sub-assembly shall be carried out at the selected points. The number of points to be taken would depend upon the results obtained after the first series of test are carried out. Prior to making radiographs of butt welds, the manufacturer shall place suitable identification markers adjacent to the welds. Each marker shall be so designed and located that the image will appear in the radiographs. The markers shall be painted, stamped or fastened as directed by the purchaser and shall not be removed until all welds have been accepted. All radiographs of welded joints shall become property of the purchaser. The radiographic test shall be carried out by the qualified technician and at such time as decided by the purchaser. The technician's interpretation reports on the radiographic examination shall be furnished by the manufacturer to the purchaser. All precautions shall be taken to minimize radiation hazards. The markers shall not be removed until all the welds have been accepted. Defective welds shall be arc air gouged or chipped out, re-welded, re-X-rayed and the cycle repeated until satisfactory results are obtained.
1.1.19.5.2	ULTRASONIC EXAMINATION

	a) Ultrasonic examination shall be performed in accordance with the Article-5 of ASME Boiler and pressure vessels code Section V. The relevant references from ASTM specification E-164-74 shall be also taken. The ultrasonic examination shall be performed and supervised by experienced and qualified personnel. If necessary special type of transducers and/or higher test frequency etc. shall be adopted to improve the reliability of the test.
	b) All indications which produce a response greater than 20% of the reference level shall be investigated to the extent that the operator can determine the shape, identity and location of all such reflectors and evaluate them in terms of the acceptance standard given below :
	– Discontinuities shall be unacceptable if the amplitude exceeds the reference level and discontinuities have length which exceeds $1/3t$ where 't' is the thickness of the weld being examined.
	– Where discontinuities are interpreted to be crack, lack of fusion or incomplete penetration, they shall be unacceptable regardless of discontinuity or signal amplitude.
1.1.19.5.3	MAGNETIC PARTICLE EXAMINATION
	All fillet welds joining diaphragm plates, rings, lugs, etc. shall have smooth transitions into the sides of plates with toes of the welds made before depositing the major bead. The surfaces shall be ground to merge smoothly into the plate surfaces. The fillet joints are subjected to magnetic particle testing. The procedure of carrying out the above test shall be as per relevant standards. Where magnetic particle testing is not possible, dye penetration test shall be undertaken as per appendix-8 of ASME Code Section VIII with the approval of the Employer / Owner.
1.1.19.6	Final Acceptance
	The final acceptance of the equipment shall be based on the following :
	a) Quality and workmanship of the equipment.
	b) Satisfactory operation of the equipment after erection as required under these specifications.
	c) Acceptance of various tests by the purchaser as mentioned in preceding pares

	All tests may be witnessed by the purchaser or his authorized representative. On successful completion of all tests the equipment shall be accepted but all the responsibility shall remain with the supplier within the guarantee period.
1.1.19.7	Guarantee
	The Contractor shall furnish guarantee of the equipment for a minimum period of two years from the date of the acceptance of equipment or commissioning whichever is later. The Contractor shall guarantee among other things the following items :
	a. Quality and strength of the materials used.
	b. Satisfactory operation of the equipment.
	c. Safe working stresses in all parts under all conditions of operation.
	d. Protection of equipment against vibrations and corrosion.
	Within two years after acceptance of the equipment if any part of the equipment covered in this contract are found defective because of workmanship or material or otherwise, the Contractor shall at his own expense, furnish and install new parts and materials approved by the purchaser. During the guarantee period, the Contractor shall have all responsibilities for direct damage covering personal injury or damage to property caused by any manufacturing defect resulting in failure of the equipment being supplied under these Specifications.
	If any part of equipment fails to meet the guarantee or other requirements of the Technical Specifications within the time covered by the guarantee, the purchaser may direct the Contractor to proceed at once to make alterations or furnish new parts as may be necessary to meet the requirements. All expenses of furnishing, delivering and installing new parts and tests made necessary by failure of the equipment to meet the guarantee and other requirements of the Technical Specifications shall be borne by the Contractor. If after due notice the Contractor refuses to correct any failure of the equipment to meet the requirement of the Technical specifications during the guarantee period, the purchaser may proceed at his own expenses to correct such failure and to collect from Contractor an amount equal to actual expenses so incurred including overheads and all other incidental expenses. The remedy of purchaser is in addition to any and all other

