

CONTRACT NO.

**GUJARAT WATER SUPPLY & SEWERAGE BOARD**  
**GANDHINAGAR**  
(GOVERNMENT OF GUJARAT UNDERTAKING)



Bid Documents for “Working Survey, Design & Construction of Intake Well with Approach Bridge, Providing, Supplying, Lowering, Laying and Jointing various dia. of DI-K9/MS Rising Main Pipelines, RCC Sump, Pump House, Staff Quarter, Compound Wall, Supplying and erecting Pumping Machinery Including all Electro-Mechanical-Instrumentation and SCADA Works at Various HWs to SHWs under Water Supply Scheme Based on Bhadbhut Barrage (RHS) for Industries (GIDC) and Rural Areas of Bharuch and Vadodara Districts with 10 Years of Comprehensive O&M of entire scope of work. Dist.: Bharuch”.

Estimated Cost: Rs. ₹ 8,28,08,62,369.00

**VOLUME – II B**  
**TECHNICAL SPECIFICATION - CIVIL**

Chief Engineer  
Gujarat Water Supply & Sewerage Board  
Zone – 6 Surat.

## VOLUME- II B:

### TECHNICAL SPECIFICATION

# Contents

SECTION: 1 GENERAL AND MATERIAL .....	
SECTION:2 SURVEY & GEOTECHNICAL INVESTIGATION FOR DESIGN .....	
SECTION:3 CONCRETE .....	
SECTION -4 BUILDING ITEMS .....	
SECTION – 5 STRUCTURAL STEEL WORK.....	
SECTION -6 WATER SUPPLY AND SANITARY WORKS .....	
SECTION -7 EARTHWORK .....	
SECTION 8 : ITEMWISE SPECIFICATIONS.....	
SCHEDULE – B1 RCC INTAKE WELL WITH APPROACH BRIDGE .....	
SCHEDULE – B2 Rising Main Pipeline.....	
SCHEDULE – B3 RCC SUMP .....	
SCHEDULE – B4 Road, Railway, Canal, Gas Pipeline Crossings .....	
SCHEDULE – B5 Canal, Nallah and River Pipeline Crossings by RCC and Steel Bridge Structures .....	
SCHEDULE – B6 Compound Wall .....	
SCHEDULE – B7 Road Restoration Works for RCC and Bituminous Roads.....	
SCHEDULE – B8 RCC - Approach Road .....	
SCHEDULE – B9 Staff Quarter .....	
SCHEDULE – B10 Security Cabin .....	
SCHEDULE – B11 Pump Room with Panel Room .....	
SCHEDULE – B12 Pumping Machinery.....	
SCHEDULE B-13 ROU, Crop Compensation and Land Compensation Works.....	
SCHEDULE C-Operation & Maintenance .....	
Vendor List–	

# ***SPECIFICATIONS***

## **SECTION: 1 GENERAL AND MATERIAL**

## **SECTION: 1**

### **GENERAL AND MATERIAL**

#### **GENERAL**

##### **1.0 Employer's Drawings:**

- 1.1. The drawings listed in the Tender document are the Employer's conceptual drawings and are to be got approved prior to start of the works with actual site conditions & level in consultation with EIC.

##### **2.0 Drawing Sheet Format:**

- 2.1. All drawings provided by the Contractor shall be on standard size sheets, prepared on computer with AutoCAD and shall show the following particulars in a title block located in the lower right hand corner, in addition to the name of Contractor and equipment manufacturer, date, scale, drawing number, revision number (R0 for drawings submitted initially, R1, R2, etc. for drawings submitted subsequently) and title.

- Executive Engineer, P.H. Works Division...
- Project name: -

A blank space of 90 mm x 100 mm shall be provided for the Engineer's approval stamp and provision shall be made for details of revisions to be recorded.

- 2.2. All drawings submitted by the Tenderer/Contractor shall use the English language and SI units. All drawings shall be clearly and fully cross-referenced to the other drawings as relevant.

##### **3.0 Tender / Contract Drawings:**

- 3.1. Drawings submitted by the Tenderer shall show all the essential items of the Plant offered together with sufficient details to enable the general arrangement of the Plant to be determined.
- 3.2. The drawings and documents to be provided by the Tenderer / Contractor shall be as per the schedules of price but shall not be limited to those listed:

##### **4.0 Submissions and Approval of Drawings:**

- 4.1. The following shall be the procedure for submission and approval of drawings:

- 4.1.1. The Contractor shall submit 4 copies of the drawings to the Employer. All the drawings are to be signed by the Contractor or his authorized representatives

- 4.1.2. The Engineer's Representative will review the drawings and, if found fit for approval, the Employer will return 2 copies to the Contractor duly approved.

- 4.1.3. In case the drawings/documents are not fit for approval but worth for review, the Engineer's Representative will mark the comments on the drawings and return 2 copies to the Contractor. In such case, the Contractor shall resubmit the revised drawings within two weeks as per sub-clause 4.1.1 above and the same shall be repeated till the drawings are finally approved as per sub-clause 4.1.2 above.

- 4.1.4. If the submitted drawings/documents are not worth for review, the Contractor will be informed accordingly.

4.1.5. On receipt of the approved drawings as per sub-clause 4.1.2 above, the Contractor shall submit floppy and documents to the employer.

4.1.6. After tests on completion, the Contractor shall submit, within 15 days of the conclusion of the tests, floppies of the "As Built Drawings" to the Employer.

4.1.7 When the drawings are received by the Engineer's Representative after revision by the Contractor, he will only review the revision made and hence the Contractor shall carefully identify all the revised details / dimensions and also describe the revisions in the revision block.

4.1.8 No drawings, with corrections made after taking the prints, will be accepted.

4.1.9 Approval of drawings by the Engineer shall not relieve the Contractor of his responsibility in terms of the Contract.

## **5.0 Delivery, Unloading and Storing at Site:**

5.1. The Contractor shall be responsible for checking all materials delivered to Site and shall keep the Engineer's Representative fully informed of the state of deliveries. The Contractor shall carry out, at his cost, all instructions of Engineer or his Representative for proper unloading, preservation, maintenance, storage and security of materials delivered to Site until he fulfills all his obligations under the Contract.

5.2. The Contractor shall erect and maintain on the Site any temporary storage facility as required and approved by the Engineer.

5.3. Multiple handling and movement of materials during storage and retrieval shall be avoided.

## **6.0 Spare Parts:**

6.1. Spare Parts required after the taking over the Plant shall be filled up by the bidder in the price schedule.

6.2. Spares during pre-commissioning trials, commissioning tests/maintenance, guarantee etc. shall be provided by the Contractor. The necessary spares shall be brought by the Contractor prior to the pre-commissioning test so as to avoid the downtime of equipment due to non-availability of them. All these spares have to be provided as required, by Contractor free of cost.

6.3. All spare parts shall be new, unused and strictly interchangeable with the parts for which they are intended to be replacements and shall be treated and packed for long storage under the climatic conditions prevailing at the Site. Each spare part shall be clearly marked or labeled on the outside of its packing with its description, number and purpose. When more than one spare is packed in a single case or other container, a general description of its contents shall be shown on the outside of such case or container and a detailed list enclosed. All cases, containers and other packages shall be marked and numbered in an approved manner for the purpose of identification. Spares shall be delivered to Site after the completion of erection but before start of commissioning of Plant along with technical leaflets and details. Spare parts shall be indicated in the assembly drawing showing clearly the part numbers.

6.4. All cases, containers or other packages are liable to be opened for such examination as the Engineer's Representative may require and packing shall be designed to facilitate opening and thereafter re-packing. In the event of some specific spares offered in the Contract being withdrawn from manufacture owing to changes in design of equipment or similar reasons viz., model being obsolete etc., the Contractor shall inform the Employer before such withdrawal so that the Employer can take timely alternative steps.

## **7.0 Tools:**

7.1. Tools shall be delivered to site just prior to Tests on Completion.

7.2. The specified tools shall not be used for the erection of the Plant being supplied and except that the Engineer may call upon the Contractor to demonstrate their use or effectiveness, they must

be handed over to the Employer in a completely new and unused condition. Should the Contractor require any such tools at site for erection, he shall provide his own.

The test equipment shall include special purpose items essential to the testing or re-calibration of related items of Facilities.

## **MATERIALS AND WORKMANSHIP:**

### **1.0 Introduction:**

- 1.1 This part of the Specification sets out the general standards of materials to be supplied and the workmanship required to be ensured by the Contractor. All component parts of the Works shall, unless otherwise specified, comply with the provisions of employer's requirement or be subject to the approval of the Employer.

Particular attention shall be paid to a neat, orderly and well-arranged installation carried out in a methodical competent manner.

### **2.0 Reference Specifications and Standards:**

- 2.1 Where reference is made in the Specification to a British Standard Specification (hereinafter abbreviated to 'B.S') issued by the British Standards Institution of 2, Park street, London W.I., or to an Indian Standard Specification (I.S.) issued by the Bureau of Indian Standards, (earlier known as Indian Standard Institution), Manak Bhavan, 9 Bahadur shah Zafar Marg, New Delhi 110 002, or American Society for Testing and materials (ASTM) issued by ASTM 1916 Race Street, Philadelphia, P.A., 19103, U.S.A. or American national Standards Institute (ANSI) issued by ANSI 1430, Broadway, New York, N.Y., 10018, U.S.A. or Japanese Industrial Standards (JIS) issued by Japanese Standards Association, 4-1-24, Alaska, Minato-Ku, Tokyo 107, Japan or to any other equivalent Standard it shall be to the latest revision of that Standard on the Tender opening date.
- 2.2 The Contractor may propose at no extra cost to the Employer, the use of any relevant authoritative internationally recognized Reference Standard.
- 2.3 All details, materials and utensils supplied and workmanship performed shall comply with the specified Standards. If Tenderer offers equipment to other Standards, the equipment/material should be equal or superior to those specified and full details of the difference shall be supplied.
- 2.4 In the event of conflict between this Specification and the Codes for equipment, provisions of this Specification shall govern. Certain specifications issued by national or other widely recognized bodies are referred to in this Specification. In referring to the Standard Specifications the following abbreviations are used:

IS:	Indian Standard
ANSI:	American National Standards Institute
API:	American Petroleum Institute
ASME:	American Society of Mechanical Engineers
ASTM:	American Society of Testing and Materials
AWS:	American Welding Society
AWWA:	American Water Works Association
ISO:	International Organization for Standardization
DIN:	Deutsches Institute fur Normung
BS:	British Standard
IEC:	International Electro technical Commission
IEE:	Institution of Electrical Engineers

IEEE:	Institute of Electrical and Electronic Engineers
NEMA:	National Electrical Manufacturers Association
AGMA:	American Gear Manufacturer's Association

**3.0 Materials – General:**

- 3.1 All materials incorporated in the Works shall be the most suitable for the duty concerned and shall be new and of reputed make/approved quality, free from imperfections and selected for long life and minimum maintenance. Non-destructive tests, if called for in the Specification, shall be carried out. All submerged moving parts of the Plant, or shafts and spindles or faces etc. in contact with them shall be of corrosion resistant materials. All parts in direct contact with various chemicals, shall be completely resistant to corrosion, or abrasion by these chemicals, and shall maintain their properties without aging due to the passages of time, exposure to light or any other cause.

**4.0 Workmanship – General:**

- 4.1 Workmanship and general finish shall be of first-class quality and in accordance with best workshop practice.
- 4.2 All similar items of the Plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same materials as the originals and shall fit all similar items.
- 4.3 All parts, which can be worn or damaged by dust, shall be totally enclosed in dust proof housings. All materials incorporated in the Works shall be the most suitable for the duty concerned, free from imperfections and selected for long life and minimum maintenance. All necessary accessories required for satisfactory and safe operation of the Plant shall be supplied by the Contractor unless it is specifically excluded from his scope. Suitable provision by means of eyebolts or other means are to be provided to facilitate handling of all items that are too heavy or bulky for lifting and carrying by two men.

**5.0 Welding:**

- 5.1 Welding shall comply with the latest revision of the BS 5135 Code.
- 5.2 Welders shall be qualified in accordance with the requirement of the appropriate section of BS 4871. The Engineer shall have the right to call for further qualification from time to time from any welder who in the opinion of the Engineer does not produce weld in accordance with the qualification. Each welder shall be assigned a number and letter. Each welding elements shall clearly be identified as to its welder marking the welder's Code adjacent to the welds. A record chart shall be maintained for each welder showing the procedures, for which he has qualified, the date of such qualification, the type of defects produced and their frequency. The Engineer shall disqualify the welder whose Work requires a disproportionate amount of repairs. All procedures where required shall be qualified as per BS EN 283-3.
- 5.3 Inspection and quality of surveillance shall not be limited to the examination of finished welds. The techniques employed shall be based on methods which are known to produce good results and which have been verified at Site by actual demonstration.
- 5.4 Haphazard striking of the electrodes for establishing an arc shall not be permitted. The arc shall be struck either on the joint or on a starting tag. The starting tag shall be of the same material or a material compatible with the base metal being welded. In case of any inadvertent strike on



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place other than the welding, the area affected shall be ground flushed and examined by liquid penetration method.

- 5.5 Generally, a stringer bead technique shall be used with a slight oscillation of necessary to avoid slag and to minimize the number of beads needed to fill exceed 3 times the wire diameter. Vertical welds shall be made in upward direction. For all pipes above 300 mm dia., welding shall be done whenever possible, by 2 welders working simultaneously along both sides of the pipe.
- 5.6 The root pass shall have less than 1.5 mm internal reinforcement. Defects like icicles, burn through and excessive “such back”, etc. shall be cause for rejection of welds.
- 5.7 Final welds shall be suitable for appropriate fabrication of the non-destructive examination of the weld. If grinding is necessary, the weld shall be blended into the parent metal without gouging or thinning of the parent metal in any way. Uneven and excessive grinding may be a cause for rejection. Fillet weld shall preferably be convex and free from undercutting and overlap at the toe of weld. Convexity and concavity shall not exceed 1.5 mm. The leg lengths shall not exceed the specified size by more than 1.5 mm.
- 5.8 All attachments such as lugs, brackets and other non-pressure parts shall also be done by qualified welders in accordance with the design details and materials specifications. Temporary attachments shall be removed in a manner that will not damage the parent metal. Areas of temporary attachments shall be dressed smooth and examined by ultrasonic or liquid penetration methods.
- 5.9 All tack welds shall be made using qualified procedure and welders, the number of sizes of tack welds shall be kept as small as to consist of adequate strength and joint alignments. All tack welds shall be examined visually for defects and if found defective shall be completely removed. As welding proceeds, tack welds shall be either removed completely or shall be properly prepared by grinding or filling their starting ends so that they may be satisfactorily incorporated in the welds. Unacceptable defects shall be removed by grinding machine or chipping or gouge. Flame gouging may be permitted provided gouged surfaces are ground at least by 1.0 mm below the deepest indentation.
- 5.10 All weld repairs shall be carried out using the approved welding procedures and welders. Re-welded areas shall be re-examined by the methods specified for the original welds and the Engineer’s Representative shall duly qualify repair procedures.

#### **6.0 Pre-heating and Post-Heating Treatment:**

- 6.1 Pre-heating and post heating treatment shall conform to the relevant application Codes. Pre-heating not exceeding 121 deg. C for all carbon steel construction above 25 mm thickness would be mandatory. Such pre-heating would be maintained during flame cutting, flame or arc gouging, welding and repairs and may be done by gas heating by gas torches/gas rings with neutral flame. The temperature shall be checked by temperature indicating crayons. However, such pre-heating will not be necessary for welds less than 6 mm size. In large diameter pipe fabricated out of plate materials, production control test plates in accordance with the BS 4870-

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part 1 Table 6 to represent 30% of the long seams and each welder's performance would be mandatory.

## **7.0 Electrodes:**

- 7.1 All electrodes shall be stored in their original sealed containers under dry conditions. Electrodes shall remain identified until consumed. All electrodes shall be dried before use. Drying ovens shall be provided in Work areas for drying purposes. Electrodes withdrawn from oven shall be promptly used and excess unused electrodes shall be promptly returned to oven.

## **8.0 Examination/NDT/Radiography**

- 8.1 The various stages of examination and types shall be as stipulated in the respective fabrication Codes. Radiographic examination shall be carried out as per provisions of BS 2600 or BS 2910; Ultrasonic tests where called for shall be carried out as per provisions of BS 3926; magnetic particle tests shall be carried out as per BS 6072. Liquid penetration tests shall be carried out as per BS 6443.

## **9.0 Stainless Steel Welding:**

- 9.1 All welding consumable such as electrodes, filler weirs, argon gas for shielding and purging shall be of high quality and the proposed brand shall be furnished for approval of the Engineer. Weld deposits shall have similar or higher physical properties and similar chemical composition to the members joined.
- 9.2 All electrodes shall be purchased in sealed containers only and stored in their packing intact. The packets opened shall be consumed as early as possible. The electrodes removed from the containers shall be kept in holding ovens at temperatures recommended by electrode manufacturer. Special care shall be taken in avoiding mixing of electrodes in the oven. The electrodes and filling wires shall be free from rust, oil, grease, earth and other foreign matter.
- 9.3 Argon gas with purity 99.5% shall be used for shielding and purging. The purity of gas shall be certified by the gas manufacturers.
- 9.4 Non-destructive examination of the welds shall be carried out to ensure quality of weld.
- 9.5 The electric current for welding shall be direct current, straight polarity (electrode negative). The welding current shall be kept minimum possible to ensure minimum heat affected zone in the parent material. Other side of the weld joint shall be periodically flushed with argon gas.

## **10.0 Castings:**

- 10.1 Cast iron shall be of standard grey close-grained quality. The structure of the castings shall be homogeneous and free from non-metallic inclusions and other injurious defects. All surfaces of castings, which are not machined, shall be smooth and shall be carefully fettled to remove all foundry irregularities.

10.2 Minor defects in depth not exceeding 12.5 percent of total metal thickness and which will not ultimately affect the strength and serviceability of the casting may be repaired by approved welding techniques. The Engineer shall be notified of large defects and no repair welding of such defects shall be carried out without prior approval of the Engineer. If the removal of metal for repair should reduce the stress resisting cross section of the casting by more than 25 percent, or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then casting shall be rejected. Test coupons cast simultaneously with the main castings shall be identified to check physical, chemical analysis of casting. Major defects on casting are not acceptable. Castings repaired by welding for minor defects shall be stress-relieved after such welding. Non-destructive tests as directed by the Engineer will be required for any casting containing defects whose extent cannot otherwise be judged, or to determine where repair welds have been properly made.

#### **11.0 Forging:**

11.1 All major stress-bearing forging shall be made to a Standard Specification. Forging shall be subjected to magnetic particle testing or dye penetration test at the areas of fillets and change in section. The testing shall be conducted after rough machining (10 microns). Any defect, which will not machine out during the final machining, will be gouged out fully, inspected by dye penetration or magnetic particle inspection to ensure that the defect is fully removed and repaired using an approved repair procedure. Any indication, which proves to penetrate deeper than 2.5% of the finished thickness of the component, shall be reported to the Engineer giving the details like location, length, width and depth. For the magnetic particle inspection, the choice of wet or dry particles shall be at the Contractor's discretion.

11.2 All forging shall be demagnetized after test and shall be heat-treated for the relief of residual stresses.

#### **12.0 Design Life:**

12.1 The Works as a whole shall be new, of sound workmanship, robustly designed for a long reliable operating life and shall be capable of 24 hours per day continuous operation for prolonged period in the climatic and working conditions prevailing at the Site, and with the minimum of maintenance. Particular attention shall be given to temperature changes, the stability of paint finish for high temperatures, the rating of engines, electrical machinery, thermal overload services, cooling systems and the choice of lubricants for possible high and prolonged operating temperatures. The Contractor shall be called upon to demonstrate this for any component part either by service records, or evidence of similar equipment already installed elsewhere or relevant type tests. Routine maintenance and repair shall as far as possible not requires the services of highly skilled personnel.

12.2 The Plant shall be designed to provide easy access to and replacement of component parts, which are subject to wear, without the need to replace whole units. No parts in contact with water shall have a life from new to replacement or repair of less than five years.

12.3 Design features shall include the protection of Plant against damage caused by vermin, dirt, dust and dampness and to reduce risk of fire. Plant shall operate without undue vibration, and parts shall be designed to withstand the maximum stresses under the most severe condition of normal service. Materials shall have a high resistance to change in their properties due to the passage of time, exposure to light, temperature and any other cause, which may have a detrimental effect upon the performance or life of the Works.

12.4 Plant located outside lockable areas/building shall have additional features to prevent unauthorized operation.

### **13.0 Name Plate:**

13.1 Each item of the Plant shall have permanently attached to it in a conspicuous position, a nameplate and rating plate. Upon these shall be engraved or stamped, the manufacturer's name, type and serial number of Plant, details of the loading and duty at which the item of Plant has been designed to operate, and such diagrams as may be required by the Engineer. All indicating and operating devices shall have securely attached to them or marked upon them designations as to their function and proper manner of use.

13.2 Nameplates, rating plates and labels shall be of a non-flame propagating material, either non-hygroscopic or transparent plastic with engraved lettering of a contrasting colour. Fixing shall be by means of non-corrosive screws; drive rivets or adhesives shall not be used.

13.3 Warning labels shall be provided where necessary to warn of dangerous circumstances or substances. Inscriptions or graphic symbols shall be black on a yellow background circumstances or substances. Inscriptions or graphic symbols shall be black on a yellow background.

13.4 Instruction labels shall be provided where safety procedures such as wearing of protective clothing are essential to protect personnel from hazardous or potentially hazardous conditions. These labels shall have inscriptions or graphic symbols in white on a blue background.

### **14.0 Nuts, Bolts, Studs and Washers:**

14.1 Nuts, bolts, studs and washers for incorporation in the Plant shall conform to the requirements of the appropriate standard. Nuts and bolts shall be of the best quality of specified grade, machined on the shank and under the head and nut.

14.2 Fitted bolts shall be a light driving fit in the reamed holes they occupy, shall have the screwed portion of such a diameter that it will not be damaged in driving and shall be marked in a conspicuous position to ensure correct assembly at Site.

14.3 Washers, locking devices and anti-vibration arrangements shall be provided where necessary. Jointing hardware for the entire Plant shall be provided with sufficient spares to cater for site losses.

14.4 Where bolts pass through structural members taper washers shall be fitted, where necessary, to ensure that no bending stress is caused in the bolt. Where there is a risk of corrosion, bolts,

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nuts and studs shall be designed so that the maximum stress does not exceed half the yield stress of the material under any conditions. All bolts, nuts and washers that are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of nickel-bearing stainless steel.

- 14.5 The Contractor shall supply all holding down, alignment and leveling bolts complete with anchorages, nuts, washers and packing required to attach the Plant to its foundations, and all bed plates, frames and other structural parts necessary to spread the loads transmitted by the Plant to concrete foundations without exceeding the design stresses.

**15.0 Allowances for Wastage:**

- 15.1 The Contractor shall supply reasonable excess quantities to cover wastage of those consumable, which will be normally subject to waste during erection, commissioning and setting to Work.

**16.0 Painting – General:**

- 16.1 The Contractor shall be responsible for the cleaning, preparation for painting, and priming or otherwise protecting, as specified, all parts of the Plant at the place of manufacture prior to packing.
- 16.2 Parts may be cleaned but surface defects may not be filled in before testing at the manufacturer's works. Parts subject to hydraulic test shall be tested before any surface treatment. After test, all surfaces shall be thoroughly cleaned and dried out, if necessary by washing with an approved de-watering fluid prior to surface treatment. Except where the specification provides to the contrary all painting materials shall be applied in strict accordance with the paint manufacturer's instructions.
- 16.3 All protective coatings shall be suitable for use in warm humid climates. All primers, under coats and finishes shall be applied by brush or airless spray, except where otherwise specified. Consecutive coats shall be in distinct but appropriate shades. All paints shall be supplied from the store to the painters, ready for application, and addition of thinners or any other material shall be prohibited.

**17.0 Painting at Place of Manufacture:**

- 17.1 Steel and cast-iron parts shall be sand blasted to near white cleaning before painting. Edges, sharp covers etc. shall be ground to a curve before sand blasting. A primer coat of a zinc rich epoxy resin-based coating with at least 75 microns' dry film thickness is to be provided. In addition, the parts are to be provided with adequate number of coats of coal tar epoxy polyamine coating to a dry film thickness of 175 microns including primer coating.

**18.0 Painting at Site:**

- 18.1 Immediately on arrival at the site, all items of Plant shall be examined for damage to the paint coat applied at the manufacturer's works, and any damaged portions shall be cleaned down to the bare metal, all rust removed, and the paint coat made good with similar paint.

18.2 After erection, such items, which are not finish painted, shall be done so and, items that have been finish painted at the manufacturer's works shall be touched up for any damaged paintwork. For finish painting, two coats of synthetic enamel conforming to IS: 2932 shall be applied. Dry film thickness of each coat shall be at least 25 microns.

18.3 The dry paint film thickness shall be measured by Electrometer or other instruments approved by the Employer. In order to obtain the dry film thickness specified the Contractor should ensure that the coverage rate given by the paint manufacturer would enable this thickness to be obtained. Strength of adhesion shall be measured with an adhesion tester and this value shall not be less than  $10 \text{ kg/cm}^2$ . Painted fabricated steel work which is to be stored prior to erection shall be kept clear of the ground and shall be laid out or stacked in an orderly manner that will ensure that no water or dirt can accumulate on the surface. Suitable packing shall be laid between the stacked materials. Where cover is provided, it shall be ventilated.

#### **19.0 Galvanizing:**

19.1 Wherever galvanizing has been specified the hot dip process shall be used. The galvanized coating shall be of uniform thickness. Weight of zinc coatings for various applications shall not be less than those indicated below:

a) Fabricated steel :

Thickness less than 2 mm but not less than 1.2 mm - 340 gms/Sq.m

Thickness 2 mm and above - 460 gms/Sq.m

b) Fasteners

Up to nominal size M10 - 270 gms/Sq.m

Over M10 - 300 gms/Sq.m

19.2 Galvanizing shall be carried out after all drilling; punching, cutting, bending and welding operations have been carried out. Burrs shall be removed before galvanizing. Any Site modification of galvanized parts should be covered well by zinc rich primer and aluminum paint.

#### **20.0 Support for Pipe work & Valves:**

20.1. All necessary supports, saddles, sling, fixing bolts & foundation bolts shall be supplied to support the pipe work. Valve and other facilities mounted in the pipe work shall be supported independent of the pipes to which they connect.

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**INSPECTION AND TESTING AT MANUFACTURER'S PREMISES**

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**1.0 Inspection and Tests:****1.1 Valve:**

1.1.1 During testing there shall be no visible evidence of structural damage to any of the valve component.

1.1.2 Motorized valves shall be tested with their actuators, with a differential head equivalent to their maximum working pressure, to prove that the actuators are capable of opening and closing the valves under maximum unbalanced head condition within the specified opening or closing period.

1.1.3 The following test shall be carried out for sluice valves:

- a) Seat leakage test at rated pressure
- b) Hydrostatic test at 1.5 times the rated pressure
- c) Valve operation

1.1.4 The following test shall be carried out for non-return valves:

- a) Seat leakage test at rated pressure
- b) Body hydrostatic test at 1.5 times rated pressure
- c) Operation

**1.2 Pipe work:**

1.2.1 Testing of pipes and fitting shall be carried out in accordance with relevant Indian Standard and internationally approved standard. Pipes, fittings and expansion bellows shall be hydrostatically tested for 1.5 times the rated pressure.

**1.3. E.O.T. Crane:**

1.3.1 The cranes shall be completely assembled in the Contractor's or subcontractor's Works and shall be subjected to the tests as specified in IS 807/IS 3177 or relevant internationally approved standard. The Contractor shall provide the test weights.

**1.4 Equipment for testing:**

Equipment required for testing CC cubes and testing of steel bars are installed at main H/W site.

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# ***SPECIFICATIONS***

## **SECTION: 2 SURVEY & GEOTECHNICAL INVESTIGATION FOR DESIGN**



## 1. Specifications for Minimum Investigations required for Project:

### 1. Survey and Soil Exploration:

To plan out and obtain pre-approval and subsequently carry out Topographic and level Survey, preparing cross sections, Longitudinal sections, Soil exploration to obtain foundation design data at various locations for all the components listed in preamble on previous page, complete all as per general pre-approved plan and as per detailed description and specifications and including submitting survey, soil exploration and analysis reports in six copies along with two soft copies and getting the same approved by the engineer in charge.

Work consists of providing all equipment, materials, labour etc. to carry out survey, to provide permanent markers of various points for later use, to create permanent bench mark of approved design and approved location on the site, to carry out soil exploration to obtain information for foundation design as well as collecting data to determine various design parameters, to collect all data, prepare interim and final reports for submission and approval of the Engineer in-charge, all as per detailed description, specifications and as directed by the Engineer in-charge. This may call for revised hydraulic design, in case location of headwork/ sub headwork/ village level sump etc. changes. However, minimum pipe size (as given in Schedules and drawings) shall be adhered to. In certain cases, due to revised location of tail end point sump, level may be higher or frictional losses may increase. This will demand pipe size of higher diameter and contractor shall carry out hydraulic design to suit specific section subject. In case level of such sump reduces or location reduces the length ultimately resulting into permission of lower size, size given in schedule & drawing shall be provided and on no account, it shall be reduced.

It must be clearly understood that the data furnished with the tender and suggested procedure for survey and soil exploration are purely for general guidance of the bidders for selecting the best design criteria. The contractor is expected to carry out additional work if it becomes necessary in the process of selecting appropriate criteria. In any case responsibility of assuring the guaranteed water supply will fully rests with him.

### Work Description:

Work under this item involves survey, soil exploration and investigation as described below. Survey maps and all interim as well as final reports of soil investigation, other tests as well as the reporting of final tests shall be submitted in six paper copies as well as two soft copies and these will form part of a permanent record of the project for use during construction, operation, and maintenance stages as well as for future use. All below mentioned work shall be all inclusive and will be carried out as per detailed specifications and as directed by the Engineer in-charge.

Survey and soil investigation shall be completed within one & half month. In case after delay of 15 calendar days the department will get completed the work from departmental agency at the risk and cost of the contractor which shall be binding to the contractor.

## 2. Survey work shall consist of the following:

- A. To carry out Block level survey based on GTS benchmark, prepare longitudinal section along alignment of all types of pipeline and prepare contour survey of the allotted plot of land and the river bed of the width of 100m – 50m on either side - of the suggested center line of the alignment, and prepare contour maps to a scale of 1:500 or larger. Survey in the river may be carried out with help of sounding technique or long metallic rod inserted in water from the boat. All the levels/ distance may be measured with help of total station or DGPS.
- B. Selecting most appropriate location (on the basis of survey) to determine various geotechnical parameters for carrying out design of various components shall be responsibility of the contractors and it shall be carried out by laboratory approved by GOG acceptable to GWSSB.
- C. Above survey shall be carried out in stages as and when required, using the latest equipment like TOTAL STATION or DGPS with high accuracy. In case dumpy level/ auto level is used, then fly back as well as closing error must be performed without which survey will be considered as NOT completed. All levels will be based on GTS, and the work shall include transferring level from a reliable established GTS benchmark in the vicinity of the site of work and establishing a permanent bench mark on site at a suitable location as per approved design and location. Above survey will be carried out jointly with the representative of the owner, as per his convenience during day time.
- D. Detailed Longitudinal Section for each pipe shall be prepared and HGL marked on it for approval of GWSSB. After marking of such data only, execution of pipeline shall be permitted.
- E. Detailed contour plan of the headwork/ sub headwork etc. prepared with interval of 0.2 m so as to determine position of various units.

## Soil exploration work for intake, RCC and framed structures, underground sumps, Pump Houses (positive/ negative suction) shall consist of the following:

- A. 150 mm bores or more diameters (Minimum one no per unit/ structure) will be made to collect information for the foundation design of the intake well, approach bridge supports, underground sump, Pump House, other structures. Minimum depth of bores from the existing level at the location of proposed sump 12 m depth, and pump house 6 m depth, or more as per requirement of structural design. Disturbed and undisturbed soil samples will be collected, and grain size analysis by dry sieving/Wet analysis, determination of liquid/plastic limit and other necessary tests like C value, N value,  $\phi$  value and important parameters to carry out structural design and facilitate execution of structures shall be carried out. All levels including ground level of the bore point, levels of various strata and water levels etc. will be noted in reference to GTS.
- (A) **Specification for drilling, investigation, furnishing details of bore logs, laboratory testing and reporting:**

1. The investigation bores shall be made by percussion method and not by rotary method. No bentonite slurry or drilling mud shall be used. The bores shall be cased when it is to be done in sandy and silty strata.
2. The quantity of boring mentioned in work description is approximate and likely to vary materially if investigating alternative location of Infiltration Well becomes necessary. Any change in the quantity of boring work shall not entitle the contractor for any claim or compensation. His rates shall be deemed to cover such an eventuality.
3. The disturbed samples shall be collected at every 1.5 Mt. Depth or at the points where the strata changes whichever is less.
4. The samples so collected shall be preserved in systematic manner in core boxes, when the bore is in progress. After the bore is completed, each of the samples shall be packed in two separate poly thin bags with contents of approx. 0.5 Kg and properly numbered giving other details so as to identify the position to which the samples represent. All other details such as the bores Sr. Nos., the depth from which the samples are taken etc. should be clearly given with the samples.
5. Out of the two sets of samples collected for every bore one set of samples with all requisite details shall be sent to the laboratory for testing and the second set of samples together with requisite details shall be supplied to the clients in their office for record. The casing pipes shall be removed after above compliance and with the approval of the Engineer in-charge. The recovered samples shall be tested in the laboratory for grain size analysis and Atterberg's limits to identify the samples in accordance with the provision in IS.1498, 1971. The testing of samples shall have to be done at the recognized laboratory approved by the engineer-in charge.
6. The drilling shall be terminated at approx. 2.0 Mts. below the impervious (e.g. clay) strata, when bores are being made primarily to find the level of impervious strata. And if the samples collected indicate the soil being predominantly clayey further drilling shall be discontinued. In sandy strata including sand with gravels and small size boulders, Bores shall be extended at least up to 15 Mts. below bed level or low water level whichever is lower, however if required by Client /Consultants, the bores may have to be carried further.
7. Where bores are required to be done in water channel in river/ nallah bed, necessary island/islands shall be prepared in sand or sand filled gunny bags. The cost of which shall be covered within the rates quoted.
8. The rates quoted shall be inclusive for drilling in all kinds of strata including boulders, soft or hard rock.
9. For every bore water level encountered shall be recorded together with variation in water level if during the period of boring.
10. All levels shall be with reference to the GTS Bench Mark. For this purpose, a pucca GTS Bench mark shall be established in the region of proposed survey and investigation area.

11. The readings are to be recorded and observations are to be submitted with the reports in the format as per prosoma 1 and 2 shown below. The Contractor shall prepare bore charts for each and every bore in the approved manner and Performa as required by Client.
12. The disturbed samples are to be analyzed as per relevant clause of I.S. 2720 Part I to IV.
13. The water samples of water pumped out during pump test shall be collected and analyzed covering requirements of I.S. 10500 to establish its portability and the results of the chemical and other tests submitted in the format shown in Performa 3.
14. A Technical report covering the observations and tests is to be submitted to the client with the contractor's recommendations for selecting the most suitable site for the Radial well which could give the desired yield. The site for location of the pumping test shall be finalized in consultation with the clients before the work of pumping test including necessary boring work for the same is taken up.

**(B) Specification for preparing and submitting the full technical report:**

1. The survey work shall be carried out with proper accuracy and permanent Bench Marks shall be established at points which are approved by the Engineer in-charge. Also, sufficient number of permanent identification marks shall be established on the bank to enable establishment of base lines and the survey map to be included in the report shall contain sufficient details with respect to these permanent marks to enable the contractor to relocate the soil investigation bores as well as pump well and piezometric bores positions.
2. Based on the soil investigation carried out, a contour map of the area investigated showing the soil strata shall be prepared and included in the technical report.
3. The soil investigation work shall be carried out as per specifications and information will be recorded in the format given in attached Performa 1 and 2.
4. The short chemical analysis of water samples shall be carried out as per I.S. 10500 and results reported in format given in attached Performa 3.
7. The Performa included in the tender are only for guidance and by no means are they to be considered as the only ones required for reporting the investigation. Additional information which is considered necessary shall be collected and recorded systematically in proper format to arrive at the relevant conclusions.
8. Using these parameters discharge shall be calculated for different water levels of the river, and the report shall make definite recommendations as regards to the number of radials, their levels, and their lengths required to obtain the desired yield.

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PERFORMA 1																
Bore hole no.	Date of start	Date of comp.	GTS value	Revision no.												
Method	Casing	Bore dia in cm	Core recovery	Depth in m	Th. Of layer in m	Soil	Visual soil description	Penetration test N-Value						Undisturbed sample	Disturbed sample	Remarks

<b>PERFORMA 2</b>						
<b>Bore hole no.</b>	<b>Date of start</b>	<b>Date of comp.</b>		<b>Termination depth</b>	<b>Revision no.</b>	
<b>Depth of sample</b>	<b>Grain size analysis</b>					
	<b>% Gravel</b>	<b>% sand</b>	<b>Hydrometer</b>		<b>LL%</b>	<b>PL%</b>
			<b>% Silt</b>	<b>% Clay</b>		<b>PI%</b>

<b>PERFORMA 3: CHEMICAL ANALYSIS OF WATER</b>				
<b>Date of collection</b>		<b>Source</b>		
<b>Date of arrival at lab</b>		<b>Location</b>	<b>Village:</b>	
<b>Lab ref. no.</b>				
<b>Sr. no.</b>	<b>Characteristics</b>	<b>Permissible value as per IS 10500</b>		
		<b>Desirable</b>	<b>Relaxation in absence of alternate source</b>	<b>Analytical value</b>
1	Color			
2	Odor			
3	Turbidity			
4	Dissolved solids			
5	pH			
6	Total hardness as CaCO <sub>3</sub>			
7	Calcium			
8	Magnesium			
9	Chloride			
10	Sulphate			
11	Nitrate			
12	Fluoride			
13	Manganese			
Signature:				
Date:				

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# ***SPECIFICATIONS***

## **SECTION: 3 CONCRETE**



## **SECTION -3:**

### **CONCRETE**

#### **1.0**                      Applicable Codes with latest revisions.

##### **1.1**      Materials

- 1)        IS.269    Specification for 33 grade ordinary Portland cement.
- 2)        IS.455    Specification for Portland slag cement.
- 3)        IS.1489 Specification for Portland- Pozzolana cement (Part 1&2).
- 4)        IS: 8112 Specification for 43 grade ordinary Portland cement.
- 5)        IS: 12269 Specification for 53 grade ordinary Portland cement.
- 6)        IS: 12330 Specification for sulphate resisting Portland cement.
- 7)        IS: 383 Specification for coarse and fine aggregates from natural sources for concrete.
- 8)        IS: 432 Specification for mild steel and medium (tensile steel bars and hard-drawn steel) wires for concrete reinforcement. (Part 1 and 2)
- 9)        IS: 1786 Specification for high strength deformed steel bars and wires for Concrete reinforcement.
- 10)       IS: 1566 Specification for hard-drawn steel wire fabric for concrete Reinforcement.
- 11)       IS: 9103 Specification for admixtures for concrete.
- 12)       IS: 2645 Specification for integral cement water- proofing compounds.
- 13)       IS: 4990 Specification for plywood for concrete shuttering work.

##### **2.0**      Material Testing:

- 1)        IS.4031 Methods of physical tests for hydraulic cement (Parts 1 to 15)
- 2)        IS: 4032 Method chemical analysis of hydraulic cement.
- 3)        IS: 650 Specification for standard sand for testing of cement.
- 4)        IS: 2430 Methods for sampling of aggregates for concrete.
- 5)        IS: 2386 Methods of test for aggregates for concrete (Parts 1 to 8)

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- 6) IS: 3025 Methods of sampling and test (physical and chemical) for water used in industry.
  - 7) IS: 6925 Methods of test for determination of water-soluble chlorides in Concrete admixtures.

**2.1 Material Storage:**

- 1) IS: 4082 Recommendations on stacking and storing of construction Materials at site.

**2.1.4 Concrete Mix Design:**

- 1) IS: 10262 recommended guidelines for concrete mix design.
- 2) SP: 23 (S&T) Handbook on Concrete Mixes

**2.1.5 Concrete Testing:**

- 1) IS.1199 Method of sampling and analysis of concrete.
- 2) IS: 516 Method of test for strength of concrete.
- 3) IS: 9013 Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
- 4) IS: 8142 Method of test for determining setting time of concrete by Penetration resistance.
- 5) IS: 9284 Method of test for abrasion resistance of concrete.
- 6) IS: 2770 Methods of testing bond in reinforced concrete.

**2.1.6 Equipment:**

- 1) IS: 1791 Specification for batch type concrete mixers.
- 2) IS: 2438 Specification for roller pan mixer.
- 3) IS: 4925 Specification for concrete batching and mixing plant.
- 4) IS: 5892 Specification for concrete transit mixer and agitator.
- 5) IS: 7242 Specification for concrete spreaders.
- 6) IS: 2505 General Requirements for concrete vibrators: Immersion type.
- 7) IS: 2506 General Requirements for screed board concrete vibrators.

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- 8) IS: 2514 Specification for concrete vibrating tables.
  - 9) IS: 3366 Specification for pan vibrators.
  - 10) IS: 4656 Specification for form vibrators for concrete.
  - 11) IS: 11993 Code of practice for use of screed board concrete vibrators.
  - 12) IS: 7251 Specification for concrete finishers.
  - 13) IS: 2722 Specification for portable swing weigh batchers for concrete (Single and double bucket type).
  - 14) IS: 2750 Specification for steel scaffoldings.

**2.1.7 Codes of Practice:**

- 1) IS: 456 Code of practice for plain and reinforced concrete.
- 2) IS: 457 Code of practice for general construction of plain and reinforced Concrete for dams and other massive structures.
- 3) IS: 3370 Code of practice for concrete structure for storage of liquids (Part 1 to 4)
- 4) IS: 3935 Code of practice for composite construction.
- 5) IS: 2204 Code of practice for construction of reinforced concrete shell roof
- 6) IS: 2210 Criteria for the design of reinforced concrete shell structures and Folded Plates.
- 7) IS: 2502 Code of practice for bending and fixing of bars for concrete Reinforcement.
- 8) IS: 5525 Recommendation for detailing of reinforcement in reinforced Concrete works.
- 9) IS: 2751 Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
- 10) IS: 9417 Specification for welding cold worked bars for reinforced concrete construction.
- 11) IS: 3558 Code of practice for use of immersion vibrators for consolidating concrete.
- 12) IS: 3414 Code of practice for design and installation of joints in buildings.
- 13) IS: 4326 Code of practice for earthquake resistant design and construction of building.
- 14) IS: 4014 Code of practice for steel tubular scaffolding (Parts 1 & 2)

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- 15) IS: 2571 Code of practice for laying in situ cement concrete flooring.
  - 16) IS: 7861 Code of practice for extreme weather concreting: Part 1 Recommended practice for hot weather concreting.

#### **2.1.8 Construction Safety:**

- 1) IS: 3696 Safety code for scaffolds and ladders.
- 2) IS: 7969 Safety code for handling and storage of building materials.
- 3) IS: 8989 Safety code for erection of concrete framed structures.

#### **2.2 General:**

The Engineer in charge shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment and the quality control system. Such an inspection shall be arranged and the Engineer in charge's approval obtained, prior to starting of concrete work. This shall however, not relieve the Contractor from any of his responsibilities. All materials which do not conform to the Specifications shall be rejected.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/standards shall generally be used. Other materials may be used after approval of the Engineer in charge and after establishing their performance suitability based on previous data, experience or tests.

#### **2.3 Materials:**

##### **2.3.1 Cement:**

Unless otherwise called for by the Engineer in charge, cement shall be ordinary Portland cement conforming to IS: 269, IS: 8112 or IS: 12269. However, in any case, cement grade shall not be lower than 43 grades.

Where Portland Pozzolana or slag cements are used, it shall be ensured that consistency of quality is maintained, there will be no adverse interactions between the materials and the finish specified is not marred.

Only one type of cement shall be used in a particular unit. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without approval from the Engineer in charge.

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Cement which is not used within 90 days from its date of manufacture shall be tested at a laboratory approved by the Engineer in charge and until the results of such tests are found satisfactory, it shall not be used in any work.

### **2.3.2 Aggregates (General):**

Aggregates shall consist of naturally occurring stones (crushed or uncrushed), gravel and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/silt/ organic impurities/deleterious materials and conform to IS: 383. Aggregates such as slag, crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used.

Aggregates shall be washed and screened before use where necessary or if directed by the Engineer in charge.

Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse effect on strength, durability and finish, including long term effects, on the concrete.

The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2.

The maximum size of coarse aggregate shall be as stated on the drawings but in no case greater than 1/4 of the minimum thickness of the member.

Plums 160 mm and above of a reasonable size may be used in mass concrete where directed. Plums shall not constitute more than 20% by volume of the concrete.

### **2.3.3 Water:**

Water to be used for both mixing and curing shall conform to IS: 456. Potable water is generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used.

### **2.3.4 Reinforcement:**

All reinforcement steel shall be TMT tor steel conforming to relevant I.S. for all RCC structure with CRS - Fe-500 conforming to IS-1786.

All reinforcement shall be clean, free from pitting, oil, grease, paint, loose mill scales, rust, dirt, dust, or any other substance that will destroy or reduce bond.

All Grade of reinforcement steel shall be as per Price bid & Data-sheet.

### **2.3.5 Admixtures:**

Accelerating, retarding, water-reducing and air entraining admixtures shall conform to IS: 9103 and integral water proofing admixtures to IS: 2645.

Admixtures may be used in concrete as per manufacturer's instructions only with the approval of the Engineer in charge. An admixture's suitability and effectiveness shall be verified by trial mixes with the other materials used in the works. If two or more admixtures are to be used simultaneously in the same concrete mix, their interaction shall be checked and trial mixes done

to ensure their compatibility. There should also be no increase in risk of corrosion of the reinforcement or other embedment.

Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts.

Wastage:

Wastage allowance for cement and steel shall be considered in the item rate and no extra payment shall be paid to the Contractor on any account.

## **2.4 Samples and Tests:**

All materials used for the works shall be tested before use.

Manufacturer's test certificate shall be furnished for each batch of cement/steel and when directed by the Engineer in charge samples shall also be got tested by the Contractor in a laboratory approved by the Engineer in charge at no extra cost. Engineer in charge may appoint separate third-party inspection for the material testing to ensure the quality of the work. The Contractor shall replace the defective material as an outcome of these tests.

Sampling and testing shall be as per IS: 2386 under the supervision of the Engineer in charge.

Water to be used shall be tested to comply with requirements of IS: 456.

The Contractor shall furnish manufacturer's test certificates and technical literature for the admixture proposed to be used. If directed, the admixture shall be got tested at an approved laboratory at no extra cost.

## **2.5 Storing of Materials:**

All materials shall be stored in a manner so as to prevent its deterioration and contamination which would preclude its use in the works. Requirements of IS: 4082 shall be complied with.

The Contractor will have to make his own arrangements for the storage of adequate quantity of cement. If such cement is not stored properly and has deteriorated, the material shall be rejected. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 15 bags shall be stacked in any tier. Storage arrangement shall be approved by the Engineer in charge. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt.

Each size of coarse and fine aggregates shall be stacked separately and shall be protected from leaves and contamination with foreign material. The stacks shall be on hard, clean, free draining bases, draining away from the concrete mixing area.

The Contractor shall make his own arrangements for storing water at site in tanks to prevent contamination.

The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground/water. Each type and size shall be stacked separately.

## **2.6 Concrete:**

### **2.6.1 General:**

Concrete grade shall be as designated on drawings. In concrete grade M15, M20 etc. the number represents the specified characteristic compressive strength of 150X150X150 mm cube at 28 days, expressed in N/mm<sup>2</sup> as per IS:456. Concrete in the works shall be "DESIGN MIX CONCRETE" or "NOMINAL MIX CONCRETE". All concrete works of grade M5, M7.5 and M10 shall be NOMINAL MIX CONCRETE whereas all other grades, M15 and above, shall be DESIGN MIX CONCRETE. Concrete grade shall not be lower than M-25 for building and M-30 for water retaining structures (all units of STP including distribution chambers, sludge chambers, inlet/outlet chambers adjacent to PST/ AT/ SST).

## 2.6.2 Design Mix Concrete:

### (a) Mix Design & Testing:

For Design Mix Concrete, the mix shall be designed according to IS: 10262 and SP: 23 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS: 456. The design mix shall be cohesive and does not segregate and should result in a dense and durable concrete and also capable of giving the finish as specified. For liquid retaining structures, the mix shall also result in water tight concrete. The Contractor shall exercise great care while designing the concrete mix and executing the works to achieve the desired result.

The minimum cement content for Design Mix Concrete shall be as per Appendix-A of IS: 456 or as given below, whichever is higher.

Grade of Concrete	Minimum Cement Content in Kg/m <sup>3</sup> of Concrete
M15	260
M20	315
M25	360
M30	380
M 35	400

The minimum cement content stipulated above shall be adopted irrespective of whether the Contractor achieves the desired strength with less quantity of cement. The CONTRACTOR's quoted rates for concrete shall provide for the above eventuality and nothing extra shall be paid to the CONTRACTOR on this account. Even in the case where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the CONTRACTOR.

It shall be the Contractor's sole responsibility to carry out the mix designs at his own cost. He shall furnish to the EMPLOYER at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS: 516 shall comply with the requirements of IS: 456.

Grade of Concrete	Minimum Compressive Strength N/sq.mm at 7 days	Specified Characteristic Compressive Strength N/sq.mm at 28 days
M 15	10.0	15.0
M 20	13.5	20.0
M 25	17.0	25.0
M 30	20.0	30.0
M 35	23.5	35.0
M 40	27.0	40.0

A range of slumps which shall generally be used for various types of construction unless otherwise instructed by the Engineer in charge is given below:

Structure/Member	<i>Slump in millimeters</i>	
	Maximum	Minimum
Reinforced foundation walls and	75	25
Plain footings, caissons and	100	25
Slabs, Beams and reinforced walls	75	25
Pump & miscellaneous Equipment Foundations	100	25
Building columns	50	25
Pavements	50	25
Heavy mass construction	50	25

**(b) Batching & Mixing of Concrete:**

Proportions of aggregates and cement, as decided by the concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within one percent of the desired value.

Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water- cement ratio specified for use by the Engineer in charge shall be maintained. Each time when the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional cement to allow for sticking in the drum.

Arrangement should be made by the Contractor to have the cubes tested in an approved laboratory or in field with prior consent of the Engineer in charge. Sampling and testing of strength and workability of concrete shall be as per IS: 1199, IS: 516 and IS: 456, IS 3370.



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**2.6.3 Nominal Mix Concrete;****(a) Mix Design & Testing:**

Mix design and preliminary tests are not necessary for Nominal Mix Concrete.

However, works tests shall be carried out as per IS: 456. Proportions for Nominal Mix Concrete and Water Cement Ratio may be adopted as per Table 3 of IS: 456. However, it will be the Contractor's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

**(b) Batching & Mixing of Concrete:**

Based on the adopted nominal mixes, aggregates shall be measured by volume. However, cement shall be by weight only.

**2.7 Formwork:**

Formwork shall be all inclusive and shall consist of shoring, bracings, sides of footings, walls, beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts, false work, wedges etc.

The design and engineering of the formwork as well as its construction shall be the responsibility of the Contractor. However, if so desired by the Engineer in charge,

The drawings and calculations for the design of the formwork shall be submitted to the Engineer in charge for approval.

Formwork shall be designed to fulfill the following requirements:

- (a) Sufficiently rigid and tight to prevent loss of grout/ slurry or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.
- (b) Made of suitable materials.
- (c) Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.
- (d) Capable of withstanding without deflection the worst combination of self-weight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, earthquake, wind and weather forces.
- (e) Capable of easy striking out without shock, disturbance or damage to the concrete.
- (f) Soffit forms capable of imparting a camber if required.

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- (g) Soffit forms and supports capable of being left in position if required.
- (h) Capable of being cleaned and/or coated if necessary immediately prior to casting the concrete; design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

The formwork may be of timber, plywood, steel, plastic or concrete depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of the Engineer in charge. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and between formwork and structures shall be sufficiently tight to prevent loss of slurry from concrete, using seals if necessary.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces dust etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.

Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of the Engineer in charge. The Contractor shall equip himself with enough shuttering to allow for wastage so as to complete the job in time.

Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves shall be used. Formwork spacers left in situ shall not impair the desired appearance or durability of the structure by causing spilling, rust staining or allowing the passage of moisture.

For liquid retaining structures, sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

Where specified all corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size.

Forms for substructure may be omitted when, in the opinion of the Engineer in charge, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavations shall be larger, as approved by the Engineer in charge, than that required as per drawing to compensate for irregularities in excavation.

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The Contractor shall provide adequate props carried down to a firm bearing without overloading any of the structures.

The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.0m or as approved by the Engineer in charge. The Contractor shall temporarily and securely fix items to be casted (embedment / inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

Formwork showing excessive distortion, during any stage of construction, shall be repositioned and strengthened. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at Contractor's cost.

The striking time for formwork shall be determined based on the following requirements:

- (a) Development of adequate concrete strength;
- (b) Permissible deflection at time of striking form work;
- (c) Curing procedure employed - its efficiency and effectiveness;
- (d) Subsequent surface treatment to be done;
- (e) Prevention of thermal cracking at re-entrant angles;
- (f) Ambient temperatures; and
- (g) Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

Under normal circumstances (generally where temperatures are above 20°C) forms may be struck after expiry of the time period given in IS: 456 unless approved otherwise by the Engineer in charge. For Portland Pozzolana/slag cement the stripping time shall be suitably modified as approved by the Engineer in charge. It is the Contractor's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resist surface damage and any stresses arising during the construction period.

## **2.8 Reinforcement Workmanship;**

Reinforcing bars supplied bent or in coils shall be straightened cold without damage. No bending shall be done when ambient temperature is below 5°C. Local warming

May be permitted if steel is kept below 10° C. All bars shall be accurately cut and bent gradually and according to the sizes and shapes shown on the drawings/ schedules or as directed by Engineer in charge. Re-bending or straightening incorrectly bent bars shall not be done without the approval of the Engineer in charge.

Reinforcement shall be accurately fixed and maintained firmly in the correct position By the use of blocks, spacers, chairs, binding wire etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by the Engineer in charge prior to concrete placement. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of the reinforcement and not cause spilling of the concrete cover. Binding wire shall be 16-gauge soft annealed wires. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.

Substitution of reinforcement, laps/splices not shown on drawing shall be subject to Engineer in charge's approval.

## 2.9 Tolerances:

Tolerance for formwork and concrete dimensions shall be as per IS: 456 unless specified otherwise.

Tolerances specified for horizontal or vertical building lines or footings shall not be construed to permit encroachment beyond the legal boundaries.

The formwork shall be designed and constructed to the shapes, lines and dimensions shown on the drawings within the tolerances given below:

(a)	Deviation from specified dimensions of cross section of columns and beams	- 6 mm+ 12 mm
(b)	Deviations from dimensions of footings (Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel or dowels	
	1) Dimension in plan	- 12 mm+ 50 mm
	2) Eccentricity	0.02 times the width of the footing in the direction of deviation but not more than 50 mm.
	3) Thickness	± 0.05 times the specified thickness

**2.10 Preparation Prior to Concrete Placement:**

Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.

All arrangements-formwork, equipment and proposed procedure, shall be approved by the Engineer in charge. Contractor shall maintain separate Pour Card for each pour as per the format enclosed.

**2.11 Transporting, Placing and Compacting Concrete:**

Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water.

In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation, concrete shall not be re handled or caused to flow. For locations where, direct placement is not possible and in narrow forms the Contractor shall provide suitable drops and "Elephant Trunks". Concrete shall not be dropped from a height of more than 1.0m.

Concrete shall not be placed in flowing water. Under water, concrete shall be placed in position by tremie or by pipeline from the mixer and shall never be allowed to fall freely through the water.

While placing concrete the Contractor shall proceed as specified below and also ensure the following:

- (a) Continuously between construction joints and pre-determined abutments.
- (b) Without disturbance to forms or reinforcement.
- (c) Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits etc.
- (d) Without dropping in a manner that could cause segregation or shock.
- (e) In deep pours only when the concrete and formwork designed for this purpose and by using suitable chutes or pipes.
- (f) Do not place if the workability is such that full compaction cannot be achieved.

- (g) Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary. In supported excavations, withdraw the linings progressively as concrete is placed.
- (h) If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.
- (i) Ensure that there is no damage or displacement to sheet membranes.
- (j) Record the time and location of placing structural concrete.

Concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set. Over-vibration shall be avoided.

Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by the Engineer in charge. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

Except when placing with slip forms, each placement of concrete in multiple lift work shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had time to settle as approved by the Engineer in charge. Concrete shall be protected against damage until final acceptance.

#### **2.12 Mass Concrete Works:**

Sequence of pouring for mass concrete works shall be as approved by the Engineer in charge. The Contractor shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

#### **2.13 Curing:**

Curing and protection shall start immediately after the compaction of the concrete to protect it from:

- (a) Premature drying out, particularly by solar radiation and wind;

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- (b) Leaching out by rain and flowing water;
  - (c) Rapid cooling during the first few days after placing;
  - (d) High internal thermal gradients;
  - (e) Low temperature or frost;
  - (f) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

All concrete, unless approved otherwise by the Engineer in charge, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas or other absorbent material for the period of complete hydration with a minimum of 7 days. The quality of curing water shall be the same as that used for mixing.

Where a curing membrane is approved to be used by the Engineer in charge, the same shall be of a non-wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be approved by the EMPLOYER before use and shall be applied with spraying equipment capable of a smooth, even textured coat.

Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be well sealed and fastened.

#### **2.14 Construction Joints and Keys:**

Construction joints will be as shown in the drawing or as approved by the EMPLOYER. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of the Engineer in charge.

Dowels for concrete work, not likely to be taken up in the near future, shall be coated with cement slurry and encased in lean concrete as indicated on the drawings or as approved by the Engineer in charge.

Before resuming concreting on a surface which has hardened all laitance and loose stone shall be thoroughly removed by wire brushing/hacking and surface washed with high pressure water jet and treated with thin layer of cement slurry for vertical joints and horizontal layers.

When concreting is to be resumed on a surface which has not fully hardened, all laitance shall be removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this, a layer of concrete not exceeding 150 thickness shall be placed and well rammed against the old work. **Thereafter work shall proceed in the normal way.**

#### **2.15 Foundation Bedding:**

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All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy areas shall be cleaned out and back filled with either soil-cement mixture, lean concrete or clean sand compacted as approved by the Engineer in charge. The surfaces of absorptive soils shall be moistened.

Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

## **2.16 Finishes:**

### **2.16.1 General:**

The formwork for concrete works shall be such as to give the finish as specified. The Contractor shall make good any unavoidable defects as approved consistent with the type of concrete and finish as specified. Defects due to bad workmanship (e.g. damaged or misaligned forms, defective or poorly compacted concrete) will not be accepted. The Contractor shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

#### **Surface Finish Type F1:**

The main requirement is that of dense, well-compacted concrete. No treatment is required except repair of defective areas, filling all form tie holes and cleaning up of loose or adhering debris. For surfaces below grade, which will receive waterproofing treatment, the concrete shall be free of surface irregularities, which would interfere with proper and effective application of waterproofing material specified for use.

#### **Surface Finish Type F2:**

The appearance shall be that of a smooth dense, well-compacted concrete showing the slight marks of well fitted shuttering joints. The Contractor shall make good any blemishes.

#### **Surface Finish Type F3:**

This finish shall give an appearance of smooth, dense, well-compacted concrete with no shutter marks, stain free and with no discoloration, blemishes, arises, air holes etc. Only lined or coated plywood with very tight joints shall be used to achieve this finish. The panel size shall be uniform and as large as practicable. Any minor blemishes that might occur shall be made good by the Contractor.

#### **Integral Cement Finish on Concrete Floor:**

In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screened off to proper level and tamped with tamper having conical projections so that the aggregate shall be forced below the surface. The surface shall be finished



with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener as approved by the Engineer-In-Charge shall be supplied and used as recommended by the manufacturer.

The formwork for concrete works shall be such as to give the finish as specified. The Contractor shall make good any unavoidable defects as approved consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g. damaged or misaligned forms, defective or poorly compacted concrete) will not be accepted. The Contractor shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

#### **2.17 Repair and Replacement of Unsatisfactory Concrete:**

Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces, rough patches, and holes left by form bolts etc. shall be inspected by the Engineer in charge who may permit patching of the defective areas or reject the concrete work.

All through holes for shuttering shall be filled for full depth and neatly plugged flush with surface.

Rejected concrete shall be removed and replaced by the Contractor at no additional cost to the Employer.

For patching of defective areas all loose materials shall be removed and the surface shall be prepared as approved by the Engineer in charge.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the Engineer in charge as to the method of repairs to be adopted shall be final and binding on the Contractor. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as approved by the Engineer in charge.

#### **2.18 Vacuum Dewatering of Slabs:**

Where specified floor slabs, either grade or suspended, shall be finished by vacuum dewatering including all operations such as poker vibration, surface vibration, vacuum processing, floating and toweling as per equipment manufacturers recommendation. The equipment to be used shall be subject to the Engineer in charge's approval.

#### **2.19 Hot Weather Requirements:**

Concreting during hot weather shall be carried out as per IS: 7861 (Part I).

Adequate provisions shall be made to lower concrete temperatures which shall not exceed 40°C at the time of placement of fresh concrete.

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Where directed by the Engineer in charge, the Contractor shall spray non-wax based curing compound on unformed concrete surfaces at no extra costs.

**Cold Weather Requirements.**

Concreting during cold weather shall be carried out as per IS: 7861 (Part II).

The ambient temperature during placement and up to final set shall not fall below 5° C. Approved antifreeze/accelerating additives shall be used where directed.

For major and large-scale concreting works the temperature of concrete at times of mixing and placing, the thermal conductivity of the formwork and its insulation and stripping period shall be closely monitored.

**2.20 Liquid Retaining Structures:**

The Contractor shall take special care for concrete for liquid retaining structures, underground structures and those others specifically called for to guarantee the finish and water tightness.

The minimum level of surface finish for liquid retaining structures shall be as defined elsewhere. All such structures shall be hydro-tested.

The Contractor shall make all arrangements for hydro-testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipe lines etc.

The Contractor shall also make all temporary arrangements that may have to be made to ensure stability of the structures during construction.

Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, guiniting or such other methods as may be approved by the Engineer in charge. All such rectification shall be done by the Contractor to the entire satisfaction of the Engineer in charge at no extra cost.

**2.21 Testing Concrete Structures for Leakage:**

Hydro-static test for water tightness shall be done at full storage level or soffit of cover slab, as may be directed by the Engineer in charge, as described below:

In case of structures whose external faces are exposed, such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven-day period for absorption after filling with water.

In the case of structures whose external faces are buried and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling; the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hrs. Over a period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level over a period for seven days shall be taken as an indication of the water tightness of the structure. The Engineer in charge shall decide on the actual permissible nature of this drop in the surface level, considering whether the structures are open or closed and the corresponding effect it has on evaporation losses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.

Each compartment/segment of the structure shall be tested individually and then all together.

For structures such as pipes, tunnels etc. the hydrostatic test shall be carried out by filling with water, after curing as specified, and subjecting to the specified test pressure for specified period. If during this period the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

## **2.22 Optional Tests:**

If the Employer feels that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the Specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the Engineer in charge, as per relevant IS Codes. Contractor shall have to pay for these tests.

In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strengths, the Engineer in charge reserves the right to order the Contractor to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, etc. The Engineer in charge also reserves the right to ask the Contractor to dismantle and re-do such unacceptable work, at no cost to the Engineer in charge. Alternately Engineer in charge also reserves the right to ask the CONTRACTOR to dismantle and re-do such unacceptable work at the cost of CONTRACTOR.

## **2.23 Grouting:**

### **2.23.1 Standard Grout:**

Grout shall be provided as specified on the drawings.

The proportion of Standard Grout shall be such as to produce a flow able mixture consistent with minimum water content and shrinkage. Surfaces to be grouted shall be thoroughly roughened and cleaned. All structural steel elements to be grouted shall be cleaned of oil, grease, dirt etc. The use of hot, strong caustic solution for this purpose will be permitted. Prior to grouting, the hardened concrete shall be saturated with water and just before grouting, water in all pockets shall be removed. Grouting once started shall be done quickly and continuously.

Variation in grout mixes and procedures shall be permitted if approved by the Engineer in charge. The grout proportions shall be limited as follows:

Use	Grout Thickness	Mix Proportions	Water Cement Ratio (max)
1. Fluid mix	Under 25mm	One-part Portland Cement to one-part sand	0.44
b) General mix	25mm and over but less than 50mm	One-part Portland Cement to 2 parts of sand	0.53
c) Stiff mix	50mm and over	One-part Portland Cement to 3 parts of sand	0.53

#### 2.23.2 Non-Shrink Grout:

Non-shrink grout where required shall be provided in strict accordance with the manufacturer's instructions / specifications on the drawing.

#### Inspection:

All materials, workmanship and finished construction shall be subject to continuous inspection and approval of Engineer in charge. Materials rejected by Engineer in charge shall be expressly removed from site and shall be replaced by Contractor immediately.

#### Clean-Up:

Upon the completion of concrete work, all forms, equipment, construction tools, protective coverings and any debris, scraps of wood, etc. resulting from the work shall be removed and the premises left clean.

#### Acceptance Criteria:

Any concrete work shall satisfy the requirements given below individually and collectively for it to be acceptable.

- a) Properties of constituent materials;
- b) Characteristic compressive strength;
- c) Specified mix proportions;
- d) Minimum cement content;

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- e) Maximum free-water/cement ratio;
  - f) Workability;
  - g) Temperature of fresh concrete;
  - h) Density of fully compacted concrete;
  - i) Cover to embedded steel;
  - j) Curing;
  - k) Tolerances in dimensions;
  - l) Tolerances in levels;
  - m) Durability;
  - n) Surface finishes;
  - o) Special requirements such as;
    - i) Water tightness
    - ii) Resistance to aggressive chemicals
    - iii) Resistance to freezing and thawing
    - iv) Very high strength
    - v) Improved fire resistance
    - vi) Wear resistance
    - vii) Resistance to early thermal cracking

The Engineer in charge's decision as to the acceptability or otherwise of any concrete work shall be final and binding on the Contractor. For work not accepted, the Engineer in charge may review and decide whether remedial measures are feasible so as to render the work acceptable. The Engineer in charge shall in that case direct the Contractor to undertake and execute the remedial measures. These shall be expeditiously and effectively implemented by the Contractor. Nothing extra shall become payable to the Contractor by the Employer for executing the remedial measures.

## **2.24 Water stops:**

### **2.24.1 Material:**

The material for the PVC water stops shall be a plastic compound with the basic resin of polyvinyl chloride and additional resins, plasticizers, inhibitors, which satisfies the performance characteristics specified below as per IS:12200. Testing shall be in accordance with IS: 8543.

a)	Tensile strength	:	3.6 N/mm <sup>2</sup> minimum
c)	Ultimate elongation	:	300 % minimum
d)	Tear resistance	:	4.9 N/mm <sup>2</sup> minimum
e)	Stiffness in flexure	:	2.46 N/mm <sup>2</sup> minimum
f)	Accelerated extraction		
g)	Tensile strength	:	10.50 N/mm <sup>2</sup> minimum
h)	Ultimate elongation	:	250% minimum
i)	Effect of Alkali	:	7 days
j)	Weight increase	:	0.10% maximum
k)	Weight decrease	:	0.10% maximum
l)	Hardness change	:	± 5 points
m)	Effect of Alkali	:	28 days
n)	Weight increase	:	0.40% maximum
o)	Weight decrease	:	0.30% maximum
p)	Dimension change	:	±1%

PVC water stops shall be either of the bar type, serrated with center bulb and end grips for use within the concrete elements or of the surface (kicker) type for external use.

PVC water stops shall be of approved manufacture. Samples and the test certificate shall be got approved by the Engineer in charge before procurement for incorporation in the works. Alternatively, G.I. sheet of 18 gage (1.3mm) thick and 200mm wide can be used by the contractor as construction joints.

Alternatively, contractors can use G.I sheet 200mm wide and 18 gauge thick as constructions joints.

#### 2.24.2 Workmanship:

Water stops shall be cleaned before placing them in position. Oil or grease shall be removed thoroughly using water and suitable detergents. Water stops shall be procured in long lengths as manufactured to avoid joints as far as possible. Standard L or T type of intersection pieces shall be procured for use depending on their requirement. Any non-standard junctions shall be made by cutting the pieces to profile for jointing. Lapping of water stops shall not be permitted. All jointing shall be of fusion welded type as per manufacturer's instructions. Water stops shall be placed at the correct location/level and suitably supported at intervals with the reinforcement to ensure that it does not deviate from its intended position during concreting and vibrating. Care shall also be taken to ensure that no honey-combing occurs because of the serrations/end grips, by placing concrete with smaller size aggregates in this region. Projecting portions of the water stops embedded in concrete shall be thoroughly cleaned of all mortar/concrete coating before resuming further concreting operations. The projecting water stop shall also be suitably supported at intervals with the reinforcement to maintain its intended position

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during concreting so as to ensure that it does not bend leading to formation of pockets. In addition, smaller size aggregates shall be used for concreting in this region also.

## **2.25 Preformed Fillers and Joint Sealing Compound:**

### **2.25.1 Materials:**

Preformed filler for expansion/isolation joints shall be non-extruding and resilient type of bitumen impregnated fibers conforming to IS: 1838 (Part I).

Bitumen coat to concrete/masonry surfaces for fixing the preformed bitumen filler strip shall conform to IS: 702. Bitumen primer shall conform to IS: 3384.

Sealing compound for filling the joints above the preformed bitumen filler shall conform to Grade 'A' as per IS: 1834.

### **2.25.2 Workmanship:**

The thickness of the preformed bitumen filler shall be 25mm for expansion joints and 50mm for isolation joints around foundation supporting rotatory equipment's. Contractor shall procure the strips of the desired thickness and width in lengths as manufactured. Assembly of small pieces/thicknesses of strips to make up the specified size shall not be permitted.

The concrete/masonry surface shall be cleaned free from dust and any loose particles. When the surface is dry, one coat of industrial blown type bitumen of grade 85/25 conforming to IS: 702 shall be applied hot by brushing at the rate of 1.20 kg/m<sup>2</sup>. When the bitumen is still hot the preformed bitumen filler shall be pressed and held in position till it completely adheres. The surface of the filler against which further concreting/masonry work is to be done shall similarly be applied with one coat of hot bitumen at the rate of 1.20 kg/m<sup>2</sup>.

Sealing compound shall be heated to a pouring consistency for enabling it to run molten in a uniform manner into the joint. Before pouring the sealing compound, the vertical faces of the concrete joint shall be applied hot with a coat of bitumen primer conforming to IS: 3384 in order to improve the adhesive quality of the sealing compound.

Expansion joints between beams/slabs shall be provided with 100mm wide x 4mm thick mild steel plate at the soffit of RCC beams/slabs to support and prevent the preformed joint filler from dislodging. This plate shall be welded to an edge angle of ISA 50 x 50 x 6mm provided at the bottom corner, adjacent to the expansion joint of one of the beams/slabs, by intermittent fillet welding. Steel surfaces shall be provided with 2 coats of red oxide zinc chrome primer and 3 coats of synthetic enamel paint finish.

CONCRETE POUR CARD					
POUR NO.:			DATE:		
DRG. NO.:			STRUCTURE:		
CONCRETE GRADE/QUANTITY/:			MAX. AGGREGATE SIZE /		
SLUMP:			START / COMPLETION TIME:		
SL.NO	ITEM				Remarks If Any
1	BEFORE CONCRETING	CENTRELINES CHECKED		YES/NO	
2		FORMWORK AND STAGING CHECKED FOR ACCURACY, STRENGTH & FINISH		YES/NO	
3		REINFORCEMENT CHECKED		YES/NO	
4		COVER TO REINFORCEMENT CHECKED		YES/NO	
5		VERIFIED TEST CERTIFICATE FOR CEMENT/STEEL		YES/NO	
6		ADEQUACY OF MATERIALS / EQUIPMENT FOR POUR		YES/NO	
7		EMBEDDED PARTS (LOCATION & PLUMB) CHECKED	CIVIL	YES/NO	
	MECH.		YES/NO		
	ELEC.		YES/NO		
8	SOFFIT(S) & POUR TOP(T) LEVELS CHECKED BEFORE (B) & AFTER (A) FORM REMOVAL		S(B)		
			T(B)		
			S(A)		
			T(A)		
9	CONSTRUCTION JOINTS LOCATION & TYPE				
	EXPANSION JOINTS – LOCATION AND TYPE				
10	CEMENT CONSUMPTION IN KGS.				
10A	REINFORCEMENT CONSUMPTION DIAWISE IN KGS				
11	NUMBER OF CUBES AND IDENTIFICATION MARKS				
12	TEST CUBE RESULTS (7 DAYS / 28 DAYS)				
13	CONCRETE CONDITION ON FORM REMOVAL		V.GOOD/GOOD/FAIR/POOR		
Contractor's Representative			Engineer- in-charge's Representative		



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**NOTES:**

1. EACH POUR TO HAVE SEPARATE CARDS, IN TRIPLICATE ONE EACH FOR CLIENT, CONTRACTOR & SITE OFFICE.
- a) UNDER REMARKS, INDICATE DEVIATIONS FROM DWGS. & SPECIFICATIONS, CONGESTION IN REINFORCEMENT IF ANY, UNUSUAL OCCURRENCES SUCH AS FAILURE OF EQUIPMENTS, SINKING OF SUPPORTS / PROPS. HEAVY RAINS AFFECTING CONCRETING, POOR COMPACTION, IMPROPER CURING, OTHER DEFICIENCIES, OBSERVATIONS ETC.

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# ***SPECIFICATIONS***

## **SECTION -4 BUILDING ITEMS**

## **SECTION - 4:**

### **BUILDING ITEMS.**

#### **Applicable Codes and Specifications**

The following codes and standards are included in this section, as part of these specifications. However, respective IS codes for the works not mentioned here shall also be applicable for those particular items of work.

IS: 110 -	Ready mixed paint, brushing, gray filler, for Enamels for use over primers
IS: 269 -	Specification for 33 grade ordinary Portland cement
IS: 280 -	Specification for mild steel wire for general Engineering purposes
IS: 287 -	Recommendations for maximum permissible Moisture content of timber used for different purposes
IS: 383 -	Specif. for coarse & fine aggregates from natural sources for concrete
IS: 412 -	Expanded metal steel sheets for general purposes
IS: 419 -	Specification for putty for use on window frames
IS: 428 -	Distemper, oil emulsion, color as required
IS: 459 -	Specification for unreinforced corrugated and semi-corrugated asbestos cement sheets
IS: 702 -	Specification for industrial bitumen
IS: 710 -	Specification for marine plywood
IS: 712 -	Specification for building limes
IS: 730 -	Specification for hook bolts for corrugated sheet Roofing
IS: 733 -	Wrought aluminum and aluminum alloys, bars, Rods and sections for general engineering purposes
IS: 777 -	Specification for glazed earthenware tiles
IS: 1003-	Specification for timber paneled and glazed shutters (Parts 1 & 2)
IS: 1038-	Specification for steel doors, windows and ventilators
IS: 1077-	Specification for common burnt clay building bricks
IS: 1081-	Code of practice for fixing and glazing of metal (steel & aluminum) doors, Windows and ventilators.
IS: 1124-	Method of test for determination of water absorption, apparent specific Gravity and porosity of natural building stones
IS: 1237-	Specification for cement concrete flooring tiles
IS: 1322-	Bitumen felts for water proofing and damp proofing
IS: 1346-	Code of practice for water proofing of roofs with bitumen felts
IS: 1361-	Specification for steel windows for industrial buildings
IS: 1443-	Code of practice for laying and finishing of cement concrete flooring tiles
IS: 1477-	Code of practice for painting of ferrous metals in buildings (Parts 1 & 2)
IS: 1542-	Specification for sand for plaster
IS: 1580-	Specification for bituminous compounds for water-proofing and caulking purposes
IS: 1597-	Code of practice for construction of stone masonry: Part 1 Rubble stone masonry
IS: 1661-	Code of practice for application of cement and cement-lime plaster finishes
IS: 1834-	Specification for hot applied sealing compound for joint in concrete
IS: 1838-	Specification for preformed fillers for expansion joint in concrete Pavements and structures (none extruding and resilient type): Part 1 Bitumen impregnated fiber.
IS: 1948-	Specification for aluminum doors, windows and ventilators
IS: 1949 -	Specification for aluminum windows for industrial buildings
IS: 2074-	Ready mixed paint, air drying, red oxide- zinc chrome, priming

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IS: 2114-	Code of practice for laying in-situ terrazzo floor finish
IS: 2116-	Specification for sand for masonry mortars
IS: 2185-	Specification for concrete masonry units (Parts 1, 2& 3)
IS: 2202-	Specification for wooden flush door shutters (Solid core type): Parts 1&2
IS: 2212-	Code of practice for brickwork
IS: 2250-	Code of practice for preparation and use of masonry mortars
IS: 2338-	Code of practice for finishing of wood and wood-based materials (Parts 1 & 2)
IS: 2395-	Code of practice for painting concrete, masonry and plaster surfaces (Parts 1 & 2)
IS: 2402-	Code of practice for external rendered finishes
IS: 2571-	Code of practice for laying in-situ cement concrete flooring
IS: 2572-	Code of practice for construction of hollow concrete block masonry
IS: 2645-	Specification of integral cement waterproofing compounds
IS: 2690-	Specification for burnt clay flat terracing tiles: Part 1 Machine made
IS: 2691-	Specification for burnt clay facing bricks
IS: 2750-	Specification for steel scaffoldings
IS: 2835-	Flat transparent sheet glass
IS: 2932-	Specification for enamel, synthetic, exterior type (a) undercoating, (b) finishing
IS: 3007-	Code of practice for laying of asbestos cement sheets - corrugated and (Part 1 & 2) semi-corrugated sheets
IS: 3067-	Code of practice of general design details and preparatory work for Damp-proofing and water- proofing of buildings
IS: 3068-	Specification for broken brick (burnt clay) coarse aggregates for use in Lime concrete.
IS: 3384-	Specification for bitumen primer for use in water-proofing and damp-proofing
IS: 3462-	Specification for unbaked flexible PVC flooring
IS: 3495-	Method of test for burnt clay building bricks: Part 1 to 4
IS: 3536-	Specification for ready mixed paint, brushing, and wood primer, pink
IS: 3696-	Safety code of scaffolds and ladders (Parts 1 & 2)
IS: 4020-	Methods of test for wooden flush door: Type test
IS: 4021-	Specification for timber door, window and ventilator frames
IS: 4351-	Specification for steel door frames
IS: 4443-	Code of practice for use of resin type chemical resistant mortars
IS: 4457-	Specification for ceramic unglazed vitreous acid resisting tile
IS: 4631-	Code of practice for laying epoxy resin floor toppings
IS: 4832-	Specification for chemical resistant mortars (Part II)
IS: 4860-	Specification for acid resistant bricks
IS: 4948-	Specification for welded steel wire fabric for general use
IS: 5318-	Code of practice for laying of flexible PVC sheet and tile flooring
IS: 5410-	Cement paint, color as required
IS: 5411-	Specification for plastic emulsion paint (Parts 1 & 2)
IS: 5437-	Wired and figured glass
IS: 5491-	Code of practice for laying of in-situ granolithic concrete floor topping
IS: 6042-	Code of practice for construction of light weight concrete block masonry
IS: 6248-	Specification for metal rolling shutters and rolling grilles
IS: 7193-	Specification for glass fiber base coal tar pitch and bitumen felts
IS: 7452-	Specification for hot rolled steel sections for doors, windows and Ventilators
IS: 8042-	Specification for white Portland cement
IS: 9197-	Specification for epoxy resin, hardeners and epoxy resin composites for floor topping

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IS: 9862	Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and chlorine resisting
IS: 12200-	Code of practice for provision of water stops at transverse contraction Joints in masonry and concrete dams

**Brickwork:****Materials:**

Bricks used in the works shall conform to the requirements laid down in IS: 1077. The class of the bricks shall be as specifically indicated in the respective items of work.

The nominal size of the modular brick shall be 200 mm x 100 mm x 100 mm with the permissible tolerances over the actual size of 190mm x90 mm x 90 mm as per IS: 1077. The nominal thickness of one brick and half brick walls using modular bricks shall be considered as 200 mm and 100 mm respectively. In the event of use of traditional bricks of nominal size 230 mmx115mmx75mm with tolerance up to  $\pm 3$  mm in each dimension, one brick and half brick walls shall be considered as 230 mm and 115 mm respectively.

Bricks shall be sound, hard, and homogenous in texture, well burnt in kiln without being vitrified, hand/machine moulded, deep red, cherry or copper colored, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 3N/sq.mm unless otherwise specified in the Items of work prepared by the Contractor.

The average water absorption shall not be more than 20 percent by weight up to class 12.5 and 15 percent by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not acceptable for use in the works. Sample bricks shall be submitted to the GWSSB for approval and bricks supplied shall conform to approved samples. If demanded by GWSSB, brick samples shall be got tested as per IS: 3495 by Contractor. Bricks rejected by GWSSB shall be removed from the site of works within 24 hours.

Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS: 2250. Mix shall be in the proportion of 1:5 for brickwork of thickness one brick or above and 1:4 for brickwork of thickness half brick or below, unless otherwise specified in the respective items of work prepared by the Contractor. Sand for masonry mortar shall conform to IS: 218. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by GWSSB. If so directed by the GWSSB, sand shall be screened and washed till it satisfies the limits of deleterious materials.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by the GWSSB. The mortar thus mixed shall be used as soon as possible, preferably within 30 minutes from the time water is added to cement. In case, the mortar has stiffened due to evaporation of water, this may be re-tempered by adding water as required to restore consistency, but this will be permitted only up to 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall

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be rejected and shall be removed from the site. Droppings of mortar shall not be re-used under any circumstances. The Contractor shall arrange for test on mortar samples if so directed by the GWSSB.

**Workmanship:**

Workmanship of brick work shall conform to IS: 2212. All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work prepared by the Contractor. Brick work 200mm/230mm thick and over shall be laid in English Bond unless otherwise specified. 100mm/115mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full-size bricks shall be used for the works and cut bricks utilized only as closers to make up required wall length or for bonding. Bricks shall be laid with frogs on top.

All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be leveled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, at least one face should be kept smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness greater than one brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45 deg. But in no case the level difference between adjoining walls shall exceed one meter. Brickwork shall not be raised more than one meter per day.

Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10mm/15mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering/ pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top. During inclement weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain.

Brickwork shall be kept constantly moist on all the faces for at least seven days after 24 hr of laying. The arrangement for curing shall be got approved from the E.I.C.

Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS:2750 and IS:3696

(Part I). Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be permitted only in certain cases as decided by the GWSSB. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering/pointing.

In the event of usage of traditional bricks of size 230 mm x115mm x75mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/floor slabs and at the top of the parapet shall be laid with bricks on edge. All brickwork shall be built tightly against columns, floor slabs or other structural members.

To overcome the possibility of development of cracks in the brick masonry following measures shall be adopted. For resting RCC slabs, the bearing surface of masonry wall shall be finished on top with 12 mm thick cement mortar 1:3 and provided with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50-micron thick polyethylene sheets.

RCC/ steel beams resting on masonry wall shall be provided with reinforced concrete bed blocks of 50 mm thickness, projecting 50mm on either side of the beam, duly finished on top with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50-micron thick polyethylene sheets.

Steel wire fabric shall be provided at the junction of brick masonry and concrete before taking up plastering work. Bricks for partition walls shall be stacked adjacent to the structural member to pre-deflect the structural member before the wall is taken up for execution. Further, the top most course of half or full brick walls abutting against either a de-shuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.

Reinforced cement concrete transoms and mullions of dimensions as indicated in the construction Drawings to be prepared by the Contractor are generally required to be provided in the half brick partition walls.

Where the drawings prepared by the Contractor indicate that structural steel sections are to be encased in brickwork, the brickwork masonry shall be built closely against the steel section, ensuring a minimum of 20mm thick cement-sand mortar 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.

Facing bricks of the type specified conforming to IS: 2691 shall be laid in the positions indicated on the Drawings prepared by the Contractor and all facing brickwork shall be well bonded to the backing bricks/RCC surfaces. The level of execution of the facing brickwork shall at any time be lower by at least 600 mm below the level of the backing brickwork. Facing bricks shall be laid over 10 mm thick backing of cement mortar. The mortar mix, thickness of joint and the type of pointing to be carried out shall be as specified in the item of works prepared by the Contractor. The pattern of laying the bricks shall be as specifically indicated in the Drawings prepared by the Contractor. For facing brickwork, double scaffolding shall be used. Faced works shall be kept clean and free from damage, discoloration etc., at all times.

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**Uncoursed Random Rubble Masonry, in Foundation, Plinth and Superstructure.****Materials:**

Stones for the works shall be of the specified variety, which are hard, durable, fine grained and uniform in color (for superstructure work) free from veins, flaws and other defects. Quality and work shall conform to the requirements specified in IS: 1597 (Part-I). The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS: 1124. The Contractor shall supply sample stones to the GWSSB for approval. Stones shall be laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.

Cement-sand mortar for stone masonry works shall be in the proportion of 1:6.

Materials and preparation of mortar shall be as specified in clause 7.2.1.

**Workmanship:**

For All Works below ground level the masonry shall be random rubble uncoursed with ordinary quarry dressed stones for the hearting and selected quarry dressed stones for the facing.

For all works above ground level and in superstructure the masonry shall be random rubble uncoursed, well bonded, faced with hammer dressed stones with squared quoins at corners. The bushings on the face shall not be more than 40 mm on an exposed face and on the face to be plastered it shall not project by more than 12 mm nor shall it have depressions more than 10 mm from the average wall surface.

Face stones shall extend back sufficiently and bond well with the masonry. The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourths the thickness of wall nor less than 150 mm. The height of stone may be up to a maximum of 300 mm. Face stones or hearting stones shall not be less than 150 mm in any direction. Chips and spalls shall be used wherever necessary to avoid thick mortar joints and to ensure that no hollow spaces are left in the masonry. The use of chips and spalls in the hearting shall not exceed 20 percent of the quantity of stone masonry. Spalls and chips shall not be used on the face of the wall and below hearting stones to bring them to the level of face stones.

The maximum thickness of joints shall not exceed 20 mm. All joints shall be completely filled with mortar. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool during the progress of the work while the mortar is still green.

Through or bond stones shall be provided in walls up to 600 mm thick and in case of walls above 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous lime stone and sand stone, etc.) the bond stone shall extend about two-thirds into the wall and a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. Each bond stone or a set of bond stones shall be provided for every 0.5 sq.m of wall surface.



All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. All connected walls in a structure shall be normally raised uniformly and regularly. However, if any part of the masonry is required to be left behind, the wall shall be raked back (and not saw toothed) at an angle not exceeding 45deg. Masonry work shall not be raised by more than one meter per day. Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly moist on all the faces for a minimum period of seven days for proper curing of the joints.

Type of scaffolding to be used shall be as specified in clause 7.2.2.

#### **Coursed Rubble Masonry (First Sort) for Superstructure:**

##### **Materials:**

The Material specification for the work shall be as per clause 7.3.1.

##### **Workmanship:**

All Courses shall be laid truly horizontal and shall be of the same height in any course. The height of course shall not be less than 150 mm and not more than 300 mm. The width of stone shall not be less than its height.

Face stones shall tail into the work for not less than their height and at least  $\frac{1}{3}$ <sup>rd</sup> the number of stones shall tail into the work for a length not less than twice their height but not more than three-fourths the thickness of the wall whichever is smaller. These should be laid as headers and stretchers alternately to break joints by at least 75 mm.

The face stones shall be squared on all joints and beds; the bed joints being hammer or chisel dressed true and square for at least 80 mm back from the face and the side joints for at least 40 mm. The face of the stone shall be hammer dressed so that the bushing shall not be more than 40 mm on an exposed face and 10 mm on a face to be plastered. No portion of the dressed surface shall show a depth of gap more than 6 mm from a straight edge placed on it. The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joints.

No spalls or pinning shall be allowed on the face. All bed joints shall be horizontal and side joints shall be vertical and no joints shall be more than 10 mm in thickness. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool, during the progress of the work while the mortar is still green.

Hearting shall consist of flat bedded stones carefully laid on their proper beds and solidly bedded in mortar. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10 percent of the quantity of the stone masonry. Care shall be taken so that no hollow spaces are left anywhere in the masonry.

The requirement regarding through or bond stones shall be as specified in clause 7.3.2 with the further stipulation that these shall be provided at 1.5 m to 1.8m apart clear in every course but staggered at alternate courses.

The quoins which shall be of the same height as the course, in which they occur, shall not be less than 450 mm in any direction. Quoin stones shall be laid as stretchers and headers alternately. They shall be laid square on their beds, which shall be rough chisel dressed to a depth of at least 100 mm from the face. These stones shall have a minimum uniform chisel draft of 25mm width at four edges, all the edges being in the same plane.

Type of scaffolding to be used shall be as per Clause 7.2.2. Requirements of execution of the work and curing shall be as stipulated in clause 7.3.2.

### **Concrete Block Masonry:**

#### **Materials**

Masonry units of hollow and solid concrete blocks shall conform to the requirements of IS: 2185 (Part I). Masonry units of hollow and solid light-weight concrete blocks shall conform to the requirements of IS: 2185 (Part 3). Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS: 2185 (Part 3). The height of the concrete masonry units shall not exceed either its length or six times its width.

The nominal dimensions of concrete block shall be as under.

Length 400, 500 or 600 mm

Height 100 or 200 mm

Width 100 to 300 mm in 50 mm increments

Half blocks shall be in lengths of 200, 250 or 300mm to correspond to the full-length blocks. Actual dimensions shall be 10mm short of the nominal dimensions.

The maximum variation in the length of the units shall not be more than  $\pm 5$  mm and maximum variation in height or width of the units shall not be more than  $\pm 3$ mm.

Concrete blocks shall be either hollow blocks with open or closed cavities or solid blocks. Concrete blocks shall be sound, free of cracks, chipping or other defects which impair the strength or performance of the construction. Surface texture shall as specify. The faces of the units shall be flat and rectangular, opposite faces shall be parallel and all arises shall be square.

The bedding surfaces shall be at right angles to the faces of the block.

The concrete mix for the hollow and solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume. Concrete blocks shall be of approved manufacture, which satisfy the limitations in the values of water absorption, drying shrinkage and moisture movement, as specified for the type of block as per relevant IS code. Contractor shall furnish the test certificates and also supply the samples for the approval of GWSSB.

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**Workmanship:**

The type of the concrete block, thickness and grade based on the compressive strength for use in load bearing and/or non-load bearing walls shall be as specified. The minimum nominal thickness of non-load bearing internal walls shall be 100mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.

The workmanship shall generally conform to the requirements of IS: 2572 for concrete block masonry, IS: 6042 for light weight concrete block masonry and IS: 6041 for autoclaved cellular concrete block masonry works.

From considerations of durability, generally concrete block masonry shall be used in superstructure works above the damp-proof course level.

Concrete blocks shall be embedded with a mortar which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works. Preparation of mortar shall be as specified in clause 7.2.1.

The thickness of both horizontal and vertical joints shall be 10mm. The first course shall be laid with greater care, ensuring that it is properly aligned, leveled and plumb since this will facilitate in laying succeeding courses to obtain a straight and truly vertical wall. For the horizontal (bedding) joint, mortar shall be spread over the entire top surface of the block including front and rear shells as well as the webs to a uniform layer of 10mm. For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or on the edges of the succeeding unit when it is standing vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joint. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen and lose its plasticity. Mortar while hardening shrinks slightly and thus pulls away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be raked to a depth of 10mm as each course is laid to ensure good bond for the plaster.

Dimensional stability of hollow concrete blocks is greatly affected by variations of moisture content in the units. Only well dried blocks should be used for the construction. Blocks with moisture content more than 25% of maximum water absorption permissible shall not be used. The blocks should not be wetted before or during laying in the walls. Blocks should be laid dry except slightly moistening their surfaces on which mortar is to be applied to obviate absorption of water from the mortar.

As per the design requirements and to effectively control cracks in the masonry, RCC bound beams/studs, joint reinforcement shall be provided at suitable locations. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS: 280 or welded wire fabric/high strength deformed basis.

For jambs of doors, windows and openings, concrete blocks shall be provided. If hollow units are used, the hollows shall be filled with concrete of mix 1:3:6. Hold fasts of doors/windows should be arranged so that they occur at block course level.

At intersection of walls, the courses shall be laid up at the same time with a true masonry bond between at least 50% of the concrete blocks. The sequence for construction of partition walls and treatment at the top of load bearing walls for the RCC slab shall be as detailed under clause 7.2 for the brick work. Curing of the mortar joints shall be carried out for at least 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet. Double scaffolding as per clause 7.2.2 shall be adopted for execution of block masonry work. Cutting of the units shall be restricted to a minimum. All horizontal and vertical dimensions shall be in respectively, adopting modular co-ordination for walls, opening locations for doors, windows etc.

Concrete blocks shall be stored at site suitably to avoid any contact with moisture from the ground and covered to protect against wetting.

#### **Damp - Proof Course:**

#### **Materials and Workmanship:**

Where Specified, all the walls in a building shall be provided with damp-proof course cover at plinth to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even under the door or other openings. Damp-proof course shall consist of 50 mm thick cement concrete of 1:2:4 nominal mix with approved water-proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 10 mm downgraded coarse aggregates.

The surface of brick work/stone masonry work shall be leveled and prepared before laying the cement concrete. Side shuttering shall be properly fixed to ensure that slurry does not leak through and is also not disturbed during compaction. The upper and side surface shall be made rough to afford key to the masonry above and to the plaster.

Damp-proof course shall be cured properly for at least seven days after which it shall be allowed to dry for taking up further work.

#### **Miscellaneous Inserts, Bolts etc.**

All the miscellaneous inserts such as bolts, pipes, plate embedment etc., shall be accurately installed in the building works at the correct location and levels, all as detailed in the construction Drawings to be prepared by the Contractor. Contractor shall prepare and use templates for this purpose, if so directed by the GWSSB. In the event, if any of the inserts are improperly installed, Contractor shall make necessary arrangements to remove and reinstall at the correct locations/levels, all as directed by the GWSSB.

#### **Wood Work for Doors, Windows, Ventilators & Partitions**

#### **Materials**

Timber to be used shall be first class Teak wood as per IS: 4021. Timber shall be of the best quality and well-seasoned by a suitable process before being planned to the required sizes. The maximum permissible moisture content shall be from 10 to 16 percent for timber 50mm and above in thickness and 8 to 14 percent of timber less than 50mm in thickness for different regions of the country as stipulated in IS:287. Timber shall be close grained, of uniform color and free from decay, fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, borer holes, splits and cracks.

Flush door shutters of the solid core type with plywood face panels shall conform to IS: 2202 (Part 1) and with particle board/hard board face panels shall conform to IS: 2202 (Part 2).

Transparent sheet glass shall conform to the requirements of IS: 2835. Wired and figured glass shall be as per IS: 5437.

Builder's hardware for fittings and fixtures shall be of the best quality from approved manufacturers.

#### **Workmanship:**

The workmanship and finish of wood work in doors, windows, ventilators and partitions shall be of a very high order. Contractor shall ensure that work is executed in a professional manner by skilled carpenters for good appearance, efficient and smooth operation of the shutters.

All works shall be executed as per the detailed Drawings prepared by the Contractor and/or as directed by the GWSSB.

All members of the door, window, and ventilator shall be straight without any warp or bow and shall have smooth well-planned faces. The right angle shall be checked from the inside surfaces of the respective members of the frame. Frames shall have mortise and tenon joints which shall be treated with an approved adhesive and provided with metal or wood pins. The vertical members of the door frame shall project 50 mm below the finished floor level. The finished dimension of frames shall be rebated on the solid for keying with the plaster and for receiving the shutters. The depth of rebate for housing the shutter shall be 15 mm. The size of the frames shall be as specified in the respective items of work prepared by the Contractor. The workmanship shall generally conform to the requirements specified in IS: 4021.

The face of the frames abutting the masonry or concrete shall be provided with a coat of coal tar.

Three hold fasts using 25 mm x 6 mm mild steel flats 225 mm long with split ends shall be fixed on each side of door and window frames, one at the center and the other two at 300 mm from the top and bottom of the frame. For window and ventilator frames less than 1 m in height, two hold fasts on each side shall be fixed at quarter points.

Timber paneled shutters for doors, windows and ventilators shall be constructed in the form of framework of stiles and rails with panel insertion. The panels shall be fixed by either providing grooves in the stiles and rails or by beading. Glazing bars shall be as detailed in the Drawings prepared by the Contractor. The stiles and rails shall be joined by mortise and tenon joints at right angles. All members

of the shutter shall be straight without any warp or bow and shall have smooth, well planed faces at right angles to each other. The right angle for the shutter shall be checked by measuring the diagonals and the difference shall not be more than  $\pm 3$  mm. Timber panels made from more than one piece shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. The workmanship shall generally conform to the requirements specified in IS: 1003 (Parts 1 & 2). The thickness of the shutter, width/thickness of the stiles/rails/panel type shall be as specified. Marine plywood panels conforming to IS: 710 shall be used for doors where specified.

Details of the wooden flush door shutters, solid core type with specific requirement of the thickness, core, face panels, viewing glazed panel, Venetian louver opening, teak wood lapping etc. shall be as specified. Panels of shutter shall be of marine plywood conforming to IS: 710. Flush door shutters shall be from reputed manufacturers and Contractor shall submit test results as per IS: 4020, if so desired by the GWSSB.

Glazing of door, window, ventilator and partitions shall be with either flat transparent sheet glass, wired or figured glass. Transparent sheet glass shall be of 'B' quality as per IS: 2835. The thickness and type of glazing to be provided shall be as specified.

The material of the fittings and fixtures either of chromium plated steel, cast brass, copper oxidized or anodized aluminum shall be as specified. The number, size and type of the fittings and fixtures shall be as specified.

Woodwork shall not be provided with the finishes of painting/varnishing etc. unless it has been approved by the GWSSB. The type of finish and the number of coats shall be as stipulated in the respective items of work prepared by the Contractor. Preparation of the wood surfaces and application of the finishes shall be in accordance with clause 7.32.

Wooden hand railing and architraves shall be of the size and shape with the fixing arrangement as indicated in the Drawings prepared by the Contractor.

The framework of the partitions with mullions and transoms shall be with the sections of dimensions as specified. Panels of double/single glazing/plywood shall be fixed as per details specified. Partitions shall be fixed rigidly between the floor and structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction Drawings prepared by the Contractor.

Any carpentry work which shows defects due to inadequate seasoning of the timber or bad workmanship shall be removed and replaced by Contractor with work as per Specifications.

#### **Steel Doors, Windows and Ventilators:**

##### **Materials:**

Hot rolled steel sections for the fabrication of steel doors, windows and ventilators shall conform to IS: 7452, which are suitable for, single glazing.

Pressed steel door frames for steel flush doors shall be out of 1.25mm thick mild steel sheets of profiles as per IS: 4351.

Transparent sheet glass shall conform to the requirements of IS: 2835. Wired and figured glass shall be as per IS: 5437.

Builder's hardware of fittings and fixtures shall be of the best quality from the approved manufacturers.

**Workmanship:**

All steel doors, windows and ventilators shall be of the type as specified in the respective items of work prepared by the Contractor and of sizes as indicated in the Drawings prepared by the Contractor prepared by the Contractor. Steel doors, windows and ventilators shall conform to the requirements as stipulated in IS: 1038. Steel windows shall conform to IS: 1361, if so specified.

Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the unit shall be with rolled section, cut to correct lengths and metered. Corners shall be welded to form a solid fused welded joint conforming to the requirements of IS: 1038. Tolerance in overall dimensions shall be within  $\pm 1.5\text{mm}$ . The frames and shutters shall be free from warp or buckle and shall be square and truly plain. All welds shall be dressed flush on exposed and contact surfaces. Punching of holes, slots and other provisions to install fittings and fixtures later shall be made at the correct locations as per the requirements. Samples of the units shall be got approved by the GWSSB before further manufacture/purchase by the Contractor.

Type and details of shutters, hinges, glazing bar requirement, couplings, locking arrangement, fittings and fixtures shall be as described in the respective items of work and / or as shown in the Drawings prepared by the Contractor for single or composite units.

For windows with fly proof mesh as per the item of work prepared by the Contractor, rotor operator arrangement, for the operation of the glazed shutters from the inside shall be provided.

Pressed steel door frames shall be provided with fixing lugs at each jamb, hinges, lock-strike plate, mortar guards, angle threshold, shock-absorbers of rubber or similar material as per the requirements of IS: 4351. Pressed steel doorframes shall be fixed as 'built-in' as the masonry work proceeds. After placing it plumb at the specified location, masonry walls shall be built up solid on either side or each course grouted with mortar to ensure solid contact with the doorframe, without leaving any voids. Temporary struts across the width shall be fixed, during erection to prevent bow/sag of the frame. Door shutters of flush welded construction shall be 45 mm thick, fabricated with two outer skins of 1.25mm thick steel sheets, 1mm thick steel sheet stiffeners and steel channels on all four edges. Double shutters shall have meeting stile edge beveled or rebated. Provision of glazed viewing panel, louvers shall be made as per the items of works and/or Drawings prepared by the Contractor. Shutters shall be suitably reinforced for lock and other surface hardware and to prevent sagging/twisting. Single sheet steel door shutters shall be fabricated out of 1.25mm thick steel sheets, mild steel angles and stiffeners as per the Drawings prepared by the Contractor.

Doors, windows and ventilators shall be fixed into the prepared openings. They shall not be 'built-in' as the masonry work proceeds, to avoid distortion and damage of the units. The dimensions of the masonry opening shall have 10mm clearance around the overall dimensions of the frame for this purpose. Any support of scaffolding members on the frames/glazing bars is prohibited.

Glazing of the units shall be either with flat transparent glass or wired / figured glass of the thickness as specified in the items of works prepared by the Contractor. All glass panels shall have properly squared corner and straight edges. Glazing shall be provided on the outside of the frames.

Fixing of the glazing shall be either with spring glazing clips and putty conforming to IS: 419 or with metal beads. Pre-formed PVC or rubber gaskets shall be provided for fixing the beads with the concealed screws. The type of fixing the glazing shall be as indicated in the items of work and/or in Drawings prepared by the Contractor.