	remedies provided in the Technical specifications or as provided by law.
1.1.19.8	Defective Equipment
	In case any part of the equipment is found to be defective in materials or workmanship or develops defects or does not otherwise meet the requirements of the specifications including errors or omissions on the part of the Contractor the following shall apply.
	a) Defects disclosed prior to final acceptance :
	Any defect in materials or workmanship or other failure to meet the requirements of these specifications including errors or omissions on the part of the Contractor, which are disclosed prior to final payment or prior to final acceptance tests, whichever occurs at a later date, shall, if so directed by the purchaser, be corrected entirely at the expense of the Contractor.
	b) Defects disclosed after final acceptance.
	Any latent defect not disclosed before date of final acceptance shall be corrected promptly by the Contractor entirely at his expense provided that the total period during which the Contractor is liable for replacement due to latent defects shall not exceed two years after date of final acceptance of the equipment.
1.1.19.9	Operation of Unsatisfactory Equipment
	The purchaser shall have the right to operate all permanent equipment as soon as and as long as it is in operating condition, whether or not such equipment is being accepted. Such operation by the purchaser shall not lessen or impair any express or implied warranties concerning such equipment. All repairs or alternations required shall be met at such times as directed by the purchaser and in such a manner as will cause the minimum interruptions in the use of the equipment by the purchaser. Operation of the equipment pursuant to this section shall not relieve the Contractor of his responsibilities to supply all equipment in complete accordance with Technical Specifications. While unsatisfactory articles can be taken out of service for correction of latent defects, errors or omissions, the period of such operation of any use pending the correction of latent defects, errors or omissions shall not exceed two years without mutual consent of the Contractor and the purchaser.
1.1.19.10	Training to Purchaser's Engineers and workmen
	The Contractor shall to impart training to Purchaser's Engineers and workmen to familiarize them with the operation and maintenance of the equipment covered in these specifications. The period and training manual shall be approved by the purchaser. The cost on account of this training shall be in built in the price bid.

1.1.20	MANDATORY SPARE PARTS
	The contractor shall supply the one set or more set (as per direction of Engineer-in-charge) of following mandatory spare parts for each gate . (a) Rubber seals along with fasteners (b) Complete wheel assembly (c) Seals for hydraulic cylinders (d) Guide roller assembly complete in all respect (e) Bush and washer for guide roller assembly (f) Spares for gantry crane & Lifting beam
1.1.21	MEASUREMENT AND PAYMENT
	The measurement of gates will be recorded in MT of complete finish gate weight based on drawings of the gates approved by Engineer-in-charge. Similarly the measurement for the embedded part will also be recorded in MT equal to weight of all embedded parts including dogging as per drawings approved by Engineer-in-charge. The measurement for hydraulic hoist complete in all respect for each gate with power packs and control equipments including supporting structure required for operation of the gate shall be recorded as one set. The measurement for mandatory spare parts shall be made in number of set supplied. One set of each gate includes the spares as specified in para 15.7 (a) to (e) above. Payment shall be made as per item unit rates under items of BOQ as per contract. Rates includes : (i) The cost of designing of the gates, embedded parts and complete hoisting arrangement and preparation of detailed drawings as per specifications to be submitted for approval from Engineer-in-charge. (ii) The cost of all materials, labour, Equipments, machineries, tool & plants and consumables for fabrication, testing at shops, transporting to work site, fixing in position the embedded parts in concrete as per design and specifications, erecting gates complete with hoisting arrangement, testing after installation, and painting. (iii) The cost of all materials, labour, Equipments, machineries, tool & plants for supplying and laying 2nd stage concrete of specified grade as per IS Specifications. (iv) All cost of excise duty, GST and all other taxes ,royalties, storage charges, insurance charges and other incidental expenditure to complete the work as per the specifications and direction of Engineer-in-charge.