Steel doors, windows and ventilators shall be provided with finish of either painting as specified or shall be hot dip galvanized with thickness of the zinc coating as stipulated all as described in the respective items of works prepared by the Contractor.

The material of the Builders hardware of fittings and fixtures of chromium plated steel, cast brass, brass copper oxidized or anodized aluminum shall be as specified in the items of works prepared by the Contractor. The number, size and type of fittings and fixtures shall be as in the Drawings /items of works prepared by the Contractor.

Installation of the units with fixing lugs, screws, mastic caulking compound at the specified locations shall generally conform to the requirements of IS:1081. Necessary holes etc. required for fixing shall be made by the Contractor and made good after installation. Workmanship expected is of a high order for efficient and smooth operation of the units.

#### **Aluminum Doors, Windows, Ventilators & Partitions:**

##### **Materials:**

Aluminum alloy used in the manufacture of extruded sections for the fabrication of doors, windows, ventilators shall conform to designation HE9-WP of IS: 733.

Transparent sheet glass shall conform to the requirements of IS: 2835. Wired and figured glass shall be as per IS: 5437.

Builder's hardware of fittings & fixtures shall be of the best quality from approved manufacturers.

##### **Workmanship:**

All aluminum doors, windows, ventilators and partitions shall be of the type and size as specified. The doors, windows, ventilators shall conform to the requirements of IS: 1948. Aluminum windows shall conform to IS: 1949, if so specified.

All aluminum units shall be supplied with anodized finish. The minimum anodic film thickness shall be 0.015 mm. Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the units shall be with the extruded sections, cut to correct lengths, mitered and welded at the corners to a true right angle conforming to the requirements of IS: 1948. Tolerance in overall dimensions shall be within  $\pm 1.5$ mm. The frames and shutters shall be free from warp or buckle and shall be square and truly plane. Punching of holes, slots and other provisions to install fittings or fixtures later shall be made



at the correct locations, as per the requirements. Aluminum swing type doors, aluminum sliding windows, partitions shall be as specified.

IS:1948 and IS:1949 referred to incorporates the sizes, shapes, thicknesses and weight per running meter of extruded sections for the various components of the units. However, new sizes, shapes, thicknesses with modifications to suit snap-fit glazing clips etc. are being continuously being added by various leading manufacturers of extruded sections, which are available in the market. As such, the sections of the various components of the unit proposed by the Contractor will be reviewed by the GWSSB and will be accepted only if they are equal to or marginally more than that given in the codes/as specified.

The framework of the partitions with mullions and transom shall be with anodized aluminum box sections. Anodized aluminum box sections shall be in-filled with timber of class 3 (silver oak or any other equivalent) as per IS: 4021. Panels of double/single glazing/plywood shall be fixed as per details indicated in the Drawings to be prepared by the Contractor. Partitions shall be fixed rigidly between the floor and the structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction Drawings to be prepared by the Contractor.

Specific provisions as stipulated for steel doors, windows, ventilators under clause 7.9.2 shall also be applicable for this item work. Glazing beads shall be of the snap-fit type suitable for the thickness of glazing proposed as indicated in the items of works prepared by the Contractor. A layer of clear transparent lacquer shall be applied on aluminum sections to protect them from damage during installation. This lacquer coating shall be removed after the installation is completed.

#### **Steel Rolling Shutters:**

##### **Materials and Workmanship:**

Rolling shutters shall be of an approved manufacture, conforming to the requirements specified in IS: 6248.

The type of rolling shutter shall be self-coiling type (manual) for clear areas up to 12 m<sup>2</sup>, gear operated type (mechanical) for clear areas up to 35 m<sup>2</sup> and electrically operated type for areas up to 50 sq.m. Mechanical type of rolling shutters shall be suitable for operation from both inside and outside with the crank handle or chain gear operating mechanism duly considering the size of wall/column. Electrical type of rolling shutter shall also be provided with a facility for emergency mechanical operation.

Rolling shutters shall be supplied duly considering the type, specified clear width/height of the opening and the location of fixing as indicated in the Drawings prepared by the Contractor. Shutters shall be built up of interlocking laths 75 mm width between rolling centers formed from cold rolled steel strips. The thickness of the steel strip shall not be less than 0.90 mm for shutters up to 3.50m width and not less than 1.20 mm for shutters above 3.50 m width. Each lath section shall be continuous single piece without any welded joint. The guide channels out of mild steel sheets of thickness not less than 3.15

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mm shall be of either rolled, pressed or built up construction. The channel shall be of size as stipulated in IS: 6248 for various clear widths of the shutters.

Hood covers shall be of mild steel sheets not less than 0.90 mm thick and of approved shape. Rolling shutters shall be provided with a central hasp and staple safety device in addition to one pair of lever locks and sliding locks at the ends.

All component parts of the steel rolling shutter (excepting springs and insides of guide channels) shall be provided with one coat of zinc chrome primer conformity to IS: 2074 at the shop before supply. These surfaces shall be given an additional coat of primer after erection at the site along with the number of coats and type of finish paint as specified in the respective items of works prepared by the Contractor. Painting shall be carried out as per clause 7.33.

In case of galvanized rolling shutter, the lath sections, guides, lock plate, bracket plates, suspension shaft and the hood cover shall be hot dip galvanized with a zinc coating containing not less than 97.5 percent pure zinc. The weight of the zinc coating shall be at least 610gms/m<sup>2</sup>.

Guide channels shall be installed truly plumb at the specified location. Bracket plate shall be rigidly fixed with necessary bolts and holdfasts. Workmanship of erection shall ensure strength and rigidity of rolling shutter for trouble free and smooth operation.

#### **Rubble Sub-Base:**

##### **Materials:**

Stones used for rubble packing under floors on grade, foundations etc., shall be clean, hard, durable rock free from veins, flaws, laminations, weathering and other defects. Stones shall generally conform to the requirements stipulated in IS: 1597 (Part I).

Stones shall be as regular as can be obtained from quarries. Stones shall be of height equal to the thickness of the packing proposed with a tolerance of  $\pm 10$  mm. Stones shall not have a base area less than 250 sq cm nor more than 500 sq.cm, and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stones shall be subject to the approval of the GWSSB.

##### **Workmanship:**

Stones shall be hand packed carefully and laid with their largest base downwards resting flat on the prepared sub-grade and with their height equal to the thickness of the packing. Stones shall be laid breaking joints and in close contact with each other. All interstices between the stones shall be wedged-in by small stones of suitable size, well driven in by crow bars and hammers to ensure tight packing and complete filling-in of the interstices. The wedging shall be carried out simultaneously with the placing in position of rubble packing and shall not lag behind. After this, any interstices between the smaller wedged stones shall be unfilled with clean hard sand by brooming so as to fill the joints completely.

The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.

**Base Concrete:**

The thickness and grade of concrete and reinforcement shall be as specified in items of works prepared by the contractor.

Before placing the blinding concrete, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

**Terrazzo and Plain Cement Tiling Work:****Materials:**

Terrazzo tiles and cement tiles shall generally conform in all respects to standards stipulated in IS: 1237. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than  $14\text{N/mm}^2$ .

The type, quality, size, thickness color etc., of the tiles for flooring/dado/skirting shall be as specified.

The aggregates for terrazzo topping shall consist of marble chips which are hard, sound and dense. Cement to be used shall be either ordinary Portland cement or white cement with or without coloring pigment. The binder mix shall be with 3 parts of cement to 1 part of marble powder by weight. The proportion of cement shall be inclusive of any pigments. For every one part of cement-marble powder binder mix, the proportion of aggregates shall be 1.75 parts by volume, if the chips are between 1mm to 6mm and 1.50 parts by volume if the chips are between 6mm to 25mm.

The minimum thickness of wearing layer of terrazzo tiles shall be 5mm for tiles with chips of size varying from 1mm up to 6mm or from 1mm up to 12mm. This shall be 6mm for tiles with chips varying from 1mm up to 25mm. The minimum thickness of wearing layer of cement/colored cement tiles shall be 5mm. This shall be 6mm for heavy duty tiles. Pigment used in the wearing layer shall not exceed 10 percent of the weight of cement used in the mix.

**Workmanship**

Laying and finishing of tiles shall conform to the requirements of workmanship stipulated in IS: 1443.

Tiling work shall be commenced only after the door and window frames are fixed and plastering of the walls/ ceiling is completed. Wall plastering shall not be carried out up to about 50 mm above the level of proposed skirting/dado.

The base concrete shall be finished to a reasonably plane surface about 40 to 45mm below the level of finished floor. Before the tiling work is taken up, the base concrete or structural slab shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. using steel wire brush and well wetted without allowing any water pools on the surface. A layer of 25mm average thickness of cement mortar consisting of one part of cement to 6 parts of sand shall be provided as bedding for the tiles over the base concrete. The thickness of bedding mortar shall not be less than 10mm at any place. The quantity of water to be added for the mortar shall be just adequate to obtain the workability for laying. Sand for the mortar shall conform to IS: 2116 and shall have minimum fineness modulus of 1.5. The surface shall be left rough to provide a good bond for the tiles. The bedding shall be allowed to harden for a day before laying of the tiles. Neat cement slurry using 4.4 kg of cement per m<sup>2</sup> of floor area shall be spread over the hardened mortar bedding over such an area at a time as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be in straight lines and shall normally be 1.5mm wide. On completion of laying of the tiles in a room, all the joints shall be cleaned and washed fairly deep with a stiff broom/wire brush to a minimum depth of 5mm. The day after the tiles have been laid, the joints shall be filled with cement grout of the same shade as the color of the matrix of the tile. For this purpose, white cement or grey cement with or without pigments shall be used. The flooring should be kept moist and left undisturbed for 7 days for the bedding/joints to set properly. Heavy traffic shall not be allowed on the floor for at least 14 days after fixing of the tiles.

About a week after laying the tiles, each and every tile shall be lightly tapped with a small wooden mallet to find out if it gives a hollow sound; if it does, such tiles along with any other cracked or broken tiles shall be removed and replaced with new tiles to proper line and level. The same procedure shall be followed again after grinding the tiles and all damaged tiles replaced, properly jointed and finished to match. For the purpose of ensuring that such replaced tiles match with those laid earlier, it is necessary that the Contractor shall procure sufficient quantity of extra tiles to meet this contingency.

Wherever a full tile cannot be provided, tiles shall be cut to size and fixed. Floor tiles adjoining the wall shall go about 10mm under the plaster, skirting or dado.

Tile skirting and dado work shall be executed only after laying tiles on the floor. For dado and skirting work, the vertical wall surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with 10mm thick backing of 1:4 cement sand mortar. For this work the tiles as obtained from the factory shall be of the size required and practically full polished. The back of each tile to be fixed shall be covered with a thin layer of neat cement paste and the tile shall then be gently tapped against the wall with a wooden mallet. Fixing shall be done from the bottom of the wall upwards. The joints shall be in straight lines and shall normally be 1.5mm wide. Any difference in the thickness of the tiles shall be evened out in the backing mortar or cement paste so that the tile faces are in conformity & truly plumb. Tiles for use at the corners shall be suitably cut with beveled edges to obtain a neat and true joint. After the work has set, hand polishing with carbonado stones shall be done so that the surface matches with the floor finish.

Wall plastering of the strip left out above the level of skirting/dado shall be taken up after the tiles are fixed.

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Chequered terrazzo tiles for flooring and for stair treads shall be delivered to site after the first machine grinding.

Machine grinding and polishing shall be commenced only after a lapse of 14 days of laying. The sequence and three numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pin holes, watering etc. shall be carried out all as specified in IS: 1443.

Tiles shall be laid to the levels specified. Where large areas are to be tiled the level of the central portion shall be kept 10mm higher than that at the walls to overcome optical illusion of a depression in the central portion. Localized deviation of  $\pm 3\text{mm}$  in any 3m length is acceptable in a nominally flat floor.

#### **In-Situ Terrazzo Work:**

##### **Materials:**

The requirements of marble aggregates for terrazzo topping shall be as per clause 7.14.1.

Cement shall first be mixed with the marble powder in dry state. The mix thus obtained shall be mixed with the aggregates in the specified proportions. Care shall be taken not to get the materials into a heap which results in the coarsest chips falling to the edges and cement working to the centre at the bottom. Materials shall be kept, as far as possible, in an even layer during mixing. After the materials have been thoroughly mixed in the dry state, water shall be added, just adequate to obtain plastic consistency for the desired workability for laying. The mix shall be used in the works within 30 minutes of the addition of water to the cement.

##### **Workmanship:**

The thickness, type, quality, size and color of chips etc. for the in-situ terrazzo finish for flooring/dado/skirting shall be as specified in the respective items of works prepared by the Contractor. Laying and finishing of in-situ work shall conform to the requirements of workmanship stipulated in IS: 2114.

In-situ terrazzo finish shall be laid over hardened concrete base. The finish layer consists of an under layer and terrazzo topping. The under layer shall be of cement concrete of mix 1:2:4 using 10mm downgraded coarse aggregates. The combined thickness of under layer and topping shall not be less than 30 mm for flooring and 20mm for dado/skirting work.

The minimum thickness of topping shall be 6mm if chips used are between 1mm to 4mm, 9mm if chips are between 4mm to 7mm and 12mm if chips are between 7mm to 10mm. If chips larger than 10mm size are used, the minimum thickness shall be one and one third the maximum size of chips.

Both the under layer and later the topping shall be divided into panels not exceeding  $2\text{ m}^2$  for laying so as to reduce the possibility of development of cracks. The longer dimension of any panel shall not exceed 2m. Dividing strips shall be used to separate the panels. When the dividing strips are not provided, the bays shall be laid alternately, allowing an interval of at least 24 hours between laying adjacent bays.

Dividing strips shall be either of aluminum, brass or other material as indicated in the items of works prepared by the Contractor. Aluminum strips should have a protective coating of bitumen. The thickness of the strips shall not be less than 1.5mm and width not less than 25mm for flooring work.

Concrete base shall be finished to a reasonably plane surface to a level below the finished floor elevation equal to the specified thickness of terrazzo finish. Before spreading the under layer, the base concrete surface shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. and well wetted without allowing any water pools on the surface. Dividing strips or screed strips, if dividing strips are not provided shall be fixed on the base and leveled to the correct height to suit the thickness of the finish. Just before spreading the under layer the surface shall be smeared with cement slurry at 2.75 Kg/m<sup>2</sup>. Over this slurry, the under layer shall be spread and leveled with a screening board. The top surface shall be left rough to provide a good bond for the terrazzo topping.

Terrazzo topping shall be laid while the under layer is still plastic and normally between 18 to 24 hours after the under layer is laid. Cement slurry of the same color as the topping shall be brushed on the surface immediately before laying is commenced. The terrazzo mix shall be laid to a uniform thickness and compacted thoroughly by tamping and with a minimum of toweling. Straight edge and steel floats shall be used to bring the surface true to the required level in such a manner that the maximum amount of marble chips come up and spread uniformly all over the surface.

The surface shall be left dry for air-curing for a period of 12 to 18 hours. Thereafter it shall be cured by allowing water to stand in pools for a period of not less than 4 days.

Machine grinding and polishing shall be commenced only after a lapse of 7 days from the time of completion of laying. The sequence and four numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pinholes, wet curing, watering etc. shall be carried out all as specified in IS: 2114.

#### **Shahabad / Tandur/ Kota Stone Slab work:**

##### **Materials:**

The slabs shall be of approved selected quality, hard, sound, dense and homogenous in texture, free from cracks, decay, weathering and flaws. The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS: 1124.

The slabs shall be hand or machine cut to the required thickness. Tolerance in thickness for dimensions of tile more than 100mm shall be  $\pm 5$ mm. This shall be  $\pm 2$ mm on dimensions less than 100mm. Slabs shall be supplied to the specified size with machine cut edges or fine chisel dressed to the full depth. All angles and edges of the slabs shall be true and square, free from any chipping giving a plane surface. Slabs shall have the top surface machine polished (first grinding) before being brought to site. The slabs shall be washed clean before laying.

##### **Workmanship:**

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The type, size, thickness and color/shade etc. of the slabs for flooring/dado/skirting shall be as specified in the respective items of works prepared by the Contractor.

Preparation of the concrete base, laying and curing shall be as per clause 7.14.2.

Dado / skirting work shall be as per clause 7.14.2. The thickness of the slabs for dado/skirting work shall not be more than 25mm. Slabs shall be so placed that the back surface is at a distance of 12mm. If necessary, slabs shall be held in position temporarily by suitable method. After checking for verticality, the gap shall be filled and packed with cement sand mortar of proportion 1:3. After the mortar has acquired sufficient strength, the temporary arrangement holding the slab shall be removed.

Grinding and polishing shall be as per clause 7.14.2 except that first grinding with coarse grade carborundum shall not be done and cement slurry with or without pigment shall not applied before polishing.

#### **Carborundum Tile Finish:**

##### **Materials:**

Carborundum tiles shall generally conform in all respects to the standards stipulated in IS: 1237 for heavy duty tiles. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than 14 N/mm<sup>2</sup>.

The topping shall be uniform and of thickness not less than 6mm. The quantity of Carborundum grit shall be not less than 1.35 kg/sq.m used with cement with or without pigment. The Carborundum grit shall pass through 1.18mm mesh and shall be retained on 0.60 mm mesh.

##### **Workmanship:**

Requirements as detailed for terrazzo/cement tile finish under clause 7.14.2 shall be applicable for Carborundum tile flooring.

#### **Glazed Tile Finish:**

##### **Materials:**

Glazed earthenware tiles shall conform to the requirements of IS: 777. Tiles shall be of the best quality from an approved manufacturer. The tiles shall be flat, true to shape and free from flaws such as crazing, blisters, pinholes, specks or welts. Edges and underside of the tiles shall be free from glaze and shall have ribs or indentations for a better anchorage with the bedding mortar. Dimensional tolerances shall be as specified in IS: 777.

##### **Workmanship:**

The total thickness of glazed tile finish including the bedding mortar shall be 20 mm in flooring/dado/skirting. The minimum thickness of bedding mortar shall be 12mm for flooring and 10mm for dado/skirting work.

The bedding mortar shall consist of 1 part of cement to 3 parts of sand mixed with just sufficient water to obtain proper consistency for laying. Sand for the mortar shall conform to IS: 2116 and shall have minimum fineness modulus of 1.5.

Tiles shall be soaked in water for about 10 minutes just before laying. Where full size tiles cannot be fixed, tiles shall be cut to the required size using special cutting device and the edges rubbed smooth to ensure straight and true joints.

Colored tiles with or without designs shall be uniform and shall be preferably procured from the same batch of manufacture to avoid any differences in the shade.

Tiles for the flooring shall be laid over hardened concrete base. The surface of the concrete base shall be cleaned of all loose materials, mortar droppings etc. well wetted without allowing any water pools on the surface. The bedding mortar shall then be laid evenly over the surface, tamped to the desired level and allowed to harden for a day. The top surface shall be left rough to provide a good bond for the tiles. For skirting and dado work, the backing mortar shall be roughened using a wire brush.

Neat cement slurry using 3.3 kg cement per m<sup>2</sup> of floor area shall be spread over the hardened mortar bed over such an area as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. For skirting and dado work, the back of the tiles shall be smeared with cement slurry for setting on the backing mortar. Fixing of tiles shall be done from the bottom of the wall upwards. The joints shall be in perfect straight lines and as thin as possible but shall not be more than 1mm wide. The surface shall be checked frequently to ensure correct level/required slope. Floor tiles near the walls shall enter skirting/dado to a minimum depth of 10mm. Tiles shall not sound hollow when tapped. All the joints shall be cleaned of grey cement with wire brush to a depth of at least 3mm and all dust, loose mortar etc. shall be removed. White cement with or without pigment shall then be used for flush pointing the joints. Curing shall then be carried out for a minimum period of 7 days for the bedding and joints to set properly. The surface shall then be cleaned using a suitable detergent, fully washed and wiped dry.

Specials consisting of coves, internal and external angles, cornices, beads and their corner pieces shall be of thickness not less than the tiles with which they are used.

#### **In-Situ Cement Concrete Floor Topping:**

##### **Materials:**

The mix proportion for the in-situ concrete floor topping shall be 1:2.5:3.5 (one-part cement: two and half parts sand: three and half parts coarse aggregates) by volume unless otherwise specified.

The aggregates shall conform for the requirements of IS: 383.



Coarse aggregates shall have high hardness surface texture and shall consist of crushed rock of granite, basalt, trap or quartzite. The aggregate crushing value shall not exceed 30 percent. The grading of the aggregates of size 12.5mm and below shall be as per IS: 2571.

Grading of the sand shall be within the limits indicated in IS: 2571.

**Workmanship:**

The thickness of the floor topping shall be as specified in the items of work prepared by the Contractor. The minimum thickness of the floor topping shall be 25mm.

Preparation of base concrete/structural slab before laying the topping shall be as per clause 7.13. The surface shall be rough to provide adequate bond for the topping.

Mixing of concrete shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the GWSSB. The concrete shall be as stiff as possible and the amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and compacting. The mix shall be used in the work within 30 minutes of the addition of water for its preparation.

Floor finish shall be laid in suitable panels to reduce the risk of cracking. No dimension of a panel shall exceed 2 meters and the length of a panel shall not exceed one and a half times its breadth. Topping shall be laid in alternate panels, the intermediate panels being cast after a gap of at least one day. Construction joints shall be plain vertical butt joints.

Screed strips shall be fixed dividing the area into suitable panels. Immediately before depositing the concrete topping, neat cement slurry at 2.75 kg/m<sup>2</sup> of area shall be thoroughly brushed into the prepared surface. Topping shall then be laid, very thoroughly tamped, struck off level and floated with wooden float. The surface shall then be tested with a straight edge and mason's spirit level to detect any inequalities and these shall be made good immediately.

Finishing of the surface by Trowelling shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled 3 times at intervals so as to produce a smooth uniform and hard surface. Immediately after laying, the first Trowelling just sufficient to give a level surface shall be carried out avoiding excessive Trowelling at this stage. The surface shall be re- trowelled after sometime to close any pores and to scrap off excess water or laitance, which shall not be trowelled back into the topping. Final Trowelling shall be done well before the concrete has become too hard but at a time when considerable pressure is required to make any impression on the surface. Sprinkling of dry cement or cement-sand mixture for absorbing moisture shall not be permitted.

Immediately after the surface is finished, it shall be protected suitably from rapid drying due to wind/sunlight. After the surface has hardened sufficiently to prevent any damage to it, the topping shall be kept continuously moist for a minimum period of 10 days.

It is preferable to lay the topping on hardened base concrete, as against being laid monolithically with a lesser thickness, since proper levels and slopes with close surface tolerances is achievable in practice,

owing to its greater thickness. Further, as this would be laid after all other building operations are over, there will be no risk of any damages or discolorations to the floor finish which are difficult to repair satisfactorily.

**In-Situ Granolithic Concrete Floor Topping:****Materials and Workmanship:**

The Requirements of materials and workmanship shall be all as per clause 7.19 for in-situ cement concrete floor topping except that the mix proportion of the concrete shall be 1:1:2 (cement: sand: coarse aggregates) by volume.

The minimum thickness of granolithic floor topping on hardened concrete base shall be 40mm.

**Floor Hardener Topping:****Materials & Workmanship:**

Floor Hardener topping shall be provided either as integrally finished over the structural slab/grade slab or lay monolithically with the concrete/granolithic floor finish on top of hardened concrete base.

Floor hardener of the metallic or non-metallic type suitable for the performance of normal / medium/ heavy duty function of the floor, the quantum of ingredients and the thickness of topping shall be as specified in the respective items of work prepared by the Contractor. For monolithic application with the floor finish/slab the thickness of the layer shall be 15mm. The topping shall be laid within 2 to 3 hours after concrete is laid when it is still plastic but stiffened enough for the workmen to tread over it by placing planks. The surface of the concrete layer shall be kept rough for providing adequate bond for the topping. Laitance shall be removed before placing the topping. The topping shall be screened and thoroughly compacted to the finished level. Trowelling to a smooth finish shall be carried out as per clause 7.19.2. After the surface has hardened sufficiently, it shall be kept continuously moist for at least 10 days. The procedure for mixing the floor hardener topping shall be as per manufacturer's instructions.

Surface shall be prevented from any damages due to subsequent building operations by covering with 75 mm thick layer of sand.

**PVC Sheet/Tile Flooring:****Materials:**

PVC floor covering shall be of either unbaked homogeneous flexible type in the form of sheets/tiles conforming to IS: 3462 or homogeneous PVC asbestos tiles conforming to IS: 3461. Surface of the sheets/tiles shall be free from any physical defects such as pores, blisters, cracks etc. which affects the appearance and serviceability. Tiles/ sheets shall meet with the tolerance limits in dimensions specified in the IS. Contractor shall submit the test certificates, if so desired by the GWSSB.

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Each tile/sheet shall be legibly and indelibly marked with the name of the manufacturer or his trade mark, IS certificate mark, and batch number.

The adhesive to be used for laying the PVC flooring shall be rubber based and of the make as recommended and approved by the manufacturer of PVC sheets/tiles.

The type, size, colour, plain or mottled and the pattern shall be as specified in the respective items of work prepared by the Contractor.

**Workmanship:**

PVC Floor covering shall be provided over an under bed of cement concrete floor finish over the base concrete or structural slab. It is essential that the sub-floor and the under bed are perfectly dry before laying the PVC flooring. This shall be ensured by methods of testing as stipulated in Appendix-A of IS: 5318.

The surface of the underbed shall have trowelled finish without any irregularities, which creates poor adhesion. Surface shall be free of oil or grease and thoroughly cleaned of all dust, dirt and wiped with a dry cloth.

PVC sheets/tiles shall be brought to the temperature of the area in which they are to be laid by stacking in a suitable manner within or near the laying area for a period of about 24 hours. Where air-conditioning is installed, the flooring shall not be laid on the underbed until the A/C units have been in operation for at least 7 days. During this period, the temperature range shall be between 20deg.C and 30deg.C and this shall be maintained during the laying operations and also for 48 hours thereafter.

Layout of the PVC flooring shall be marked with guidelines on the underbed and PVC tiles/sheets shall be first laid for trial, without using the adhesive, according to the layout.

The adhesive shall be applied by using a notched trowel to the surface of the underbed and to the backside of PVC sheets/tiles. When the adhesive has set sufficiently for laying, it will be tacky to the touch, which generally takes about 30 minutes. The time period need be carefully monitored since a longer interval will affect the adhesive properties. Adhesive shall be uniformly spread over only as much surface area at one time which can be covered with PVC flooring within the stipulated time.

PVC sheet shall be carefully taken and placed in position from one end onwards slowly so that the air will be completely squeezed out between the sheet and the background surface and no air pockets are formed. It shall then be pressed with a suitable roller to develop proper contact. The next sheet shall be laid edge to edge with the sheet already laid, so that there is minimum gap between joints. The alignment shall be checked after each row of sheet is completed and trimmed if considered necessary.

Tiles shall be laid in the same manner as sheets and preferably, commencing from the center of the area. Tiles should be lowered in position and pressed firmly on to the adhesive with minimum gap between the joints. Tiles shall not be slide on the surface. Tiles shall be rolled with a light wooden roller of about 5kg to ensure full contact with the underlay. Work should be constantly checked to ensure that all four edges of adjacent tiles meet accurately.

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Any excess adhesive which may squeeze up between sheets/tiles shall be wiped off immediately with a wet cloth. Suitable solvents shall be used to remove hardened adhesive.

A minimum period of 24 hours shall be given after laying for the development of proper bond of the adhesive. When the flooring is thus completed, it shall be cleaned with a wet cloth soaked in warm soap solution.

Metallic edge strips shall be used to protect the edges of PVC sheets/tiles which are exposed as in doorways/ stair treads.

Hot sealing of joints between adjacent PVC sheet flooring to prevent creeping of water through the joints shall be carried out, using special equipment as per manufacturer's instructions.

#### **Acid Resisting Brick/Tiling Work:**

##### **Materials:**

The ceramic unglazed vitreous acid resisting tiles shall conform to the requirements of IS: 4457. Acid resistant bricks shall conform to the requirements of IS: 4860.

The finished tile/brick when fractured shall appear fine grained in texture, dense and homogeneous. Tile/brick shall be sound, true to shape, flat, free from flaws and any manufacturing defects affecting their utility. Tolerance in dimensions shall be within the limits specified in the respective IS.

The tiles/bricks shall be bedded and jointed using chemical resistant mortar of the resin type conforming to IS: 4832 (Part II). Method of usage shall generally be as per the requirements of IS: 4443.

##### **Workmanship:**

The resin shall have viscosity for readily mixing with the filler by manual methods.

The filler shall have graded particles which permit joint thickness of 1.5 mm.

The base concrete surface shall be free from dirt and thoroughly dried. The surface shall be applied with a coat of bitumen primer conforming to IS: 3384. The primed surface shall then be applied with a uniform coat of bitumen conforming to IS: 1580. Tiles or bricks shall be laid directly without the application of bitumen, if epoxy or polyester resin is used for the mortar. Just adequate quantity of mortar which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for bedding and jointing. Rigid PVC/Stainless steel/chromium plated tools shall be used for mixing and laying. For laying the floor 6 to 8 mm thick mortar shall be spread on the back of the tile/brick. Two adjacent sides of the tile/brick shall be smeared with 4 to 6 mm thick mortar. Tile/brick shall be pressed into the bed and pushed against the floor and with the adjacent tile/ brick, until the joint in each case is 2 to 3 mm thick. Excess mortar shall then be trimmed off and allowed to harden fully. Similar procedure shall be adopted for the work on walls by pressing the tile/brick against the prepared wall surfaces and only one course shall be laid at a time until the initial setting period.

The mortar joints shall be cured for a minimum period of 72 hours with 20 to 25% hydrochloric acid or 30 to 40% sulphuric acid. After acid curing, the joints shall be washed with water and allowed to thoroughly dry. The joints shall then be filled with mortar to make them smooth and plane. Acid curing is not required to be carried out if epoxy or polyester resin is used for the mortar.

Resin mortars are normally self-curing. The area tiled shall not be put to use before 48 hours in case epoxy, polyester and furan type of resin is used for the mortar. If phenolic or cashew nut shell liquid resin is used for the mortar, the area tiled shall not be put to use for 7 to 28 days respectively, without heat treatment. This period shall be 2 to 6 days respectively, if heat treatment is given with infrared lamp.

**Epoxy Lining Work:****Materials:**

The epoxy resin and hardener formulation for laying of joint less lining work in floors and walls of concrete tanks/trenches etc. shall be as per the requirements of IS:9197.

The epoxy composition shall have the chemical resistance to withstand the following conditions of exposure:

Hydrochloric acid up to 30% concentration

Sodium hydroxide up to 50% concentration

Liquid temperature up to 60deg.C

Ultraviolet radiation

Alternate wetting and drying

Sand shall conform to grading zone III or IV of IS: 383.

The hardener shall be of the liquid type such as Aliphatic Amine or an Aliphatic/Aromatic Amine Adduct for the epoxy resin. The hardener shall react with epoxy resin at normal ambient temperature.

Contractor shall furnish test certificates for satisfying the requirements of the epoxy formulation if so directed by the GWSSB.

**Workmanship:**

The minimum thickness of epoxy lining shall be 4 mm. It is essential that the concrete elements are adequately designed to ensure that water is excluded to permeate to the surface, over which the epoxy lining is proposed. The epoxy lining shall be of the trowel type to facilitate execution of the required thickness for satisfactory performance.

The concrete surfaces over which epoxy lining is to be provided shall be thoroughly cleaned of oil or grease by suitable solvents, wire brushed to remove any dirt/dust and laitance. The surfaces shall then

be washed with dilute hydrochloric acid and rinsed thoroughly with plenty of water or dilute ammonia solution. The surfaces shall then be allowed to dry. It is essential to ensure that the surfaces are perfectly dry before the commencement of epoxy application. Just adequate quantity of epoxy resin which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for laying and jointing. Rigid PVC/stainless steel/chromium plated tools shall be used for laying. Trowelling shall be carried out to obtain uniformly the specified thickness of lining.

Lining shall be allowed to set without disturbance for a minimum period of 24 hours. The facility shall be put to use only after a minimum period of 7 days of laying of the lining.

**Water-Proofing:****General:**

The work shall include waterproofing for the building roofs, terraces, toilets, floor slabs, walls, planters, chajjas, sills and any other areas and at any other locations and situations as directed by the Employers Representative.

The waterproofing treatment shall be carried out on top of lime concrete (brick bat coba) laid to slope on roof surfaces. The brick bat-coba shall be covered as specified below.

The work shall be carried out by an experienced specialist Sub-Contractor who shall be appointed only after prior approval of the GWSSB.

**Modified Bituminous Membrane:**

Modified Bituminous Membrane shall be "SUPER THERMOLAY" 4 mm thick weighing 4 Kg/sq.m, manufactured using APP Polymer modified bitumen with a central core of non-woven polyester reinforcement (200 gms/Sq.m) and with top and bottom layers of thermo fusible film (top layer could also be sand finished) made by STP Limited in collaboration with Bitumen Company Limited. "PLYFLEX" of Bitumen Company Limited, Saudi Arabia supplied by STP Limited shall also be acceptable or other equivalent specification.

**Waterproofing of Roofs with Lime Concrete:****Materials:**

Broken brick coarse aggregates prepared from well/over burnt bricks shall be well graded having a maximum size of 25mm and shall generally conform to IS: 3068.

Lime shall be class C lime (fat lime) or factory-made hydrated lime conforming to IS: 712.

**Workmanship:**

Lime concrete shall be prepared by thoroughly mixing the brick aggregates inclusive of brick dust obtained during breaking with the slaked lime in the proportions of 2 1/2 (two and a half) parts of brick

aggregates to 1 part of slaked lime by volume. Water shall be added just adequate to obtain the desired workability for laying. Washing soap and alum shall be dissolved in the water to be used. The quantity of these materials required per cum of lime concrete shall be 12kg of washing soap and 4kg of alum. Brick aggregates shall be soaked thoroughly in water for a period of not less than six hours before use in the concrete mix. Lime concrete shall be used in the works within 24 hours after mixing.

The roof surface over which the water-proof treatment is to be carried out shall be cleaned of all foreign matter by wire brushing, dusting and made thoroughly dry. Preparation of surfaces shall be as stipulated in IS: 3067.

The slope of the finished waterproofing treatment shall be not less than 1 in 60 for efficient drainage. This shall be achieved either wholly in the lime concrete layer.

The average thickness of lime concrete, slope and the finish on top of machine-made burnt clay flat terracing tiles conforming to IS:2690 (part I) shall be as specified in the items of work to be prepared by the Contractor. Cement concrete flooring tiles in lieu of clay terracing tiles shall be provided if so specified in the items of work prepared by the Contractor, duly considering the traffic the terrace will be subjected to.

The minimum compacted thickness of lime concrete layer shall be 75mm and average thickness shall not be less than 100mm. In case, the thickness is more than 100mm, it shall be laid in layers not exceeding 100mm to 125mm. laying of lime concrete shall be commenced from a corner of the roof and proceeded diagonally towards center and other sides duly considering the slopes specified for effectively draining the rain-water towards the downtake points. Lime concrete fillet for a minimum height of 150mm shall be provided all along the junction of the roof surface with the brick masonry wall/parapet/column projections. These shall then be finished on top with provision of clay terracing tiles/cement concrete tiles.

After the lime concrete is laid it shall be initially rammed with a rammer weighing not more than 2 Kg and the finish brought to the required evenness and slope. Alternatively, bamboo strips may be used for the initial ramming. Further consolidation shall be done using wooden THAPIES with rounded edges. The beating will normally have to be carried on for at least seven days until the THAPI makes no impression on the surface and rebounds readily from it when struck. Special care shall be taken to properly compact the lime concrete at its junction with parapet walls or column projections. During compaction by hand-beating, the surface shall be sprinkled liberally with lime water (1 part of lime putty and 3 to 4 parts of water) and a small proportion of sugar solution for obtaining improved water-proofing quality of the lime concrete. On completion of beating, the mortar that comes on the top shall be smoothened with a trowel or float, if necessary, with the addition of sugar solution and lime putty. The sugar solution may be prepared in any one of the following ways as directed by the GWSSB.

a) By mixing about 3 Kg of Jaggery and 1.5 Kg of BAEL fruit to 100 liters of water.

b) By mixing about 600 gm of KADUKAI (the dry nuts shall be broken to small pieces and allowed to soak in water), 200 gm of jaggery and 40 liters of water for 10 sq.m of work. This solution shall be brewed for about 12 to 24 hours and the resulting liquor decanted and used for the work.

The lime concrete after compaction shall be cured for a minimum period of seven days or until it hardens by covering with a thin layer of straw or hessian which shall be kept wet continuously. Machine made flat terracing tiles shall be of the size and thickness as specified. Tiles shall be soaked in water for at least one hour before laying. Bedding for the tiles shall be 12mm thick in cement mortar 1:3. Tiles shall be laid, open jointed with 4 to 6 mm wide joints, flat on the mortar and lightly pressed and set to plane surface true to slope, using a trowel and wooden straight edge. They shall be laid with their longitudinal lines of joints truly parallel and generally at right angles to the direction of run-off gradient. Transverse joints in alternate rows shall come directly in line with each other. Transverse joints in adjacent courses shall break joints by at least 50 mm. The joints shall be completely filled and flush pointed with cement mortar 1:2 mixed with water proofing compound as per manufacturer's instructions. Curing shall be carried out for a minimum period of seven days. Finishing on top with cement concrete tiles or in-situ cement concrete floor topping shall be carried out in similar fashion as described for clay tiles in above paragraph. Tiles to be used shall be supplied after the first machine grinding of the surface.

#### **Waterproofing of Roofs/Terraces etc.:**

##### **(A) Water proofing of Horizontal Surfaces:**

The waterproofing shall be applied as follows:

A coat of Blown Bitumen 85/25 shall be applied at the rate of 1.45 kg/sq.km

A roll of Modified Bituminous Membrane shall be unrolled over the primed surface and completely bonded to the substrate by pressing down evenly for the full width of the roll using a wooden roller. Torching shall be done, where recommended by the manufacturer and where directed by the GWSSB, as the unrolling progresses.

The side overlaps shall be minimum 100 mm whereas the end overlaps shall be minimum 150 mm; both shall be bonded and sealed by flame torching. Care shall be taken that the membrane is lapped with the treatment along the vertical surface and roof gutter treatment for at least 500 mm. The membrane shall be properly overlapped/terminated at all openings, rainwater down takes etc. to ensure that such junctions do not become sources of leakage.

Top of membrane finally shall be painted with antiglouse reflective paint.

##### **(B) Waterproofing of Vertical Surfaces at Roof Level and Gutters:** The Water proofing shall be applied as described in (a) above.

Modified Bituminous membrane shall be unrolled and bonded to the substrate after applying a coat of bitumen and by pressing down evenly for the full width of the roll. Light torching shall be done to ensure complete bonding.

The membrane shall be overlapped with treatment for the horizontal surface by at least 500 mm.

The membrane shall be taken up to a pre-cut chase anchored and sealed.



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**Khurras and Rainwater down Pipes:**

Down pipes shall be isolated from RCC work with 6 mm polyethylene foam fixed with adhesive (Araldite) and sealed with silicone sealant prior to laying membrane. A water proofing flashing composed of one layer of Hessian based self-finished felt Type 3 Grade 1 and two layers of aluminum foil of 0.075 mm thickness shall be provided. This flashing shall be carried into the down take pipes for at least 150 mm and sealed with hot bitumen. The Contractor shall closely coordinate the work with the agency providing and fixing the rainwater down take pipes.

**Testing:**

The treated area (flat and horizontal only) shall be tested by allowed water to stand on the treated areas to a depth of 150 mm for a minimum period of 72 hours.

The treated area (flat and horizontal) shall have continuous slope towards the rainwater outlets and no water shall pond anywhere on the surface.

**Cement Plastering Work:****Materials:**

The proportions of the cement mortar for plastering shall be 1:3 (one part of cement to three parts of sand). Cement and sand shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS standards. The quality and grading of sand for plastering shall conform to IS: 1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the GWSSB. If so desired by the GWSSB sand shall be screened and washed to meet the Specifications. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding water as required to restore consistency but this will be permitted only up to 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.

**Workmanship:**

Preparation of surfaces and application of plaster finishes shall generally conform to the requirements specified in IS: 1661 and IS: 2402.

Plastering operations shall not be commenced until installation of all fittings and fixtures such as door/window panels, pipes, conduits etc. are completed.

All joints in masonry shall be raked as the work proceeds to a depth of 10mm/20mm for brick/stone masonry respectively with a tool made for the purpose when the mortar is still green. The masonry

surface to be rendered shall be washed with clean water to remove all dirt, loose materials, etc., Concrete surfaces to be rendered shall be roughened suitably by hacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. The masonry surfaces should not be too wet but only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.

Interior plain faced plaster - This plaster shall be laid in a single coat of 13mm thickness. The mortar shall be dashed against the prepared surface with a trowel. The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth surface. Interior plaster shall be carried out on jambs, lintel and still faces etc. as shown in the drawing and as directed by the GWSSB.

Plain Faced Ceiling plaster - This plaster shall be applied in a single coat of 6mm thickness. Application of mortar shall be as stipulated in above paragraph.

Exterior plain faced plaster - This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14mm thick. The rendering coat shall be applied as stipulated above except finishing it to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for at least two days and then allowed to dry. The second coat or finishing coat shall be 6 mm thick. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item of work. The finished plastering work shall be cured for at least 7 days.

Interior plain faced plaster 20mm thick if specified for uneven faces of brick walls or for random/coursed rubble masonry walls shall be executed in 2 coats similar to the procedure stipulated in above paragraph.

Exterior Sand Faced Plaster- This plaster shall be applied in 2 coats. The first coat shall be approximately 14mm thick and the second coat shall be 6mm thick. These coats shall be applied as stipulated above. However, only approved quality white sand shall be used for the second coat and for the finishing work. Sand for the finishing work shall be coarse and of even size and shall be dashed against the surface and sponged. The mortar proportions for the first and second coats shall be as specified in the respective items of work.

Wherever more than 20mm thick plaster has been specified, which is intended for purposes of providing beading, bands, etc. this work shall be carried out in two or three coats as directed by the GWSSB duly satisfying the requirements of curing each coat (rendering/floating) for a minimum period of 2 days and curing the finished work for at least 7 days.

In the case of pebble faced finish plaster, pebbles of approved size and quality shall be dashed against the final coat while it is still green to obtain as far as possible a uniform pattern all as directed by the GWSSB.

Where specified in the Drawings to be prepared by the Contractor prepared by the Contractor, rectangular grooves of the dimensions indicated shall be provided in external plaster by means of timber battens when the plaster is still in green condition. Battens shall be carefully removed after the initial set of plaster and the broken edges and corners made good. All grooves shall be uniform in width and depth and shall be true to the lines and levels as per the Drawings to be prepared by the Contractor prepared by the Contractor.

Curing of plaster shall be started as soon as the applied plaster has hardened sufficiently so as not to be damaged when watered. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.

For waterproofing plaster, the Contractor shall provide the water-proofing admixture as specified in manufacturer's instruction while preparing the cement mortar.

For external plaster, the plastering operations shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/windows etc. Ceiling plaster shall be completed first before commencing wall plastering.

Double scaffolding to be used shall be as specified in clause 7.2.2.

The finished plaster surface shall not show any deviation more than 4mm when checked with a straight edge of 2m length placed against the surface.

To overcome the possibility of development of cracks in the plastering work following measures shall be adopted.

Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.

Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/thermal movement.

Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.

**Cement Pointing:****Material:**

The cement mortar for pointing shall be in the proportion of 1:3 (one part of cement to three parts of fine sand). Sand shall conform to IS: 1542 and shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by GWSSB and if so directed it shall be washed/screened to meet specification requirements.

**Workmanship:**

Where pointing of joints in masonry work is specified, the joints shall be raked at least 15mm/20mm deep in brick/stone masonry respectively as the work proceeds when the mortar is still green.

Any dust/dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be raised, flat, sunk or 'V' as may be specified in the respective items of work. No false joints shall be allowed.

The work shall be kept moist for at least 7 days after the pointing is completed. Whenever colored pointing has to be done, the coloring pigment of the color required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the GWSSB.

#### **Water-Proofing Admixtures;**

Water-proofing admixture shall conform to the requirements of IS: 2645 and shall be of approved manufacture. The admixture shall not contain calcium chloride. The quantity of the admixture to be used for the works and method of mixing etc. shall be as per manufacturer's instructions and as directed by the GWSSB.

#### **Painting of Concrete, Masonry & Plastered Surfaces:**

##### **Materials:**

Oil bound distemper shall conform to IS: 428. The primer shall be alkali resistant primer of the same manufacture as that of the distemper.

Cement paint shall conform to IS: 5410. The primer shall be a thinned coat of cement paint. Lead free acid, alkali and chlorine resisting paint shall conform to IS: 9862.

Color wash shall be made by addition of a suitable quantity of mineral pigment, not affected by lime, to the prepared white wash to obtain the shade/tint as approved by the GWSSB.

All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the GWSSB for the brand of manufacture and the color/shade. All materials shall be brought to the site of works in sealed containers.

##### **Workmanship:**

Contractor shall obtain the approval of the GWSSB regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting. Painting of new surfaces shall be deferred as much as possible to allow for thorough drying of the sub- strata.

The surfaces to be treated shall be prepared by thoroughly brushing them free from dirt, mortar droppings and any loose foreign materials. Surfaces shall be free from oil, grease and efflorescence. Efflorescence shall be removed only by dry brushing of the growth. Cracks shall be filled with Gypsum. Workmanship of painting shall generally conform to IS: 2395. Surfaces of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them.

**White Wash:**

The prepared surfaces shall be wetted and the finish applied by brushing. The operation for each coat shall consist of a stroke of the brush first given horizontally from the right and the other from the left and similarly, the subsequent stroke from bottom upwards and the other from top downwards, before the first coat dries. Each coat shall be allowed to dry before the next coat is applied. Minimum of 2 coats shall be applied unless otherwise specified. The dry surface shall present a uniform finish without any brush marks.

**Color Wash:**

Color wash shall be applied in the same way as for white wash. A minimum of 2 coats shall be applied unless otherwise specified. The surface shall present a smooth and uniform finish without any streaks. The finished dry surface shall not show any signs of peeling/powdery and come off readily on the hand when rubbed.

**Cement Paint:**

The prepared surfaces shall be wetted to control surface suction and to provide moisture to aid in proper curing of the paint. Cement paint shall be applied with a brush with stiff bristles. The primer coat shall be a thinned coat of cement paint. The quantity of thinner shall be as per manufacturer's instructions. The coats shall be vigorously scrubbed to work the paint into any voids for providing a continuous paint film free from pinholes for effective water proofing in addition to decoration. Cement paint shall be brushed in uniform thickness and the covering capacity for two coats on plastered surfaces shall be 3 to 4 kg/m<sup>2</sup>. A minimum of 2 coats of the same color shall be applied. At least 24 hours shall be left after the first coat to become sufficiently hard before the second coat is applied. The painted surfaces shall be thoroughly cured by sprinkling with water using a fog spray at least 2 to 3 times a day. Curing shall commence after about 12 hours when the paint hardens. Curing shall be continued for at least 2 days after the application of final coat. The operations for brushing each coat shall be as detailed above.

**Oil bound Distemper:**

The prepared surfaces shall be dry and provided with one coat of alkali resistant primer by brushing. The surface shall be finished uniformly without leaving any brush marks and allowed to dry for at least 48 hours. A minimum of two coats of oil bound distemper shall be applied, unless otherwise specified. The first coat shall be of a lighter tint. At least 24 hours shall be left after the first coat to become completely dry before the application of the second coat. Broad, stiff, double bristled distemper brushes shall be used for the work. The operations for brushing each coat shall be as detailed above.

**Acid, Alkali Resisting Paint:**

A minimum of 2 coats of acid/alkali resisting paint shall be applied over the prepared dry surfaces by brushing. Primer coat shall be as per manufacturer's instructions.

**Plastic Emulsion Paint:**

The prepared surface shall be dry and provided with one coat of primer which shall be a thinned coat of emulsion paint. The quantity of thinner shall be as per manufacturer's instructions. The paint shall be laid on evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard for the first time over and then brushing alternately in opposite directions two or three times and then finally brushing lightly in a direction at right angles. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off constitutes one coat. The next coat shall be applied only after the first coat has dried and sufficiently become hard which normally takes about 2 to 3 hours. A minimum of 2 finishing coats of the same color shall be applied unless otherwise specified. Paint may also be applied using rollers. The surface on finishing shall present a flat velvety smooth finish and uniform in shade without any patches.

**Acrylic Emulsion Paint:**

Acrylic emulsion paint shall be applied in the same way as for plastic emulsion paint. A minimum of 2 finishing coats over one coat of primer shall be provided unless otherwise specified.

**Painting & Polishing of Wood Work:****Materials:**

- Wood primer shall conform to IS: 3536.
- Filler shall conform to IS: 110.
- Varnish shall conform to IS: 337.
- French polish shall conform to IS: 348.
- Synthetic enamel paint shall conform to IS: 2932.

All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the GWSSB for the brand of manufacture and the color/shade. All materials shall be brought to the site of works in sealed containers.

**Workmanship:**

The type of finish to be provided for woodwork of painting or polishing, the number of coats, etc. shall be as specified in the respective items of work to be prepared by the Contractor. Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall

be from the same manufacturer. Painting shall be either by brushing or spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer.

The workmanship shall generally conform to the requirements of IS: 2338 (Part I). All the wood surfaces to be painted shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it across the grains and dusted off. Wood primer coat shall then be applied uniformly by brushing. The number of primer coats shall be as specified in the item of work to be prepared by the Contractor. Any slight irregularities of the surface shall then be made- up by applying an optimum coat of filler conforming to IS: 110 and rubbed down with an abrasive paper for obtaining a smooth surface for the undercoat of synthetic enamel paint conforming to IS: 2932. Paint shall be applied by brushing evenly and smoothly by means of crossing and laying off in the direction of the grain of wood. After drying, the coat shall be carefully rubbed down using very fine grade of sand paper and wiped clean before the next coat is applied. At least 24 hours shall elapse between the applications of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the GWSSB. The number of coats of paint to be applied shall be as specified in the item of work to be prepared by the Contractor. All the wood surfaces to be provided with clear finishes shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it in the direction of the grains and dusted off. Any slight irregularities of the surface shall be made up by applying an optimum coat of transparent liquid filler and rubbed down with an abrasive paper for obtaining a smooth surface. All dust and dirt shall be thoroughly removed. Over this prepared surface, varnish conforming to IS: 337 shall be applied by brushing. Varnish should not be retouched once it has begun to set. Staining if required shall be provided as directed by the GWSSB. When two coats of varnish are specified, the first coat should be a hard-drying undercoat or flatting varnish which shall be allowed to dry hard before applying the finishing coat. The number of coats to be applied shall be as specified. For works where clear finish of French polish is specified the prepared surfaces of wood shall be applied with the polish using a pad of woolen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles to give an even finish over the entire area. The surface shall be allowed to dry before applying the next coat. Finishing shall be carried out using a fresh clean cloth over the pad, slight dampening with methylated spirit and rubbing lightly and quickly in circular motions. The finished surface shall have a uniform texture and high gloss. The number of coats to be applied shall be as specified.

#### **Painting of Steel Work:**

##### **Materials:**

- Red-oxide – zinc chrome primer shall conform to IS: 2074.
- Synthetic enamel paint shall conform to IS: 2932.
- Aluminum paint shall conform to IS: 2339.

All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the GWSSB for the brand of manufacture and the color/shade. All the materials shall be brought to the site in sealed containers.

##### **Workmanship:**

Painting work shall be carried out only on thoroughly dry surfaces. Painting shall be applied either by brushing or by spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirement of IS: 1477 (Part 2).

The type of paint, number of coats etc. shall be as specified in the respective items of work. Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer. All the surfaces shall be thoroughly cleaned of oil, grease, dirt, rust and scale. The methods to be adopted using solvents, wire brushing, power tool cleaning etc., shall be as per IS: 1477 (Part – I) and as indicated in the item of work. It is essential to ensure that immediately after preparation of the surfaces; the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a continuous film without holidays. After the first coat becomes hard dry, a second coat of primer shall be applied by brushing to obtain a film free from 'holidays'. After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of synthetic enamel paint of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry. The first finishing coat of paint shall be applied by brushing and allowed to hard-dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing. At least 24 hours shall elapse between the applications of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the GWSSB.

**Flashing:****Materials:**

Anodized Aluminum sheets shall be 1.00mm thick with anodic film thickness of 0.025 mm.

Galvanized mild steel sheets shall be 1.00mm thick with zinc coating of 800 gms/Sq.m.

Bitumen felt shall be either Hessian base self-finished bitumen felt Type-3 Grade I conforming to IS: 1322 or glass fiber base self-finished felt Type-2 Grade 1 conforming to IS: 7193.

**Workmanship:**

The type of the flashing and method of fixing shall be as specified.

Flashing shall be of the correct shape and size as indicated in the construction Drawings to be prepared by the Contractor and they shall be properly fixed to ensure their effectiveness.

Flashing shall be of long lengths so as to provide minimum number of joints. The minimum overlap at joints shall be 100mm.



Fixing of the flashing shall be either by bolting with bitumen washers or by tucking into the groove 75 mm wide x 65 mm deep in masonry/concrete along with cement mortar 1:4 filleting as indicated in the Drawings to be prepared by the Contractor. Curing of the mortar shall be carried out for a minimum period of 4 days.

Bitumen felt flashing of the type as specified shall be provided with 2 coats of bituminous paint at the rate of 0.10 liter/m<sup>2</sup> after the installation.

#### **Thermal Insulation for Ceiling**

Thermal insulation shall be "Thermocole" TF type or similar approved or Resin bonded fiber glass boards.

#### **Fixing:**

##### **"Thermocole" Boards:**

Soffit of R.C.Slab shall be thoroughly cleaned with wire brush and 85/25 industrial grade hot bitumen conforming to IS: 702 shall be applied uniformly over the surface at the rate of 1.5 Kg/m<sup>2</sup>.

Thermocole boards (T.F. variety) of 50mm thickness shall be stuck by means of the same grade of hot bitumen. The boards shall be further secured with screws, washers and plugs. The joints of the boards shall be sealed with bitumen.

##### **Fiber Glass Boards:**

Timber pegs 50mm x 50mm x 50mm shall be fixed to the slab at 600mm centers with 6mm x 65mm long wood screws. 20-gauge G.I. lacing wire shall be tied to the pegs. 'Crown' 200 fiberglass boards 50mm thick shall be stuck to the pegs with CPRX compound or any other suitable adhesive and be held in position by the 20-gauge G.I. lacing wires. The insulation boards shall be covered with 20mm – 24-gauge hexagonal G.I. chicken wire mesh, nailed to the timber pegs and 30-gauge aluminum sheets shall be fixed over the chicken wire mesh with 50mm overlap and secured to the timer pegs by screws. If the insulation is specified to rest on top of the false ceiling, it shall be properly installed and anchored to the framework. In case additional battens are required for proper installation, Contractor shall include its cost in the rate for insulation.

##### **Plaster of Paris Board for False Ceiling:**

#### **Materials:**

##### **Plaster of Paris Boards:**

- The plaster of Paris boards to be used in the false ceiling shall be of an approved manufacture or manufactured at site by methods and materials approved by GWSSB.

· The plaster of Paris shall be of the calcium-sulphate hemi-hydrate variety and shall contain not less than 35 percent Sulphur trioxide and other requirements as per IS:2547 (Part I) However, its fineness shall be such that the residue, after drying, and sieving on I.S. sieve designation 3.35mm for 5 minutes shall not be more than 1 percent by weight. Initial setting time shall not be less than 13 minutes. The average compressive strength of plaster determined by testing 5 cm cubes 24 hours after removal from moulds and drying in an oven at 40 Deg. C till the weight of the cubes is constant, shall not be less than 84 Kg per sq.cm.

· The plaster of Paris boards reinforced with hessian cloth or coir shall be prepared in suitable sizes as shown on the drawings or as directed by GWSSB. Wooden forms of height equal to the thickness of boards shall be placed on truly level and smooth surface such as a glass sheet. The edges of the boards shall be truly square. The glass sheet or surface on which form is kept and the form sides shall be given a thin coat of non-staining oil to facilitate the easy removal of the board. Plaster of Paris shall be evenly spread into the form up to about half the depth and hessian cloth or coir shall be pressed over the plaster of Paris layer. The weight of hessian cloth or coir in the board shall be 250 gm per sq.m. The ends of the hessian/coir reinforcement shall be turned over at all edges to form a double layer for a width of 50mm. The hessian cloth shall be of an open web texture so as to allow the plaster below and above to intermix with each other and form an integral board. The form shall then be filled with plaster of Paris which shall be uniform pressed and then wire cut to an even and smooth surface. The board shall then be allowed to set initially for an hour or so and then removed from the form and allowed to dry and harden for about a week. The board after drying and hardening shall give a ringing sound when struck. The boards shall be true and exact to shape and size and the exposed face shall be truly plane and smooth.

· The size of boards shall generally be 600mm x 600 mm x 12 mm thick. Boards shall be kept dry in transit and stored flat in a clean dry place and shall not be exposed to moisture. The boards shall always be carried on edges.

#### **Timber Frame Work:**

Timber for frame work of false ceiling grid and hangers shall be of good quality and well-seasoned. It shall have uniform color, reasonably straight and close grains and shall be free from knots, cracks and sapwood. It shall be treated with approved anti-termite preservative as directed by the GWSSB. Extreme care shall be taken so that the preservative treatment does not stain the ceiling boards. In case metal hangers are used, these shall be M.S. flats or bars, having two coats of red oxide zinc chromate paint primer, as shown on drawings or as approved by GWSSB.

#### **Metal Framework:**

The metal frame work may be made of sections of light metal, such as anodized aluminum, mild steel or as shown on the drawings. The shape of cross-section shall be such as to facilitate proper suspension and proper fixing of the ceiling boards covering them and shall be structurally sound and rigid.

#### **Construction:**

· Contractor shall ensure that the frame to support the ceiling is designed for structural strength and the sizes, weight and strength of ceiling boards to be fixed and other loads due to live load, air-conditioning ducts, grills, electrical wiring and lighting fixtures, thermal insulation, etc. as shown on the drawings. Contractor shall also submit a detailed drawing to show the grid work, sizes of grid members, method of suspension, position of openings for air-conditioning and lighting, access doors, etc.

- Structural design of timber member for the frame shall be in accordance with IS: 883, and metal sections shall be of appropriate size and thickness and shall be of approved manufacture, all as approved by GWSSB.
- The false ceiling grid work shall be carried out as per the approved drawings or as directed by GWSSB. In case of timber grid work, the grid work shall consist of teak wood runners of minimum size 60mm deep x 40mm wide along one direction at 1.2m centre to centre and secondary runners of size 50mm deep x 40 mm wide at 60mm centre to centre perpendicular to the main runners.
- The timber grid work shall be suspended with the help of wooden hangers or metal hangers at 1.2m centre to centre in both the directions. Wooden hangers shall be adopted for flat R.C. roof slab structures whereas metal hangers for flat R.C. roof or structural steel floors / tresses. Metal hangers shall be fabricated from mild steel / galvanized flats of 35mm x 6mm size or bars of 10mm dia. Threaded at the lower end and anchored securely in the roof concrete or welded to inserts provided on the underside of slabs, beams etc. All M.S. hangers shall be given two coats of red oxide zinc chromate paint primer. In case the roof work is of A.C. sheeting supported on purlins and trusses, hangers shall be suspended from roof steel work. The arrangement of metal hangers shall be such that the level of false ceiling can be adjusted during fixing of the ceiling frame work. The ceiling frame work shall be secured to hangers by means of washers and nuts. The ends of main runners shall preferably be embedded into the masonry work.
- The metal frame work when it is anodized aluminum false ceiling grid system shall consist of aluminum main member of special T-Profile of 38mm x 38mm x 1.5mm thick, interlocking with each other to form frames of various sizes, 600mm x 600 mm or as shown on the drawing. The main members shall be suspended from the roof structures by means of steel hangers as described for timber frame work and supported at the walls by means of anodized aluminum wall angles.
- In the case of timber frame work, all the edges of the plaster of Paris board shall be fixed to frame members by means of counter sunk and rust less screws of 2.74 mm size, 40mm long at a spacing of 100mm to 150 mm c/c and 12mm from the edge of the board. Holes for screws shall be drilled and screws slightly countersunk into the boards. The boards shall be fixed to wooden framework with a joint clearance of about 3mm. The joints shall always be in perfect line and plane.
- In case of aluminum grid system, boards shall be just placed into the frames formed by the main 'T' members and the cross members fitted with the clips for locking boards. Contractor shall take utmost care so as not to force the boards in position and a slight gap shall be provided so as not to make a tight joint. The boards shall be cut with a saw, if required, to any shape and size.
- As the work of false ceiling may be inter-connected with the work of air-conditioning ducts and lighting, Contractor shall fully co-operate with the other agencies entrusted with the above work, who may be working simultaneously. Contractor shall provide necessary openings in the false ceiling work for air-conditioning, lighting and other fixtures. Additional framing, if required, for the above opening shall also be provided at no extra cost to Employer. Removable or hinged type inspection or access trap doors shall be provided at locations specified by GWSSB.

**Finishing:**

It is essential that false ceiling work should be firm and in perfect line and level and all boards free from distortion, bulge, and other defects. All defective boards and other material shall be removed from site immediately and replaced, and ceiling restored to original finish to the satisfaction of GWSSB. The workmanship shall be of highest order and all joinery work for timber work shall be in the best workmanship manner. The joints for aluminum frame work shall be of inter-locking type so that when the cross member is in place, it cannot be lifted out. The countersunk heads of screws and all joints shall be filled with plaster of Paris and finished smooth. After filling the joints, a thick skin of the finishing material shall be spread about 50mm wide on either side of the joint and on to it shall be trowelled dry a reinforcing scrim cloth about 10mm wide. If metal scrim is used, a stiffer plaster will be necessary to enable the Troweling the scrim down to the board.

**Fire Stopping:**

In case of fire protective ceilings, fire resisting barriers at suitable intervals shall be provided. These shall completely close the gap between the false ceiling and soffit of the structural slab. The material of the barrier shall be as indicated by GWSSB (Reference may be made to the British Standards Institutions CP 290: Code of Practice for suspended ceiling and lining of dry construction using metal fixing system, for guidance).

**False or Cavity Floor; Frame Work:**

The false floor shall consist of a framework of suitable structural member designed to carry the loads specified. This frame work shall be supported on suitably designed stools placed at 600mm centre to centre in both directions. The stools shall consist of a mild steel base plate with a mild steel stud having adjustable lock nut and coupling at the centre and another mild steel plate at top serving as a prop head.

The above framework shall be suitably designed to accommodate 35mm thick, 600mm square panels. The base plate shall be fixed to the reinforced concrete floor with an approved adhesive compound or with 4 Nos. 6mm dia. Anchor fasteners. Bedding of 1:2 or richer cement sand mortar shall be provided locally under the base plates of stools to provide a level surface.

The prop head shall be provided with mild steel lugs welded on top and each placed perpendicular to the other for proper positioning and supporting the main and cross members. The stools shall be capable of adjustment to accommodate concrete floor level irregularities up to plus or minus 15mm. The framing members shall be completely removable and shall remain in position without screwing or bolting to the prop heads. All steel framework including steel stools shall be given a coat of zinc chromate primer and two coats of enamel paint of approved color and shade. Floor Panels:

The floor panels shall be made of 600mm x 600mm x 35 mm thick medium density unvinegared/ non-prelaminated teak wood particle boards having a density of not more than 800 kg/cu.m bonded with boiling water proof phenol formaldehyde synthetic resin and shall be of fire resistant, termite resistant and moisture proof quality, generally conforming to IS: 3087-specification for wood particle boards (Medium Density) for general purposes.

The thermal conductivity of the boards shall not exceed 0.12 kCal/hr./Sq.m/deg./C/m. The panel size given above may be suitably modified near electrical panel/equipment and also to suit room dimensions with panel size not more than 600mm under any circumstances. Exposed 2mm thick vinyl edging shall be provided on all edges of individual panels. Each panel shall be given a coat or primer and two coats of approved fire-resistant paint from underside. The particle boards shall be faced with 600mm x 600 mm x 2mm thick approved make flooring tiles conforming to IS:3462 – “Specification for unbaked flexible PVC flooring” and of approved color and shade. The completed panel shall be completely removable and shall remain in position without screwing or bolting to the on the inner side with stickers for easy identification and reassembly whenever required. Suitable backing material shall be provided on the underside of the particle board to prevent warping and / or to cater to specified loading. Suitable removable covers shall be provided to serve as outlets for the cables.

**Imposed Loading:**

The finished floor shall be capable of supporting uniformly distributed loads of 500 to 1000 Kg. per m<sup>2</sup> of floor area as specified in data sheet. A point load of 450 Kg on 600 sq.mm on any part of the panel or a line load of 725 Kg on 100mm strip across the panel length shall not result in a deflection greater than 2.5mm.

**Finish:**

The finished floor shall be true to lines and levels and present a neat flush surface.

**Vendor Drawing:**

Vendor shall prepare and submit a layout drawing for false floor giving all details including supporting system for approval. If so called for, vendor shall also submit his calculations for the supporting system with all relevant data assumed, to the GWSSB for his approval. Work shall be carried out on approved drawings only.

**Fire Proof Doors:****Material and Workmanship:**

The design of fire proof doors and the materials to be used in their fabrication have to be such that they shall be capable of providing the effective barrier to the spread of fire. The materials, fabrication and erection of fire proof doors shall conform to IS: 3614 (Part – I). The fire proof doors shall be obtained from an approved manufacturer. Specific approval for such purchase shall be obtained beforehand. Sample approval shall also be obtained from testing authority as per the standard IS: 3614 (Part – 2) for the specified degree of fire rating in hours. All fire proof doors shall have specified sizes and confirm to the description in the respective items of work.

Fire proof door shutters shall be of zinc coated weldable steel (confirming to BS: 6687) or stainless steel (conforming to IS: 304) sheet (18G minimum) fixed in a frame work of rolled channel. The shutter shall consist of an insulating material like mineral wool in required thickness to satisfy the specified fire rating. Normally the thickness of door shutter shall not be less than 35mm for two-hour fire rating and

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46 mm for four-hour fire rating. The shutter with the required insulating material shall be mounted on angle iron frame or the special made frame from zinc coated (16G minimum) weldable steel sheet. The shutter shall be fixed to frame by means of suitable hinges and shall have a three-way latching system. All the doors shall be provided with a coat of primer and one coat of synthetic enamel paint to attain the specified fire rating. All other accessories like hinges, door lock, hold fasts, etc. shall be provided as approved by TAC (Tariff Advisory Committee). All these accessories shall be compatible with the material used for door and shutter.

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# ***SPECIFICATIONS***

## **SECTION – 5 STRUCTURAL STEEL WORK**

## SECTION - 5:

### STRUCTURAL STEEL WORK

#### Applicable Codes and Specifications:

The supply, fabrication, erection and painting of structural steel works shall comply with the following specifications, standards and codes unless otherwise specified herein. All standards, specifications and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

IS: 808	Dimensions for Hot Rolled Steel sections
IS: 814	Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel
IS: 800	Code of Practice for General Construction in Steel
IS: 801	Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members in General Building Construction
IS: 806	Code of Practice for Use of Steel Tubes in General Building Construction
IS: 7205	Safety Code for Erection of Structural Steel Work
IS: 7215	Tolerances for Fabrication of Steel Structures
IS: 4000	High Strength Bolts in Steel Structure – Code of Practice
AISC	Specifications for Design, Fabrication and Erection of Buildings
IS: 1161	Steel Tubes for structural purposes
IS:10 IS:102	Ready Mixed paint, Brushing, Red Lead, Non-setting, Priming.
IS:110	Ready Mixed paint, brushing, grey filler for enamels for use over primers.
IS:117	Ready Mixed paint, Brushing, Finishing, and Exterior Semigloss for general purposes, to Indian Standard colors.
IS:158	Ready Mixed paint, Brushing, Bituminous, Black, Lead free, Acid, Alkali and heat resisting.
IS:159	Ready Mixed paint, Brushing, Acid resisting for protection against acid fumes, color as required.
IS:341	Black Japan, Types A, B and C
IS:2339	Aluminum paint for general purposes, in Dual container
IS:2932	Specification for enamel, synthetic, exterior, type 1, (a) Undercoating, (b) finishing
IS:2933	Specification for enamel, exterior, type 2, (a) Undercoating, (b) finishing.
IS:5905	Sprayed aluminum and zinc coatings on Iron and Steel.
IS:6005	Code of practice for phosphating of Iron and Steel.
IS:9862	Specification for ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water & chlorine resisting.
IS:13183	Aluminum paint, Heat resistant.
SIS-05-5900	(Swedish Standard)
IS: 1239	Mild steel tubes, tubulars and other Wrought steel fittings
	Part 1 – Mild steel tubes
	Part 2 – Mild steel tubulars and other wrought steel pipe fittings



IS: 1363 (Parts 1 to 3)	Hexagon Head Bolts, Screws and Nuts of product Grade C (Size range M5 to M64)
IS: 1367 (All parts)	Technical Supply Conditions for Threaded Fasteners
IS: 1852	Rolling and Cutting Tolerances for Hot Rolled Steel Products
IS: 1977	Structural Steel (Ordinary Quality)
IS: 2062	Steel for General Structural Purposes
IS: 2074	Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming
IS: 3502	Steel Chequered Plate
IS: 3757	High Strength Structural Bolts
IS: 5369	General Requirements for Plain Washers and Lock Washers
IS: 5372	Taper Washers for Channels
IS: 5374	Taper Washer for 1 Beams
IS: 6610	Heavy Washers for Steel Structures
IS: 8500	Structural Steel-micro alloyed (medium and high strength qualities)
IS: 803	Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded storage tanks
IS: 816	Code of Practice for use of Metal Arc Welding for General construction in Mild Steel
IS: 822	Code of Procedure for Inspection of Welds
IS: 1182	Recommended Practice for Radiographic examination of Fusion – Welded Butt Joints in Steel Plates
IS: 1200	Method of Measurement in Building Civil Works
IS: 1477	Code of Practice for Painting of (Parts 1&2) Ferrous Metals in Buildings
IS: 2595	Code of Practice for Radiographic Testing
IS: 3658	Code of Practice for Liquid Penetrate Flaw Detection
IS: 5334	Code of Practice for Magnetic Particle Flaw Detection of Welds
IS: 9595	Recommendations for Metal Arc Welding of Carbon and Carbon Manganese Steel

**Steel Materials:**

Steel materials shall comply with the referred to in **Sub-Clause 4.1**.

All materials used shall be new, unused and free from defects.

Steel conforming to IS: 1977 shall be used only for the following:

Fe310-0 (St 32-0)	For general purposes such as door/window frames, grills, steel gates, handrails, fence posts, tee bars and other non-structural use.
Fe410-0 (St 42-0)	For structures not subjected to dynamic loading other than wind loads such as: Platform roofs, foot over bridges, building, factory sheds etc.
Fe510-0 (St 42-0)	Grade steel shall not be used
a) b) c)	If welding is to be employed for fabrication If site is in severe earthquake zone If plastic theory of design is used

**Drawings prepared by the VENDOR/CONTRACTOR:**

The VENDOR/CONTRACTOR shall prepare all fabrication and erection drawings for the entire work. All the drawings for the entire work shall be prepared in metric units. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible.

All fabrication drawings shall be submitted to the Engineer-In-Charge for approval.

No fabrication drawings will be accepted for Engineer In charge's approval unless checked and approved by the VENDOR/Contractor's qualified structural engineer and accompanied by an erection plan showing the location of all pieces detailed. The VENDOR/CONTRACTOR shall ensure that connections are detailed to obtain ease in erection of structures and in making field connections.

Fabrication shall be started by the VENDOR/CONTRACTOR only after Engineer In charge's approval of fabrication drawings. Approval by the Engineer-In-Charge of any of the drawings shall not relieve the VENDOR/CONTRACTOR from the responsibility for correctness of engineering and design of connections, workmanship, fit of parts, details, material, errors or omissions or any and all work shown thereon. The Engineer In charge's approval shall constitute approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.

The drawings prepared by the VENDOR/CONTRACTOR and all subsequent revisions etc. shall be at the cost of the VENDOR/CONTRACTOR for which no separate payment will be made.

**Fabrication:****General:**

All workmanship and finish shall be of the best quality and shall conform to the best-approved method of fabrication. All materials shall be finished straight and shall be machined/ground smooth true and square where so specified. All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Unless otherwise approved by the Engineer-In-Charge, reference may be made to relevant IS codes for providing standard fabrication tolerance. Material at the shops shall be kept clean and protected from weather.

**Connections:**

Shop/field connections shall be as per approved fabrication drawings. In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers to be used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that at least one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be at least three times the pitch of the thread.

In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.

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All connections and splices shall be designed for full strength of members or loads. Column splices shall be designed for the full tensile strength of the minimum cross section at the splice.

All bolts, nuts, washers, electrodes, screws etc., shall be supplied/brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity.

All members likely to collect rainwater shall have drain holes provided.

**Straightening:**

All materials shall be straight and, if necessary, before being worked shall be straightened and/or flattened by pressure and shall be free from twists. Heating or forging shall not be resorted to without the prior approval of the Engineer-In-Charge in writing.

**Rolling and Forming:**

Plates, channels, R.S.J. etc., for circular bins, bunkers, hoppers, gantry girders, etc., shall be accurately laid off and rolled or formed to required profile/shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

**High Strength Friction Grip Bolting:**

Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used.

**Welding:**

Welding procedure shall be submitted to the Engineer-In-Charge for approval. Welding shall be entrusted to qualified and experienced welders who shall be tested periodically and graded as per IS 817, IS: 7310 (Part 1) and IS: 7318 (Part 1).

While fabricating plated beams and built up members, all shop splices in each component part shall be made before such component part is welded to other parts of the members. Wherever weld reinforcement interferes with proper fit-up between components to be assembled off welding, these welds shall be ground flush prior to assembly.

Approval of the welding procedure by the Engineer-In-Charge shall not relieve the Contractor of his responsibility for correct and sound welding without undue distortion in the finished structure.

No welding shall be done when the surface of the members is wet nor during periods of high wind.

Each layer of a multiple layer weld except root and surfaces runs may be moderately panned with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from overweening.

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No welding shall be done on base metal at a temperature below  $-5^{\circ}\text{C}$ . Base metal shall be preheated to the temperature as per relevant IS codes.

Electrodes other than low-hydrogen electrodes shall not be permitted for thickness of 32 mm and above.

All welds shall be inspected for flaws by any of the methods described under **Sub-clause 4.6.3**. The choice of the method adopted shall be agreed with the Engineer-In-Charge.

The correction of defective welds shall be carried out in a manner approved by the Engineer-In-Charge without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means approved by the Engineer-In-Charge shall be used to ensure that the whole of the crack and material up to 25 mm beyond each end of the crack has been removed. The cost of all such tests and operations incidental to correction shall be borne by the Contractor.

#### **Tolerances:**

The dimensional and weight tolerances for rolled shapes shall be in accordance with ARE: 1852 for indigenous steel and equivalent applicable codes for imported steel. The tolerances for fabrication of structural steel shall be as per ARE: 7215.

Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant IS codes.

#### **End Milling:**

Where compression joints are specified to be designed for bearing, the bearing surfaces shall be milled true and square to ensure proper bearing and alignment.

#### **Inspection:**

##### **General:**

The Contractor shall give due notice to the Engineer-In-Charge in advance of the works being made ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the Engineer In charge's inspection. The fact that certain material has been accepted at the Contractor's shop shall not invalidate final rejection at site by the Engineer-In-Charge if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevent proper assembly nor shall it invalidate any claim which the Employer may make because of defective or unsatisfactory materials and/or workmanship.

No materials shall be painted or dispatched to site without inspection and approval by the ENGINEER INCHARGE unless such inspection is waived in writing by the ENGINEER-IN-CHARGE.

The Contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified.

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For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the Engineer-In-Charge.

Inspection and tests on structural steel members shall be as set forth below.

**Material Testing:**

If mill test reports are not available for any steel materials the same shall be tested by the Contractor to the Employer's Representative's satisfaction to demonstrate conformity with the relevant specification.

**Tests on Welds:**

**(a) Magnetic Particle Test:**

Where welds are examined by magnetic particle testing, such testing shall be carried out in accordance with relevant IS codes. If heat treatment is performed, the completed weld shall be examined after the heat treatment. All defects shall be repaired and retested. Magnetic particle tests shall be carried out using alternating current. Direct current may be used with the permission of the Engineer-In-Charge.

**(b) Liquid Penetrate Inspection:**

In the case of welds examined by Liquid Penetrate Inspection, such tests shall be carried out in accordance with relevant IS Code. All defects shown shall be repaired and rechecked.

**(c) Radiographic Inspection:**

All full-strength butt welds shall be radiographed in accordance with the recommended practice for radiographic testing as per relevant IS code.

**Dimensions, Workmanship & Cleanliness:**

Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements shown in the Contractor's approved fabrication drawings.

**Test Failure:**

In the event of failure of any member to satisfy inspection or test requirement, the Contractor shall notify the Engineer-In-Charge. The Contractor must obtain permission from the Engineer-In-Charge before any repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the Engineer-In-Charge.

The Engineer-In-Charge has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the Employer, only in case of successful testing.

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The Contractor shall maintain records of all inspection and testing which shall be made available to the Engineer-In-Charge.

**Shop Matching:**

For structures like bunkers, tanks, etc. Shop assembly is essential. For other steel work, such as columns along with the tie beams/bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc., if so desired by the Engineer-In-Charge. All these shop assemblies shall be carried out by the Contractor.

**Drilling Holes for other works:**

As a part of this Contract, holes in members required for installing equipment or steel furnished by other manufacturers or other contractors shall be drilled by the VENDOR/CONTRACTOR at no extra cost of the EMPLOYER. The information for such extra holes will be supplied by the EMPLOYER/ENGINEER-IN-CHARGE.

**Marking of Members:**

After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

Erection marks on like pieces shall be in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

**Errors:**

Any error in shop fabrication which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the Engineer-In-Charge as defective workmanship. Where the Engineer-In-Charge rejects such material or defective workmanship, the same shall be replaced by materials and workmanship conforming to the Specifications by the Contractor, at no cost to the Employer.

**Painting of Steel Work:**

All fabricated steel material, except those galvanized shall receive protective paint coating as specified in specification, which is described below.

**Materials:**

Red-oxide – zinc chrome primer shall conform to IS: 2074.

Synthetic enamel paint shall conform to IS: 2932.

Aluminum paint shall conform to IS: 2339.

All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the Engineer-In-Charge for the brand of manufacture and the color/shade. All the materials shall be brought to the site in sealed containers.

**Workmanship:**

Painting work shall be carried out only on thoroughly dry surfaces. Painting shall be applied either by brushing or by spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirement of IS: 1477 (Part 2).

The type of paint, number of coats etc. shall be as specified in the respective items of work. Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer. All the surfaces shall be thoroughly cleaned of oil, grease, dirt, rust and scale. The methods to be adopted using solvents, wire brushing, power tool cleaning etc., shall be as per IS: 1477 (Part – I) and as indicated in the item of work. It is essential to ensure that immediately after preparation of the surfaces; the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a continuous film without holidays. After the first coat becomes hard dry, a second coat of primer shall be applied by brushing to obtain a film free from `holidays.

After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of synthetic enamel paint of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

The first finishing coat of paint shall be applied by brushing and allowed to hard dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing.

At least 24 hours shall elapse between the applications of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the Engineer-In-Charge.

**Acceptance of Steel, its Handling & Storage:**

The Contractor shall carefully check the steel to be erected at the time of acceptance. Any fabrication defects observed should be brought to the notice of the Engineer-In-Charge.

No dragging of steel shall be permitted. All steel shall be stored 300mm above ground on suitable packing to avoid damage. It shall be stored in the order required for erection, with erection marks visible. All storage areas shall be prepared and maintained by the Contractor. Steel shall not be stored in the vicinity of areas where excavation or grading will be done and, if so stored temporarily, this shall be removed by

the Contractor well before such excavation and/or grading commences to a safe distance to avoid burial under debris. Scratched or abraded steel shall be given a coat of primer in accordance with the Specifications for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and also from damage.

**Anchor Bolts & Foundations:**

The Contractor shall carefully check the location and layout of anchor bolts embedded in foundations constructed, to ensure that the structures can be properly erected as shown on the drawings. Any discrepancy in the anchor bolts/foundation shall be reported to the Engineer-In-Charge.

Leveling of column bases to the required elevation may be done either by providing shims or three nuts on the upper threaded portion of the anchor bolt. All shim stock required for keeping the specified thickness of grout and in connection with erection of structures on foundations, crane brackets or at any other locations shall be of good M.S. plates and shall be supplied by the Contractor at his cost.

A certain amount of cleaning of foundations and preparing the area is considered normal and shall be carried out by the Contractor at no extra cost. Here beams bear in pockets or on walls; bearing plates shall be set and leveled as part of the work. All grouting under column base plates or beam bearing plates will be carried out by the Contractor.

**Assembly & connections:**

Field connections may be affected by riveting, bolting, welding or by use of high strength friction grip bolts as shown on the design and erection drawings.

All field connection work shall be carried as per the drawings. All bolts, nuts, washers, rivets, electrodes required for field connections shall be supplied by the Contractor free of cost. All assembling shall be carried on a level platform. Drifts shall be used only for drawing the work to proper position and must not be used to such an extent as to damage the holes. Size of drifts larger than the normal diameter of hole shall not be used. Any damaged holes or burrs must be rectified to the satisfaction of the Engineer-In-Charge.

Corrections of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets shall be considered as a part of erection. Any error in the shop, which prevents proper fit on a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to the Engineer-In-Charge.

**Erection:**

All structural steel shall be erected as shown on the drawings prepared by the Contractor. Proper size steel cable slings, etc., shall be used for hoisting. Guys shall not be anchored to existing structures, foundations, etc., unless so permitted by the Engineer-In-Charge in writing. Care shall be taken to see that ropes in use are always in good condition.

Steel columns in the basement, if any, are to be lowered and erected carefully with the help of a crane and/or derrick without damaging the basement walls or floor.



Structural steel frames shall be erected plumb and true. Frames shall be lifted at points such that they are not liable to buckle and deform. Trusses shall be lifted only at node points. In the case of trusses, roof girders, all of the purlins and wind bracing shall be placed simultaneously and the columns shall be erected truly plumb on screed bars over the pedestals. All steel columns and beams shall be checked for plumb and level individually before and after connections are made. Temporary bracings shall be introduced wherever necessary to take care of all loads to which the structure may be subjected, including erection equipment and the operation thereof. Such bracings shall be left in place as long as may be required for safety and stability.

Chequered plates shall be fixed to supporting members by tack welding or by countersunk bolts as shown/specified in relevant drawings and/or as approved by the Engineer-In-Charge. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing, care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding. The erection of chequered plates shall include:

- a) Welding of stiffening angles/vertical stiffening ribs
- b) Cutting to size and making holes to required shape wherever necessary to allow service piping and/or cables to pass through
- c) Splicing as shown in relevant drawings
- d) Smoothing of edges
- e) Fixing of chequered plates by tack welding or by countersunk bolts
- f) Providing lifting hooks for ease of lifting.

As erection progresses, the work shall be securely bolted to take care of all dead load, wind, seismic and erection stresses. No riveting or welding or final bolting shall be done until the structure has been properly aligned and approved by the Engineer-In-Charge. No cutting, heating or enlarging of the holes shall be carried out without the prior written approval of the Engineer-In-Charge. The Contractor shall furnish test certificates.

#### **Inspection:**

The Engineer-In-Charge shall have free access to all parts of the job during erection and all erection shall be subjected to his approval. In case of faulty erection, all dismantling and re-erecting required will be at the Contractor's cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by the Engineer-In-Charge.

#### **Tolerances:**

##### **General:**

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb.

<b>Columns:</b>		
Deviation of column axes at foundation top level with respect to true axes:		
(a)	In longitudinal direction	±5 mm
(b)	In lateral direction	±5 mm
Deviation in the level of bearing surface of columns at foundation top with respect to true level±5mm.		
Out of plumb ness (verticality) of column axis from true vertical axis, as measured at column top:		
(a)	For columns up to and including 15 meters	±1/1000 of column height in mm

	or $\pm 15$ mm whichever is less
(b) For columns exceeding	$\pm 1/1000$ of column height in mm or $\pm 20$ mm whichever is less
Deviation in straightness in longitudinal transverse planes of column at any height	$\pm 1/1000$ of column height in mm or $\pm 10$ mm whichever is less
Point along the height	
Difference in erected position of adjacent Pairs of columns along length or across width of building prior to connecting trusses/beams with respect to true distance	$\pm 10$ mm
Width of building prior to connecting trusses/beams with respect to true distance	$\pm 10$ mm
Deviation in any bearing or seating level with respect to true level	$\pm 5$ mm
Deviation in differences in bearing level of a member on adjacent pair of columns both across and along the building	$\pm 10$ mm

**Trusses and Beams:**

Shift at the center of span of top chord member with respect to the vertical plane passing through the center of bottom chord.	$\pm 1/250$ of height of truss in mm or $\pm 15$ mm whichever is less
Lateral shift of top chord of truss at the center of span from the vertical plane passing through the center of supports of the truss	$\pm 1/1500$ of height of truss in mm or $\pm 15$ mm whichever is less
Lateral shift in location of truss from its true vertical position	$\pm 10$ mm
Lateral shift in location of purlin true position	$\pm 5$ mm
Deviation in difference of bearing levels of trusses or beams from	1. $\pm 20$ mm for trusses 2. For beams: the true difference
Depth < 1800mm:	$\pm 6$ mm
Depth > 1800mm:	$\pm 10$ mm
Deviation in sag in chords and diagonals of truss between node points	$1/1500$ of length in mm or 10mm whichever is smaller
Deviation in sweep of trusses, beams etc. horizontal plan	$1/1000$ of span in mm subject to a maximum of 10 mm

**Crane Girders & Rails**

Shift in the center line of crane rail respect to center line of web of with crane girder	$\pm 5$ mm
Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point	$\pm 1$ mm
Difference in alignment of crane rail in plan measured between any two points 2 meters apart	$\pm 1$ mm
Deviation in crane track with respect to true gauge	
For track gauges up to and Including 15 meters	$\pm 5$ mm
For track gauges more than 15 meters	$\pm [5 + 0.25 (S-15)]$ where S in meters are true gauge
Deviation in the crane rail level at any point from true level	$\pm 1/1200$ of the gauge distance or $\pm 10$ mm whichever is less
Difference in the crane rail actual levels between any two points 2 meters apart along the rail length	$\pm 2$ mm

Difference in levels between crane track Rails at	
(a) Supports of crane girders	±15 mm
(b) Mid span of crane girders	± 20 mm
Relative shift of crane rail surfaces at a joint in plane and elevation surfaces for smooth transition	2 mm
Relative shift in the location of crane stops (end buffer along the crane tracks with track gauge S	1/1000 of track gauge subject to maximum of 20 mm S in

**Painting:**

After steel has been erected, all bare and abraded spots, rivet heads, field welds, bolt heads and nuts shall be spot painted with primer. Before paint is applied, the surface shall be dry and free from dust, dirt, scale and grease. All surfaces inaccessible after erection shall receive two coats of the approved paint before erection.

**Clean up of Work site:**

During erection, the Contractor shall at all times keep the working and storage areas used by him free from accumulation of waste materials or rubbish. Before completion of erection, he shall remove or dispose of in a satisfactory manner all temporary structures, waste and debris and leave the premises in a condition satisfactory to the Engineer-In-Charge.

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# ***SPECIFICATIONS***

## **SECTION -6 WATER SUPPLY AND SANITARY WORKS**

## SECTION -6:

### WATER SUPPLY AND SANITARY WORKS

#### Applicable Codes:

The following standards and codes are made a part of this Employer's Requirement. All standards, codes of practice referred to herein shall be the latest editions including all official amendments and revisions.

IS: 210	: Specification for grey iron castings
IS: 269	: Specification for ordinary and low heat Portland cement
IS: 383	: Specification for coarse and fine aggregates from natural sources for concrete
IS: 432	: Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement
IS: 456	: Code of Practice for plain and reinforced concrete
IS: 458	: Concrete Pipes (with and without reinforcement).
IS: 516	: Methods of tests for strength of concrete
IS: 554	: Dimensions for pipe threads where pressure tight joints are required on the threads.
IS: 651	: Salt glazed stoneware pipes and fittings.
IS: 774	: Flushing Cisterns for water closets and urinals (valueless siphonic type)
IS: 775	: Cast iron brackets and supports for wash basins and sinks.
IS: 781	: Sand-cast brass screw-down bib taps and stop taps for water services.
IS: 783	: Code of practice for laying of concrete pipes.
IS: 1068	: Electroplated coatings of nickel and chromium of iron and steel.
IS: 1077	: Specification for common burnt clay building bricks
IS: 1786	: Specification for high strength deformed steel bars and wires for concrete reinforcement
IS: 1239	: Mild steel tubes (Part I) and mild steel tubular and other wrought steel pipe fittings (Part II)
IS: 1536	: Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
IS: 1626	: Asbestos cement building pipes, gutters and fittings (spigot and socket types).
IS: 1703	: Copper Alloy float valves (horizontal plunger type) for water supply purposes.
IS: 1726	: Cast iron manhole covers and frames.
IS: 1729	: Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS: 1742	: Code of practice for buildings drainage
IS: 2116	: Specification for sand for masonry mortars
IS: 2212	: Code of practice for brickwork
IS: 2250	: Code of practice for preparation and use of masonry mortars
IS: 2326	: Automatic flushing cisterns for urinals
IS: 2470	: Code of practice for design and construction of septic tanks (Parts I & II)
IS: 2556	: Vitreous sanitary appliances (Part I to Part XV)
IS: 2963	: Specification for copper alloy waste fittings for wash basins and sinks
IS: 3006	: Specification for chemically resistant glazed stoneware pipes and fittings
IS: 3311	: Waste plug and its accessories for sinks and wash basins
IS: 5455	: Specification for cast iron steps for manholes
IS: 4127	: Code of Practice for laying of glazed stoneware pipes
IS: 3495	: Methods of tests of burnt clay building bricks
IS: 4111	: Code of practice for ancillary structures in sewerage system manholes
IS: 5382	: Specification for rubber sealing rings for gas mains, water mains and sewers
IS: 5329	: Code of practice for sanitary pipe work above ground for buildings

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IS: 5434 : Non-ferrous alloy bottle traps for marine use

**Sanitary Installation:**

The work shall be carried out complying in all respects with any specific requirements of the local body in whose jurisdiction the work is situated, and as approved by the Employer's Representative.

Any damage caused to the building, or to installations therein, either due to negligence on the part of the Contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the Contractor.

All sanitary and plumbing work shall be carried out by licensed plumbers.

All sanitary appliances including sanitary fittings, fixtures, and toilet requisites shall be of size, and design as approved by the Employer's Representative. All white glazed porcelain fixtures, such as wash basin, sink drain board, water closet pan, urinal, 'P' trap etc. shall have hard durable white glazed finish. They shall be free from cracks and other glazing defects. No chipped porcelain fixtures shall be used. Joints between iron and earthenware pipes shall be made perfectly air and water tight by caulking with neat cement mortar.

**A) Indian Type Water Closet:**

This shall be the long pan pattern with separate footrests made of white glazed earthenware; white glazed vitreous china or of white glazed fire clay. The general requirements shall conform to IS: 2556 (Parts III and X). Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush type. The flushing rim and inlet shall be of the self-draining type. It shall have a weep hole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise approved by the Employer's Representative. The inside of the bottom of pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth enable easy and quick disposal while flushing. The exterior surface shall be unglazed and sufficiently rough or grooved at right angles to the axis of the outlet. Pans shall be provided with a trap 'P' or 'S' type with a minimum 50 mm water seal and 50 mm dia. vent horn. Pan shall be laid at the correct location and level over a bed of lime concrete using brick aggregates (1-part lime mortar to 2 parts brick bats with lime mortar to 2 parts of sand) or cement-sand admixture as specified in the drawings.

**B) European Type Water Closet:**

Water closets shall be either of white glazed earthenware, white glazed vitreous china or white glazed fire clay as specified and shall be of "Symphonic Wash down type" conforming to IS.2556 (Part VIII). The closets shall be of one-piece construction with approved plastic/Bakelite seat and cover. Each water closet shall have 4 fixing holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type. It shall also have an inlet of supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. The water closet shall have a weep hole at the flushing inlet. Each water closet shall have an integral trap with either "S" or "P" outlet with at least 50 mm water seal. The water closets shall have an ant siphonage 50 mm dia. vent horn on the outlet side of the trap. The inside of water closets and traps shall be uniform and smooth in order to ensure in efficient flush. The serrated part of the outlet shall not be glazed externally. The water closet

when sealed at the bottom of the trap in line with the back plate shall be capable of holding not less than 10 liters of water between the normal water level and the highest possible water level of the water closet installed.

#### Urinals:

Urinals shall be of the bowl pattern, either flat back or angle back type lipped in front. They shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay, and of size as specified conforming to IS:2556 (Part VI). The urinals shall be of one-piece construction. Each urinal shall be provided with not less than two fixings holes of a minimum dia. of 6.5 mm on each side. Each urinal shall have an integral flushing box rim of suitable type and inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. It shall have a weep hole at the flushing inlet of the urinal. At the bottom of the urinal, an outlet horn for connecting to an outlet pipe shall be provided. The exterior of the outlet horn shall not be glazed and the surface shall be provided with grooves at right angles to the axis of the outlet to facilitate fixing to the uniform and smooth throughout to ensure efficient flushing. The bottom of pan shall have sufficient slope from the front, towards the outlet such that there is efficient draining of the urinal. The waste fittings shall be chromium plated.

#### Wash Basins:

Wash basins shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay as approved by the Employer's Representative and conforming to IS.2556

Type		Size
	Flat Back	630 x 450 mm
	Flat Back	550 x 400 mm

(a) Wash basins shall be of one-piece construction, including a combined overflow. All internal angles shall be designed so as to facilitate cleaning. Each shall have a rim sloping inside towards the bowl on all sides except skirting at the back. Basins shall be provided with single or double tap holes as approved. The tap holes shall be square. A suitable tap hole button shall be supplied if one tap hole is not required in installation. Each basin shall have a circular waste hole to which the interior of basin shall drain. The waste hole shall be either rebated or beveled internally with diameter of 65 mm at top and a depth of 10 mm to suit a waste plug having 64 mm diameter. Each basin shall be provided with non-ferrous 32 mm waste fittings. Stud slots to receive the brackets on the underside of the wash basins shall be suitable for a bracket with stud not exceeding 13 mm diameter, 5 mm high and 305 mm from the back of basin to the center of the stud. The stud slots shall be of depth sufficient to take 5 mm stud. Every basin shall have an integral soap holder recess or recesses which shall fully drain into the bowl. The position of the chain stay-hole shall not be lower than the overflow slot. A slot type of overflow having an area of not less than 5 cm<sup>2</sup>. shall be provided and shall be so designed as to facilitate cleaning of the overflow. The Employer's Requirements for waste plug, chain and stay shall be the same as given for sinks.

(b) All the waste fittings shall be chromium plated. Bottle trap shall conform to IS. 5434. The chromium plating shall be of service grade No. 2 conforming to IS.1068.

#### Sinks:

(a) The sinks shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay as approved by the Employer's Representative conforming to IS.2556 (Part V) and shall be of the following sizes:



450 x 300 x 150 mm  
600 x 450 x 200 mm

(b) They shall be of one-piece construction, including a combined overflow. The floor of the sink shall gently slope towards the outlet. The outlet shall in all cases be suitable for waste fittings having flange of 64 mm diameter and the waste hole shall have a minimum diameter of 65 mm at the bottom to suit the waste fittings. The waste hole shall be either rebated or beveled having a depth of 10 mm. Each sink shall be provided with a non-ferrous 40 mm dia. waste fitting. The sink shall have overflow of the weir type and the inverts shall be 30 mm below the top edge. Each sink shall be provided with a waste plug, of suitable dia. chain and stay. The plug shall be of rubber or other equally suitable material and shall be water tight when fitted. Plug chains shall be of brass wire chromium plated. It shall have an overall length from the collar to the stay of not less than 300 mm. There shall be a triangular or D shackle at each end, one of which shall be brazed to the plug and the other securely fixed to the stay. The 150 mm long shank of the waste shall be threaded conforming to the requirements of IS: 2556 for sinks only. The waste fittings and plug fittings shall be chromium plated. The chromium plating shall be of service grade No.2 conforming to IS: 1068.

#### **Flushing Cisterns:**

The flushing cisterns shall be automatic or manually operated high level or low level, as approved by the Employer's Representative. For water closets and urinals high level cistern is intended to operate with minimum height of 125 cm and a low-level cistern a maximum height of 30 cm between the top of the pan and the underside of the cistern. They shall be of cast iron, glazed earthenware, or pressed steel complying iron, glazed requirement of IS: 774. Automatic flushing cistern for urinals shall conform to IS: 2326.

#### **Cast Iron Soil Waste and Vent Pipes and Fittings:**

All cast iron pipes and fittings shall be of uniform thickness with strong and deep sockets, free from flaws, air holes, cracks, sand holes and other defects and conform to IS: 1536. The diameter approved shall be internal diameter of pipe. The pipes and fittings shall be true to shape, smooth and cylindrical and shall ring clearly when struck over with a light hand hammer. All pipes and fittings shall be properly cleaned of all foreign material before being fixed.

All plug bends of drainage pipes shall be provided with inspection and cleaning caps, covers, which shall be fixed with nuts and screws. Pipes shall be fixed to the wall by W.I. or M.S. holder bat clamps, unless projecting ears with fixing holes are provided at socket end of pipe. The pipes shall be installed, truly vertical or to the lines and slopes as indicated. The clamps shall be fixed to the walls by embedding their hooks in cement concrete blocks (1:2:4) 10 cm x 10 cm making necessary holes in the walls at proper places. All holes and breakages shall be made good. The clamps shall be kept 25 mm clear of the finished face of the walls to facilitate cleaning and painting of pipes.

The annular space between the socket and spigot shall be filled with a gasket of hemp or spun yarn soaked in neat cement slurry. The joint shall then be filled with stiff cement mortar 1:2 (1 cement: 2 fine sand) well pressed with caulking tool and finished smooth on top at an angle of 45°. The joint shall be kept wet for not less than 7 days by tying a piece of gunny bag kept moist. Joints shall be perfectly air tight as well as water tight.

C.I. pipes and fittings which are exposed shall be first cleaned and then painted with a coat of red lead primer. Two coats of zinc paint with white base and mixed with pigment of required color to get the approved shade shall be given over the base primer coat.

The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimensions approved for the corresponding sizes of straight pipes.

The connection between the main pipe and branch pipes shall be made by using branches and bends with access for cleaning. Floor traps shall be provided with 25 mm dia. puff pipe where the length of the waste is more than 1800 mm or the floor trap is connected to a waste stack through bends.

All cast iron pipes and fittings including joints shall be tested by a smoke test to the satisfaction of the Employer's Representative and left in working condition after completion. The smoke test shall be carried out as stated under:

Smoke shall be pumped into the pipe at the lowest and from a smoke machine which consists of a bellow and a burner. The material usually burnt is greasy cotton waste which gives out a clear pungent smoke which is easily detectable by sight as well as by smell if there is a leak at any point of the pipeline. Water test and air test shall be conducted as stipulated in IS: 5329.

#### **Galvanized Mild Steel (G.I.) Pipe:**

The pipes shall be galvanized mild steel welded pipes and seamless screwed and sockets tubes conforming to the requirements of IS: 1239, for medium grade. They shall be of the diameter (nominal bore) approved. The sockets shall be designated by the respective nominal bores of the pipes for which they are intended. The pipes and sockets shall be finished neatly, well galvanized on both inner and outer surfaces, and shall be free from cracks, surface flaws, laminations and other defects. All screws, threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS.554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

The fittings shall be of malleable cast iron or mild steel tubes complying with all the appropriate requirements as approved for pipes. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended. The fittings shall have screw threads at the ends conforming to the requirements of IS: 554. Female threads on fittings shall be parallel and male threads (except on running nipples and collars of unions) shall be tapered.

The pipes and fittings shall be inspected at site before use to ascertain that they conform to the specification. The defective pipes shall be rejected. Where the pipes have to be cut or rethreaded, the ends shall be carefully filled out so that no obstruction to bore is offered. The ends of the pipes shall then be threaded conforming to the requirements of IS.554 with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening bent and damaged screw threads and shall not be used for turning of the threads so as to make them slack, water tight joint. The screw- thread of pipes and fittings shall be protected from damage until they are fitted. The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped around the screwed end of the pipe. The end shall then be screwed in the socket, tee, etc., with the pipe wrench. Care should be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burrs from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be

temporarily plugged to prevent access of soil or any other foreign matter. Any threads exposed after jointing shall be painted or in the case of underground piping thickly coated with approved anticorrosive paint to prevent corrosion.

For internal work the galvanized iron pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm clear of the wall. Pipes and fittings shall be fixed truly vertical/horizontal. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts of recesses etc. provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage, but the joints in pipes shall not be buried. M.S. pipe sleeve shall be fixed at a place where a pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion/contraction and other movements/maintenance. In case the pipe is embedded in walls or floors it should be painted with anti-corrosive bitumastic paint of approved quality. The pipe should not come in contact with lime mortar or lime concrete as the pipe is affected by lime. Under the floors the pipes shall be laid in layer of sand filling or as approved by the Employer's Representative.

G.I. pipes with socket and spigot ends shall be provided with lead caulked joints wherever specified and the joints shall conform to the requirements of IS.3114.

The work of excavation and backfilling shall be done true to line and gradient in accordance with General Employer's Requirements for earthworks in trenches for pipes laid underground.

The pipes shall be laid on a layer of 10.0 cm sand and filled up to 15 cm above the pipes. A sand cushion of 15cm on either side of the pipe shall also be provided. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be got rid of as directed. When excavation is done in rock the bottom shall be cut deep enough to permit the pipes to be laid on a cushion of sand 75 mm minimum.

The pipes and fittings after they are laid and jointed shall be subjected to hydrostatic pressure test as approved by the Employer's Representative and shall satisfactorily pass the test. Pipe line system shall be tested in sections as the work proceeds, keeping the joints exposed for inspection. Pipes shall be slowly and carefully charged with water allowing all air to escape. All draw off taps shall then be closed and water pressure gradually raised to test pressure. Care shall be taken to ensure that pressure gauge is accurate and preferably should have been recalibrated before the test. Pump used having been stopped; the section of the pipeline shall maintain the test pressure for at least half an hour. Any joints or pipes found leaking shall be removed and replaced by the Contractor.

The G.I. pipe line shall be cut to the required length at the position where the meter and stop cock are required to be fixed. The ends of the pipes shall be threaded. The meter and stop cock shall be fixed in position by means of connecting pipe, G.I. nuts, sockets, etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed and meter installed exactly horizontally or vertically and with the arrow cast on the body of the meter pointing in the direction of flow. Care shall be taken that the factory seal of the meter is not disturbed. Whenever the meter is to be fixed to a newly fitted pipe line, the pipe line will have to be completely washed before fixing the meter. For this purpose, a connecting piece of pipe equal to the length of the meter is to be fixed on the new pipe line. The

water shall be allowed to flow completely to wash the pipe line and then the meter installed as described above by replacing the connecting piece.

#### **Stoneware pipes and fittings:**

All pipes with spigot and socket ends shall conform to IS: 651/3006 and shall be of grade 'A'. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the pipes shall be free from crazing. The pipes shall give a sharp clear note when struck with a light hammer.

The following information shall be clearly marked on each pipe and fitting:

- (a) Internal diameter;
- (b) Grade;
- (c) Date of manufacture;
- (d) Name of manufacturer or his registered trade-mark or both.

All pipes and fittings shall have ISI mark.

Jointing of GSW pipes and fittings shall be done as per the requirements of the following Employer's Requirements and the relevant IS. After jointing, extraneous material if any shall be removed from the inside of the pipes and fittings and the newly made joints shall be thoroughly cured. In case, rubber sealing rings are used for jointing, these shall conform to IS: 5382.

#### **Spigot and Socket Joint (Cement Joint):**

The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. In each joint, spun yarn soaked in neat cement slurry or tarred gasket shall be passed around the joint and inserted in it by means of a caulking tool. More skeins of yarn or gasket shall be added if necessary and shall be well caulked. Yarn or gasket so rammed shall not occupy more than one-fourth of the depth of socket. Cement mortar (1:1) shall be slightly moistened and carefully inserted by hand into the remaining space of the joint after caulking of yarn or gasket. The mortar shall then be caulked into the joint with a caulking tool. More cement mortar shall be added until the space of joint has been completely filled with tightly caulked mortar. The joint shall then be finished off neatly outside the socket at an angle of 45 degrees. The cement mortar joints shall be cured at least for seven days before testing.

The approximate quantity of cement required for each joint for certain common sizes of pipes are given below for guidance:

Nominal diameter of pipe (mm)	Cement (kg)
150	1.5
200	2.0
250	2.5
300	3.25
350	4.5
400	5.5
450	6.5

#### **Spigot and Socket Joint (Bituminous Joint):**

The general requirements for this type of joint shall be as specified in 5.12.1 the material for jointing shall consist of composition of asphalt and sand in the ratio of 1:7. Asphalt and sand shall be boiled together and filled into the socket in a molten state with the aid of special moulds.

#### **Spigot and Socket Joint (Rubber Ring Joint):**

The pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a jack or similar appliance. The rubber rings conforming to IS: 5382 shall be used, and the manufacturer's instructions shall be deemed to form a part of this Employer's Requirements. The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

#### **Cleaning of Pipes:**

As soon as a stretch of GSW pipes has been laid complete from manhole to manhole or for a length as approved by the Employer's Representative, the Contractor shall run through the pipes both backward and forward a double disc or solid or closed cylinder 50 mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipeline shall be securely closed as approved by the Employer's Representative to prevent entry of mud or silt etc. If as a result of the removal of any obstruction the Employer's Representative considers that damages may have been caused to the pipe lines, he shall be entitled to order the length to be tested immediately. Should such test prove unsatisfactory the Contractor shall repair the pipeline and carry out such further tests as are required by the Employer's Representative.

It shall also be ascertained by the Contractor that each length from manhole to manhole or the length as approved by the Employer's Representative is absolutely clear and without any obstruction by means of visual examination of the interior of the pipeline suitably illuminated by projected sunlight or otherwise.

After laying and jointing of GSW pipes is completed the pipe line shall be tested as per the following Employer's Requirements and as approved by the Employer's Representative. All equipment for testing at work site shall be supplied and erected by the Contractor. Water for testing of pipeline shall be arranged by him. Damage during testing shall be the Contractor's responsibility and shall be rectified by him to the full satisfaction of the Employer's Representative. Water used for test shall be removed from pipes and not released to the excavated trenches. After the joints have thoroughly set and have been checked by the Employer's Representative and before backfilling the trenches, the entire section of the sewer or storm water drain shall be proved by the Contractor to be water tight. Before commencing the hydraulic test, the pipelines shall be filled with water and maintained full for 24 hours by adding water, if necessary, under a head of 0.6 m of water. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head; or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation. The pipeline shall be subjected to a test pressure of at least 2.5 m head of water at the highest point of the section under test. The tolerance of two liters per centimeter of diameter per kilometer may be allowed during a period of 10 minutes. Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good. If any damage is caused to the pipeline during the execution of work or while cleaning/testing the pipeline as specified. The Contractor shall be held responsible for the same and shall replace the damaged pipeline and re-test the same to the full satisfaction of the Employer's Representative.

Water for testing of pipeline shall be arranged by the Contractor.

#### **Stop Cock and Bib Cock:**

A bibcock (bib tap) is a draw off tap with a horizontal inlet and free outlet and stopcock (stop tap) is a valve with a suitable means of connections for insertion in a pipe line for controlling or stopping the flow. They shall be of specified size and shall be of the screw down type. The closing device should work by means of a disc carrying a renewable non-metallic washer, which shuts against water pressure on a seating at right angles to the axis of the threaded spindle which operates it. The handle shall be either crutch or butterfly type securely fixed to the spindle. The cocks shall open in anti-clockwise direction. When the bib cocks and stop cocks are required to be chromium plated, the chromium plating shall be of service Grade No. 2 conforming to IS.1068. In finish and appearance, the plated articles shall be free from plating defects such as blisters, pits, and roughness and shall not be stained or discolored.

These fittings shall be of brass heavy class; chromium plated (C.P) and of approved manufacture and pattern with screwed or flanged ends as specified. The fittings shall in all respects comply with the requirements of IS.781. The standard size of brass fittings shall be designated by the nominal bore of the pipe to which the fittings are attached. A sample of each kind of fitting shall be approved by the Employer's Representative and all supplies made according to the approved samples.

All cast fittings shall be sound and free from laps, blow holes and fittings, both internal and external surfaces shall be clean, smooth and free from sand etc. Burning, plugging stopping or patching of the casting shall not be permitted. The bodies, bonnets, spindles and other parts shall be truly machined and when assembled the parts shall be axial, parallel and cylindrical with surfaces smoothly finished. The area of the waterway of the fittings shall not be less than the area of the nominal bore.

The fittings shall be fully examined and cleared of all foreign matter before being fixed. The fittings shall be fitted in the pipe line in a workman like manner. The joints between fittings and pipes shall be made leak- proof. The joints and fittings shall be leak proof when subjected to a pressure test approved by the Employer's Representative and the defective fittings and joints shall be replaced or redone.

#### **Soak Pit:**

Soak pit shall be constructed at the location specified by the Employer's Representative. Earthwork excavation shall be carried out to the exact dimensions. Brick masonry lining with open joints shall be constructed in the pit up to 150 mm below the outlet pipeline. Brick masonry in cement mortar 1:6 shall be constructed above this level up to ground. Well burnt brick aggregates of nominal size 40 mm to 80 mm and coarse sand shall be filled within the chamber. Construction of pit lining and filling of the brick ballast shall progress simultaneously.

#### **Manholes:**

##### **Location:**

Manholes shall be constructed at places approved by the Employer's Representative.

##### **Excavation:**

Excavation, shoring, dewatering etc. for the pits of manholes, laying of pipes and fittings/specials shall be done in accordance with Employer's Requirements described elsewhere in the document.

##### **Bed Concrete:**

The bed concrete for manholes shall be done in accordance with Employer's Requirements described elsewhere in the document.

**Bricks:**

Bricks to be used for construction of manholes shall conform to the relevant Indian Standards. They shall be sound, hard, and homogeneous in texture, well burnt in kiln without being vitrified, table moulded, deep red, cherry or copper colored, of regular shape and size and shall have sharp and square and parallel faces. The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containing ungrounded particles and/or which absorb water more than 1/6th of their weight when soaked in water for twenty-four hours shall be rejected. Over burnt or under burnt bricks shall be liable to rejection. The bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 50 kg/sq.cm. Unless otherwise noted in drawings. The class and quality requirements of bricks shall be as laid down in IS: 1077.

The size of the brick shall be 23.0 x 11.5 x 7.5 cm. unless otherwise specified; but tolerance up to 3 mm in each direction shall be permitted. Only full-size brick shall be used for masonry work. Brick bats shall be used only with the permission of Employer's Representative to make up required wall length or for bonding. Sample bricks shall be submitted to the Employer's Representative for approval and bricks supplied shall conform to approved samples. If required by the Employer's Representative, brick sample shall be tested as per IS: 3495 by Contractor. Bricks rejected by the Employer's Representative shall be removed from the Site within 24 hours.

**Cement Mortar:**

Mortar for brick masonry shall be prepared as per IS: 2250. Manholes shall be constructed in brick masonry with cement mortar (1:2) unless otherwise specified. Gauge boxes for sand shall be of such dimensions that one bag containing 50 kg. Of cement forms one unit. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be as approved by the Employer's Representative. If required by the Employer's Representative Sand shall be thoroughly washed till it is free of any contamination.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry conditions. Water shall then be added and mixing continued to give a uniform mix of required consistency. Cement mortar shall be used within 25 minutes of mixing. Mortar left unused in the specified period shall be rejected.

The Contractor shall arrange for tests on mortar samples if so required by Employer's Representative. Retendering of mortar shall not be permitted.

**Brick Masonry:**

All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work of manholes shall be in the proportion specified in 5.15.5. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. 115 mm thick brick work shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.

All brickwork shall be plumb and square unless otherwise shown on drawing and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be leveled. The thickness of brick courses shall be kept uniform. For walls of thickness greater than 230 mm both faces shall be kept in vertical planes

unless otherwise specified. All interconnected brickwork shall be carried out at nearly one level (so that there is uniform distribution of pressure on the supporting structure) and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45 degrees. But in no case the level difference between adjoining walls shall exceed 1.25 M. Workmanship shall conform to IS: 2212.

Brick shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 12 mm by raking tools daily during the progress of work when the mortar is still green, so as to provide a proper key for the plastering to be done. When plastering is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top. If mortar in the lower courses has begun to set, the joints shall be raked out to a depth of 12 mm before another course is laid.

**Cement Plaster:**

All joints in masonry shall be raked to a depth of 12 mm with hooked tool made for the purpose when the mortar is still green and in any case within 48 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose material, grease etc. and thoroughly wetted for 6 hours before plastering work is commenced. Concrete surfaces to be rendered will however be kept dry. The wall should not be too wet but only damp at the time of plastering. The damping shall be uniform to get uniform bond between the plaster and the wall.

The proportion of the cement mortar shall be as approved on relevant drawings. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as per relevant I.S. The mortar thus mixed shall be used immediately and in no case shall the mortar be allowed to remain for more than 25 minutes after mixing with water.

Curing of plaster shall be started as soon as the applied plaster has hardened enough so as not to be damaged. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.

Plastering shall be done on both faces of brick masonry in cement mortar (1:2) and 20 mm thick unless otherwise specified.

Plastering work shall be carried out in two layers, the first layer being 14 mm thick and the second layer being 6 mm thick. The first layer shall be dashed against the prepared surface with a trowel to obtain an even surface. The second layer shall then be applied and finished leaving an even and uniform surface, trowel finished unless otherwise approved by the Employer's Representative.

**Cement Concrete Channel:**

The channel for the manhole shall be constructed in cement concrete of M15 grade. Both sides of the channel shall be taken up to the level of the crown of the outgoing sewer. They shall be benched up in concrete and rendered in cement mortar (1:1) of 20 mm thickness and formed to a slope of 1 in 12 towards the channel.



**Pipe Entering or Leaving Manhole:**

Whenever a pipe enters or leaves a manhole, bricks on edge must be cut to a proper form and laid around the upper end of the pipe so as to form an arch. All around the pipes, there shall be a joint of cement mortar (1:2) 13 mm thick between it and the bricks.

**Cast Iron Steps:**

Cast iron steps shall be as per IS: 5455. The steps shall be of grey cast iron of grade 15 as per IS: 210. The steps shall be clean, well-cast and they shall be free from air and sand holes, cold shuts and warping. The portion of the step which projects from the wall of the manhole shall have a raised chequered design to provide an adequate non-slip grip. C.I. steps shall weigh not less than 4.5 kg each and shall be of 150 mm x 375 mm overall dimensions. These steps shall be coated with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63 degrees C and shall not be brittle as to chip off at temperature of 0-degree C.

Where the depth of invert of manhole exceeds 800 mm, cast iron steps of approved pattern shall be fixed in the brick work at the interval of 300 mm vertically and staggered at 380 mm horizontally centre to centre. In case of pipe diameter greater than 600 mm, box type C.I. steps weighing 19 kg each shall be provided at 300 mm vertically in channel of manhole.

**Frame and Covers:**

Frame and covers for manholes shall be of required type and dimensions as per the relevant drawings prepared by the Contractor. Following information shall be clearly marked on each cover.

- i. Year of manufacture,
- ii. Identification mark of the Employer: PROJECT DIRECTOR AND CHIEF ENGINEER.
- iii. Arrow showing direction of flow.

**(a) Cast Iron Frame and Cover:**

The cast iron frame and cover shall be of grey cast iron as per IS: 1726. The general requirements for casting and coating of CI frame and cover shall be as specified for CI steps in Clause 5.15.10. The covers shall have a raised chequered design to provide an adequate non-slip grip. The rise of the chequered shall not be less than 4 mm. The locking device for the cover shall be provided as approved by the Employer's Representative. The CI covers for the load test shall be selected at one for every lot of fifty or part thereof for each type and size manufactured and as approved by the Employer's Representative. The frame shall be fixed in cement concrete of M15 grade all round and finished with neat cement. The manhole frame shall have 560 mm diameter clear opening and shall weigh not less than 208 kg. Including cover. In case of rectangular CI frame and cover of 900 mm x 600 mm clear opening, the total weight shall not be less than 275 kg. In case of scraper manhole, the frame shall have clear opening of 1200 mm x 900 mm and shall weigh not less than 900 kg including cover. The manhole cover and frame shall be painted with three coats of anti-corrosive paint after fixing in position.

**(b) Fiber Reinforced Concrete Frame and Cover:**

Fiber reinforced concrete frame and cover shall be capable of withstanding load of 35 tones. The frame shall be fixed in cement concrete of M15 grade all around and finished with neat cement. The fiber reinforced frame shall have clear opening of 560 mm diameter and weighing 102 kg. The cover shall have a minimum thickness of 100 mm and weighing 78 kg. The fiber shall

constitute 1% of the weight of the concrete in the form of 50 mm to 100 mm long high tensile steel wires. For the cover, MS sheet lapping of 18 gauge shall be provided to avoid damage to the edges. Similarly, for frame, MS angle/flat shall be provided along the edge. Both MS sheet and angle shall be painted with black bituminous paint. The cover should have suitable lifting arrangement. The fiber reinforced frame and cover shall be manufactured as approved.

**(c) Reinforced Cement Concrete Frame and Cover:**

Reinforced cement concrete frame and cover for manholes shall be of required dimensions and shape as shown on the drawing prepared by the Contractor. The frame and cover shall be cast in cement concrete of M25 grade. Minimum cover to the reinforcement shall be 40 mm. The edges of frame and covers shall be provided with mild steel angles to avoid damages to the corners. These angles shall be painted with black bituminous paint. The covers should have suitable lifting arrangement.

**Drop Manhole:**

When a sewer connects a main sewer, and where the difference in level between water line (peak flow levels) of main line and the invert level of branch lines is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connection within 600 mm, a drop connection shall be provided for which a manhole shall be constructed as per relevant drawing, incorporating a vertical drop pipe from the higher sewer to the lower one. This pipe shall be provided outside the shaft and encased in concrete. A continuation of the branch sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange. The diameter of the back drop should be at least as large as that of the incoming pipe. The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degrees or less to the direction of the flow in the main sewer. The pipe unless of cast iron should be surrounded with 150 mm thick concrete.

In the case of sewers over 450 mm in diameter the drop-in level may be accomplished by one of the following approved methods:

- (a) A cascade;
- (b) A ramp;
- (c) By drops in previous manholes.

**RCC Manhole:**

M25 grade of concrete used for construction of RCC manhole shall have minimum cement content of 360 kg/cum of concrete. Minimum cover to the reinforcement shall be 50 mm.

**Vent Shafts:**

**(a) General:**

Vent shafts shall be erected at such places as approved by the Employer's Representative.

**(b) Mild Steel Vent Shaft:**

Mild steel vent shaft shall be of 150 mm diameter and 12.17 m height from ground level with C.I. ornamental cap. This shall be fixed firmly and encased in cement concrete of M15 grade as shown on relevant drawing with necessary mild steel bolts, plates etc. for foundation. The vent shaft shall be painted with one coat of silver paint over one coat of red lead oxide paint. The

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vent shaft shall be connected to manhole by 150 mm diameter glazed stoneware pipe encased by M10 concrete of 150 mm thickness all around as approved by the Employer's Representative.

**(c) RCC Vent Shaft:**

Reinforced cement concrete vent shaft shall be of M25 grade concrete, 200 mm diameter at bottom and tapered to 100 mm diameter at top (both inside clear openings) and 6 m height from ground level. The vent shaft shall be embedded in concrete of M10 grade and anchored by 2 nos. of 16 mm diameter and 600 mm long MS bars. The vent shaft shall be connected to manhole as specified in (b) above through a brick masonry flue chamber.

**Miscellaneous:**

If any damage is caused to the other services such as water supply pipeline, sewer, cable, etc. during the construction of manholes and erection of vent shafts, the Contractor shall be held responsible for the same and shall replace the damaged services to the full satisfaction of the Employer's Representative.

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# ***SPECIFICATIONS***

## **SECTION -7 EARTHWORK**

**SECTION -7:****EARTHWORK****Applicable Codes**

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to.

IS 3764 – 1992	Excavation work - Code of Safety.
IS 2720	Methods of test for soils:
(Part-1) - 1983	Part 1 Preparation of dry soil samples for various tests.
(Part-2) - 1986	Part 2 Determination of Water Content.
(Part-4) - 1985	Part 4 Grain size analysis.
(Part-5) - 1985	Part 5 Determination of liquid and plastic limit.
(Part-7)	Part 7 Determination of water content - dry density relation using light compaction.
(Part-9)	Part 9 Determination of dry density - moisture by constant weight of soil method.
(Part-14) – 1983	Part 14 Determination of density index (relative density) of cohesion less soils.
(Part-22) – 1978	Part 22 Determination of organic matter.
(Part-26) – 1987	Part 26 Determination of pH Value.
(Part-27) – 1987	Part 27 Determination of total soluble sulphates.
(Part-28) – 1974	Part 28 Determination of dry density of soils in place by the sand replacement method.
(Part-33) – 1971	Part 33 Determination of the density in place by the ring and water replacement method.
(Part-34) – 1972	Part 34 Determination of density of soil in place by rubber balloon method.
(Part-38) – 1976	Part 38 Compaction control test (Hilf Method ).

**General:**

The Contractor shall furnish all tools, plant, instruments, qualified supervisory personnel, labour, materials, any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the work in accordance with the Employer's Requirements.

The Contractor shall survey the site before excavation and set out all lines and establish levels for various works such as grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/grid lines at 8m intervals or nearer, if necessary, based on ground profile and thereafter properly recorded.

The excavation shall be carried out to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night.

Excavated material shall be dumped in regular heaps, bunds, riprap with regular slopes within the lead specified and leveling the same so as to provide natural drainage. Rock/soil & murrum excavated shall be stacked properly as approved by the Employer's Representative. As a rule, all softer material shall be laid along the center of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately. Top soil shall be stock piled separately for later re-use.

**Clearing:**

The area to be excavated / filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter. If any roots or stumps of trees are encountered during excavation, they shall also be removed. The material so removed shall be disposed off as approved by the Employer's Representative. Where earth fill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter/ materials before fill commences.

**Excavation:**

All excavation work shall be carried out by mechanical equipment unless, in the opinion of Employer's Representative, the work involved requires it to be carried out by manual methods.

Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings provided by the Contractor or such other lines and grades as may be agreed with the Employer's Representative. Rough excavation shall be carried out to a depth of 150mm above the final level. The balance shall be excavated with special care.

Soft pockets shall be removed below the final level and extra excavation filled up with lean concrete as approved by the Employer's Representative. The final excavation should be carried out just prior to laying the blinding course.

To facilitate the permanent works the Contractor may excavate, and also backfill later, outside the lines shown on the drawings provided by the Contractor as agreed with the Employer's Representative. Should any excavation be taken below the specified elevations, the Contractor shall fill it up with concrete of the same class as in the foundation resting thereon, up to the required elevation at no cost to the Employer.

All excavations shall be to the minimum dimensions required for safety and ease of working. Prior approval of the Employer's Representative shall be obtained by the Contractor in each individual case, for the method proposed for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope.

**Rock:****General:**

'Rock' means a natural aggregate of mineral crystals, which for its excavation would normally require the use of heavy pneumatic/hydraulic breaker and/or cutting equipment or explosives. The term shall exclude any material that can be removed by ordinary excavating machinery and which in any individual mass has a volume not exceeding  $1\text{m}^3$  or  $0.25\text{m}^3$  where the net width of excavation is less than 2 m. Ordinary excavating machinery means a hydraulic back hoe with rated output of 50 kW or less.

Before classification of material as rock the Contractor shall demonstrate to the satisfaction of the Employer's Representative his inability to excavate it without resort to heavy percussion tools complete

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with rock bits, hydraulic wedges or blasting. Excavation by the use of explosive will not normally be permitted except for pipeline.

Material shall not be classified as rock unless the Employer's Representative has agreed to such classification on the basis of such a demonstration before its excavation. Excavations where rock has been encountered and classified as such shall not be backfilled before examination of the excavated faces by the Employer's Representative to enable the extent of the rock excavation to be determined.

#### **Excavation by the Use of Explosives**

Unless otherwise stated herein, I.S. Specification "IS: 4081: Safety Code for Blasting and related Drilling Operations" shall be followed. As far as possible all blasting shall be completed prior to commencement of construction. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines specified for the excavation, in the soundest possible condition. The quantity and strength of explosives used shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Employer's Representative, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structures as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of Employer's Representative at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and number of explosives used shall be progressively and suitably reduced.

The contractor shall obtain a valid Blasting License from the authorities concerned. No explosive shall be brought near the work in excess of quantity required for a particular amount of firing to be done; and surplus left after filling the holes shall be removed to the magazine. The magazine shall be built as far possible from the area to be blasted. Employer's Representative's prior approval shall be taken for the location proposed for the magazine.

In no case shall blasting be allowed closer than 30 meters to any structure or to locations where concrete has just been placed. In the latter case the concrete must be at least 7 days old.

For blasting operations, the following points shall be observed.

- i) Contractor shall employ a competent and experienced supervisor and licensed blaster in-charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.
- ii) Before any blasting is carried out, Contractor shall intimate Employer's representative and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.
- iii) Contractor shall ensure that all workmen and the personnel at site are excluded from an area within 200 m radius from the firing point, at least 15 minutes before firing time by sounding warning whistle. The area shall also be given a warning by sounding a distinguishing whistle.
- iv) The blasting of rock near any existing buildings, equipment or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done by MS plates with adequate dead weight over them. Blasting shall be done with small charges only and where directed by Employer's Representative; a trench shall have to be cut by chiseling prior to the blasting operation, separating the area under blasting from the existing structures.

- v) The firing shall be supervised by a Supervisor and not more than 6 (six) holes at a time shall be set off successively. If the blasts do not tally with the number fired, the misfired holes shall be carefully located after half an hour and when located, shall be exploded by drilling a fresh hole along the misfired hole (but not nearer than 600 mm from it) and by exploding a new charge.
- vi) A wooden tamping rod with a flat end shall be used to push cartridges home and metal rod or hammer shall not be permitted. The charges shall be placed firmly into place and not rammed or pounded. After a hole is filled to the required depth, the balance of the hole shall be filled with stemming, which may consist of sand or stone dust or similar inert material.
- vii) Contractor shall preferably detonate the explosives electrically.
- viii) The explosives shall be exploded by means of a primer, which shall be fired by detonating a fuse instantaneous detonator (F.I.D) or other approved cables. The detonators with F.I.D. shall be connected by special nippers.
- ix) In dry weather and normal dry excavation, ordinary low explosive gunpowder may be used. In damp rock, high explosive like gelatin with detonator and fuse wire may be used. Underwater or for excavation in rock with substantial accumulated seepage electric detonation shall be used.
- x) Holes for charging explosives shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting will be suitable for handling without secondary blasting.
- xi) When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level.
- Any rock excavation beyond an over break limit of 75 mm shall be filled up as instructed by Employer's Representative, with concrete of strength not less than M10. Stopping in rock excavation shall be done by hand trimming.
- xii) Contractor shall be responsible for any accident to workmen, public or Employer's property due to blasting operations. Contractor shall also be responsible for strict observance of rules, laid by Inspector of explosives, or any other Authority duly constituted under the State and / or Union Government as applicable at the place of excavation.

**Stripping Loose Rock:**

All loose boulders, detached rocks partially and other loose material which might move therewith not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of Employer's Representative, to fall or otherwise endanger the workmen, equipment, or the work shall be stripped off and removed from the area of the excavation. The method used shall be such as not to render unstable or unsafe the portion, which was originally sound and safe.

Any material not requiring removal in order to complete the permanent works, but which, in the opinion of Employer's Representative, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed.

**Classification of Strata:**

The decision regarding, classification of strata shall rest with the Engineer in charge and his decision shall be final and binding to the contractor.

All the materials encountered in the excavation shall be classified as under: -

**ORDINARY SOIL AND SOFT MURRUM:**



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These will include all materials of an earthy or sandy nature, which can be easily ploughed or small shingle, and gravel, which can be easily removed.

**HARD MURRUM:**

This shall include all kinds of disintegrated rock or shale or inundated clay which can be removed with a shovel without difficulty and which do not require blasting.

**SOFT ROCK:**

This shall include all materials which is rock or hard conglomerate, all decomposed and whether rock, highly fissured rock old masonry and also soft rock boulders bigger than 1/2 cubic meter and other varieties of rock. Which do not require blasting and which can be removed with the pie crowbars wedges and hammer.

**HARD ROCK:**

This shall include rocks, occurring in masses, which could best be removed by chiseling or by blasting.

**Fill, Backfilling and Site Grading:****General:**

All fill material shall be subject to the Employer's Representative's approval. If any material is rejected by Employer's Representative, the Contractor shall remove the same forthwith from the site. Surplus fill material shall be deposited/disposed off as directed by Employer's Representative after the fill work is completed.

No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with to the approval of the Employer's Representative.

**Material:**

To the extent available, selected surplus spoil from excavations shall be used as backfill. Backfill material shall be free from lumps, organic or other foreign material. All lumps of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murrum or earth to fill the voids and the mixture used for filling.

If fill material is required to be imported, the Contractor shall decide to bring such material from outside borrow pits. The material and source shall be subject to the prior approval of the Employer's Representative. The approved borrow pit areas shall be cleared of all bushes, roots of trees, plants, rubbish, etc. Topsoil containing foreign material shall be removed. The materials so removed shall be disposed of as directed by Employer's Representative. The Contractor shall provide the necessary access roads to borrow areas and maintain the same if such roads do not exist.

**Filling in pits and trenches around foundations of structures, walls, etc.**

As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches, etc., shall be cleared of all debris, and filled with earth in layers not exceeding 15 cm, each layer being watered, rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of Employer's Representative. Earth shall be ramming with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless the Employer's Representative is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and leveled to a proper profile to the approval of the Employer's Representative.

**Plinth Filling:**

Plinth filling shall be carried out with approved material as described hereinbefore in layers not exceeding 15cm, watered and compacted with mechanical compaction machines. The Employer's Representative may, however, permit manual compaction by hand tampers where he is satisfied that mechanical compaction is not possible. The finished level of the filling shall be trimmed to the level/slope specified.

The thickness of each unconsolidated fill layer can in this case be up to a maximum of 300mm. The Contractor will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used and the approval of the Employer's Representative obtained prior to commencing filling.

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated, then filled and consolidated.

**Sand Filling in Plinth and Other Places:**

Where backfilling is required to be carried out with local sand it shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until the Employer's Representative has inspected and approved the fill.

**Filling in Trenches:**

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipe and drains have been tested and passed. The backfilling material shall be properly consolidated taking due care so that no damage is caused to the pipes.

Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the center line of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm; backfilling above the level of the center line of the pipes shall be done with selected earth by hand compaction, or other approved means in layers not exceeding 15 cm.

In case of excavation of trenches in rock, the filling up to a level 30 cm above the top of the pipe shall be done with fine materials such as earth, murrum, etc. The filling up to the level of the centerline of the pipe shall be done by hand compaction in layers not exceeding 8 cm whereas the filling above the centerline of the pipe shall be done by hand compaction or approved means in layers not exceeding 15 cm. The filling from a level 30 cm above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

Filling of the trenches shall be carried out simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

**General Site Grading:**

Site grading shall be carried out as indicated in the drawings and as approved by the Employer's Representative. Excavation shall be carried out as specified in the Employer's Requirements. Filling and compaction shall be carried out as specified under Clause 2.7 and elsewhere unless otherwise indicated below.

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If no compaction is called for, the fill may be deposited to the full height in one operation and leveled. If the fill has to be compacted, it shall be placed in layers not exceeding 225 mm and leveled uniformly and compacted as indicated in Clause 2.7 before the next layer is deposited.

To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the Contractor.

Field compaction tests shall be carried out in each layer of filling until the fill to the entire height has been completed. This shall hold good for embankments as well. The fill will be considered as incomplete if the desired compaction has not been obtained.

The Contractor shall protect the earth fill from being washed away by rain or damaged in any other way, the Contractor shall remove the affected material and make good.

If so specified, the rock as obtained from excavation may be used for filling and leveling to indicate grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12-ton roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

#### **Fill Density:**

The compaction, under the plant road area and building plinths shall comply with minimum 95% compaction by Standard Proctor at moisture content differing not more than 4% from the optimum moisture content. The Contractor shall demonstrate adequately by **field and laboratory tests that the specified density has been obtained. In other areas the** soil should be backfilled and compacted suitably as specified by the Engineer.

#### **Timber Shoring:**

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 25 cm x 4 cm sections or as approved by the Employer's Representative. The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal walling of strong wood at maximum 1.2 meter spacing, strutted with bullies or as approved by the Employer's Representative. The length of the bully struts shall depend on the width of the trench or pit. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical walling, which in turn shall be suitably strutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

Timber shoring shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench. The type of timbering shall be as approved by the Employer's Representative. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc. from collapsing.

Timber shoring may also be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instructions from the Employer's Representative.

The withdrawal of the timber shall be done carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded with, systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber.

In the case of open timbering, the entire surface of the side of trench or pit is not required to be covered. The vertical boards of minimum 25 cm x 4 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50 cm average width. The detailed arrangement, sizes of the timber and the spacing shall be subject to the approval of the Employer's Representative. In all other respects, the Employer's Requirements for close timbering shall apply to open timbering.

In case of large pits and open excavations, where shoring is required for securing safety of adjoining structures or for any other reasons and where the planking across sides of excavations/pits cannot be strutted against, suitable inclined struts supported on the excavated bed shall be provided. The load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut.

**Dewatering:**

The Contractor shall ensure that the excavation and the structures are free from water during construction and shall take all necessary precautions and measures to exclude ground/rain water so as to enable the works to be carried out in reasonably dry conditions in accordance with the construction planning. Sumps made for dewatering must be kept clear of the excavations/trenches required for further work. The method of pumping shall be approved by Employer's Representative, but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction. The dewatering shall be continued for at least (7) seven days after the last pour of the concrete. The Contractor shall, however, ensure that no damage to the structure results on stopping of dewatering.

The Contractor shall study the sub-soil conditions carefully and shall conduct any tests necessary at the site with the approval of the Employer's Representative to test the permeability and drainage conditions of the sub-soil for excavation, concreting etc., below ground level.

The scheme for dewatering and disposal of water shall be approved by the Employer's Representative. The Contractor shall suitably divert the water obtained from dewatering from such areas of site where a buildup of water in the opinion of the Employer's Representative obstructs the progress of the work, leads to unsanitary conditions by stagnation, retards the speed of construction and is detrimental to the safety of men, materials, structures and equipment.

When there is a continuous inflow of water and the quantum of water to be handled is considered in the opinion of Employer's Representative, to be large, a well point system- single stage or multistage, shall be adopted. The Contractor shall submit to the Employer's Representative, details of his well point system including the stages, the spacing, number and diameter of well points, headers etc., and the number, capacity and location of pumps for approval.

**Rain Water Drainage:**

Grading in the vicinity of excavation shall be such as to exclude rain/ surface water draining into excavated areas. Excavation shall be kept clean of rain and such water as the Contractor may be using for his work by suitably pumping out the same. The scheme for pumping and discharge of such water shall be approved by the Employer's Representative.

## SECTION 8: ITEMWISE SPECIFICATIONS

## SCHEDULE – B1 RCC INTAKE WELL WITH APPROACH BRIDGE

### Item No.1

#### **RCC INTAKE WELL WITH APPROACH BRIDGE**

**Intake well ( 813 MLD with Approach Bridge not less than 95 m Length)**

#### **DETAILED SPECIFICATIONS FOR COFFER DAM FOR INTAKE STRUCTURE: -**

Providing and constructing temporary cofferdam in river basin including excavation, filling middle portion with B.C. soil in empty cement/gunny bags, to the entire satisfaction of Engineer-in-Charge till completion of the work, including maintaining in dry condition by dewatering, and dismantling cofferdam after completion of work including disposal of all dismantled materials as directed by EIC. Rate to include all materials, labour, tools & plants, dewatering, maintenance, dismantling charges, complete.

#### **COFFER DAM: -**

Work includes construction of coffer dam or islands which shall be temporary enclosure built to exclude water from the working area and to permit free access to the area, during the construction of foundations and sub-structure. The item includes the diversion of water course during the construction of coffer dams if it is necessary. The coffer dam may either be made of earth, timber or sheet piling whichever is found suitable as per site conditions with enough working space around & as directed by Engineer in charge. Contractor can also utilize barge/pontoon for construction of foundations and sub-structure.

The work include to provide three layers of sand bags and polyethylene plastic sheet on outside of sloping length of cofferdam to prevent water seepage. Also work includes pumping out water from the cofferdam during laying of the foundation for the intake structure or pier as required during the entire actual execution of the work. The dewatering done by any convenient methods, deploying pumping sets of required capacity in working conditions with all accessories to run the sets as required from commencement of work till its completion and until the foundation structures and all concrete work of sub-structure, superstructure is completed. All the trenches for foundation shall be kept free from water till the concrete in foundation has reached initial setting. Before the execution of work contractor shall submit the detailed drawings and design showing the details of his proposed method of coffer dam or island construction and other detailed design shall have to be approved from the Engineer-in-Charge from time to time.

The rate of the item includes the cost of construction and maintenance of any coffer dam, bunds, dams, or other devices etc. necessary for diverting the flow of water or any such item of any sort, whatsoever required to prevent water entering the foundation trenches. No extra rate shall be paid for removing any stuff of any sort outside which might find access by blowing or for any other reasons, whatsoever from the sides or bottom of foundation or from elsewhere when

Dewatering operations are in progress the contractor shall make all arrangements for necessary plant such as pumps, engines and other machineries and all other materials required in this connection.

It is envisaged that the task could be completed within one working season. However, in case, if task could not be completed within one season, the coffer dam shall have to be maintained for more working seasons in the event the foundation and sub-structure work being not completed in single working season. The rates shall include the provision of reconstruction of coffer dam as per the requirements for any Subsequent one or more working seasons if necessary. The contractor shall not claim for extra payments for increase of work as due to such additional requirements. The rate includes all these operations necessary plants, machineries, labour, and maintenance etc. including all taxes, royalties, insurance etc. complete. The work shall be followed as per IRC/IS/ international stipulations. Removal of the coffer dam shall be done within period of one month of completion of works and at least 15 days prior to testing and commissioning.

Contractor also may construct barge/pontoon for pile driving and other construction facilitation the complete work to be executed as mentioned in "Schedule B-1" or as directed by the Engineer in Charge.

#### **Technical Item Description — Intake Well (Sinking Well / Open Caisson Method):**

Item: Construction of RCC Intake-cum-Jack Well by well sinking method for drawing raw water from the river/reservoir source, including all civil works complete as per drawing and technical specifications.

##### **Description of Work:**

The Intake Well shall be a RCC well of specified internal dimensions, constructed by the open caisson (sinking) method. The work comprises:

1. Well Curb (Cutting Edge): Casting of RCC well curb (M-30) with a mild-steel cutting edge fabricated from structural angles/plates, set true to line and level to facilitate uniform sinking.
2. Well Steining: Construction of RCC well steining (M-30) of designed thickness in successive lifts, providing adequate self-weight for sinking and structural resistance against earth and water pressure during service. Steining to be reinforced with vertical and hoop (transverse) reinforcement as per design.
3. Sinking Operation: Sinking of the well to the required founding level by grabbing/dredging of material from inside the dredge hole, with sand-island/staging support as required, maintaining verticality and tilt/shift within permissible limits. Provision of kentledge loading where additional sinking effort is needed.
4. Intake Arrangements: Provision of raw-water intake ports/penstocks at two or more levels (to suit minimum, average and maximum water levels) fitted with cast-iron sluice/penstock gates and SS coarse and fine screens to exclude floating matter and debris.
5. Bottom Plug & Filling: Laying of RCC bottom plug (M-30) by tremie, sand filling of the dredge hole to the designed level, and provision of intermediate/top plug as specified.
6. Top Slab / Well Cap: Casting of RCC top slab (M-30) with necessary openings, supporting the pump-house floor / gantry and access arrangements.

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7. Allied Works: Embedment of suction/connecting pipes, foot bridge/approach gantry connections, puddling, dewatering, and curing — all complete.

During sinking of the intake well, the contractor shall ensure accurate setting out and construction of the well curb and steining as per approved drawings. Excavation inside the well shall be carried out uniformly to avoid tilt, shift, cracking, or sudden sinking. The verticality and position of the well shall be checked regularly, and any tilt or shift beyond permissible limits shall be corrected immediately at the contractor's cost. Kentledge, where required, shall be applied uniformly and carefully. Adequate precautions shall be taken against flooding, scouring, piping, boiling, and instability of surrounding soil. Any boulders, logs, rock strata, or other obstructions encountered during sinking shall be removed by approved methods. The well shall be sunk to the specified founding level or approved bearing stratum under the supervision of the Engineer-in-Charge. Proper safety measures, including barricading, life-saving equipment, lighting, and trained personnel, shall be provided throughout the work. The contractor shall maintain daily records of sinking depth, soil strata encountered, tilt, shift, loading, and water levels, and shall be responsible for the safety, stability, and successful completion of the intake well until bottom plugging and all related works are completed as per specifications and directions of the Engineer-in-Charge.

**General Specifications:-**

1.0 The design of RCC Intake Well Cum Pump House supplied by the contractor in his own design shall be in accordance with the design criteria. The design and drawing supplied by contractor should be accepted after the approval by the competent authority from the Department.

2.0 The contractor should mention the name, qualification, experience etc. of the design engineer who will be the necessary design scrutiny work etc. The design Engineer should attend the office of the Department if required at any stage prior to the acceptance of design or drawing construction with reference books etc. It will be the duty of designer to submit the design drawings and compliance of remarks by the Department.

**3.0 PAYMENT AS PER PAYMENT SCHEDULE****4.0 COMMON CONDITIONS:**

4.1 The contractor shall engage on in experience and qualified supervisor as his authorized agent for the work. He shall be responsible to take from time to time such orders as may be given by the Engineer-in-charge to carry them.

4.2 As order book shall be maintained on the work site and the contractor shall sign the orders given by the Engineer-in-charge and he shall carry out them promptly. The order books shall be surrendered to the Department on completion of Work.

4.3 The contractor shall have to clear the site of work before it commences and after the work is completed for which separate claim shall not be entertained.



4.4 In addition in the required stores the contractor shall provide at his own cost the suitable temporary office shed with a covered area of about 20 sq mt. with necessary furniture for the use of Government staff while in works. The shed and furniture on completion of the work shall be removed by the contractor at his own cost.

4.5 The contractor shall provide at his own cost all labour charges setting out the as may be required for lining and setting out the as may be required for lining and setting up the works satisfactory and adequate facilities site scaffolding etc. for facility of checking his work or taking measurements etc.

### **DETAILED SPECIFICATION**

Detailed specification given here shall be treated as extension or partial modifications to the specifications of respective items given in the volume of specification published by Gujarat Water Supply and Sewerage Board.

#### **1.0 EXCAVATION FOR FOUNDATION:**

1.0 When the rates are to be quoted for a work based on "contractors own design" the word excavation for foundation shall mean excavation for foundation in all types strata such as soil soft murrum as well as hard rocks up to the designed depth at which foundation is to rest. No extra payment will be given for any change in strata at the same place. The rate shall also include dewatering and shoring strengthen if and where found necessary.

1.1 Excavation shall be carried out as per approved drawing. The excavation made deeper or wider than that required as per drawing shall not paid, but such deeper excavation if carried out shall have to be filled up using C.C. 1:3:6 by the contractor without extra cost. If the type of strata requires wider excavation at top (GL) or deeper Then contractor shall excavate the trench accordingly but no extra payment for such wider or deeper excavation shall be made.

1.2 The rate shall include providing cured warnings lights during night time providing barricading consisting of metal ropes and bamboo for which no extra payment will be made.

1.3 The contractor shall make his own arrangements to obtain prior permission directly from relevant authorities for staking of excavated stuff near work side. If he fails to obtain such permission, then he will have to make his own arrangement with out claiming extra cost to transport and stack the excavated stuff at a suitable place approved by the Engineer-in-charge of work.

1.4 The excavated stuff shall be stacked at least 3.0 meter away from the edge of excavated trench; If enough space is not available at work site then the excavated stuff shall be stacked at suitable place situated away from site. Similarly the surplus stuff shall have to be disposed off at a suitable place for which contractor shall have to obtain permission directly from relevant authorities. No extra payment for transportation of excavated stuff or surplus stuff shall be made.

1.5 No excavated stuff shall be disposed off or used for any purpose other than refilling without prior permission of Engineer-in-charge of work.

1.6 Details shown in the data sheet regarding water table are approximate. The contractor should make his own arrangements for taking trial pits at his own cost more quoting his rates for as certain type of strata water table, quantity of seepage water etc.

1.7 Work at night shall be carried out only with written permission of Engineer in-charge.

1.8 Bottom of the excavated foundation trench shall be sprinkles with water (If water table is not above foundation level) and wall rammed to obtain a reasonably firm and level bedding.

1.9 The rates shall include continuous dewatering of seepage water or rainwater from, trenches to keep the trench dry particularly during casting of base concrete, Concrete for footing and columns of shaft etc. till concrete fully set etc.

1.10 Whenever collapsible types of strata are encountered pucca shoring and strutting shall be invariably claim shall be entertained.

## **2.0 C.C. M 100 BASE CONCRETE FOR LEVELLING COURSE:**

2.1 For all practical purpose and in absence of proportioning of concrete on base of preliminarily tests, C.C. 1:3:6 may be provided as a leveling course i.e. one part of cement three parts of sand and six parts of black trap kapachi. Specification for various ingredients of concrete such as sand, cement, kapachi, water shall be as these given in specification for C.C.M. 15.

2.2 While laying base concrete for leveling course the concrete shall not be dumped from above but shall be carried out to the bottom and gently placed from a height not exceeding 1.5 meter. If concrete is transported by chutes, then the same shall be remixed at bottom of chutes to overcome any segregation that might have occurred.

## **3.0 C.C. M 300:**

3.1 As far as possible the preparation of various ingredients of concrete shall be determined on the bases of preliminary tests as per ISS using the actual materials to be used on site. However in absence of such preliminary tests the volumetric proportion of 1:1:2 may be adopted i.e. one part of cement, one parts of sand and two parts of kapachi just sufficient to attain desired workability may be added. However the aim while proportioning should be to fix the proportion of aggregation and water cement ratio shall be always sufficiently low enough to get desired strength.

## **3.2 Materials:**

3.2.1 Coarse aggregate shall consist of tough angular black trap kapachi. The kapachi shall be obtained from approved source only. Normally at least two stock piles of different size of 12 to 20 mm and 25 mm to 40 mm shall be maintained. It will however, be preferably to maintain third stock pile of 6 mm to 12 mm also for better control on mix of concrete.

3.2.2 The maximum size of coarse aggregate to be used shall be as large as possible within the limits of requirements, based on size of member and spacing of reinforcement. But aggregate exceeding 40 mm shall not be used in concrete.

3.2.3 Depending up on the size of member, spacing of reinforcement and degree of workability desired, the coarse aggregates from different stockpiles may be mixed in a suitable proportion to get a uniform mix that does not segregate.

3.2.4 The coarse aggregate shall not contain dust, clay or other such harmful material. If directed by the Engineer the same shall be washed with water and dried before being used.

**3.3.0 Fine Aggregates:**

Fine aggregates shall consist of course, angular river sand free dirt and other harmful organic materials. If directed the same shall be screened and washed before being used. Sand brought from approved source shall only be used.

**3.4.0 Cement:**

Contractor shall provide a temporary store with double lock arrangement for storage of this cement on work site without extra cost. Cement shall be stored in such a way that it is not affected by moisture.

**3.5.0 Water:**

Water to be used in concrete work shall be potable, free from injurious elements such as chloride or sulfate etc. and shall be obtained from approved source only. Contractor shall make his own arrangements to obtain and store sufficient quantity of water at all times.

**3.6.0 Reinforcement Steel:**

The reinforcing bars to be provided with CRS Fe-500D Steel & shall confirm to the Tender specifications and relevant IS specifications. In spite of producing test certificates by Contractor for the proper quality of reinforcing bars, the quality of steel could also be tested by checking coating firm at plant site for bend test before doing coating and that if the reinforcing bar fails in bend test, then it shall not be provided with FBEC and in that case, cost of conveyance of such steel to plant and removing from plant shall be of the Contractors.

The rechecking quality of Steel, for bend test will be done by the coating agency in the presence of contractor provided the contractor choose to remain present. Reinforcing bars to be used shall be fresh from rolling mills as far as possible. If the bars are very much rusted in quality before providing FBEC, such bars shall have a loss of weight at contractor's risk. To ascertain the loss in weight of reinforcing bars on account of removal of rust during coating, random weighment before and after coating shall be done and that loss in weight shall be borne by the contractor.

**3.7.0 CRS Bars:**

The CRS bars shall be confirming relevant IS code.

3.8.0 The coated reinforcement bars shall be tested at plant by the contractor. Test reports shall be jointly signed by authorized representatives of Contractor and the coating agency. The tests on coated bars shall be as per I.S. for the following tests.

- (a) Thickness
- (b) Continuity
- (c) Adhesion

**3.9.0 HANDLING:**

3.9.1 The bars shall be carefully handled in order not to drop them, not to rub them on hard surface or against another bar while conveying, stacking, placing or stacking of fabricated bars and that for this purpose wooden packing batons shall be used at spacing of not more than 60 cms.

The bars shall be tied to make bundles with appropriate material so as to avoid damages to coating.

3.9.2 The coated bars shall be stacked with separation gap between ground and bars with wooden batons between rows of bars or bundles of such tied bars. Such wooden or padded contact shall

be at spacing of not more than 60 cms In spite of all test certificates, if the coated bars are roughly handled by contractor either during transport, fabrication, stacking, placing and concreting etc. or handled in such a manner as to damage the coating for area or portion more than reasonable, the Engineer-in-Charge or Department/Owner reserve the right to reject the CRS coated bars and that if rejected then such rejected bars shall be removed by contractor from work site within three days. The decision of Engineer-in-charge will be final as to reject the bars with damage coating or to allow repairing the coating, or to get it recoated at contractor's cost.

#### **4.0 FORM WORK:**

Form work shall consist of steel plates or smooth timber planks to be joined by nuts, bolts, nails or pegs so as to have a reasonably water tight joints. Sufficient number of vertical and horizontal supports shall be provide when completed. Formwork shall be sufficiently sturdy & strong to absorb all stresses and movements. Before concrete is placed in position the formwork and steel shall be got checked through Engineer-in charge of work. Advance intimation shall be given to the Engineer-in-charge for this purpose. The ultimate responsibility for safety and of lives of workmen and that of forms etc. from beginning of work till its completions shall always rest with the contractor proper ladders and plant forms for easy access shall be provided by the contractor without extra cost.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces dust etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost. Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of the Engineer In charge. The Contractor shall equip himself with enough shuttering to allow for wastage so as to complete the job in time.

Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves shall be used. Formwork spacers left in situ shall not impair the desired appearance or durability of the structure by causing swelling, rust staining or allowing the passage of moisture.

For liquid retaining structures, sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

The striking time for formwork shall be determined based on the following requirements:

- (a) Development of adequate concrete strength;
- (b) Permissible deflection at time of striking form work;
- (c) Curing procedure employed - its efficiency and effectiveness;
- (d) Subsequent surface treatment to be done;

(e) Prevention of thermal cracking at re-entrant angles;

(f) Ambient temperatures; and

(g) Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

Under normal circumstances (generally where temperatures are above 20 C) forms may be struck after expiry of the time period given in IS:456 unless approved otherwise by the Engineer In charge. For Portland Pozzolana/slag cement the stripping time shall be suitably modified as approved by the Engineer In charge. It is the Contractor's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resist surface damage and any stresses arising during the construction period.

## 5.0 MIXING, TRANSPORTATION AND LAYING:

5.1 For important works like RCC Intake Well Cum Pump House mixing of concrete shall be invariably done in approved machine mixer only. The mix obtained from the mixer shall be a uniform mass consisting of all aggregates coated with cement paste.

5.2 Fresh concrete shall be transported horizontally in ghamellas or wheelbarrows. Vertical transportation shall be done either by manual labour or using mechanical vertical lifts. When chutes are used for transportation, care should be exercised avoid segregation and concrete may be remixed at bottom of chutes to get uniform mix. Before any concrete is placed in position all loose materials such as dirt, chips of stones, wood, steel etc. should be removed. Inner side of forms should be coated with thin layer of oil to get a good finished surface.

Concrete should not be dumped from above in which case aggregate will segregates, but placed gently from a height not exceeding 1.5 meter. Compaction of concrete shall be done by vibrators till cream appears at top. Over vibration shall be avoided to avoid segregation.

## 6.0 CURING:

After concrete is set in position it shall be kept continuously wet with water for 7 days either by using gunny bags(column and walls) by ponding (slab) or as directed by spraying of water.

Unless otherwise specified the rate shall include finishing the exposed surface to get good finished surface.

The forms shall be kept in position for period given below:-

1)	Vertical sides of walls, beams, columns	2	Days
2)	Slabs (props left under.)	4	"
3)	Bottom of beam (props left under)	7	"
4)	Removal of prop to slab spanning up to 4.5 specious over 4.5 m.	7	"
5)	Removal of props to fearus spanning up to 6.0 m.	14	"
6)	Spanning over 6.0 m.	21	"

Contractor shall have to design the Mix of M300 grade concrete or IS latest revision by govt. laboratory or any govt. approved laboratory as per instruction of Engineer in Charge. Trial of Mix

design test is taken in laboratory & site for conforming the test results of Mix of concrete of grade M300 & same is to be tested in the presence of representative of the GWSSB. Since M - 300 mix is normally used in water retaining parts of container where the aim is to get dense, strong and watertight concrete, special care shall be exercised in controlling proportion of aggregate, water cement ratio, compaction and curing.

#### **7.0 PROVIDING AND PLACING IN POSITION STEEL REINFORCEMENT:**

- 7.1 Reinforcement bars to be used in RCC work shall have to be supplied by the contractor. The rates include providing, cutting, bending, binding, hooking and placing in position including cost of binding wire. The bars shall be fusion bonded and epoxy coated.
- 7.2 Depending upon the type of reinforcement steel proposed in design (i.e. M.S. or deformed etc.) the steel shall conform to relevant ISS codes in practice. Contractor shall produce necessary test certificate in absence of which the steel bars shall be get tested by the Department at the contractor's cost.
- 7.3 Steel bars shall be cut, bent up, hooked bound with wires and then placed in position as per approved drawing. The steel shall be got checked through Engineer-in-charge. Before any concrete is placed in formwork advance intimation shall be given to the Engineer-in-charge for this purpose. The steel shall be cleared of any dust or rust that might have been deposited on bars.
- 7.4 Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by the Executive Engineer prior to concrete placement. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of the reinforcement and not cause scaling of the concrete cover.

Binding wire shall be 16 gauge soft annealed wires. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.

Substitution of reinforcement, laps/splices not shown on drawing shall be subject to Executive Engineer's approval.

#### **8.0 PAINTING LETTER:**

Name of project shall be painted on structure as per instruction of Engineer-in-charge.

#### **9.0 CEMENT PLASTER: WATERPROOF PLASTER**

The cement mortar shall consist of two parts of fine river sand free from any dust and other organic matter and one part of approved quality of cement. The mortar shall be properly mixed on watertight platform. The mortar shall be used within half an hour after mixing. The water proofing materials weighting 1.5 kg of powder in one bag of cement shall be added.

The plaster shall be applied in uniform thickness of 20 mm and shall be properly smoothened with wooden & finished with cement finishing of required. The curing

shall be done at least for week by sprinkling the water over the wall. The wall shall be tested for waterproof ness. The rate includes the cost of waterproofing materials. The test for waterproof ness shall be carried out by the contractor at his own cost by filling the contractor with water and it shall be checked out that there is no percolation of water from the wall. Payment shall be made per sq. m. of plaster done.

#### **10.0 10 MM TK. IN C.M 1:3**

##### **PLASTER**

The outer & inside Pump room plaster shall be applied in uniform thickness of 10 mm and shall be properly smoothened with wooden & finished with cement finishing of required. The curing shall be done at least for week by sprinkling the water over the wall. The wall shall be tested for waterproof ness and it shall be checked out that there is no percolation of water from the wall. Payment shall be included in Mode of Payment.

#### **11.ELECTRICALWORK:**

- 1.Electric Point shall be of non-corrosive type material and approved make before use or before electric work.
- 2.Electric Point, specials, anchored or comet make switches, plug point, two/three Pin combined half points with switching arrangement are to be approved by E.I.C. prior to providing, supplying and fixing.
3. All the materials should be carried out as per Standard practice and as per I. S.
- 4.Before commencing work of, the location shall be shown to E.I.C to have better work and the complete work shall be carried out strictly as per instruction of Engineer in charge.
5. No any damaged materials shall allowed.
6. Switches of ISI material shall use.
- 7.All the work shall be of minimum and one drawing/diagram copy set shall be provided by agency to E.I.C after completion of actual work.
- 8.Any damaged or any accident occurred during the defect liability period, agency is responsible to rectify the such incident.
9. All electric work shall be brought to Main Switch as location shall be shown by Engineer in Charge, from their G.EB main connection shall be brought by Department.

#### **DETAILED SPECIFICATIONS FOR R.C.C. BORED PILE WORK:**

##### **1.0 PURPOSE**

This document defines the scope of works for RCC bored cast-in- situ piles and its specific requirements including pile foundation system for the proposed Intake Structure of Water Supply Project.

##### **2.0 CODES, STANDARDS & SPECIFICATION:**

- a. IS: 2911 (All Parts)
- b. Specification for materials for Reinforcement concrete piles
- c. Specification for construction and installation for bored cast in situ piles
- d. Specification for testing of concrete piles

##### **3.0 SCOPE**

##### **3.1 General**

The Contractor shall carry out the works in accordance with a method statement which has been approved by GWSSB. Providing RCC bored cast in situ piles as per design carried out by the bidder,

vetted by any reputed Engineering Institutes/ Consultant and submitting to GWSSB for review before commencement of piling work. All jobs to be completed within the specified time period mentioned in the tender. Supply of all materials is also included in contractor's scope.

The scope in general consists of designing the RCC pile foundation basis the soil investigation report/ recommendation, which shall be provided to the successful bidder. The party has to carry out the design of the pile foundation basis the soil report after the award of the contract and get the design vetted by reputed Engineering Institutes/ Consultant duly approved by GWSSB within the quoted rates.

### 3.2 Surveying and Staking:

The Contractor shall be required to employ an approved Licensed Surveyor who will set up the positions of the piles as shown in the pile layout plans of the detailed design. The Contractor will be responsible for the accuracy of location and positioning of each pile. Any errors in setting out and any consequential loss to the Employer will be made good by the Contractor to the satisfaction of the Engineer.

The Contractor shall preserve the pegs set out by the Surveyor. Should any peg be displaced or lost it must be replaced by a Licensed Surveyor to the approval of the Engineer. Upon completion of all piling works, the Contractor shall produce as-built Drawings showing the positions of all piles as installed. The positions of piles shall be verified by a Licensed Surveyor.

It is the express responsibility of the contractor to bring to site all surveying instruments necessary for the marking out, fixation of levels, etc. and conduct these survey operations himself with utmost accuracy. The contractor shall put-up stable bench marks etc. as necessary for the work. GWSSB officials will remain present when this work is being carried out and will inspect all these operations with the Contractor's assistance. The contractor shall be entirely responsible for accurate setting out of the work and he shall at his own expense make good any defects arising from errors in line and levels.

## 4.0 DESIGN CONSIDERATIONS:

### 4.1 Structural Design:

The piles shall have necessary structural strength consideration all the load effects and their structural capacity examined. The self-load of pile or lateral load due to earthquake, water current force etc. on the portion of free pile up to scour level should be duly accounted for as per Relevant standards of IS: 2911 (Part I/ Sec.2) or relevant IRC code and specific requirements shall be considered to design of piles.

Permanent steel casing/liner should be provided at least up to maximum scour level.

The thickness of casing/liner should not be less than 6.00 mm.

### 4.2 Reinforcement:

4.2.1 The reinforcements in pile should be provided complying with the requirements of relevant IS standards or IRC: 112. The minimum longitudinal reinforcement should not be less than 0.4% nor greater than 2.5% of the cross-sectional area of the cast in situ concrete bored pile.



4.2.2 Clear cover to the main reinforcement shall be 50 mm. This shall be increased to 75 mm in case of aggressive soils and ground water conditions.

4.2.3 The minimum clear distance between the vertical bars should not less than 100 mm for the full depth of cage. The bars shall be so placed as not to impede the placing of concrete.

4.2.4 The lateral ties in the reinforcing cage should not less than 150 mm center to center.

4.2.5 The minimum diameter of the lateral ties shall be 8 mm.

### **5.0 Minimum Requirement of Piling Equipment:**

The equipment and accessories must be capable of safely, speedily and efficiently installing piles to the design requirements at the project site. Sufficient units of equipment and accessories must be provided to keep to the agreed construction schedule. Equipment of piling means by hydraulic self-propelled or manual rotary piling rig or any other required equipment to complete the entire job as per the time schedule provided in this tender document. The Contractor shall mobilize sufficient spares; cutting tools (e.g. flat teeth bits, round shank bits, holders, etc) to avoid any stoppage of work. Full Technical details of piling rigs and accessories in the form of catalogues, data sheets, piling procedure, piling programme and accessories etc. to be provided by the contractor at no Extra cost to the client.

### **6.0 BORED CAST IN-PLACE PILES**

The Contractor shall carry out the works in accordance with a method statement which has been approved by the Engineer. This method statement shall include, inter alia, length of casing/liner, details of the constituent materials of any drilling fluid used for stabilization, the method of inspection, details of the concrete design mix, concreting method, the minimum time between the completion of one pile and the commencement of the next, and the pattern of construction.

Unless otherwise described in the Specifications, reinforcement and concrete shall comply with the requirements in Specification on Concrete for Structures. The Contractor shall ensure that damage does not occur to completed piles through his method of working. The Contractor shall submit to the Engineer in charge a pile installation programme. The proposed sequence and timing of pile installation shall be such that the installation works shall not cause any damage to adjacent piles. Piling works shall not commence until approval of the Engineer has been obtained. No bored pile excavation shall commence within 8m of any concreted pile which has not been cured for 24 hours.

#### **6.1 Pile Excavation**

##### **6.1.1 Pile size and length**

The Contractor shall carry out own tests along the proposed intake alignment to determine the bedrock level. Probing of bedrock shall be carried out along the proposed intake line at intervals to be agreed by the Engineer.

##### **6.1.2 Boring near recently Cast Piles**

Piles shall not be bored next to other piles which have recently been cast less than 24 hours or contain unset concrete, whichever longer to avoid damage to any of these piles.

### 6.1.3 Stability of Boreholes

It is held that the Contractor has to implement all necessary measures, including the provision of all materials, labour and machineries for maintaining the stability of the sides of boreholes during bored pile installation and successful completion of the piles. The Contractor shall submit his proposed methods for agreement prior to commencement of boring operations.

Irrespective of the presence of ground water, the sides of all boreholes shall be kept intact and no loose material shall be permitted to fall into the bottom of the boreholes. The Contractor's boring equipment shall be able to sink a steel casing/liner to support the sides of all boring.

If the sides of boreholes are found to be not stable, steel casing/liner shall be driven into stable stratum. The borehole shall be filled with drilling fluid to a level sufficiently to stabilize the boreholes. Steel casing/liner of appropriate size and length in conjunction with stabilizing fluid or other alternatives of sufficient strength shall be used to support the sides of the borehole and permit boring operations to proceed smoothly and safely. The proposed drilling fluid mix must be submitted to the Engineer for approval.

Excavations shall not be exposed to the atmosphere longer than is necessary and shall be covered at all times when work is not in progress. Pile excavated shall be cast within 24 hours unless otherwise agreed by the Engineer.

### 6.1.4 Stability of bore by casing method

Where the use of casing is required to maintain the stability of a bore, the bottom of casing shall be kept a minimum of one meter or more below the unstable strata to prevent the inflow of soil and the formation of cavities in the surrounding ground.

Casings shall be thin-walled mild steel cylindrical casing, spirally welded or other similar construction. The dimensions and quality of the casing shall be adequate to withstand without damage or distortion all handling, construction and ground stresses to which they will be subjected, including preventing concrete from within the pile from displacing soft soil or soil squeezing in and displacing fresh concrete. The casings shall have an internal diameter not less than the specified pile diameter. They shall be free of significant distortion, of uniform cross-section throughout each continuous length and free from internal projections and encrusted concrete which might prevent the proper formation of piles. The joints of casings shall be reasonably watertight.

If casings are damaged during installation in a manner which prevents the proper formation of the pile, such casings shall be withdrawn from the bore before concrete is placed, repaired if necessary or other action taken as may be approved to continue the construction of the pile.

All reasonable steps shall be taken to prevent the spillage of drilling fluid on the site in areas outside the immediate vicinity of boring. Discarded drilling fluid shall be removed from the site without delay. In disposal of unwanted drilling fluid, the Contractor shall comply with relevant government regulations and shall propose a proper disposal method to be approved by the Engineer.

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**6.1.5 Inspection of Pile Excavation**

All pile excavations shall be inspected for their full length before concreting. The Contractor shall provide all the apparatus necessary for the inspection.

Inspection shall be carried out either from the ground level or below ground level at the sole discretion of the Engineer prior to concrete being placed in the borehole. For such inspection to be carried out safely, the Contractor shall provide all facilities and assistance to enable the said inspection to be done. In the course of inspection any loose or soft material in the borehole which is likely to affect the performance of the pile shall be removed to the satisfaction of the Engineer. In the case of inspection from ground level, the base of the boring shall be inspected by approved method for wet hole and by means of a light for dry hole to ensure that all loose, disturbed and/or remolded soil is removed and that the sides of the boring will remain stable during the subsequent concreting operations. The verticality and position of the boring shall be checked to ensure that they meet the specified tolerances.

Inspection below ground level shall be carried out for piles with shafts of 760mm (2'6") diameter and above. For this purpose the Contractor shall, apart from providing other safety measures, also provide the required facilities such as an approved type of a steel safety cage with an air-line, lifting cable and hoist, gas detector, lights, etc. to enable descent into and ascent from the borehole to be carried out safely without any danger to life. In this regard the safety precautions described irrelevant IS or IRC standards. "Safety Precautions and Procedures for the Construction and Descent of Machine-Bored Shafts for Piling and Other Purposes" shall generally be followed, unless otherwise directed by the Engineer.

**6.1.6 Cleaning Out**

Upon completion of boring the excavation shall be cleaned of all loose, disturbed and or remoulded soil and sediment soil to expose a firm base of undisturbed material using a suitable and effective method to be approved by the Engineer.

**Continuity of Construction**

A pile constructed in a stable soil with the use of casing or other support shall be bored and concreted without prolonged delay to ensure that the soil characteristics are not significantly altered. Surplus earth resulting from piling operations shall be used where required or removed from site as directed by the Engineer.

**Surface Water**

All boreholes shall be protected from the possibility of any surface water entering the hole from time to time and until the hole is completed and ready to be concreted.

**6.1.7 Dewatering**

Dewatering of accumulated water in all locations on job site from whatever source or cause until the virtual completion of the entire work shall be done by the contractor at his own expense and shall not be separately paid for. The rates quoted by the contractor shall be deemed to be inclusive of this.

**7.0 CONCRETE:**

Unless otherwise stated, concrete used shall comply with Specification on Concrete for Structures and as approved by the Engineer. The grade of concrete for Pile shall be 30 (characteristic strength of 30 N/mm<sup>2</sup> at 28 days) with minimum cement content of 380 kg per cubic meter of concrete.

**Mix design shall be carried out considering extreme Weather condition. The cement for concrete shall be Sulphate resistant cement.** Concrete admixture shall only be used with the permission of the Engineer, and shall be used strictly in accordance with Specification on Concrete for Structures. The contractor shall use only Ready mixed concrete for the proposed piling works and complete details of the mix proportions and workability have been submitted to him for prior approval. The Contractor shall ensure that the Engineer shall have access to the supplier's mixing plant at all times for inspection and checks on quality of concrete supplied. Each load shall be accompanied by a delivery note stamped with the time of mixing and stating the consignee and quantities of each material in the mix including water and additives.

### 7.1 Testing of Cube:

Close control of the mixing of the concrete shall be exercised and cube strength tests shall be carried out in accordance with IS codes (IS 2911 Part 1/Sec 2). The cube testing shall be done as per IS 456. The test cubes shall be made from a representative batch of concrete as that used for the piling works and each cube shall be properly marked and identified with details relating the specimen to the borehole in which the concrete is used. Test shall be carried out by Government approved lab.

The Contractor shall not carry out the specified cube strength tests without prior notice to the Engineer. The tests must be witness by the Engineer or his representative. The contractor shall provide sufficient quantity of all necessary equipment at site to carry out these tests.

The allowable slump shall be as per relevant latest revision of IS codes (IS 2911 Part 1/Sec 2). The Engineer-in-charge may allow marginal adjustment in water/cement ratio to obtain concrete of good workability. The other concrete specifications shall be as per relevant clauses of this tender. The concrete for piles shall be as specified in the design requirement with suitably enriched cement content to permit a high slump mix. Alternatively, the Contractor may incorporate an approved set retarding additive into the mix to ensure extended workability of the concrete after placement. If the concrete cubes as tested failed to satisfy the criteria as prescribed in Specification, the Contractor shall undertake all necessary additional and consequential remedial/compensatory Work to the approval of the Engineer. Any piling work rejected by the Engineer not truly constructed and installed in accordance with this Specification shall be replaced or rectified by the Contractor to the approval of the Engineer and this include reinstallation of piles, and the design and construction of a modified foundation and also constructing of additional compensation piles.

### 7.2 Concreting in Wet Hole:

Immediately after the boring for the pile has been completed, approval to commence concreting shall be sought and, when this has been obtained, concreting shall start forthwith and continue without interruption. All cast-in-situ concrete shall be dense homogeneous and method for produce concrete approved by the Engineer.

Concrete to be placed under drilling fluid shall place using a tremie concrete pipe in accordance with relevant standard. Where discrepancies arise, the provisions of this specification shall take precedence.

Alternative methods of placing concrete such as the use of a drop bottom bucket or hose from a concrete pump will not be accepted by the Engineer. At no stage concrete be permitted to discharge freely into drilling fluid.

Before placing concrete contractor to ensure that there is no accumulation of contaminated drilling fluid, silt or other deleterious material at the base of the bore. Contaminated drilling fluid could impair the free flow of concrete from the tremie pipe and affecting the performance of the pile.

The tremie concrete pipe shall consist of a series of metal pipes with appropriate internal diameter. The receiving hopper shall have a capacity at least equal to that of the pipe it feeds. At all times, a sufficient quantity of concrete shall be maintained within the pipe to ensure that the pressure from concrete exceeds that from the water or drilling fluid.

The hopper and pipe of the tremie shall be clean and watertight throughout. The pipe shall extend to the base of the bore and a sliding plug or barrier Placed at the discharge outlet of the pipe to prevent direct contact between the first charges of concrete in the tremie pipe and drilling fluid.

The tremie pipe outlet shall be kept at least 1.5 meters below the surface of the concrete at all stages in the pour. The Contractor shall develop a system of level checks for the concrete and pipe outlet to ensure that this requirement is met. The tremie pipe shall be withdrawn upward gently behind the concrete level, and shall not be subject to any shock or violent movement either in dislodging the concrete within the pipe or for any other reason.

Concrete placement shall be halted should a delay or breakdown occur during the concreting operation which in the opinion of the Engineer, could cause a cold joint, entrapment of latency in the tremie concrete, or otherwise lead to defective concrete. Before the remainder of the pile shaft can be concreted, the pile shall be dewatered and the top surface of the tremie concrete cut back to sound concrete and cleaned of all laitance and weak concrete. The remainder of the pile shall either be cast by tremie or in the dry, as directed by the Engineer. If this remedial work cannot be carried out due to construction difficulty, the Contractor will need to construct a replacement pile.

The concrete for each pile shall be from the same source. The Contractor is to ensure that the supply from whatever source (ready-mixed) is of sufficient quantity so that concrete for each pile shall be placed without such interruption.

All holes bored shall be concreted within the same day. In the event of rain, the Contractor is to provide adequate shelter to keep the hole dry and to concrete under cover.

The method of placing and the workability of concrete shall be such that a continuous monolithic concrete shaft of the full cross-section is formed. The method of placing shall be approved by the Engineer. The Contractor shall take all precautions in the design of the mix and the placement of concrete to avoid arching of the concrete in the pile shaft. No spoil, liquid or other deleterious matter shall be allowed to contaminate the concrete.

When casings/liners are withdrawn as concreting proceeds, a sufficient head of concrete shall be maintained to prevent the entry of ground water which may cause reduction of cross-section of the pile. No concrete shall be placed after the bottom of the casing or lining has been lifted above the top of the concrete. Concrete shall be placed continuously as the casing is extracted until the desired head of concrete is obtained.

Adequate precautions shall be taken in all cases where the withdrawal of casing could result in excess heads of water or drilling fluid. Excess pressure heads are caused by the displacement of water or fluid by concrete as the concrete flows into its final position against the wall of the shaft. Precautions such as the use of two or more discontinuous lengths of casing (double casing) shall be deemed an acceptable method of construction in this case.

In the event of the ground water level being higher than the required pile head cut-off level shown in the contract drawings, the Contractor shall submit his proposals for agreement prior to placing concrete. The pile head shall not be let below the ground water level unless adequate and agreed precautions are taken.

The top of the pile shall be brought above the required cut-off level by an amount sufficient to ensure a sound concrete at cut-off level and the surplus removed to ensure satisfactory bonding of the pile head to the structure.

The actual volume of concrete used for each pile must be measured with the calculated volume required. If the difference between these two volumes indicates a possible necking, the Contractor shall propose and carry out appropriate tests and measures to the approval of the Engineer to ensure the adequacy of the pile. Any consequences causing the pile rejected by the Engineer due to supply of concrete shall be on contractor's own risk.

### **7.3 Tolerances:**

#### **(a) Position:**

The pile heads shall be positioned as shown on the Drawings within a maximum deviation of 75mm in either direction from its design position.

#### **(b) Verticality:**

For bored cast-in-situ piles, the maximum permitted deviation of the finished pile from the vertical at any level is 1 in 150. The contractor shall demonstrate to the satisfaction of Engineer the pile verticality is within the allowable tolerance.

#### **(c) Correction:**

Should piles be installed outside these tolerances affecting the design of the structure, the Contractor shall propose remedial design and carry out immediate remedial measure to the approval of the Engineer.

### **8.0 REINFORCEMENT**

All reinforcement shall be as per the drawings. The reinforcement shall be assembled and tied together and made up into cages sufficiently rigid to withstand handling without damage and distortion. Where indicated in Data Sheet, the reinforcement bars shall be coated with anti-corrosion fluid as specified. The method of application of coating shall be such that there are no holidays. After fabrication of the cage all surfaces which become exposed due to scrapping,

welding etc. shall be recoated. All tie wires, stiffener bars, spreader forks, lacings etc. used to fabricate the cage shall also be coated similarly.

Where the number and diameters of reinforcement bars change as per the drawing, laps of reinforcement bars shall be as indicated on the drawing. Joints in longitudinal bars, if unavoidable, shall be made by lapping. Laps shall be tack-welded as approved by the ENGINEER to prevent distortion of the reinforcing cage. The number of joints in longitudinal steel bars shall be kept to a minimum and staggered. Joints in reinforcement shall be such that the full strength of each bar is effective across the joint and shall be made such that there is no detrimental displacement of the reinforcement during the construction of the pile. Mechanical splices if and as approved by the ENGINEER may be used for jointing reinforcement bars of same diameters.

The projecting lengths of the longitudinal bars beyond the pile cut-off level shall be equal to a minimum of 24 times bar diameter or such other length as shown on the drawings.

The lateral links or helical reinforcement shall fit closely around the main longitudinal bars and be fixed to them by soft annealed 16 gauge black iron wire, the free ends of which shall be turned towards the center.

Concrete cover over all reinforcement including lateral links or helical shall be 60mm unless shown otherwise on the drawing. Suitable and adequate cover blocks shall be provided. The cover blocks shall be circular with a concentric hole of adequate size to allow lateral reinforcement to pass through and allow free rotation. The cover blocks shall be manufactured of concrete of grade higher than that of concrete designated for the pile, using the same grade and type of cement. Alternately, the cover block shall be of more durable material approved by the ENGINEER which will not lead to corrosion of the reinforcement or spalling of the concrete cover. The cover blocks shall be placed all along the length of the reinforcement cage with adequate number in the upper portion over the length of the temporary casing. The cover blocks shall be aligned for smooth lowering of the cage into the pile bore and for lifting of the temporary casing without displacing the reinforcement cage from its seated position.

Stiffener bars, spreader forks and lacings within the reinforcement cage shall be provided to prevent twisting or any type of distortion of the reinforcement cage during its lifting, handling and lowering into the pile bore. These shall be placed in a manner and pattern such that the inside dimension of the reinforcement cage is adequate for concentric placement of the tremie pipe and its operation without disturbing the cage during concreting.

Corrosion resistant Steel reinforcement: The reinforcement shall conform to IS: 1786, Fe-500D grade.

Welding: Field welding of reinforcing bars will not be permitted without the written consent of the Engineer-in-Charge. Where welding is permitted it must be at staggered locations. Tests shall be made to provide that the joints are of the full strength of bars connected. Welding of reinforcement shall be done in accordance with the recommendation of IS: 2751.

Storage: The steel reinforcement shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion.

General: General construction details and workmanship relative to reinforcement including bar bonds, lap splices and installation shall be in accordance with I S: 2502 - Code of Practice for Bonding and Fixing of Bars for concrete reinforcement, as well as the detailing of reinforcement

given in I S: 456. Hot bending of bars shall not be allowed. The number of sizes, shape and position of all the reinforcement shall, unless otherwise directed or authorized by the Engineer-in-Charge, be strictly in accordance with the drawings. The reinforcement shall be adequately secured and held in position by metal chairs and spacers. Ties of inter-sections shall be made with 16 SWG soft black annealed binding wire. The contractor must obtain the approval of the Engineer-in-Charge for the reinforcement placed, before any concrete is placed in the forms. The reinforcement of this time shall be free from loose rust or scale or other coating that will destroy or reduce bond. Concrete spacer blocks of the same strength as parent concrete shall be used to ensure correct cover to the reinforcement. This clear cover shall be as shown on the drawings or as per instructions of the Engineer-in-Charge. All the reinforcing bars shall be so tied as to form a rigid cage to prevent displacement before or during concreting.

## **9.0 PILE TESTING:**

### **9.1 SCOPE**

This Specification covers the requirement and methods of testing of a single pile for evaluating its safe capacity in:

### **9.2 VERTICAL LOADING (COMPRESSION):-**

Equipment and Test Set-up: The test pile shall be decided by the Engineer-in-Charge. It may be one of the working piles or a separate test pile. The head of the test pile shall be brought to the proper level and provided with a pile cap with a level and plane surface and with adequate space for proper seating of a jack and dial gauges. Test pile surface shall be prepared for testing purposes on the expiry of one week after casting the pile.

Loading Systems: Loading shall be applied by the reaction method consisting of a hydraulic jack centrally against a loaded platform. Supports of the platforms shall be adequately designed. Special anchor piles or any other suitable type of anchorage systems may be used. However, use of the uplift capacity of neighboring piles for providing the reaction shall normally not be permitted. The loading system shall be adequate to ensure that the test can be carried up to the specified limit. The reaction to be made available for the test shall be at least 25% greater than the maximum jacking force required.

Measuring system: The load applied on the pile shall be recorded on a calibrated pressure gauge mounted on the jack.

Settlement of the pile shall be recorded by dial gauges suspended datum bars. Four dial gauges of 0.01 mm sensitivity shall be positioned on four corners around the pile.

The datum bars shall have rigid supports preferably of concrete pillars or steel sections, embedded well into the ground. The supports shall be located more than three times the pile diameter, subject to a minimum of 1.5 m, clear away from the pile face and also sufficiently away from the supports of the loaded platform to avoid any disturbance on these accounts. Movements near the supports of the datum bar shall be avoided while the test is in progress.

### **9.3 METHOD OF CONDUCTING TEST:**



The test shall be carried out by the direct method of loading in successive increments or by the cyclic loading method as specified and as described by the Engineer-in-Charge.

Direct Method of Loading in Successive Increments: The test shall be carried out as per the procedure outlined.

The load shall be applied to the pile top in increments of about of fifth of the rated capacity of the pile or as specified. Settlement readings shall be taken before and after the application of each new load increment and at 2, 4, 8, 15, 30, 60 minutes and at every two hours until application of the next load increment.

Each stage of loading shall be maintained till the rate of movement of the pile top is not more than 0.2 mm per hour or until two hours have elapsed, whichever is later.

Further loading shall then be continued as in (a) above till one of the following occurs:

Yield of soil-pile system occur causing progressive settlement of the pile exceeding a value of one tenth of the pile diameter.

The loading on the pile top equals twice the rated capacity or as specified in the case of a separate test pile and 1.5 times the rated capacity of the pile in case of a working pile.

Where yielding of the soil does not occur, the full test load shall be maintained on the pile head for 24 hours or more if necessary and settlement readings shall be taken at 6 hours interval during the period.

Unloading shall be carried out in the same steps as loading. A minimum of half hour shall be allowed to elapse between two successive stages of load decrement. The final rebound shall be recorded 6 hours after the entire test load has been removed.

If so directed by the Engineer-in-Charge, loading and unloading cycles shall be carried out for all load stages within the assumed working load.

Assessment of Safe Load The safe capacity of the pile shall be the least of the following values

Load corresponding to settlement specified in specific requirements which is based on the nature and type of structure.

50 percent of the final load at which the total displacement equals 10 percent of the pile diameter in case of uniform diameter piles and 7.5 percent of bulb diameter in case of under-reamed piles.

#### **9.4 CYCLIC LOADING TEST:**

The test shall be carried out as per procedure outlined by IS: 2911-(Part-IV) and as described:

The load shall be applied to the pile top in increments of about one fifth the estimated safe capacity of the pile or as specified. Settlement readings shall be taken before and after the application of each new load increment at 2, 4, 8, 15, 30, 60 minutes and at every two hours until application of the next load increment.

Alternate loading and unloading shall be carried out at each stage and the total and net settlements recorded as specified. If so directed by the Engineer-in-Charge, more than one cycle of loading and unloading shall be carried out at any or all of the stages.

Each stage of loading or unloading shall be maintained till the rate of movement of the pile top is not more than 0.2 mm per hour provided

That the minimum period if two hours for loading and one hour for unloading. The following load stages shall be maintained for longer periods as given below:

At load of 1.5 time assumed safe capacity (for routine test only) – 24 hours

At load of twice assumed safe capacity (for initial test only) –24 hrs.

The loading shall be continued till one of the following occurs:

Yield of the soil pile system occur causing progressive settlement exceeding one tenth of the pile diameter.

The loading on the pile top equals twice the estimated safe load in case of a separate test pile and 1.5 times the rated capacity of the pile in case of a working pile.

### **ASSESSMENT OF SAFE LOAD**

The safe capacity of the pile shall be the least of the following:

- i) Load corresponding to settlement specified in specific requirements Which is Based on the nature and type of structure.
- ii) Half of the final load at which the total settlement equals one tenth of the pile diameter.

### **9.5 LATERAL LOADING: LATERAL LOADING TEST**

Equipment and Test Set -up

Test Pile:

The test pile shall be decided by the Engineer-in-Charge. It may be one of the working piles or a separate test pile. The test pile shall be cut off at the proper level and provided with a cap with vertical plane sides having an adequate area for proper seating of the jack and dial gauges.

Loading System:

Loading shall be applied by a hydraulic jack of adequate capacity, abutting the pile horizontally and reacting against the suitable system. The reaction may be provided by the wall of the excavated pit when the test is being conducted below ground level or by a neighboring pile in which case thrust pieces shall be inserted on either end of the jack to make up the gap.

Measuring System:

Lateral load applied on the pile shall be measured by a calibrated pressure gauge mounted on the jack, having a least count of 500 kg. Deflection of the pile head shall be measured by dial gauges, fixed to datum bars and having a least count of 0.01 mm. The datum bars shall be provided with rigid supports as described in Clause 2.1.3.2 (b) above.

Method of Conducting Tests:

The test shall be carried out in accordance with the provisions of IS: 2911-(Part-IV)

And as detailed below:

Loading shall be applied in increments of 500 kgs or as specified.

Each stage shall be maintained for a period till the rate of movement of the pile head is not more 0.2 mm/hr or 1 hr whichever is greater.

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Loading shall be continued till one of the following occurs: Deflection of the pile head exceeds 12 mm.

The applied load on the pile is twice the assumed lateral load capacity of the pile in case of a separate test pile and 1.5 times the rated capacity in the case of a working pile.

**Assessment of Safe Load:**

The safe load shall be the smaller of the following:

- i) Half of the final load for which the total deflection is 12 mm.
- ii) Load corresponding to 5 mm total deflection. Note: The deflection is at the cut off level of the pile.

**9.6 PULL OUT:****Pullout Capacity Of Piles****Test Pile:**

The test pile shall be decided by the Engineer-in-Charge. The test shall be conducted on separate pile installed specifically for this purpose. The test pile shall be built up to the proper length and the head provided with suitable arrangements for anchoring the load applying system.

**Loading System**

Load shall be applied using an approved reaction system. Uplift force on the pile may be applied directly to the test pile or through a level system. The reaction may be provided by neighboring piles or blocks may be constructed for the purpose. A hydraulic jack shall be used for load application.

**Measuring System**

Load applied by jack shall be measured by a calibrated pressure gauge with a least count of 1000 kgs. Movement of the pile shall be measured by dial gauges, fixed to datum bar and having a least count of 0.01 mm. A minimum of two dial gauges, placed diametrically opposite shall be used. Datum bars shall be provided with rigid supports as described in 2.1.3.2 (b) above.

**METHOD OF CONSTRUCTING TEST:**

Loading shall be applied to the pile top in increments of one fifth the rated capacity of pile. Each stage shall be maintained for a period till the pile head is not more than 0.2 mm/hr or one hour, whichever is greater.

Loading shall be continued till one of the following occurs:

- a) Yield of soil pile system occurs causing progressive movement of the pile exceeding 12 mm.
- b) The loading on the pile top equals twice the estimated safe load or as specified.

**9.7 COMBINED VERTICAL AND LATERAL LOADING****Equipment and Test set -up:**

The equipment and test set up shall be same as described in Clause 3. In addition platform shall be constructed on the pile top, and loaded to 1.0 times the pile capacity in vertical loading. The pile

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shall be first subjected to the full vertical load. The lateral load shall commence after all settlements due to the vertical load have ceased and while the full vertical load is in position.

## **9.8 SPECIAL TYPE OF LOADING SUCH AS VIBRATORY LOADINGS**

This shall include evaluating the pile response to vibratory loads, both horizontal and vertical in nature. The test set up and method of conducting the test shall be covered under specific requirements.

All testing shall be performed in accordance with the following codes and the provision of these specifications IS: 2911-(Part IV) – Code of Practice for design and construction of pile foundations –Load Test on Piles.

## **9.9 GENERAL**

Any number of test piles and working piles as specified in the schedule of items or at the discretion of the ENGINEER shall be subjected to load tests. The CONTRACTOR shall provide everything necessary including equipment, measuring devices, jacks, structural framework, kentledges etc. This includes installation of test piles also and concreting of pile cap either temporary or permanent over single or group of piles for testing the piles. The pile cap concreting will not be paid for separately.

Load tests shall in general be carried out as per IS: 2911(Part IV) except as modified herein or directed otherwise by the ENGINEER.

Piles to be load tested shall be so designated on the drawings or specified/ selected by ENGINEER in the field.

Test load shall be applied to the piles by any suitable means preferably by a properly calibrated hydraulic jack with a remote-control pump. Test load applied to the piles shall be such that a constant load is maintained under increasing settlement.

The required reaction may be derived from either a loaded platform or anchor piles. Anchor piles shall not be closer than 6 times the pile diameter on either side. Working piles shall not be used as anchor piles. Anchor piles, if provided, shall be at CONTRACTOR's cost.

Load tests shall in general be carried out not earlier than 28 days from the time of casting the pile and may be performed concurrently with the pile installation operations if permitted by the ENGINEER.

The design and arrangement of application of loading etc. for all types of load tests, shall be submitted to the ENGINEER for approval.

All load tests shall be conducted under the supervision of the ENGINEER. All responsibilities for conducting the tests safely and properly shall rest with the CONTRACTOR.

## **9.10 CALIBRATION OF EQUIPMENT:**

The CONTRACTOR shall ensure, that all the equipment/ instruments are properly calibrated, at the start of the tests, to reflect the correct values. If so demanded by the ENGINEER, the CONTRACTOR shall have all or such specific instruments tested at an approved testing laboratory at the

CONTRACTOR's cost and the test report shall be submitted to the ENGINEER. If the ENGINEER desires to witness/inspect such tests, the CONTRACTOR shall arrange for this and also provide such access and facilities for inspection as are required.

### **9.11 INITIAL LOAD TESTS**

Immediately on mobilization to site, the CONTRACTOR shall prepare to install piles for conducting initial vertical load (downward and pull-out) and lateral pile load tests.

In case the cut-off is below ground level, a suitable excavation shall be made to provide access to the level after breaking off the unsound concrete as specified earlier in Clause 13.0.

For the compression type of test, the pile head shall be cut off level and capped by a R.C. cap to provide a horizontal plane bearing surface upon which a steel plate shall be placed. Earth from under the pile cap shall be scooped out so that

pile cap has no soil support. Thereafter, the kentledge and all other accessories outside the pit pertaining to and necessary for conducting the test shall be set up. An easy access to the pile test head shall be provided.

If the pile test head is below the ground water level, the CONTRACTOR shall provide suitable sumps and dewater the pit so as to render the pit dry enough to enable conducting the test. Any dewatering will be considered as part of the test and the CONTRACTOR shall not be separately paid for the same.

The test load shall be so applied that it reaches the pile in a static manner. The loading may be applied directly by kentledge or jacking against a reaction system provided by means of kentledge, tension piles or ground anchors. Where kentledge is used it shall be supported on a properly designed frame or gantry such that there is no possibility of the load tilting or collapsing. The foundations of this frame or gantry should be sufficiently far away from the test pile so as not to affect its behavior to any significant extent. Where tension piles or ground anchors are used, they shall be located a minimum distance of three times the test pile size from the centre of the test piles to the centre of the pile/ anchor.

The displacement of the test pile shall be related to a fixed datum. This may consist of a reference beam (datum bar) supported by two foundations positioned outside the zones of influence of the reaction support area. The deflection measuring equipment must be set up in such a way that any tilting of the test pile will not cause errors in the measurements. Dial gauges shall be used for measuring deflection. The least count of the dial gauges shall be at least 0.02mm. At least two but preferably four dial gauges shall be used and shall be placed at diagonally opposite corners.

The reference bars for the strain gauges shall be adequately rigid and on firm supports. The supports for the reference bars shall be so located that they are beyond the zone of influence of the loaded test pile (equal to three times the pile size from pile edge) and the zone of influence of kentledge supports. The bars shall be adequately stiffened and placed on supports in a manner such that any effect due to ambient temperature variations and vibrations due to traffic etc. are minimized. The reference bars and strain gauges shall not be exposed to direct sun and the pit shall be protected by tarpaulin sheets while the test is in progress.

The total test load shall be three (3) times the estimated safe load carrying capacity of the pile or failure, whichever is earlier, and shall be applied in equal increments of 20 percent of the estimated safe load. Unloading may however be in higher decrements with total number not less than five. At each load increment, pile deflection shall be observed accurate to 0.02mm at an interval of 1, 5, 10, 15, 25, 35, 50 and 60 minutes and thereafter at half hourly intervals, upto a time when the rate of deflection of the pile top reduces to 0.1mm in half hour or 0.2mm in one hour. The load increment in any case shall be maintained for 1 hour at least. The design load as well as the final load shall be maintained for 24 hours at least. At these load increments, after the first hour, deflection readings shall be taken at every one hour interval.

During the release stage, each load decrement shall be maintained at least for 30 minutes and readings of deflection noted. When the load is fully released to zero, measurements of rebound shall be continued till the deflection of the pile top is not more than 0.1 mm per half hour.

Initial cyclic tests shall be carried out to determine skin friction and point resistance of piles. This shall be carried out as per IS:2911 (Part-IV). However, each cycle of loading and unloading shall be repeated allowing a time interval of 10 minutes between the end of one cycle and the beginning of the next.

For the initial lateral pile load test pairs of piles for lateral load tests shall be driven. Lateral load test shall be conducted as per IS:2911 (Part-IV). The total test load shall be three (3) times the estimated safe load carrying capacity of the pile or failure, whichever is earlier. Load shall be applied at cut-off level.

Piles specified for pull out test shall be subjected to pull-out force equal to (2) times the estimated safe load carrying capacity of the pile in equal increments of not more than 2.5 tonne till the rise exceeds 12mm whichever is earlier. A graph of pull out force and the corresponding rise of pile top shall be plotted immediately.

If the initial test pile(s) which is (are) load tested fails (fail) to attain the specified safe structural capacity of piles and if this can be attributed to defective workmanship and/or negligence on the part of the CONTRACTOR, the OWNER reserves the right to terminate the contract and to award the contract to other parties. In such an event, all costs of mobilization, installation and testing of test pile(s) and any other work in connection with the test piles, shall be borne entirely by the CONTRACTOR.

While executing the pile bore for all test piles, a record of bore log and Standard Penetration Tests shall be maintained over the continuous length of boring in an approved format. Subsoil samples and rock cuttings shall be collected and systematically preserved as per Clause 9.3 above.

#### **9.12 LOAD TESTS ON WORKING PILES**

These tests shall be carried out on piles selected by the ENGINEER after they have been cast. Tests to be carried out on working piles shall essentially be ordinary compression type. The test will be similar to that conducted on initial test piles, except that the test load on pile shall be limited to 1.5 times the safe pile capacity. The maximum settlement during test loading shall not exceed 12mm.

The working pile shall be considered to have stood the test satisfactorily if total settlement under final test load is not more than 12mm and net (residual) settlement after removal of test load not more than 6 mm.

If the pile does not satisfy these requirements and if this can be attributed to defective workmanship or negligence on the part of the CONTRACTOR, all costs of the load test, the cost of providing and installing additional piles, cost of additional or enlarged pile caps and other work necessitated because of the defective pile, shall be at the cost of the CONTRACTOR.

### **9.13 RECORDS OF LOAD TEST RESULTS**

Within 48 hours of completion of each test, the CONTRACTOR shall furnish a copy of all recorded test data to the ENGINEER. Upon completion of pile load tests, the CONTRACTOR shall furnish the ENGINEER at no extra cost with a pile test report in triplicate and this shall include the following information where applicable.

- a) Identification of working pile/test pile as per drawing.
- b) Co-ordinate axes of pile, elevation of bottom of pile, cut off level of pile, type of pile, pile size.
- c) Pile Bore log Records.
- d) SPT results
- e) Deviation from designated location/ alignment.
- f) Jack gauge calibration curves from approved Test House.
- g) Tabulation of loads and settlement readings during the loading and unloading of the pile.
- h) Graphic representations of the test results in the form of time-load-settlement curves.
- i) Graphic analysis of Initial Cyclic test results to separate skin friction and end bearing as set out in IS:2911 (Part-IV).
- j) Remarks concerning any unusual occurrences during installation or test loading of the working piles/ test piles.

### **9.14 INDIRECT INTEGRITY TESTS FOR PILES**

The ENGINEER may desire to get bored cast in situ piles subject to integrity tests by indirect methods through another agency. The CONTRACTOR shall give all co-operations in getting such tests conducted. The ENGINEER reserves the right to give due weightage and consideration to results of these tests which will affect the integrity of the installed piles.

### **9.15 Recording of Data:**

Full record of pile load test results shall be submitted in triplicate to the Engineer-in-Charge immediately on completion of each test. The record shall also include the plots of load-settlement (for various stages of loads) characteristics of pile and also the interpretation of the pile load test curve as per criteria for safe loads mentioned in the specifications for testing concrete piles forming a part of this tender. Any special observations shall be duly explained by the contractor. Daily site records shall be maintained by the Contractor for the installation of piles against each Rig and shall contain the number and dimension of the pile, depth bored ( including depth in soft / hard rock ), time taken for boring, concreting and empty boring ( cut-off level) , chiseling and where the pile is wet or dry.

Sample bore log in the initial stage or when major variation occur should be shown. When drilling mud is used, amount of bentonite needed for stabilization of bore, specific gravity of the fresh supply and contaminated mud in the bore hole before concreting shall be checked and recorded regularly. Concrete volume actually cast per pile against required volume and actual cement consumption. Detail of any obstruction encountered its nature, depth and obstruction time. Any deviation from the designated location alignment or load capacity of any pile shall be noted.

Typical data sheet in triplicate for facility of recording piling data to be prepared by the Contractor before starting of actual piling operation at site and information to be recorded against each pile in the data sheet shall be signed by the contractor and countersigned by GWSSB. One copy of the data sheet shall be retained by the Contractor and the other two copies to be submitted to GWSSB for records & future reference.

Required photographs are to be taken by the party depicting progress of the job in every interval as specified by GWSSB, submitted for review and record to GWSSB.

A competent supervisor shall be present to record the necessary information during the installation of piles. The data to be recorded shall include:

- a) The dimensions of the piles, including the reinforcement detail and the mark of the pile.
- b) The boring method employed.
- c) The type of soil in which pile is terminated
- d) The depth bored.
- d) The depth of water table.
- e) When drilling mud is used, the specific gravity of the fresh supply and contaminated mud in the borehole before concreting is taken up, in case of first few piles and subsequently at suitable interval of piles.
- f) The time taken for concreting.
- g) The cut-off level/working level
- h) The consumption of cement.
- i) Any other important observations.

Any deviation from the designed location, alignment or load carrying capacity of any pile shall be noted and promptly reported to the Engineer-in-Charge.



## Vertical / Lateral / Pull Out Test

Pile No..... Date of ..... WT of Hammer  
 Type..... Driving..... AVR. Drop of  
 Diameter (cm)..... Casting..... Total No. of  
 Length below Commence of Test Sum of Temporary Compression  
 in cms  
 G.L. (M)..... Completion of  
 Location..... Test..... Ground level

Date	Time	Total time (hr)	Load	Load off (T)	Total load(T)	Settlement( Deflection) G auge (mm)	AVR.Settlement (Deflection) (mm)		Rebound (mm)	Remarks
							Total	Net		

**STANDARD SPECIFICATION FOR MATERIALS FOR REINFORCED CONCRETE PILES:-****1.0 GENERAL:****1.1 Scope:**

This specification establishes the material specification of reinforced cement concrete to be used in pile foundation. Any special requirements as shown or noted on the drawings shall govern over the provisions of these specifications. All materials which may be used in the Plain or Reinforced Cement Concrete work shall be of Standard quality conforming to IS or IRC or equivalent and shall have IS certification mark as far as possible unless otherwise approved by the Engineer-in-Charge. The contractor shall get all materials approved by Engineer-in -Charge prior to its procurement and before actual use. The Engineer-in-Charge shall have the right to determine whether all or any of the materials offered or delivered for use in the works are acceptable. Any material brought to site and not conforming to specification and instruction of Engineer-in -Charge shall be rejected and the contractor shall have to remove the same immediately from site at his own expense.

For specific work requirements concerning design and construction or otherwise modifying or supplementing the provision of this specification, refer to the specific requirements. In case of conflict between specific requirements and provision of this specification, former shall govern.

**1.2 Definitions:**

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1.2.1 Reference to IS or IRC Codes shall always mean reference to the latest issue of the relevant standards including all its amendments up to date.

1.3 Codes:

All design and construction shall be performed in accordance with the IRC and Indian Standard Code of Practice for Plain and Reinforced Concrete IS: 456 & IS: 2911

**2.0 MATERIALS FOR CONCRETE:**

2.1 Cement.

2.1.1 General:

The cement used shall be Sulphate Resistant Cement conforming to IS: 1489 latest version. The vendor of the same shall be approved by GWSSB.

2.1.2 Tests after Delivery:

Each consignment of cement may, after delivery on the site at the discretion of the Engineer-in-Charge, be subjected to any or all of tests and analysis required by the relevant Indian Standard Specifications. Facilities for testing shall be provided by contractor at his own cost.

2.1.3 Storage on the Site:

The cement shall be stored in a suitable weather-tight building and in such a manner as to permit easy access for proper inspection to prevent deterioration due to moisture and to minimize warehouse deterioration. Cement of different type and brands shall be kept in separate storage. All accepted cement stored on the site shall be arranged in batches, and used in the same order as received from the manufacturer. The contractor shall maintain a cement register, in which all entries shall be completed day to day showing the quantities received, date of receipt, source of dispatch, type of cement, etc. and also the daily cement consumption on site. The register shall be accessible to the Engineer-in- Charge for his verification.

2.1.4 Rejection of Cement:

The Engineer-in-Charge may reject any cement as a result of any tests thereof, notwithstanding the manufacturer's certificate. He may also reject cement which has deteriorated owing to inadequate protection from moisture or due to intrusion of foreign matter or other causes. Any cement which is considered defective by the Engineer-in-Charge shall not be promptly removed from the site of the work by the contractor at his own expense.

2.2 Aggregates for Concrete:

2.2.1 General:

Coarse and fine aggregates for concrete shall conform in all respect to IS: 383, "Specification for Coarse and Fine Aggregates from Natural Sources for Concrete". Aggregates shall be obtained from a source known to produce those satisfactory for concrete. Aggregates shall consist of naturally occurring sand and granite/basalt trap stone, crushed or uncrushed, or a combination thereof. They shall be chemically inert, hard, strong, dense, durable, clean and free from veins, adherent

coatings and shall be of limited porosity. Flaky and elongated pieces shall not be used. The source of aggregates shall be approved by the Engineer-in-Charge and shall not be changed during the course of the job without his approval. Rejected aggregates shall be removed from the work site by the contractor at his own expense.

#### 2.2.2 Deleterious Materials:

Aggregates shall not contain any harmful materials such as iron pyrites, coal, mica, shale or similar laminated materials, clay, alkali, soft fragments, sea shells, organic impurities etc. in such quantities as to affect the strength or durability of the concrete. In addition to the above, for reinforced concrete, any material which might cause corrosion of the reinforcement and aggregates which are chemically reactive with the alkalis of cement shall not be used. The maximum quantities of deleterious materials in the aggregates, as determined in accordance with IS: 2386 (Part-II) "Methods of Test for Aggregates for Concrete", shall not exceed the limits given in Table-I of IS:383. The sum of the percentages of all deleterious materials shall not exceed five. Deleterious materials also include material passing 75 micron IS sieve.

#### 2.2.3 Coarse Aggregates:

Coarse aggregate is aggregate most of which is retained on 4.75 mm IS sieve. These may be obtained from crushed or uncrushed granite/basalt trap stone as per CI.

2.3.1 and may be supplied as single sized or graded aggregates given in Table-II of IS:

383. The Engineer-in-Charge may allow all-in-Aggregate to be used provided they satisfy the requirements of clause 4.4 and Table-IV of IS 383.

#### 2.2.4 Fine Aggregates:

Fine aggregate is aggregate most of which passes 4.75 mm IS Sieve but not more than 10% pass through 150 microns IS Sieve. These shall comply with the requirements of grading zones I, II and III and given in Table-III of IS: 383. Fine aggregate conforming to grading zone IV shall not be normally used in reinforced concrete unless tests have been made by the contractor to ascertain the suitability of the proposed mix proportion and approved by the Engineer-in-Charge. Fine aggregate shall consist of natural sand resulting from natural disintegration of rock and which has been deposited by streams or glacial agencies, or crushed stone sand or crushed gravel sand.

#### 2.2.5 Sampling and Testing:

In case of doubt the Engineer-in-Charge may require the contractor to carry out tests, at the contractor's expense in accordance with – IS: 516 – Method of Tests for Strengths of Concrete; and IS: 2386- Method of Tests for Aggregates for Concrete.

#### 2.2.6 Storage of Aggregates:

The contractor shall at all times maintain at the site of work such quantities of aggregate as are considered by the Engineer-in -Charge to be sufficient to ensure continuity of work. Each type and grade of aggregate shall be stored separately on hard firm ground having sufficient slope to provide adequate drainage to rain water. Any aggregate delivered to site in a wet condition or becoming

wet at site due to rain shall be kept in storage for at least 24 hrs. to obtain adequate drainage, before it is used for concreting, or the water content of mix must be suitably adjusted as directed by Engineer-in-Charge.

### 2.3 Water:

Water to be used for concrete shall be clear and free from injurious amounts of Oil, Acid Alkali, Organic matters or other harmful substances in such amount that may impair the strength or durability of structure. Potable water shall generally be considered satisfactory for mixing and curing concrete. The Engineer-in-Charge may require the contractor to prove at latter's expense, that the concrete mixed with water proposed to be used should not have a compressive strength, lower than 90% of the strength of concrete mixed with distilled water. The Engineer-in -Charge may require the contractor to get the water tested from an approved laboratory at his own expenses and in case the water contains any sugar or an excess of acid, alkali, any injurious salts, etc. the Engineer-in-Charge may refuse to permit its use.

### 3.0 Admixtures :

Admixtures shall be used as per mix design and approval of Engineer-in-concrete Charge.

### 4.0 Reinforcement :

#### 4.1 Corrosion resistant Steel reinforcement

4.1.1 The reinforcement shall confirm to IS: 1786, Fe-500D grade. The reinforcement shall be Corrosion resistant steel conforming to IS: 432-Grade 1 unless specified otherwise.

#### 4.1.2 Hard-Drawn Steel wire Fabric :

When specified in the drawings, hard drawn steel wire fabric shall be used conforming to IS: 1566, It shall be of approved type and of the weights and dimensions shown in the drawings.

### 4.2 Welding:

4.2.1 Field welding of reinforcing bars will not be permitted without the written consent of the Engineer-in-Charge. Where welding is permitted it must be at staggered locations. Tests shall be made to provide that the joints are of the full strength of bars connected. Welding of reinforcement shall be done in accordance with the recommendation of IS: 2751.

### 4.3 Storage:

4.3.1. The steel reinforcement shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion.

### 4.4 Other Specifications:

4.4.1 General construction details and workmanship relative to reinforcement including bar bonds, lap splices and installation shall be in accordance with IS:2502- Code of Practice for Bonding and Fixing of Bars for concrete reinforcement, as well as the detailing of reinforcement given in IS:456.

4.4.2 Hot bending of bars shall not be allowed.

4.4.3 The number of sizes, shape and position of all the reinforcement shall, unless otherwise directed or authorized by the Engineer-in-Charge, be strictly in accordance with the drawings. The reinforcement shall be adequately secured and held in position by metal chairs and spacers. Ties of inter-sections shall be made with 16 SWG soft black annealed binding wire.

4.4.4 The contractor must obtain the approval of the Engineer-in-Charge for the reinforcement placed, before any concrete is placed in the forms. The reinforcement of this time shall be free from loose rust or scale or other coating that will destroy or reduce bond.

4.4.5 Concrete spacer blocks of the same strength as parent concrete shall be used to ensure correct cover to the reinforcement. This clear cover shall be as shown on the drawings or as per instructions of the Engineer-in-Charge.

4.4.6 All the reinforcing bars shall be so tied as to form a rigid cage to prevent displacement before or during concreting.

Comments made by GWSSB/Consultants on drawing submittal shall not relieve CONTRACTOR of any responsibility in meeting the requirements of the specifications. Such comments shall not be construed as permission to deviate from requirements of the Purchase Order unless specific and mutual agreement is reached and confirmed in writing.

Each drawing shall be provided with a title block in the bottom right-hand corner incorporating the following information:

- Official trade name of the company.
- CONTRACTORs drawing number.
- Drawing title giving the description of contents whereby the drawing can be identified.
- A symbol or letter indicating the latest issue or revision.
- PO number and item tag numbers.

Revisions to drawings and documents shall be identified with symbols adjacent to the alterations, a brief description in tabular form of each revision shall be given, and if applicable, the authority and date of the revision shall be listed. The term "Latest Revision" shall not be used.

**Item No.2 Intake Well (182 MLD with Approach bridge not less than 145 m length )**

Item specifications same as per the item no.1

**Item No.3 Approach Bridge for Intake Structure having capacity of 813 MLD**

**General Specifications for RCC APPROACH BRIDGE**

One RCC "Approach Bridge" of clear width as mentioned in data sheet / related item and specified clear length shall be constructed with M30 grade Reinforced cement concrete and CRS bars or as Structural Steel truss Bridge, as per drawings and specifications from the Intake well. If the bridge is to be construct in RC girder there shall be parapet railing on both sides of the bridge as specified in data sheet / item description. Clear width of the bridge for movement of Trolley, for carrying, Pumps; Motors, Pipes, Specials, Valves, Electrical accessories and other materials to and from the Pump House as well as for walk way of maintenance and other personnel shall be as per data sheet.

The "Approach Bridge" and allied works shall be constructed conforming to IS: 876 and IS: 456 – 2000, IRC: 78 – 2000, IS 800-2007, IS 808 and other relevant IS and IRC Codes. The RCC deck slab of the bridge shall rest on RCC long Girders as per approved design and drawings. These RCC long girders shall rest on the Pier with a top cap for providing the elastomeric neoprene bearings. The RCC Pier shall rest on the RCC pile foundation to be constructed at a suitable point under the bed level as per design and approved drawing.

### **3.1 PIERS AND ABUTMENT: -**

Pier shall be constructed in reinforced cement concrete. Piers shall be constructed to withstand the load and forces transferred from the super structure and the load and forces on the pier itself apart from the effect of its self-weight. The width of the abutment and pier caps shall be sufficient to accommodate:-

The bearing leaving an offset of 150 mm. beyond them. The space for jacks to lift the super structure for repair / replacement of bearings etc. Drainage arrangement for the water on the cap.

The thickness of Pier cap over the Pier shall not be less than 250 mm and as per design considering all load combination and factor of safety.

The Pier / Abutment caps shall be suitable and reinforced to take care of concentrated point loads dispersing in Pier / Abutment. The Pier cap cantilevering out from the supports or resting on two or more columns shall be designed to cater for the lifting of super structure on jacks for repair / replacement of bearings. The minimum width of cap at the top of Piers and Abutments of RCC slab and girder bridges just below the caps shall be 1.20 meters as shown in the drawing.

### **3.2 Laminated Elastomeric (Neoprene) Bearings: -**

3.2.1 The Laminated Elastomeric (Neoprene) Bearings consist of rubber Layers with steel Plates Vulcanized altogether in order to ensure a bond on their connection faces. The steel plates shall be completely embedded in the rubber to prevent any corrosion.

3.2.2 Bearings shall be stored under cover away from sunlight, heat, oil and chemical and shall be handled and stacked carefully. Damaged bearings with bend steel interleaving plates and partially deboned layers shall not be accepted. The bearing shall be got approved by the Engineer-in-Charge / Consultant before use.

#### **3.2.3 Installation of Elastomeric (Neoprene) Bearings:**

The concrete surface on the top of the pier cap was Elastomeric (Neoprene) Bearings are to be placed shall be true to line and level. One 6 mm thick bedding of 1:2 cement mortar (1 cement and 2 fine dry sharp sand) shall be constructed over the pier cap for installation of the bearing.

Whole installation work and the bearing shall be carried out as per approved specifications as contained in I.R.C Code (83-part-1) and as per direction of the Engineer-in-Charge/Consultant.

**Auxiliary Items of Work:**

1. Appropriate numbers C. I. Ventilators of 150 mm dia in addition to central ventilating shaft shall be provided on top slab of well as directed by Engineer.
2. Appropriate No. of C.I. Medium class Manhole frame & covers (wt. 53 Kg.) with locking arrangement shall be provided and fixed in the roof slab of well as directed by Engineer.
3. Electronic water level indicator assembly of approved type and make shall be provided & installed as directed by Engineer.
4. Vertical & Horizontal piping of MS. double flanged pipes & Specials of required sizes for inlet, outlet, overflow, bye pass & washout arrangement together with suitable MS. double flanged sluice valves shall be provided as per approved drawings. For washout one tee shall be fixed on the outlet pipe with one sluice valve of suitable diameter. Sluice valves confirming to IS 14846 – 2000 of Kirloskar, IVC, IVI make only shall be provided.
5. Inside and Outside surface of well, exposed faces of columns, beams, bottom portion of gallery & bottom slab and all exposed surfaces of slab be provided with smooth finish and then three coats (one primary coat of white cement and two coats of snowcem) of approved shade of snowcem paint as per colour scheme approved by the Engineer shall be rendered.
6. Internal surface of container including top slab bottom shall be provided with two coats of epoxy paint (food grade) as directed by Engineer.
7. On completion of work hydraulic test or water tightness test shall be done as per standard specification till satisfaction of the Engineer. Water required for testing & construction shall be made available by the contractor at his cost. If during testing any damage or leakage or sweating occurs to the structure it will be the responsibility of the contractor to rectify the same.

**Requirement of Auxiliary items of works:****1. R. C. C. Stair Case**

R. C. C. stair case of 1.0 meter clear width shall be provided from Approach bridge to bottom slab. Structural details shall be as per approved design and drawing. The tread and rise of the steps shall be 300 mm and 200 mm respectively. The stair case shall be provided with parapet from side and cage from top to prevent entry of trespassers. A sturdy C. I. gate of 2.5 m height with locking arrangement shall be provided at the start of the stair case. The construction of stair case should progress as along the main reservoir structure & it should not lag behind in any way. The Engineer should be able to inspect & check the reinforcement at each brace level using this stair case only.

**2. Aluminium Ladder**

Aluminium ladder 450 mm wide shall be made up of aluminium rectangular section of 65 x 35 mm (3 mm thick) and 25 mm bars as approved by Engineer. Welded as 300 mm center to center. The ladder shall be provided in two flights i.e. first flight from flat slab at top to intermediate landing at 3.5 m depth provided & constructed to container wall and second flight from intermediate landing to bottom slab level. The landing shall be casted homogeneously with the

container wall and shall be 1.0 m x 1.0 m size. It should have G. I. pipe railing from two sides. Aluminium ladder shall be provided inside the container of the Well.

### **3. M. S. Ladder**

The M.S. ladder shall be provided & fixed to give access to the top slab from Approach Bridge. The ladder shall be comprising of 65 mm x 65 mm x 6 mm. M. S. angles placed at 450 mm apart with 16 mm M. S. bars in double rows as steps at 200 mm center to center distance. The ladder shall be properly fixed at site as directed and bottom & top shall be properly embedded in 1:2:4 C.C. block. In order to have stiffness to the ladder cross supports or stiffeners at suitable intervals as directed shall be provided of suitable M.S. flats duly embedded in walls and welded to the ladder. The M. S. ladder & supports shall be provided with three coats of anticorrosive paint as directed.

### **4. Pipe Railing**

As per data sheet.

### **5. Stainless Steel Grating**

20 mm Dia stainless steel bars welded grating with 100 mm c/c spacing, fixed firmly in the over the outlet pipe and drain pipe.

### **6. Electronic Water Level Indicator**

The electronic water level indicators are used for direct measurement of liquid level in wells. The specifications of electronic water level indicator shall be under:

#### **1. Electrical**

Power supply: Operating voltage 230 V AC nominal + 10 %, 50 Hz.

Indication: 16 x 2 alphanumeric LCD

Low level and high level audio alarm (adjustable).

#### **2. Mechanical**

Mounting: Wall type.

Size: 255 mm (W) x 182 mm (H).

Enclosure:

IP 65 (Splash proof) UV protected virgin plastic cabinet.

The display unit shall be housed in splash proof cabinet to withstand the harsh environment generally encountered in practice. Clear LCD display shall be easily readable from a wide viewing angle.

The sensors shall be of sufficient length and resolutions so that the unit can be used anywhere in premises irrespective of the size & shape of the well.

Electronic Water level indicator of approved make with constant display placed in office room shall be provided as directed by Engineer.

**For concrete and all other related item general specification as well as detail specification of item no.1 shall be applicable.**

Item No.4 Approach Bridge for Intake Structure having capacity of 182 MLD
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Item specifications same as per the item no.3



## Schedule B-2 Rising Main Pipeline comprising MS pipe and DI K-9 pipe as per Design Requirements

### ITEM NO.1

Manufacture, Supply & Delivery of Submerged Arc Welded M.S. Pipe having bevelled ends plate or coil conforming to IS-3589-2001 or its latest revision/ amendment for following thickness and diameter at GWSSB store or site anywhere in Gujarat State including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading conveyance to Departmental stores/ Contractor's own stack yard, stacking, stack yard to site transportation charges etc. all complete. I/S Solvent free food grade Liquid Epoxy Lining (406 micron) as per AWWA C210 + O/S 3 LPE as per DIN 30670 Coated M. S. Pipe.

### MS PIPE SPECIFICATION

#### Applicable Codes & Specifications

The following specifications, standards and codes are made a part of the specification. All standards, tentative specifications, specifications, codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between this specification and those referred to herein, this specification shall govern.:

IS	: 2062	Steel for general structural purposes.
IS	: 808	Dimensions for hot rolled steel beam, column, channel and angle sections.
IS	: 814	Covered Electrodes for manual Metal Arc Welding of carbon and C-Mn steel.
BS EN	: 499	Welding Consumables. Covered Electrodes for Manual Metal Arc Welding of Non Alloy and Fine Grain Steel Classification
AWS	: A-5.17	Specification for Mild Steel Covered Arc Welding Electrodes.
IS	: 3613	Acceptance Tests for Wire Flux combinations for Submerged - Arc Welding.
AWS	: A-5.17	Specification for Bare Mild Steel Electrodes and Fluxes for Submerged Arc Welding
IS	: 1367	Technical Supply Conditions for Threaded Fasteners (Parts 1 to 3).
IS	: 2016	Plain Washers.
IS	: 2074	Ready Mixed Paint, Red Oxide Zinc Chrome and Priming.
IS	: 102	Ready Mixed Paint, Brushing, Red Lead, no setting, Priming.
IS	: 1786	High Strength Deformed Steel Bars and Wires for Concrete Reinforcement
IS	: 432	Specification for Mild Steel & (Part-I) Medium Tensile bars and hard drawn steel wire for concrete reinforcement : mild Steel & Medium tensile steel bars.
IS	: 432	Specification for mild steel & (Part-II) Medium Tensile steel bars and hard drawn steel wires for concrete reinforcement : Hard drawn steel wire
IS	: 269	Specification for Ordinary and Low heat Portland cement
IS	: 8041	Specification for Rapid hardening Portland Cement
IS	: 383	Specification for coarse and fine aggregate from natural source for concrete
IS	: 12330	Specification for Sulphate Resisting Portland Cement
IS	: 456	Code of practice for plain and reinforced concrete
IS	: 800	Code of practice for General Construction in Steel.

IS	:	816	Code of practice for use of Metal Arc Welding for General Construction in mild steel.
IS	:	4353	Submerged Arc Welding of Mild Steel & Low Alloy Steels - Materials Recommendations.
IS	:	817	Code of practice for Training and Testing of Metal Arc Welders.
IS	:	1182	Recommended practice for Radiographic examination of Fusion – Welded Butt Joints in steel plants
IS	:	2595	Code of Practice for Radiographic Testing.
IS	:	3658	Code of Practice for Liquid Penetrate Flaw Detection
IS	:	5334	Code of practice for Magnetic Particle Flaw Detection of welds.
ASTME	:	94	Guide for Radiographic Testing
ASTME	:	709	Guides for Magnetic Particle Examination.
ASTME	:	165	Test Method for Liquid Penetrate Examination.
IS	:	3600	Methods of Testing Fusion Welded Joints and weld metal in steel (Parts 1 to 9)
IS	:	4853	Recommended Practice for Radiographic Inspection of Fusion Welded Butt Joints in Steel Pipes
IS	:	1239	Seamless or Electrically welded steel pipes for Water Gas and Sewage (Up to 166.5 mm Outside Diameter)
IS	:	3589	Seamless or Electrically welded steel pipes for Water Gas and Sewage (168.3 to 2540 Outside Diameter)
IS	:	6631	Steel pipes for Hydraulic Purposes
IS	:	7343	Code of practice for ultrasonic Testing of Ferrous Welded Pipes and Tubular Products
IS	:	2598	Safety Code for Industrial Radiographic Practice
IS	:	5822	Code of Practice for Laying of Electrically Welded steel pipes for water supply
IS	:	1608	Mechanical testing of Metals.
IS	:	9595	Metal Arc welding of Carbon and Carbon-Manganese Steels.
IS	:	2825	Code of unfired Pressure Vessels
IS	:	5504	Code for Spiral Welded PIPES(457mm to 3250mm Outside Diameter)
IS	:	10748	Requirements for Weldable Hot Rolled Carbon Steel Strip in Coils.
IS	:	10234	Recommendation for radiography for general pipeline welding.
API	:	1104	Welding of pipeline & related facilities
ASME	:	Sec. V	Non Destructive Examination

## 1.0 MATERIALS

Steel Coils - The raw material of H.R. steel Coils used for pipes, fittings, specials and stiffeners shall be conforming to IS: 10748 grade III and shall bear ISI mark. The HR Coils older than 6 months from date of its manufacturing shall not be allowed to manufacture pipes.

Welding Consumables - such as electrodes, filler rods and wires shall conform to IS:814, IS: 3613, IS: 6419 and IS: 7280 and shall be of GWSSB approved make.

Before fabrication of pipes and specials/fittings is commenced, the copies of the mill sheets and the manufacturer's test certificates for Coils and other materials required for the fabrication shall be submitted by the Contractor to the Engineer for his approval.

When requested by the Engineer, the Contractor shall supply free of charge to the Employer, for testing suitable samples of the materials to be used/used in the Works. The cost of such tests shall be borne by the Contractor and shall be included in his item rates.

## 2.0 INSPECTION

All works and material under specification will be rigidly inspected during all phases of manufacture and testing and such inspection shall not relieve the Contractor of his responsibility to furnish materials and performed work in accordance with this specification.

The Contractor shall notify the Engineer, in advance of the production of materials and fabrication thereof, in order that the Employer may arrange for mill and shop inspection.

The Engineer may reject any or all materials or works that do not meet with any of the requirements of this specification. The Contractor shall rectify or replace such rejected material/performed work at his own cost, to the satisfaction of the Engineer.

The Engineer shall have free access to those parts of all plants or any other premises and sites that are concerned with the furnishing of materials or the performance of work under this specification.

The Contractor shall furnish to the Employer's inspector reasonable facilities and space without charge for inspection, testing and obtaining of any information he desires in respect of the character of material used and the progress and manner of the work.

The Contractor shall supply free of cost required specimen of materials for testing by the Owner at any time during the progress of work and shall bear the cost of all such tests or retests to the satisfaction of Engineer.

The Contractor shall provide 2 (two) sets of accurate 'Go' and 'No Go' ring gauges to measure the diameter of pipes specials and fitting for the use of the Engineer at no extra cost.

### **3.0 FABRICATION OF PIPE**

#### **GENERAL**

All pipes and specials shall be manufactured as per IS: 1239 part 1/ IS: 3589 and IS: 5504 out of new mild steel HR Coils (IS: 10748 grade-III) (as mentioned above) which shall be free from any cracks, surface flaws, laminations, excessive fittings or any other defects. The pipes shall be truly cylindrical, and straight in axis. The ends shall be accurately cut and prepared for field welding. The external circumference of the pipe pieces which are to be fixed adjacent to flange adapter with fixed outer diameter shall not deviate from theoretical one by more than 1 mm. To obtain this accuracy the pipe shall be rolled several times, if necessary, as pipe pieces should be truly cylindrical. The external longitudinal welding of this pipe shall be ground smooth flush with surface to the satisfaction of the Engineer, for a length of 200 mm. No extra cost shall be charged by the Contractor for this grinding work. However, the pipe shall be manufactured as per tender specification. HR Coil shall not be older than 6 months from the date of its manufacturing.

Minor repair by welding or otherwise shall be permitted at the discretion of the Engineer, but such repairs shall be done only after obtaining the previous permission of the Engineer. Any pipe or part thereof which develops injurious defects during shop welding or other operations shall be rejected.

**Permissible Stress :** The permissible stress in the pipe shell shall be related to yield stress of pipe material making due allowance for weld efficiency of the joint.

working stress for combined bending and direct tensile stress shall not exceed 60% of yield stress of the material making due allowance for efficiency of welded joint (as per IWWA M-1).

Working stress for combined bending and direct compressive stress shall not exceed 50% of yield stress making due allowance for weld efficiency (as per IWWA M-1).

It is also necessary to check the shell thickness for adequate factor of safety against failure by buckling (as per IWWA M-11).

For field welded joint, efficiency factor of 80% is generally adopted, while for shop welding joint 90% efficiency is allowed (as per IS 5822 ).

**FABRICATION**

The Contractor shall get the fabrication work done in a duly valid licensed factory of his own or that of an approved nominated sub-contractor. This factory meant for fabrication of pipes, specials etc. shall also be involved with testing etc., machining as well as painting. For completing the work under the present contract within the contract period, the factory shall be equipped with adequate number of various equipment and plant such as :

- I. Plate bending machines for rolling of pipe drums
- II. Automatic welding machines (suitable for circumferential welding)
- III. Hydraulic Testing Machines
- IV. Travelling gantry or crane of capacity 10 Tones or above.
- V. Mobile cranes for loading/unloading of Coils, pipes etc. 15 tones capacity each
- VI. Lathe for machining of the flanges rings, Coils etc.
- VII. Equipment for sand blasting and applying paint by spray gun.
- VIII. Equipment for cold pressing of Coils up to 25 mm thick to the required curvature (specials, plug Coils etc.)
- IX. Bending machine of adequate capacity for manufacturing ring girders and other necessary equipment.

The factory shall have adequate area, and shall also have stacking yard for the stacking of Coils, structural, fabricated pipes etc. and the scrap.

The Bidder may establish pipe fabrication factory within the project site for minimizing the transportation of pipes after fabrication to bring the pipes to the trench where pipes are to be laid. Contractor shall furnish with his bid the details of the factory where he intends to get the fabrication done, such as its location within the project site and the equipment, plant and other facilities available in the factory for the manufacture of M.S. Pipes and special required under this contract. This shall be as per the MOU executed with the pipe manufacturer.

**CUTTING OF COILS or FROM COIL ROLLED AS PER REQUIRED SIZES**

The Coils shall be indented in such length as to have minimum wastage and so as to make the pipe as far as possible.

Before cutting, all the edges of the Coils shall be cleaned by brushing/grinding on both the sides. After the Coils are cut, the edges shall be made smooth and even by polishing with an electrical or pneumatic grinder to remove all inequalities. Care shall be taken to see that the cut edges of the plate are perfectly straight. Jigs to be used for this purpose shall depend upon the types of cutting machine used. The Coils cut to the required shape shall be checked for correctness before they are rolled into pipe drums. If any corrections are required, the Contractor shall do the same by re-cutting, if necessary.

**ROLLING OF COILS**

The Coils prepared as mentioned above are cut to the exact size shall be put into a rolling machine to form a pipe of the required diameter as under :

The Contractor shall adjust the rolling machine so as to give a uniform curvature to the pipe throughout its circumference.

The curvature obtained shall be checked by the Contractor's foreman during the process of rolling and if proper curvature is not obtained at any place including the ends, the rolling operation shall be repeated at this stage.

Heating of Coils to obtain the desired curvature shall not be permitted.

**WELDING**

All components of a standard shell, either straight or bent etc. shall be welded, wherever possible by use of automatic arc welding machine by Submerged Arc Welding Process with alternating current. Generally hand welding shall not be permitted except specific cases, where it is absolutely necessary. This should be done in consent with client's representative. Hand welding shall also not be permitted except for sealing runs and such other minor works at the discretion of the Engineer-in-charge. The strength of the joint shall be at least equal to that of the parent material.

The Contractor shall use electrodes of GWSSB/GWSSB approved make and size, the size depending on the thickness of coil and the type of joint. It shall also be used with standard current and arc voltage required for the machine in use with such modifications as may be found necessary after experimental welding. For this purpose, samples of welded joints shall be prepared and tested in the presence of the Engineer. The values once determined shall be maintained throughout the work and if any modifications are to be made, a written permission of the Engineer shall be obtained. In the case of thin sheets, electric arc welding may not give satisfactory results and gas welding shall be resorted to. Gas welding shall be subject to the same specifications and tests as those for electric welds. Welding should be carried out inside as well as outside.

All the shop and field joints shall be welded, all welding shall conform to the requirements of ASME SECTION IX or IS 9595 and IS 4353.

All circumferential joints shall be double welded butt joints. Field joints shall be from outside, with a sealing weld from inside. End preparation for such welding shall conform to IS: 2825.

All circumferential welds involving Coils of unequal thickness shall be so kept that the inside surfaces of Coils match to provide stream lined joints without alteration in the internal diameter.

As far as practicable, welding of dissimilar thickness of shells shall be carried out in the shops.

The welding shall be of the best workmanship free from flaws, burns, etc. and the Contractor shall provide for his own electrodes and equipment, ovens to keep the electrodes at the desired temperatures and dry. In order to maintain a good standard in welding, welders shall be tested by the Contractor with prior intimation to the client before they are entrusted with the job. Qualification standard for welding procedures, welders and welding operation shall conform to the requirements of ASME SECTION IX or IS: 7307 and IS: 7310 (latest). Periodical tests as regards their efficiency shall also be taken at intervals of about 6 months and those found inefficient shall be removed from the job. Only those who pass the test shall be posted on the job. If an incompetent welder has already welded some pipes, all welding done by him previously shall be fully checked by X-ray in addition to the regular X-ray inspections. The defects if any shall be set right to the satisfaction of the Engineer. All such check tests and rectification of defects shall be entirely at the cost of the Contractor. No pipes or steel sections shall be erected unless the work of the welder concerned has been proved to be satisfactory. Specially selected welders shall do site welds.

A record shall be maintained showing the names of welders and operators who have worked on each individual joint. Hand-welding shall preferably be carried out by a pair of welders (parallel welding putting two welders at a time both will be working in diametrically opposite side of the curvature. Welding shall be divided into 4 quadrants shall be welded simultaneously, so that by observing proper sequence, distortion can be avoided. A joint entrusted to a particular individual or a pair shall be as far as possible, completed by them in all respects, including sealing run. No helper or other unauthorized person shall be permitted to do any welding whatsoever. In case of infringement of above, the persons shall be punished as directed by the Engineer.

The welded joint after welding should not become brittle or sensitive to blows and there should be no loss of toughness due to welding or heat treatment. The material after welding and heat treatment is to be tougher than the base metal and is to retain its original ductility. No allowance

will be made for thinning of weld and the weld should in no point be less than the nominal thickness of plate.

Upon receipt of the order and prior to the start of fabrication, the Contractor shall submit to the Engineer for his approval the "welding procedure" he intends to use in the shop work. Similarly, prior to the start of the field welding, procedure for the field welding must be submitted to the Engineer for his approval. Manual welding shall be adopted only when machine welding is not possible.

#### **4.0 ULTRASONIC & RADIOGRAPHIC TEST OF WELDED JOINTS**

##### **MANUFACTURED IN SITE FACTORY/WORKSHOP**

For the mild steel pipes manufactured in site factory/workshop, fabricated from mild steel Coils, 100% of weld length of each pipe shall be subjected to Ultrasonic Test either on line or off line. (As per API 5L or ASME SECTION V or API 1104 ) For the mild steel pipes manufactured in site Factory/Workshop fabricated from mild steel coils, 15% of weld length of each pipe shall be subjected to Radiography Test by Digital Image/ X-Ray Film Method. (As per API 5L or ASME SECTION V or API 1104 )

The weld ripples or weld surface irregularities, on both inside and outside shall be removed by any suitable mechanical process to a degree such that resulting radiographic contact due to any remaining irregularities cannot mark or be confused with that of objectionable defect. The radiograph shall be made in strict accordance with the latest requirements and as per the latest and most efficient technique either with X-ray or gamma ray equipment.

The photographs are to be marked in such a way that the corresponding portion of the welded seam can be readily identified. All radiographs will be reviewed by the Engineer to identify the defect and determine those which must be removed. Defects that are not acceptable shall be removed by chipping, machining or flame gouging to sound metal and the resulting cavities shall be welded. After rectification, the joint is to be radiographed again to prove the quality of the repair. The Engineer based on the latest standards prescribed by Indian Standard specification will judge the radiographs as acceptable or unacceptable.

All X-ray shall be made with equipment and by personnel furnished by the Contractor. Films shall be developed within 24 hours of exposure and be readily accessible at all times for inspection by the Engineer. The Contractor shall provide for the use of the Engineer suitable X-ray viewing equipment. X-ray films shall be properly maintained by the Contractor and shall be handed over to the department on completion of the Contract. All films shall be identified by the No. and chart prepared indicating location of the joint each X-ray photo represents. In the event of additional radiographic inspections required of any work associated with the pipe erection, the Radiographer at the discretion of the Engineer shall perform such inspection.

#### **5.0 RADIOGRAPHIC INSPECTION**

##### **GENERAL**

The Engineer shall assure himself that the welding procedure employed in the construction of pipes has been qualified. The Contractor shall submit evidence to the Engineer that the requirements have been met. The Contractor shall certify that the welding of pipes has been done only by qualified welders and welding operators and the Engineer shall ensure himself that only qualified welders and welding operators have been used.

The Contractor shall make available to the Engineer a certified copy of the records of the qualification tests of each welder and welding operator. The Engineer shall have the right at any

time to call for and witness tests of welding procedure or of the ability of any welder and welding operator.

#### **RADIOGRAPHIC INSPECTION OF WELDED JOINTS**

All welded joints to be radiographed shall be examined in accordance with IS : 2595- Code of Practice for Radiographic Testing

IS : 4853 : Recommended Practice for Radiographic Inspection of Fusion Welded Butt joints in Steel Pipes.

IS : 1182 : Recommended Practice for Radiographic Examination of Fusion Welded Butt-Joints in steel Coils.

The reinforcement on each side of all butt welded joints shall not exceed 1.5 mm. A complete set of radiographs and records as described in IS: 2595 for each job shall be retained by the Contractor and kept on file for a period of at least five years.

Radiographers performing radiograph shall be qualified in accordance with SNT-TC-1A. Supplements and Appendices "Recommended Practice for Non-destructive Testing Personnel Qualification and Certification" published by the American Society for Non-destructive Testing as applicable for the technique and methods used.

Final acceptance of radiographs shall be based on the ability to see the prescribed pentameter image and the specified hole.

The acceptance criteria for radiography of the joint shall be as per API 5L or as per API -1104 standard.

#### **6.0 TOLERANCE**

The shell in the completed work shall be substantially round. The difference between maximum and minimum inside diameters at any cross section shall not exceed 1% of the nominal diameter of the cross section under consideration subject to a maximum of 10 mm.

Machined parts shall be within the limits specified by IS 3589.

Straight pipes shall have their faces perpendicular to the axis of the section with a maximum deviation of 2 mm on either side of the plane. Pipe ends shall be bevelled as per IS: 3589. The pipes shall be supplied in length of 10.5 meters to 12.5 meters.

For the Pipe thickness, no negative tolerances are acceptable.

All dimensions of pipe like Outside Diameter, thickness, out of roundness, length, straightness, bevel angle, weld bead height shall be as per IS 3589.

#### **7.0 SHOP TESTING**

After fabrication, but before application of protective coatings all pipes and specials shall be subjected to a shop hydraulic test (100%). Standard lengths of pipes shall be directly subjected to test and non-standard pipe and elbows can be tested as standard pipe before being cut to size. Each pipe shall be filled with water and the pressure slowly and uniformly increased until the required test pressure is reached.

The pipe to be tested shall be given a serial no. which shall be painted on its inside together with details such as pipe No. Shell thickness, diameter, length etc. as directed. It shall be entered in the register to be maintained by the Contractor.

Prior to testing, the pipe shall be inspected thoroughly and all the apparent defects in welding such as jumps, porosity etc. shall be repaired by gouge and re-welding.

The hydraulic test shall be carried out under cover at the fabrication shop, in the presence of and to the satisfaction of the Engineer or the inspection agency appointed by the Employer.

For indicating the pressure inside the pipe an accurate pressure gauge of approved make duly tested and calibrated for the accuracy of readings shall be mounted on one of the closures which close the pipe ends.

The pressures shall be applied gradually by approved means and shall be maintained for a period of 5 Seconds. The pipe shall be hammered throughout its length with sharp blows, by means of a 1 kg. hand hammer.

The pipe shall withstand the test without showing any sign of weakness, leakage, oozing or sweating. If any leak or sweating is observed in the welded joints, the same shall be repaired by gouging and re-welding after dewatering the pipe. The repaired pipe shall be re-tested to conform to the specified pressure.

If any leak or sweating is observed in pipe shell the pipe under test shall be rejected temporarily. The Contractor shall stack such rejected pipes separately in his yard. The Engineer shall inspect the same and after taking cuts if necessary, shall determine the nature of repairs to be carried out thereon and shall then decide as to how and where they shall be used. No payment shall be made for handling or carrying out repairs, but, payment for the fabrication and hydraulic testing of the pipe shall be released only after acceptance of the pipe with necessary repairs and subsequent testing etc. are carried out by the Contractor to the satisfaction of the Engineer. The Engineer shall be supplied with two copies of the results of all the tests carried out.

The Mechanical Tests for Pipe material at Manufacturers work shall be carried as per approved Quality Assurance Plan (QAP) and tests shall be as per IS:1239/ IS:3589/IS:5504.

## **8.0 TESTING OF SITE WELDED JOINTS**

The welded joints at site shall be tested for Tensile test and Bend test in accordance with procedure laid down in as per the latest edition of IS 3600 “code of procedure for testing of fusion welded joints and weld metals in steel”.

Test pieces shall be taken by the contractors from the welded joints at the position on fabricated pipes pointed out by the Engineer in-charge.

The sample so taken shall then be cut to the exact shape and dimensions and machined as described below and handed over to the Engineer-in-charge for testing. All the work up to and including machining and arranging for test shall be done by the contractors.

## **9.0 SUBMISSION OF DAILY PROGRESS REPORT**

The Contractor shall submit to the Engineer a daily progress report in the proforma approved by the Engineer, wherein all the details of the work carried out in the factory shall be fully recorded. Similarly, works done in the various units in the factory shall be separately mentioned. The Contractor shall maintain a register of all the finished materials giving dates of carrying out important operations such as testing, transport, etc. The register shall be presented at least once a week to the Engineer who shall initial the entries after verification.

## **10.0 MARKING**

The component parts of the pipes shall be carefully marked for identification in the field. The marking shall be on the side which will be the inside of the pipe after bending.

The marking operation shall be conducted with full size rulers. Only blunt nose punches should be used.

The Coils used for fabrication of pipes shall be laid out in such a way that when the shells are completed one set of original identification markings for the material will be plainly visible. In



case these markings are unavoidably cut out, they shall be accurately transferred by the Contractor to a location where these markings will be visible on the completed work.

After the hydraulic tests on the specials and other items, the number of the shell in the line as it will be erected and the direction of flow shall be stamped in a prominent manner on each piece.

A register shall be maintained in suitable Performa giving the following information for each shell tested:

- i. Serial No.
- ii. Shell No.
- iii. Date of test
- iv. Thickness and specification of steel
- v. Weight of shell tested
- vi. Maximum test pressure
- vii. Details of test performance
- viii. Details of radiographic examination of welds
- ix. Name of Engineer's representative witnessing tests

A copy of these details shall be furnished to the owner free of cost.

No separate payment will be made for these markings and the rates for the items concerned shall be deemed to include the cost of such markings.

## 11.0 EXTERNAL COATING: 3-LAYER POLYETHYLENE (3LPE)

### SCOPE

This Specification defines the minimum requirements for the application of three-layer polyethylene coating to the external surface of steel pipes and internal surface of steel pipes with solvent free liquid epoxy lining for water transmission pipe line.

For the factory applied coating the system shall comprise of a layer of fusion bonded epoxy (FBE), overlaid with adhesive with an outer layer for high density polyethylene (HDPE) and internally lined with an air less spray applied solvent free epoxy.

### CODES AND STANDARDS

This latest edition of the following codes and standards shall establish the minimum standards for the work :

ANSI/AWWA C213	Standard for Fusion-bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
ASTM D149	Standard test method for dielectric breakdown voltage and dielectric strength of solid electrical insulating materials at commercial power frequencies.
ASTM D257	Test methods for dc resistance or conductance of insulating materials.
ASTM D570	Standard test method for water absorption of plastics
ASTM D638	Standard test method for tensile properties of plastics
ASTM D746	Standard test method for brittleness temperature of plastics and elastomers by impact.
ASTM D790	Standard test method for flexural properties of unreinforced and reinforced plastics and electrical insulating materials.

ASTM D1238	Standard test method for melt flow rates of thermoplastics by extrusion plastometer.
ASTM D1505	Standard test method for Density of plastics by the Density Gradient Technique.
ASTM D1525	Standard test method for Vicat softening temperature of plastics.
ASTM D1531	Standard test methods for relative permittivity (dielectric constant) and dissipation factor by fluid displacement procedures.
ASTM D1603	Standard test method for carbon black in define plastics
ASTM D1928	Standard practice for preparation of compression-molded polyethylene test sheets and test specimens.
ASTM D2240	Standard test method for rubber property – durometer hardness.
ASTM D3417	Standard test method for enthalpies of fusion and Crystallization of polymers by differential scanning calorimetry (dsc)
ASTM D4703	Standard test practice for compression Molding Thermoplastic Materials into Test Specimen, Plaques or Sheets.
ASTM F372	Standard test method for water vapor transmission rate of flexible barrier materials using an infrared detection technique.
AWWA C 200-97	Steel water pipe line
ASTM G8	Standard test method for Cathodic Dis-bonding of pipeline Coatings.
CAN/CSA Z 245:1	Internal fusion bond epoxy coating / lining of steel pipes.
DIN 30670	Polyethylene Coatings of Steel pipes and Fittings – Requirements and Testing.
DIN EN ISO 9001 2000	Quality management systems – Requirements
DIN EN ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
DIN EN ISO 8502-2	Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness – Part 2 : Laboratory determination of chloride on cleaned surfaces.
DIN EN ISO 8502-3	Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness–Part 3 : Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)
DIN EN ISO 8502-4	Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness Part 4 : Guidance on the estimation of the probability of condensation prior to paint application
DIN EN ISO 8502-9	Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness Part 9 : Field method for the conductometric determination of water-soluble salts
DIN EN ISO 8503-1	Preparation of steel substrates before application of paints and related products – Surface roughness characteristics of blast- cleaned steel substrates – Part 1 : Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast cleaned surfaces.
DIN EN ISO 8503-2	Preparation of steel substrates before application of paints and related products – Surface roughness characteristics of blast- cleaned steel

	substrates – Part 2 : Method for the grading of surface profile of abrasive blast-cleaned steel – comparator procedure.
ISO 8502-5	Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness – Part 5 : Measurement of chloride on steel surfaces prepared for painting (ion detection tube method)
NACE RP0490	Holiday Detection of Fusion-Bonded Epoxy External Pipeline Coatings of 250 to 760 $\mu\text{m}$ (10 to 30 mils)
NACE RP-01-75	Recommended practice : control of Internal corrosion in steel pipe lines and Piping system.
SIS 05-5900	Preparation of steel substrates before application of paints and related products – visual assessment of surface cleanliness – PT 1 : grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous.

## GENERAL

### Environmental Conditions

The environmental conditions operating conditions, product data, etc. under which the pipes shall operates and defined in Documents. Scope of Work, Project Design Data and Site Conditions and Specification for Pipeline construction.

### Definitions

The terms “Contractor”, “Pipe Supplier”, “Pipe Coating Contractor”, “Engineer”, etc. used in this specification shall have the meanings defined in the General and Special Conditions of Contract.

### Abbreviations

ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
DIN	German Standards Institute
ISO	International Organization for Standardization
NACE	National Association of Corrosion Engineers
NPS	Nominal Pipe Size
MPI	Magnetic Particle Inspection
UT	Ultrasonic Testing
SI	Swiss standard
AWWA	American Water Works Association.

### Conflicting Requirements, Exceptions

The Pipe Coating Contractor shall notify the Engineer of any conflict between this specification, the codes and standards and any other specifications included as part of the contract documents related with line pipes and coating.

Any exceptions to this specification and referenced documentation shall be raised by the Pipe Coating Contractor and approved by the Engineer in writing

## TECHNICAL REQUIREMENTS

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**HANDLING OF COATING MATERIALS :****General :**

Materials shall be brought from the GWSSB approved vendor list only and shall be handled and stored in accordance with the material manufacture's recommendations, which shall be available for review by the Engineer at the Pipe Coating Contractor's premises. Materials shall be stored in temperature controlled environment until required for use.

Coating materials shall be segregated by type and batch during storage and handling. Materials from damaged containers shall be rejected unless otherwise agreed with the Engineer.

As a minimum, all packages of the coating materials shall be marked with the following data:

- a) Name of manufacturer
- b) Complete material identification – trade name, chemical name and
- c) style of product details
- d) Batch number
- e) Date of manufacture
- f) Place of manufacture
- g) Shelf life/expiry date (if appropriate)
- h) Health and safety, and environmental instructions
- i) Hazard Warnings
- j) Storage instructions
- k) Quantity
- l) Manufacturing Standard

Any material not labelled with the above information shall not be used

**Abrasive Grit**

The abrasive shall be steel grit, also in combination with steel shot of the required grade to achieve the specified surface profile. The use of sand is not permitted.

Blasting abrasives shall be kept dry, clean and free from contamination. When recovered metallic grit systems are used, a stabilized working mix of blast cleaning material shall be established. This mix shall be maintained throughout the entire course of the production, by frequent small additions from fresh or cleaned stock at a rate sufficient to refurnish consumption. Blasting and other dust producing areas shall be kept separate from coating application areas. The surface cleaning shall be degree of cleanliness as per SA 21/2 & ISO 8502-3.

**FBE Powder**

The FBE powder selected shall be suitable for use at the design temperatures in the proposed environment and be suitable for a three layer polyethylene coating system. The FBE shall be endorsed by the Pipe Coating contractor of the adhesive and Polyethylene as being compatible with these products under the specified service conditions.

Each batch of FBE shall be accompanied by a certificate stating the following tests have been carried out on every batch and results are in accordance with the coating material manufacturer's product specifications;

- Gel Time
- Cure Time
- Moisture content
- Thermal analysis

**Adhesive**

The adhesive selected shall be completely suitable for use at the design temperatures in the proposed environment and be suitable for a three layer polyethylene coating system.

Each batch of adhesive shall be accompanied by a certificate stating the following tests have been carried out on every batch and results are in accordance with the coating material manufacturer's product specifications:

- Melt flow rate
- Vicat softening point
- Specific gravity

### Polyethylene

The polyethylene selected shall be of high density and shall be completely suitable for use at the design temperatures in the described environment. The polyethylene shall be suitable for a three-layer polyethylene can be stabilized against UV-rays before or after granulating the material.

Each polyethylene batch shall be accompanied by a certificate stating the following tests have been carried out on every batch and results are in accordance with the coating material manufacturer's product specification:

- Melt flow rate
- Specific gravity
- Moisture content
- Vicat softening point
- oxidation induction time

## 12.0 PROPERTIES OF EPOXY POWDER, ADHESIVE & POLYETHYLENE

MANUFACTURER shall choose such a brand of epoxy powder and adhesive that will achieve the functional requirement and properties of coating system as specified and shall submit a compatibility certificate in this regard from the manufacturer of materials. In absence of such certificate, compatibility test shall be conducted by the contractor by contractor at his own cost. In addition, the Manufacturer shall also furnish Infra-red Scan for each batch of epoxy powder. The coating materials Supplier shall issue test certificates as per EN 10204 for each batch of materials supplied to MANUFACTURER and the same shall be submitted to PURCHASER for approval prior to their use. Epoxy powder properties shall be as per CSA Z245.20.98 (latest revision). The color of epoxy powder shall be either green or dark red or any other color approved by COMPANY except grey color. Epoxy Powder shall have the following properties.

Sr. No	Properties	Unit	Requirements	Test Method
A	Gel Time	Second	24.0 seconds min	CSA-Z245
B	Density	g/L	1410 min	CSA-Z245
C	Particle Size Distribution			CSA-Z245
D	Moisture Content	%	Max 0.6	CSA-Z245
E	Thermal Analysis		Degree C	CSA-Z245
F	Infrared Scan			CSA-Z245
G	Cure Time	Second	Max. 120 sec.	CSA-Z245

3) Adhesive shall have the following properties.

Sr. No.	Properties	Unit	Requirement	Test Method
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a.	Adhesion	--	As per raw material manufacturer recommendation.	--
b.	Melt Flow Rate (190°C / 2.16 kg)	g/10 Minutes	Minimum 1.0 g/10 min.	ASTM D 1238 or DIN 53735
c.	Specific Gravity + 25°C	-	0.926 minimum	ASTM D 792
d.	Vicat Softening Point	0 <sub>c</sub>	100 0 <sub>c</sub> minimum	ASTM D 1525

#### 4) Properties of Polyethylene Compound

Sr. No.	Properties	Unit	Requirements	Test Method
a.	Tensile Strength @ + 25 °C	N/mm <sup>2</sup>	17 min	ASTM D638
b.	Melt Flow Rate (190°C / 2.16 kg)	g/10 minutes	0.25	ASTM D 1238 or DIN 53735
c.	Specific Gravity + 25°C	-	0.926 min. (MDPE), 0.941 min.(HDPE)	ASTM D 792
d.	Hardness @ + 25°C	Shore D	55 min.	ASTM D 2240
e.	Water Absorptions, 24 hours @ + 25 0C	%	0.05 mz.	ASTM D 570
f.	Volume Resistivity @ + 25 0C	Ohm-cm	10 <sup>15</sup> min.	ASTM D 257
g.	Dielectric Volt/sec rise @ + 250C	Volts/mm	30,000 min.	ASTM D 149
h.	Vicat Softening Point	0 <sub>c</sub>	110 min.	ASTM D 1525
i.	Elongation	%	600 min.	ASTM D 638
j.	Oxidative Induction Time in Oxygen at 2200C, Aluminum pan, no screen	Minutes	10 min.	ASTM D 3895
k.	Environmental Stress Crack Resistance (ESCR) (for F50) - Medium Density , Condition "C" - High Density, Condition "B"	Hours	300 300	ASTM D 1693
l.	Carbon Black Content	%	2 min.	ASTM D 1603

In addition to vendor's certificate, the MANUFACTURER shall draw samples from each batch of epoxy, adhesive and polyethylene in the presence of PURCHASER and the test for the following properties at the coating yard at least one week prior to its use, to establish compliance with the Manufacturer's test certificates.

- (A) Epoxy Powder: Gel Time, Cure Time, Moisture content, Thermal Characteristics (Tg1, Tg2, ΔH)
- (B) Adhesive: Specific gravity, Melt Flow Rate, Vicat Softening Point
- (C) Polyethylene: Melt Flow Rat, Specific Gravity, Vicat Softening Point, Moisture content, Oxidative Induction Time.

In Case of the failure of any of the above tests in a batch, that batch of material shall be tested for all other tests required including the tests which failed. If all tests pass, the batch shall be accepted for coating. If any of the tests fail, entire batch of material shall be rejected and shall not be used for the coating.

MANUFACTURER shall ensure that all coating materials are properly stored in accordance with the Manufacturer's recommendation at all times, to prevent damage and deterioration in quality prior to use.

Properties of coating System :

Sr. No.	Properties	Unit	Requirement	Test Method
a.	Bond Strength (using Type 2 Test assembly i.e. Dynamometer) @ Room temperature $\geq 20^{\circ}\text{C}$ @ $80\pm 3^{\circ}\text{C}$	N/cm	150 (Minimum) 30 (Minimum)	DIN 30670- Latest Version
b.	Impact Strength (Mon. of 30 impacts on body along the length. No breakdown allowed when tested at 25 Kv)	Joules per mm of coating thickness	7 min	DIN 30670- Latest Version
c.	Indentation Hardness - @ $23 \pm 3^{\circ}\text{C}$ - @ $80 \pm 3^{\circ}\text{C}$	mm	0.2 max 0.4 max	DIN 30670- Latest Version
d.	Elongation at Failure	%	300 min	DIN 30670- Latest Version
e.	Coating Resistivity (*)	Ohm-m <sup>2</sup>	$10^8$ min.	DIN 30670- Latest Version
f.	Heat Ageing (*)	-	Melt Flow rate shall not deviate by more than 35% of original value	DIN 30670- Latest Version
g.	Light Ageing (*)	-	Melt flow rate shall not deviate by more than 35% of original value.	DIN 30670- Latest Version
h.	Cathodic Disbondment - @ $+ 65^{\circ}\text{C}$ after 30 days - @ $+ 65^{\circ}\text{C}$ after 48 hrs	Minimum radius of disbandment (**)	15 (Max) 7 (Max)	ASTM G42- Latest Version
i.	Degree of Cure of Epoxy - Percentage Cure, $\Delta H$ - $\Delta T_g$	% OC	95 +3/-2	CSA Z 245.20 – 98 (***)

(\*) Test carried out in an independent laboratory of national / international recognition of PE top coat is also acceptable.

(\*\*) Disbondment shall be equivalent circle radius of total unsealed area as per ASTM G 42.

(\*\*\*) Temperature to which the test specimens are to be heated during cyclic heating shall however be as per the recommendations of epoxy powder manufacturer.

The latest version of DIN 30670 shall be considered applicable.

## **Acceptance of Pipe Materials**

### **Identification and Tracking**

Upon receipt at the coating factory, the Pipe Coating Contractor shall record the following pipe information:

The unique pipe identification number, measured length, and measured weight (both to be found stenciled in paint on one end or the pipe).

This data shall be used as a basis for monitoring pipe from the time of receipt until the delivery of coated pipe.

The Pipe Coating Contractor shall identify (or maintain identification of) every coated item, by using a weatherproof mark on the inside of the pipe and on the outside of the coated item. The pipe identification shall be the unique pipe identification number (the number required by the applicable pipes specification). The pipe coating contractor may use additional tracking numbers at his discretion but these shall relate simply to the unique pipe number in the QC documentation.

Pipe tracking shall be carried out in accordance with approved procedures.

### **Preliminary Inspection**

The Pipe Coating Contractor shall carry out visual inspection of all pipes.

The Pipe Coating Contractor shall record all external damage on pipes against the unique item serial number. This damage shall be brought to the attention of the Engineer and the Pipe shall not be coated without prior release by Engineer.

Bevel protectors at each end of every pipe joint shall not be removed unless showing signs of damage or if removal is required to facilitate surface preparation, or they would be damaged by coating operations. If the protectors are removed the conditions of the bevel shall be recorded against the pipe serial number and any damage shall be brought to the attention of the Engineer.

### **Damage to Pipe and Pipe Ends and Repair**

No repair work shall proceed until a written procedure has been prepared by the Pipe Coating Contractor and approved by the Engineer.

Minor damage to pipe and pipe ends/bevels, identified either at time of receipt or after abrasive blasting shall be repaired by grinding. The number of such damages shall be not more than 3 per pipe. Repair by grinding on the pipe or pipe ends/ bevels outside diameter shall not reduce the wall thickness to less than the minimum requirements of the line pipe specification, when measured using ultrasonic thickness measurement equipment.

All other damage to pipe ends/bevels shall be advised to the Engineer for review. Subject to Engineer's approval, these defects may be repaired by removal of damaged pipe material and re-beveling. No welding on the pipe surface shall be allowed.

Pipe identification numbers shall be preserved during repair. Any reduction in pipe lengths shall be recorded in the relevant forms and files.

## **Prior to Coating Application Stages**



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The principle stages of pipe coating shall be as follows:

- Solvent cleaning followed by steam or hot bath cleaning (if required)
- Abrasive blasting
- Application of fusion bond epoxy (FBE) layer
- Application of adhesive layer
- Application of polyethylene layer

#### **Cleaning Prior to Abrasive Blasting**

All surface contaminants such as oil, grease, tar, salt, or other contaminants on the pipe shall be removed by solvent cleaning followed by steam or hot bath cleaning, in accordance with a procedure approved by the Engineer.

Following the steam or hot bath cleaning the pipe shall be tested for salt and chloride contamination in accordance with the requirements of DIN EN ISO 8502-2, ISO 8502-5 or DIN EN ISO 8502-9.

The removal of hydrocarbon contamination shall be confirmed by a water spray test, where a fine spray is applied to the surface and uniform wetting confirms the removal. This check shall be performed before and after blasting, as a pre-qualification test and as a minimum, once per 100 items during production, or when necessary.

Items found to be contaminated shall be cleaned as above and re-blasted if testing after blasting establishes that salt, chloride or hydrocarbon contamination is still present. The remainder of the batch concerned shall all be checked individually.

All water used for rinsing or cleaning purposes shall be potable with less than 200 ppm total dissolved solids and 50 ppm chlorides.

#### **Abrasive Blasting**

Blasting and other dust producing areas shall be separate from coating application areas.

After cleaning and prior to abrasive blasting the pipe lengths shall be free from moisture, dust, and grease and free from other foreign materials.

Abrasive and dust, which entered the inside of the pipe during blasting operation, shall be removed by suitable means.

Weld joints, sharp-edge projections; weld spatter and slag etc. shall be dressed prior to blast cleaning.

Using dry blasting techniques only, the exterior surface of the pipe joints shall be abrasively cleaned to remove all mill scale, and other impurities from the surface.

No blast cleaning shall take place when the prevailing relative humidity is higher than 85 percent unless pipe is preheated to at least 3° C above the dew point.

Twice per shift, samples of the abrasives mixture shall be removed from the hopper and checked for hydrocarbon contamination. The sample shall be placed in a beaker to which de-ionized water is added. The beaker shall then be sealed and shaken vigorously. Once the grit has settled the surface of the water shall be examined for signs of hydrocarbon contamination. If any signs are found all the abrasive in the hopper shall be rejected and not re-used.

Additionally, abrasive materials shall be checked at least once per shift to ensure that only uncontaminated angular grit with an acceptable size distribution is used.

As a minimum the following shall be carried out.

- Correct abrasive size distribution shall be carried out by sieve analysis.
- Placing a sample of abrasive on a clean, dry sheet of absorbent paper to determine water contamination.

The surface of the pipes shall be blasted until a finish of Grade 2.5 to DIN EN ISO 8501-1 is attained. The surface profile shall be between 50 to 75 microns, measured in accordance with

DIN EN ISO 8503-2. Profile measurements shall be made with a Keane Tator Profile Comparator, Testex Press –O-Film or other Engineer approved method suitable for the abrasive being used. Following abrasive blasting, the surface shall not be contaminated with dirt, dust, metal particles, hydrocarbons, water, chlorides, sulphates or any other foreign matter, which would be detrimental to the coating.

Prior to the coating application, the exterior surface shall be thoroughly inspected under adequate lighting. Any damage such as surface imperfections, slivers, scabs, burrs, gouges, or sharp edged defects, shall be repaired in accordance with this specification. Pipes that have damage repaired by grinding and have ground areas greater than 50 mm diameter shall be re-blasted to meet the requirements. After grinding or mechanical repairs the wall thickness shall be ultrasonically examined and compared with the minimum requirements of the applicable code / standard.

Any dust or loose residue that has accumulated during blasting and/ or grinding operations shall be removed by the use of clean compressed air or by vacuum extraction. Alternative methods for removing dust and lint shall require approval of the Engineer.

The elapsed time between the start of blasting and the heating of pipe shall be indicated in the application procedure submitted by the Pipe Coating Contractor and shall be reflected on his plant scheme.

The total elapsed time between the start of blasting of any pipe and the heating of that pipe to the specified temperature shall not exceed the following time-humidity table:

PERCENT RELATIVE HUMIDITY	ELAPSED TIME (HOURS)
85	0.5
80	1.0
70	2.0
60	2.0

Any pipe surface not processed within the above time-humidity table shall be completely re-cleaned and re-blasted before coating. The maximum time limit between blasting and coating for humidity below 60% shall be 4 hours.

Note : The Method of Blasting will be finalized at the time of execution based on site condition.

### 13.0 COATING APPLICATION

#### General

The application of the coating shall be in accordance with the material manufacturer recommendations and the procedure outlined below.

The Pipe Coating Contractor shall perform coating procedure qualification testing (PQT) prior to commencing production or on his own risk at the start of production in accordance with this specification.

Prior to start-up of the coating process the powder application and recovery systems shall be thoroughly cleaned to remove any powder other than that is use, minimum once per day and the collected powder shall be disposed off.

#### FBE Layer

The FBE shall be applied to a minimum thickness of 200 microns.

The pipe shall be uniformly preheated in accordance with the FBE manufacturer's instructions. This temperature shall have been confirmed during PQT. The surface temperature shall not exceed 260 deg C in accordance with AWWA C213.

Pipe temperature shall be checked periodically using pyrometer. The pyrometer shall be checked for error not less than every four hours against a calibrated temperature measuring instrument. The coating shall be applied by electrostatic spray with the pipe at earth potential and the epoxy powder charged to high potential.

The use of reclaimed FBE powder is only permitted if the reclaimed powder is screened to remove foreign or deleterious material before being reintroduced into the powder application system.

The clean reclaimed powder up to a maximum of 20% shall be introduced back into the fresh virgin material by means of proportional weight.

During application, the beveled ends and pipe bore shall be protected against mechanical damage and from contamination with coating material.

#### **Adhesive Layer**

The adhesive shall be applied to a thickness of 200 microns.

The adhesive layer shall be applied before gel time of the FBE has expired. Application of the adhesive shall not be permitted after the FBE has fully cured. The Pipe Coating Contractor shall establish to the satisfaction of the Engineer that the adhesive is applied within gel time window of the FBE and at the temperature recommended by the adhesive manufacturer. The Pipe Coating Contractor shall state the proposed minimum and maximum time interval between FBE and adhesive applications at the proposed pre-heat temperature.

#### **Polyethylene Layer/Cutback**

The polyethylene layer shall be applied to a minimum thickness as per DIN 30670 over the pipe body and to a minimum of 90% body thickness over the production welds.

Nominal Size	Minimum Thickness in mm	
	Normal (n)	Increased (v)
≤ DN 100	1.8	2.5
> DN 100 to ≤ DN 250	2.0	2.7
> DN 250 to < DN 500	2.2	2.9
≥ DN 500 to < DN 800	2.5	3.2
≥ DN 800	3.0	3.7

A polyethylene layer cutback of 150 mm (+10/-10mm) shall be provided at pipe ends.

Cutback length shall be protected by PVC end seal tape from approved vendor after surface preparation to preserve surface cleanliness and prevent surface rusting.

The polyethylene shall be applied over the adhesive within the time limits established during pre-production testing.

The coating shall be cooled to below 60 deg C before handling.

The ends of the coating shall be chamfered and beveled to 30 to 45 deg

Immediately after the coating is fully cured, pipe identification marks shall be re-applied on the coated pipe using a method approved by Engineer.

## **14.0 INSPECTION, TESTING AND CERTIFICATION**

### **GENERAL**

In order to demonstrate that the manufacturer's proposed coating procedure is capable of meeting the specification, the Pipe Coating Contractor shall undertake coating procedure qualification testing (PQT) prior to commencing production, or at his own risk at the start of production. The pipe coating Contractor shall also be required to test the finished coating during

production to demonstrate continued compliance with this specification. Details of all inspections and testing shall be fully documented in accordance with this section.

All states of the surface preparation, coating and testing shall be subject to 100% inspection by the Pipe Coating Contractor. The Engineer shall be informed at least two weeks prior to the start of surface preparation to allow scheduling of inspection supervision work.

### Coating Procedure Qualification Testing (PQT)

Prior to commencing or at the start of full production, 10 nos. pipes shall be selected for PQT. Out of 10 nos. pipes, five pipe joints of each diameter coated with FBE only and five pipe joints of each diameter with the full coating system shall be selected for PQT and one pipe shall be partially coated with Epoxy and adhesive. All coating shall be in accordance with the coating procedure specifications and shall be witnessed by the Engineer or its representative.

The produced pipes will not be released until the successful results of the PQT can be provided. In case of long-term tests the PQT report shall be updated once the results can be provided. Any failure in meeting the specified acceptance criteria for the PQT will result in rejection of the coated pipes. Engineer shall approve any remedial action, repairs or re-use.

The test methods for all tests required for PQT on the FBE and the complete coating system shall be performed in the same manner as the production tests described in this specification.

Pipes selected for PQT testing shall pass all the criteria containing before production commences. Any change in the coating material or coating procedure shall require re-qualification.

If any of the tests fails to meet the minimum acceptance criteria defined in this specification, then the pre-qualification pipes shall be rejected. Further pipes may be prepared and coated using revised procedures and further tests performed. Once acceptable results are obtained and approved by Engineer, the Pipe Coating Contractor's quality plan and procedures shall be revised, and submitted to the Engineer for approval. All items coated using the rejected procedures shall be striped and recoated to the revised procedures.

### PQT Inspection and Test Summary

Inspection and testing summary for procedure qualification test (PQT) for three layer coating system for each pipe diameter:

Sr No	property	Acceptable Values	Frequency of tests
1	On arrival		
	Visual inspection	No defect and damage	Each pipe
	Oil contamination	No oil contamination	Each pipe
2	After abrasive blasting		
	Degree of cleanliness	SA 2.5	Each pipe
	Surface roughness profile	50 – 75 $\mu\text{m}$	Each pipe
	Chloride test	2 mg/cm <sup>2</sup>	Each pipe
	Dust contamination	Maximum rating 3	Each pipe
	Quality of abrasive mix	No hydrocarbon	Twice per day
3	FBE and Adhesive		
	FBE Layer thickness	Min 200 micron	Once in party coated
	Adhesive layer thickness	Min 200 micron	Once in partly coated
	Holiday test	No holiday	Each pipe

	'X' cut adhesion test	Any disbondment shall be ignored	Each pipe
4	3LPE Coating		
	Coating thickness	Min. 3 mm on body and 2.7 mm on weld	Each pipe
	Visual inspection	Free from any scratches and pin holes having uniform color finish	Each pipe
	Holiday inspection	No holiday	Each pipe
	Impact strength	No holiday on impact area	Each pipe
	Elongation	Min 300 %	2 nos per pipe
	Cathodic disbondment	As specified	2 nos per pipe
	Indentation hardness	Maximum 0.2mm at 23±5°C & Maximum 0.3mm at 70±2°C	2 nos per pipe
	Peel test at both end	>100 N/cm minimum at 23±5°C >50 N/cm minimum at 50±5°C	2 nos per pipe

**PRODUCTION TESTING**

5) Production testing shall be performed at the frequency shown below:

Sr No	property	Acceptable Values	Frequency of tests
1	On arrival		
	Visual inspection	No defect and damage	Each pipe
	Oil contamination	No oil contamination	1 in 50 pipes
2	After abrasive blasting		
	Degree of cleanliness	SA 2.5	Each pipe
	Surface roughness profile	50 – 75 µm	1 in 20 pipes
	Chloride test	2 mg/cm <sup>2</sup>	Each pipe
	Dust contamination	Maximum rating 3	1 in 20 pipes
	Quality of abrasive mix	No hydrocarbon	Twice per day
3	FBE and Adhesive		
	FBE Layer thickness	Min 200 micron	Twice per shift
	Adhesive layer thickness	Min 200 micron	Twice per shift
	Holiday test	No holiday	Twice per shift
	'X' cut adhesion test	Any disbandment shall be ignored	Twice per shift
4	3LPE Coating		
	Coating thickness	Min. 3 mm on body and 2.7 mm on weld	Each pipe
	Visual inspection	Free from any scratches and pin holes having uniform color finish	Each pipe
	Holiday inspection	No holiday	Each pipe

	Impact strength	No holiday on impact area	Each pipe
	Elongation	Min 300 %	2 nos per pipe
	Cathodic disbondment	As specified	1 pipe last pipe and 1 in 500 pipes
	Indentation hardness	Maximum 0.2mm at 23±5°C & Maximum 0.3mm at 70±2°C	Twice per day
	Peel test at both end	>100 N/cm minimum at 23±5°C >50 N/cm minimum at 50±5°C	1 in 25 pipes at both end

The frequency of tests shown in the table above will be for normal production operations. This frequency of tests is subject to change at the discretion of the Engineer as a result of change of materials or consistent poor production performance.

## HOLIDAY DETECTION

### FBE Layer:

The FBE coating shall be 100 % holiday tested with a pulse type DC holiday detector equipped with audible signaling device. The test shall be carried out in accordance with NACE RP0490 or equivalent.

### FINAL COATING:

Each fully coated pipe shall be inspected for holidays over 100 percent of its coated surface using a high voltage DC detector.

The detector shall be a type, which maintains complete contact with the coating. It may be either constant or pulsed voltage type. If constant voltage type, holiday detection shall be carried out on a dry coating. The operating voltage between electrode and pipe shall be checked at least twice per working shift, and shall be maintained at 10 kilovolt/mm of coating thickness.

The Pipe Coating Contractor shall demonstrate to the Engineer that the setting of the detector is satisfactory for detecting pinhole defects. This setting shall be checked once every two hours. The correct travel speed shall be determined by consistent detection of an artificial pinhole made in a good coating sample but shall not exceed 300 mm/s.

All holidays and other detects shall be marked for subsequent repair and re-testing. On retesting, no holidays shall be permitted in the final coating.

The number of holidays for each pipe length shall be recorded. Coated pipe having holidays in excess of 1 per 1 square meter shall be stripped and re-coated.

If there is an excess occurrence of holidays on successive pipes, the Pipe Coating Contractor shall immediately stop the coating operation to determine the cause and remedy it.

## 15.0 ADHESION (PEEL) TEST

### FBE Layer:

With a sharp narrow bladed knife, two incisions (approximately 13 mm long) shall be made, in the form of an X. through to the metal substrate. At the intersection of the X. an attempt shall be made to force the lining from the steel substrate with the knife point. The point of the knife shall be inserted horizontally i.e., the flat of the blade under the lining at the point of intersection of the X such that the blade point is on the metal surface. Using a levering action, the flat point shall be forced away from the steel in an attempt to pry off the coating. Refusal of the lining to disbond from the substrate shall be recorded as a pass. A pass shall also be recorded where the lining fails cohesively. Partial or complete adhesive failure between the lining and the substrate shall be

recorded as a failure. Disbondment at the point of the intersection is common due to the action of marking the 'X' cut. Therefore for 1 mm away from the tip of the intersection any disbandment shall be ignored.

**Final Coating:**

The adhesion for the complete coating shall be determined in accordance with the requirements for bond strength in DIN 30670. The relevant test temperature and acceptance criteria for these tests shall be as specified. Automatic chart recording equipment shall be used and the average peeling force shall be recorded.

The failure mode shall be recorded. The failure should occur at the adhesive/polyethylene interface or adhesive/FBE interface or cohesively in the polyethylene layer. If failure should occur at the FBE/steel interface this will be considered a total failure of the system.

**Impact Test**

A sample or coated pipe shall be impact tested in accordance with the procedures and acceptance criteria of DIN 30670.

**Resistance to Indentation Test (Indentation Hardness)**

Once per shift (and when the FBE or polyethylene batch is changed), the indentation hardness of two coated samples shall be measured (at  $23\text{oC} \pm 5\text{oC}$  and  $70\text{oC} \pm 2\text{oC}$ ) in accordance with DIN 30670

Indentation depth shall not exceed 0.2mm at  $23\text{oC} \pm 5\text{oC}$  or 0.3mm at  $70\text{oC} \pm 2\text{oC}$ .

**Percentage Elongation at Failure**

This test shall be conducted in accordance with DIN 30670 on each of the full system pre-qualification pipes, but at least the coating of three pipes shall be tested for elongation at failure, from which five test pieces shall be taken. The percentage elongation at failure shall be at least 300% - on each of the full system pre-qualification pipes, 2 samples per pipe to the requirements of DIN 30670.

**Other DIN 30670 Tests**

The Pipe Coating Contractor shall demonstrate, for the same system to be applied for this order, attainment of DIN 30670 requirements for Coating Resistivity, to Thermal Ageing and Light Ageing as required by DIN 30670.

**CATHODIC DISBONDMENT TEST**

Cathodic Disbondment testing shall be conducted:

As a pre-qualification test - 48 hours duration at  $65 \pm 2\text{oC}$  as a pre-qualification test - 28 days duration at  $23 \pm 2\text{oC}$

As a production test - 48 hours duration, at the frequency of one test per 50D coated pipes at  $65 \pm 2\text{oC}$

The test requirements shall be in accordance with ASTM G 8.

The final unsealed diameter (including the initial holiday diameter of 6.35 mm) shall not exceed 15 mm. This shall apply to both, the 28 day test at  $23 \pm 2\text{oC}$  and the 2 days test at  $65 \pm 2\text{oC}$ .

The Pipe Coating Contractor may propose alternative Cathodic disbondment test standards provided the essential requirements of this specification are retained. Any such alternatives shall be submitted to the Engineer for review and approval.

Every 24 hours the applied voltage and current flow shall be recorded. Any drift from the specified voltage setting shall be corrected

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**DESTRUCTIVE TEST**

A sufficient length of production pipe shall be cold cut to provide the required number of samples for conducting the coating destructive tests listed in this specification.

Items that fail individual tests and that cannot be repaired shall be rejected. Subject to the approval of Engineer, the rejected coating shall be stripped and the joint shall be re-blasted and coated in the manner specified for new pipe in this specification.

Where a test relates to a quantity of coated items, e.g. 1 per 50 items or 1 per 100 items etc., the quantity or items represented by the item tested (e.g. 50 or 100) shall be considered to be a batch.

If a test on an item in a batch fails then this item shall be rejected and two further items shall be randomly selected from the batch for repeat testing. If either of these tests fails then the whole batch shall be quarantined for review by Engineer. The cause of failure shall be established and reported to the Engineer and if deemed necessary by the Engineer the coating procedure shall be amended and re-qualified. The Engineer will decide whether the whole batch is rejected and sent for re-blasting and re-coating or whether acceptance may be on the basis of acceptable tests carried out on individual items.

**COATING REPAIRS**

The Pipe Coating Contractor shall submit detailed coating repair procedures for approval by Engineer. These shall include procedures for repair or 'pin-hole', 'small area' and 'large area' defects. The minimum and maximum areas for which each type of repair is applicable shall be stated taking into consideration the below mentioned requirements.

The maximum number of coating defects allowable, before a joint of pipe shall be classed as rejected and recoated, shall not exceed 1 per 1 square meter (exclusive of damage caused by testing).

**Repair areas of sizes < 5 mm<sup>2</sup>**

Pinhole damage shall be repaired by cleaning with an emery cloth followed by application of a two (2) pack epoxy repair kit or an approved hot melt mastic smoothed flush with the polyethylene surface. If the mastic is used, it shall be spread with the aid of a hot air or a propane torch.

**Repair areas of sizes > 5 mm<sup>2</sup> up to < 250 mm<sup>2</sup>**

The area shall be cleaned with solvent and abraded with an emery cloth to ensure that the surrounding polyethylene is well bonded, the surface shall be roughened for a distance of at least 25 mm beyond the damage area. Approved hot melt mastic shall be applied to the damage area and smoothed flush. The mastic and surrounding area shall be warmed with hot air or propane torch until the surrounding polyethylene has a slight sheen. An approved polyethylene patch material shall be applied overlapping the damage but not overlapping the pre-abraded areas. Torch heat and smoothing pressure shall be applied to fuse the patch and ensure that no blisters are formed.

**Repair areas of sizes 250 mm<sup>2</sup> up to 625 mm<sup>2</sup>**

Heat shrink-wrapping pipe sleeves shall be used for repair according to the following procedure:  
Thoroughly clean the area to be coated

Bevel the extremities of the mill-coating with a rasp Pre-heat the area to be coated to a temperature of approximately 700C.

Install the sleeve over the area to be coated

Warm the shrink sleeve to a temperature above 1500C with a propane torch or a warm-air ring.



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**Repair areas of sizes exceeding 625 mm<sup>2</sup>**

No single defect shall exceed an area or 625 mm<sup>2</sup>. Pipes with a coating defect exceeding 625 mm<sup>2</sup> shall be cause for rejection and shall be subsequently rejections and recoated. All rejections shall be recorded.

Repairs shall provide a finished coating equal in effectiveness to that of the parent coating. The limit of the repair area shall be revised.

Each repaired area shall be holiday inspected in accordance as specified.

The Pipe Coating Contractor shall submit coating stripping procedure for pipes rejected for coating quality. The rejected coating may be stripped by heating in an oven. Under these circumstances, the temperature of the pipe joint shall not be allowed to rise above 400 °C.

**16.0 HANDLING, TRANSPORT AND STORAGE**

The Manufacturer shall be responsible for any damage occurring to the pipes from unloading to reloading on the relevant transportation means.

The Manufacturer shall consequently:

inspect the bare pipes upon delivery to check that they have suffered no previous damage, take all necessary precautionary measures to prevent any deterioration during the following operations:

- handling,
- transfer to storage yards.
- storage,
- loading of pipes for shipment.

All repairs and inspections shall be at the Manufacturer's expense.

**Handling**

The pipes shall be handled without causing damage to the pipe bevels and coating.

Direct contact steel or hamp slings or with any material whose shape or nature may deteriorate the pipe coating shall be strictly prohibited. Polyamide slings or hooks fitted with thermoplastic protection may be used.

Use of electromagnetic device is recommended.

**Transfer to Storage Yard**

During transport of pipes to the storage yard of the Manufacturer, the latter shall take all their required measures to avoid pipe and coating damage.

**Storage Yard of the Manufacturer**

Stockpiling of coated pipes shall be made so as to avoid any deterioration of coating. Coated pipes, when non concrete weight coated, shall be protected against ultraviolet rays action in particular.

**Pipe Loading for Shipment**

When loading the coated pipes for shipment, the Manufacturer shall take all necessary measures to avoid the deterioration of pipes and coating during handling and transport.

**End Caps**

If the bare pipes have been delivered to the Manufacturer with end caps, these end caps or new ones) should be fitted again on the pipe ends after coating if required in the CONTRACT.

**REPAIR OF COATING**

MANUFACTURER shall submit to PURCHASER, its methods and materials proposed to be used for executing a coating repair and shall receive approval from PURCHASER prior to use. In open storage the repair materials must be able to withstand a temperature of at least (+) 80°C without impairing its serviceability and properties. MANUFACTURER shall furnish manufacturer's test certificates for the repair materials clearly establishing the compliance of the repair materials with the applicable coating requirements indicated in this specification.

All repair material will be of Class C.70 as specified in the relevant DIN Standard.

All pipe coating plan, shall have sound external with no holiday or porosity on 100% of the surface.

Defects, repairs and acceptability criteria shall be as follows:

Pipes showing porosities or very small damage not picked up during holiday test and having a surface less than 0.5 cm<sup>2</sup> or linear damage (cut) of less than 3 mm shall be repaired by stick using material of same quality.

Damages caused to coating by handling such as scratches, cuts, dents, gouges, not picked up during holiday test, having a total reduced thickness on damaged portion not less than 2 mm and an area not exceeding 20cm<sup>2</sup> shall be rebuild as per approved method and without exposing to bare metal.

Defects of size exceeding the above and mentioned area of or holidays of width less than 300 mm shall be repaired as per approved method by exposing the bare metal surface.

Defect exceeding the above and in number not exceeding 2 per pipe and their length not exceeding 500 mm shall be repaired as per approved method.

Pipes with bigger damage shall be stripped and recoated.

In case of coating defect close to coating cut back, MANUFACTURER shall remove the coating throughout the entire circumference of the pipe down to the steel surface and increase the coating cut back length. Now, if the coating cut back exceeds by 30 mm than the specified cut back length, then the coating shall be repaired as per approved method thereby making up the coating cut back length as per specification.

In case the defect exceeds 70 mm from the original coating cut back length, the entire coating shall be removed and the pipe shall be recycled through the entire coating procedure.

Irrespective of type of repair, the maximum number of repair of coating shall be as follows:

Holiday repair of size  $\leq 100$  cm<sup>2</sup> attributable to process of coating application shall be maximum one number per pipe.

In addition to the above, defects to be repaired as per approved method shall be maximum 2 (two) per pipe.

Defects exceeding the above limits shall cause pipe coating rejection, stripping and recoating. The above is exclusive of the repairs warranted due to testing as this specification.

All repairs carried out to the coating for whatever reason shall be to the account to MANUFACTURER.

Cosmetic damages occurring in the polyethylene layer only need not be repaired by exposing up to steel surface, as deemed fit by the Purchaser. In any case the Manufacturer shall establish his material, methods and procedure of repair that result in an acceptable quality of product by testing and shall receive approval from Purchaser prior to use.

Testing of repairs shall be in the same form as testing coating. All repairs shall result in a coating thickness no less than the parent coating thickness.

Manufacturer shall test repairs to coating as and when required as and when required by Purchaser.

## **REPAIR MATERIAL**

HTPL-80, PERP 80 PERP FILLER, S 1239 Epoxy or Canusa GTS-80, CRP 80 Mastic Filler, S/E/liquid epoxy and then should be followed by or equivalent material to be qualified by the material manufacturer and approved by Purchaser.

Any combination of epoxy, adhesive and polyethylene shall be tested and certified by an internationally recognized agency.

In case the Manufacturer proposed coating material other than above e mentioned combination of epoxy, adhesive and polyethylene, coating procedure and qualification need to be carried out by an internationally recognized agency by the coating material Manufacturer.

All materials to be used shall be supplied in sealed, damage free containers and shall be suitable marked with the following minimum information:

- a) Name of the Manufacturer
- b) Type of Materials
- c) Batch Number
- d) Place and Date of Manufacture
- e) Shelf Life/Expiry Date (if Applicable)
- f) Quantity

All materials noted to be without above identification shall be deemed suspect and shall be rejected by Purchaser. Such materials shall not be used for coating and shall be removed from site and replaced by Manufacturer at his expense.

## 17.0 INTERNAL COATING: SOLVENT FREE FOOD GRADE EPOXY LININGS

### GENERAL

All steel pipes and fittings outside the pumping station shall be internally lined with a spray applied solvent free epoxy approved for contact with potable water under the United Kingdom Water Regulations Advisory Scheme authorized for use under Regulation 31 (4)(a) of the water supply (Water Quality) Regulations 2000 for contact with potable water. The applicable specifications for the coating system shall be in accordance with BS 6920/NACE RP-01-75/AWWA C210-97/CAN-CSA Z 245:21 or clients specifications.

### Internal coating system

The internal food grade solvent free epoxy coating system of chemically cured resin(epoxy) & hardener(curing agent) mixed in the ratio as recommended by the manufacturer and applied to a dry film thickness of minimum 406 micron. Physical properties of internal coating material as follows.

Sr No	Property	Requirement	Test method
1	Long term contact with potable water	Long term contact with potable water. No effects for human consumption as certified by NSF	NSF/ANSI 61
2	Thickness	406 micron min.	SSPC-PA-2
3	Dielectric strength	450 V/mil	ASTM D149
4	Hardness shore D	85 min.	ASTM D2240
5	Adhesion to steel	800 psi min.	ASTM D4541
6	Tabor abrasion	1560 cycles/min	ASTM D4060
7	Compressive strength	70 MPA	ASTM C109

## Coating Application

### General

All internal epoxy lining work for main pipeline shall be done in coating plant using two component airless plural spray machine. For internals of bends, short section of pipes, tees, fittings etc., internal epoxy will be manually spray applied either in the coating plant or in the field using suitable two component airless plural spray machine. Internal field joint coating shall be spray/ brush applied. The internal epoxy lining shall be applied only on blasted steel surface. Pipe Preparation Internal surface of the pipe shall be free from mud, mill scale, mill lacquer, wax, oil, grease or any other foreign material. Before blast cleaning, surfaces shall be inspected and pre-cleaned according to SSPC-SP 1 to remove oil, grease and loosely adhering deposits. Visible oil and grease spots shall be removed using a solvent. Only solvents that do not leave a residue shall be used. Preheating to remove oil, grease, and mill scale may be used provided that all pipes is preheated in a uniform manner to avoid distortion. After drying and removing all loosely adhering foreign materials, the pipe surface shall be cleaned by blasting with grit or steel shots to achieve a surface preparation at least equal to SA 2.5 that specified in BS 7079/ISO 8501-1:2007. The blast anchor pattern or profile depth shall be 2 mils to 3 mils (50  $\mu$ m to 75  $\mu$ m) measured in accordance with ASTM D-4417 and/or ISO 8503-4. For consistent surface finish, a stabilized working mix shall be maintained in abrasive recycling blasting machines by frequent small additions of new grit, shot infrequent large additions shall be avoided. The abrasive working mix, abrasive recycling blasting machines shall be maintained clean of contaminants by continuous effective operation of blasting machine scalping and air-wash separators. The cleaned interior pipe surface shall be inspected for adequate surface preparation. Surface imperfections such as slivers, scabs, burrs, weld spatter and gouges shall be removed by hand filing or grinding if necessary to prevent holidays. Blast-cleaned pipe surfaces shall be protected from conditions of high humidity, rainfall or surface moisture. No pipe shall be allowed to flash rust before coating. To ensure a dry pipe surface at the time of liquid epoxy application, the minimum steel substrate temperature shall be 10°C and at least 3°C above the dew point.

### Coating Application A. Main Pipe Line

**Application temperature** The temperature of the mixed coating material and of the pipe at the time of application shall be not lower than 10°C. Preheating of the coating material by using in line heaters to heat the coating material may be used to facilitate the application. Heating shall conform to the recommendations of the epoxy coating manufacturer. **b. Application of epoxy** The epoxy shall be applied directly to the abrasive roughened steel surface pipe using a hot plural component airless spray equipment with all necessary ancillary equipment like spraying boom etc, in accordance with the epoxy coating manufacturer's recommendations. Pipe will be rotated at a suitable speed and the boom of the spray machine carrying the spray gun will travel inside the pipe at a predetermined speed to ensure that thickness of minimum 406 microns is achieved in one single spray application. Alternatively, fixed boom & spray machine with moving pipe with predetermined speed to achieve minimum thickness of 406 micron in a single spray is also accepted. **c. Curing** After application of epoxy, curing of the epoxy shall be natural air convection. Typical dry time of the epoxy at ambient temperature of 25 - 40°C shall be between one hour to three hours. Shore D hardness of the epoxy after 10 hours shall be > 65. **d. Internal coating cutback** Internal coating cutback on either side of the pipe shall be 150 mm.

## MATERIALS & WORKMANSHIP

The coating system shall be factory lined and the lining shall be suitable for application in an environment with black bulb temperature up to 85 deg C. Coating materials shall be of GWSSB approved make only.

All steel pipes shall be lined at the factory. Pipes welded on site shall be lined on site to the same standards as for pipes.

Detailed proposals of the lining method, materials and apparatus to be used for both factory and site application shall be submitted to and approved by the Engineer before work starts. Storage and application shall be accordance with recommendations of the coating manufacturer, but as a minimum:

A visual examination of the surface to be coated shall be carried out and any slivers or similar deposits removed.

Prior to blasting all oil and grease shall be removed from the surface to be coated.

Preparation of steel surfaces for both factory and site application shall be to a minimum of Sa 2.5 accordance with BS 7079/ ISO 8501-1:2007 specifications /or as per client specifications and roughness should be 50-75 micron.

The surface to be coated shall be dry, clean and free from foreign material and coating shall take place before any surface rusting and at least within 4 hours of blasting.

Surface preparation and coating shall not be carried out when the relative humidity exceeds 85% or when the surface to be coated is less than 3 deg C above the dew point.

The coating shall have a minimum DFT (Dry Film Thickness) of 406 microns.

Coatings shall be used within the pot life specified by the manufacturer.

Pipe linings shall be inspected on site, and damaged, defective or otherwise unsatisfactory linings may be condemned. All defective areas shall be made good to the satisfaction of the Engineer.

Inspection and testing shall be detailed in the contractors Quality Plan and as a minimum undertaken to the following frequencies:

Visual Inspection of blasted profile on every pipe to be coated.

Visual inspection of finished coating on every pipe.

Measurement of coating thickness at four points on each pipe.

Each completed pipe shall be subjected to holiday detection tests which shall be carried out to the satisfaction of the Engineer. The applied voltage shall be those appropriate to the coating under test as recommended by the coating material manufacturer.

Peel Test as per Manufacturers standard specification shall also carried out.

## **PRESERVATION, MARKING AND SHIPPING PRESERVATION**

### **Preservation**

Cutback of minimum 150 mm +/- 10mm shall be provided over both ends of pipes on internal coating . The bare ends of each pipe shall be painted outside with a removable varnish as temporary corrosion protection during transportation.

Spiders and Bevel protectors of a type to be approved by the Engineer shall protect the bare ends of each pipe. Spiders shall be welded with pipes in such a way that inside coating do not get burnt.

### **Marking**

In addition to the marking required by API 5L, the specification MO1 "Steel Pipes for Mainlines and other applicable project specifications, the Pipe Coating Contractor's unique coating number shall be marked to the internal surface or the pipe with synthetic resin paint.

Further marking details like color coding etc. shall be agreed upon with the Engineer.

The marking shall have at least a distance of 150 mm to the pipe end.

**Shipping**

Shipping and Loading preparation shall be in accordance with API Specification 5L or otherwise stated in the contract documents.

The Pipe Coating Contractor shall submit detailed loading, stacking- and shipping procedures for approval by the Engineer.

**18.0 DOCUMENTATION****Pre-Production Documentation**

The Pipe Coating Contractor shall submit the following documents to the Engineer for approval prior to commencing production:

The manufacturer's trade name and data sheets for all proposed coating Materials. This includes cleaning and abrasive blasting consumables.

Procedure for identifying or maintaining the identification of each coated item.

Handling procedure.

Stacking procedure.

Materials control and traceability procedure for the batches of coating materials.

Materials storage procedure (pipe and coating materials)

Procedure for steel surface preparation including materials, cleaning, inspection, verification of cleanliness and surface profile.

Coating application procedures, including fusion bonded epoxy (FBE). Adhesive and polyethylene layers.

The results of the batch tests for batches to be used for pre-qualification tests.

Details of testing methods including instrument types and copies or current calibration certificates.

Details of inspection methods for bare and coated pipe.

Full test results from the coating Procedure Qualification Test (PQT).

Repair procedure and results or tests on demonstration of repairs.

Project specific Quality Plan.

Work shall not commence until these procedures have been reviewed and approved by the Engineer.

The selection of proposed coating materials shall be subject to Engineer's approval.

**Production Records**

A daily log containing the following data shall be maintained and be available for inspection by the Engineer during and/or after production. Data shall be recorded against the pipe unique identification number.

- a) Bare pipe inspection data
- b) Ambient temperature (every 4 hours)
- c) Humidity (every 4 hours)
- d) Coating progress (no. of items coated, including item serial numbers)
- e) Blast pipe surface amplitude
- e) Tests for cleanliness of blast surface
- f) Tests for cleanliness of blast medium
- g) Film thickness measurements
- h) Average, maximum and minimum coating thickness during each shift
- i) Details of any coating defects recorded and defect density on respective pipe lengths
- j) Details of any coating repairs
- k) The unique identification number of all items that are stripped for recoating
- l) Pipe coating test results

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This log shall be available to the Engineer throughout all coating operations

**Release Documentation**

The Pipe Supplier and/or Pipe Coating Contractor shall submit to the Engineer the following documentation in hard copy and softcopy (format to be agreed upon with the Engineer) with each batch of pipes released:

- a) Mill certificates for line pipe
- b) Production listing for each batch
- c) Unique pipe identification numbers
- d) Unique coating identification number (if different)
- e) Pipe length
- f) Length of the coated portion of each pipe and total coated lengths of all pipes.
- g) Reductions in lengths due to use in tests, damage or repairs, recorded against pipe unique identification number
- h) Date of coating
- i) Batch numbers of coating materials used

This shall be followed within two weeks by the following:

- a) Manufacturer's certificates for each batch of coating materials
- b) Certification/calibration certificates for all testing and coating equipment
- c) Inspection and test records, results, and other documentation of all materials and coating tests

All reports shall be signed by the Pipe Coating Contractor to signify compliance with the requirements of this specification.

**19.0 TRANSPORTING OF PIPES, SPECIALS etc.**

All pipes and specials fabricated in the site factory / workshop and temporarily stacked in the Contractor's yard shall be transported to the site of laying after cleaning them internally etc. The loading in the factory shall be carried out by means of either a crane, gantry or shear legs, so as not to cause any damage to the finished material. Similarly, while unloading and stacking, great care shall be taken to ensure that the material is not damaged or dented. The contrivances to be used for unloading will be different in different situations and in each case the one approved by the Engineer shall be adopted. The material stacked at site shall be jointly inspected by the Engineer and the Contractor and defect or damage noticed shall be repaired to the satisfaction of the Engineer before payment is admitted.

Props of approved designs for maintaining circularity having M.S. Angle/Pipe at both ends to avoid metal to metal contact shall be fixed to the pipes during transit to avoid undue sagging and consequent distortion. After the pipes are carefully stacked, props should be retained till pipes are joined in trenches and then props are re-used for subsequent similar operations. The stacking ground, both in the Contractor's yard and at the site of laying shall be selected in such a way as not to get waterlogged during monsoon. If this cannot be done, the pipes shall be supported on sleepers to avoid contact with wet earth and subsequent rusting. In order to prevent sagging during transit, savings of steel Coils can be utilized by cutting to the required length and tacking the same to the pipe ends, in place of props, if approved by the Engineer.

As explained in earlier paragraphs, materials such as pipes, tapers, etc. may be transported to the site of laying as soon as the material is finished in all respects with the permission of the Engineer to avoid congestion in the Contractor's yard. However, materials such as expansion joints, composite bends, 'T' branches and other complicated materials shall be stacked in the

Contractor's yard until they are required for laying in the field. In view of this, the work of fabrication of such materials shall be properly synchronized as far as possible with the laying operations.

Fabricated materials such as specials, appurtenances, bolts, nuts, distance pipes, flanges, saddles, collars bypass arrangements etc. shall be transported to the site of laying from the fabrication shop according to the needs of the laying operations only. In regards access roads, the Contractor shall note that access road may lead up to some points on the alignment the Contractor shall have to make his own arrangement for connecting approaches to transport the pipes cross country to the actual site of laying at his own cost. Whatever may be the mode of transport he uses it shall be incumbent on the Contractor to carry and stack the pipes and specials along the alignment as close as possible to the site of laying.

## **20.0 PROCEDURE FOR RECEIVING STEEL PIPES**

### **General**

To ensure that the work of erecting pipes is not held up at any stage and place, the Contractor shall maintain an adequate stock of standard specials, flange rings, plug Coils, manhole covers, etc. and short length of smaller diameter pipelines, etc. at site in his field stores, in consultation with the Engineer. Wherever possible, the Contractor shall arrange one full month's requirement of pipes, specials, etc. stacked along the alignment.

### **Stacking of Pipes, etc. and Inspection**

The Contractor shall keep in each section a responsible representative to take delivery of the pipes, specials and appurtenances, etc. transported from the fabricating stockyard or received from any other work site to the site of laying and to stack along the route on timber skids. Padding shall be provided between coated pipes and timber skids to avoid damage to the coating. Suitable gaps in the pipes stacked shall be left at intervals to permit access from one side to the other. The pipes, specials, appurtenances so received on site shall be jointly inspected and defects recorded, if any, such as protrusions, grooves, dents, notches, damage to the internal coating etc. shall be pointed out immediately to the Engineer at the site and in the acknowledgement challans. Such defects shall be rectified or repaired to the satisfaction of the Engineer entirely at the Contractor's risk and cost.

### **Handling of Pipes, Special Appurtenances etc.**

It is essential to avoid damage to the pipes, fittings and specials, etc. or their coatings at all stages during handling. The pipes and specials shall be handled in such a manner as not to distort their circularity or cause any damage to their surface treatment. Pipes shall not be thrown down from the trucks nor shall they be dragged or rolled along hard surfaces. Slings of canvas or equally non-abrasive materials of suitable width of special attachment shaped to fit the pipe ends shall be used to lift and lower coated pipes to prevent damage to the coating.

Great care shall be taken in handling the pipe right from the first operation of manufacture until they are laid and jointed. The Contractor will provide temporary props as described earlier in order to prevent any sagging of the pipes while they are stacked in their yard and while transporting to the site of delivery, i.e. laying. The props shall be retained until the pipes are laid and welded. If at any time these props are found to be dislodged or disturbed, the Contractor shall immediately reinstate them in such a way that the true shape of the pipe shell or specials is maintained to the satisfaction of the Engineer. No defective or damaged pipe or special shall be



allowed to be used in the work without rectification to the satisfaction of the Engineer. Any damage to the coating shall be repaired by the Contractor at his own cost to the satisfaction of the Engineer.

### Dents

Whenever any dent, i.e. a significant alteration of the curvature of the pipe shell is noticed, the depth of the dent shall be measured between the lowest point of the dent and the pipe shell curvature line. All dents exceeding 2 percent of the outer diameter of the pipe shall be removed by cutting out a cylindrical portion of the pipe and replacing the same by an undamaged piece of the pipe. The Engineer may permit insert patching if the diameter of the patch is less than 25 percent of the nominal diameter of the pipe. Repairs by hammering with or without heating shall not be permitted. Any damage to the coating shall also be carefully examined and rectified.

#### ITEM NO.2

M.S Specials

M.S Specials Plain ended

**Above 300 mm**

MS Special Flanged Ended

Above 300 mm

### GENERAL

1.1 M.S. specials shall confirm to IS 7322-1974 or latest I.S.S for steel cylinder specials standards applies to specials for use in distribution system of water supply project and in sewer lines and irrigation work.

1.2 The details given below briefly cover the requirements of materials design, dimension and tests for specials.

1.3 The specification covers specials having

- (a) Spigot and socket ends.
- (b) Plain ends or slipin type and suitable for field welding.
- (c) Flanged ends for connection with valves and accessories.

### 2.0 CLASSIFICATION

2.1 Steel cylinder specials shall have the following classifications.

CLASS	TEST PRESSURE
1,2,3	15 KG / CM2
4,5	25 KG / CM2
SPECIAL CASES	25 KG / CM2

As a general guide the corresponding working pressure for such specials shall be taken as 50 % and 67 % of the above valves for pumping main and graily respectively.

### 3.0 DIMENSIONS

#### 3.1 LENGTH OF SPECIALS

The essential dimensions for bends, tees, scour tee and flanged details, shall be as indicated in I.S. 7, 1332-1974, or its latest revision.

### 4.0 MANUFACTURE

4.1 Steel core : The steel core shall be formed by shaping and welding together steel plates of specified thickness. Filter lap welding or butt welding may be adopted for all longitudinal and circumferential welds.

**MS Specials welding shall be done as per item no.1. After welding special shall be coated with epoxy paint as per instruction of EIC.**

### **5.0 MODE OF MEASUREMENT AND PAYMENT.**

5.1 The measurement of special shall be taken per kg .

5.2 The rate shall include the cost of specials with the railway freight, loading, unloading, carting, stacking, as directed local taxes, insurance octroi, inspection charges etc.

### **ITEM NO.3**

Providing and supplying D.I. K-9 grade pipes with as per site requirement for following nominal bore diameter with internal cement mortar lining and outside minimum 400g/m<sup>2</sup> zinc coating with finishing layer of minimum 200 micron thick epoxy paint including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete. (IS 8329-2000) or its latest amendments.

### **This item includes:**

**Note:** Wherever International Standards or Indian standards / specifications are mentioned, their equivalent or higher standards / specifications are also acceptable Supply and Delivery of Ductile Iron Pipe as per IS:8329-2000 or its latest revision or amendments if any including jointing material as EPDM ring as per IS 5382-1985 and ISO: 4633-1996 or its latest revision or amendments if any

### **Standards**

The following standards, specifications and codes are part of this specification. In all cases, the latest revision of the including all applicable official amendments and revisions shall be referred to. In case of discrepancy between this specification and those referred to herein, this specification shall govern.

- ✓ ISO: 10803-1997 Design method for ductile iron pipes
  - ✓ IS:8329-2000 Centrifugally Cast (spun) ductile iron pressure pipes for water, gas and sewage or its latest amendments
  - ✓ ISO:2531-1991 Ductile iron pipes, fittings and accessories for pressure pipelines.
  - ✓ ISO:4179-1985 Ductile iron pipes for pressure and non-pressure-Centrifugal cement mortar lining - General requirements.
  - ✓ IS:8112 Specification for 43 Grade ordinary Portland cement.
  - ✓ BS:3416 Bitumen based coatings for cold application, suitable for use in contact with potable water.
  - ✓ ISO:8179-1995 Ductile iron pipes-External coating-Part-1 Metallic Zinc with finishing layer.
  - ✓ IS:638 Sheet rubber jointing and rubber insertion jointing.
  - ✓ ISO:4633-1996 Rubber seals-Joint rings.
  - ✓ IS:5382-1985 Specification for Rubber sealing rings for gas mains, water mains and sewers.
  - ✓ AWWA C600 Installation of ductile iron water mains and their appurtenances.
- 1.0 **Internal Diameter:**  
The nominal values of the internal diameters of pipe, expressed in millimeters are approximately equal to the number indicating their nominal sizes DN.

**2.0 Length:**

The working length of socket and spigot pipes shall be 5 m ,5.5 m, or 6 metres.

**3.0 Thickness:**

The wall thickness of pipe 'e' in mm shall be calculated as a function of the nominal diameter by the following equation with minimum of 5 mm

$$e = K(0.5 + 0.001 DN)$$

where : e = wall thickness in mm, DN = the nominal diameter, K = the whole number coefficient

**4.0 EPDM Rubber Gasket:**

Rubber Gasket shall be suitably for Push-on-Joint.

The spigot ends shall be suitably chamfered or rounded off to facilitate smooth entry of pipe in the socket fitted with the rubber gasket Rubber

Gasket shall confirm to IS 5382-1985 and ISO : 4633-1996 its latest revision or amendments if any

**5.0 Sampling Criteria:**

Sampling criteria for various tests, unless specified in IS 8329-2000, shall be as laid down in IS 11606. Mechanical test, Brinell Hardness test, Hydrostatic test etc. are shall be as per IS 8329-2000

**6.0 Tolerances on External Diameter:**

The nominal external diameter (DE) of the spigot end of socket and spigot pipes and when measured circumferentially using a diameter tape shall confirm to the requirements specified as follow. The positive tolerance is +1 mm and applies to all thickness classes of pipes. The maximum negative tolerance of the external diameter are specified as follow:

DN	Nominal	Positive Tolerance	Negative Tolerance
80	98	+1	-2.2
100	118	+1	-2.8
125	144	+1	-2.8
150	170	+1	-2.9
200	222	+1	-3.0
250	274	+1	-3.1
300	326	+1	-3.3
350	378	+1	-3.4
400	429	+1	-3.5
450	480	+1	-3.6
500	532	+1	-3.8
600	635	+1	-4.0
800	842	+1	-4.5

**1.0 Tolerance on Ovality:**

Pipes shall be as far as possible circular internally and externally. The tolerance for out-of-roundness of the socket and spigot ends is given below:

Nominal Diameter in mm	Allowable Difference Between Minor Axis and DE in mm
80 to 300	1.0
350 to 600	1.75
700	2.0
750 to 800	2.4
900 to 1000	3.5

## 2.0 Tolerance in thickness

The tolerance on wall thickness (e) and the flange thickness (b) of the pipes shall be as below:

Dimensions	
Wall thickness (e)	- (1.3 + 0.001 DN )1)
Flange thickness (b)	+ (2+0.05b) & - (2+0.05b)

## 1.0 Special type of coating for above dia. DI K-9 Pipeline

Pipe shall be delivered internally and externally coated.

**External Coating:** Pipe shall be metallic zinc coated and after that it shall be given a finishing layer of epoxy paint as per IS - 8329-2000 Zinc coating shall comply with IS:8329/EN 545/ ISO 8179. Only molten zinc spray coating shall be acceptable. The mass of zinc coating shall not be less than 400 g/sqm. Finishing layer of epoxy as per IS 8329 / ISO 8179 shall be applied of minimum 200 microns thickness. Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe. **Internal lining:** Internally pipe shall be Portland Cement mortar lined (as per IS - 8329-2000). The mortar shall contain by mass at least one part of cement to 3.5 part of sand. All pipes and fittings shall be internally lined with cement mortar using high speed centrifugal process in accordance with IWO 4179/IS 8329. Cement mortar lining shall be applied at the pipe manufacturing shop in conformity with the aforesaid standards. No admixtures in the mortar shall be used without the approval of the Engineer. The sand to cement proportion of sand if justified by the sieve analysis.

Pipe lining shall be inspected on site and any damage or defective areas shall be made good to the satisfaction of the Engineer.

Lining shall be uniform in thickness all along the pipe. The minimum thickness of factory applied cement mortar lining shall be as per IS: 8329 Annex-B or ISO 4179. This is given below.

Nominal Pipe Size (mm)	Nominal lining thickness
Up to 300	3
350-600	5
700-1200	6
1400-2000	9

## 2.0 Joint

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Jointing of DI pipes and fittings shall be push-on type **Push-on-joints**

The Contractor shall source the push-on-joint gaskets only from the pipe manufactures. In turn the pipe manufacturer shall supply at least 10% additional quantity of gaskets over and above the requirement to the Contractor at no extra cost. The gasket used for joints shall be suitable for natural and purified water conveyance. In jointing DI pipes and fittings, the Contractor shall take into account the manufacturer's recommendations as to the methods and equipments to be used in assembling the joints. In particular the Contractor shall ensure that the spigot end of the pipe to be jointed is smooth and has been properly chamfered, so that once the rubber ring is correctly positioned before the joint is made, does not get damaged by friction or sharp edges of the spigot Chamfer. The rubber rings and the recommend lubricant shall be obtained only through the pipe manufacturer.

Rubber ring bundles form every lot shall carry with them manufacturers test certificate for the following mechanical properties.

1. Hardness
2. Tensile strength
3. Compression set
4. Accelerated aging test
5. Water absorption test
6. Stress relaxation test

Rubber rings shall be clearly labeled in bundles to indicate the type of ring, the type of joint, the size of the pipe with which they are to be used, the manufacturer's name and trade mark, the month and year of manufacture and the shelf life.

### 3.0 **Testing of Pipe:**

The main test among others to be conducted shall be as per IS:8329-2000 or with its latest revision/amendments.

#### **[a] Mechanical Tests**

Mechanical tests shall be carried out during manufacture of pipes as specified in the Standards. The frequency and sampling of tests for each batch of pipes shall be in accordance with IS 11606-1986. The test results so obtained for all the pipes and fittings of different sizes shall be submitted to Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per IS:8329/EN 545 for pipes and IS:9523/EN 545 for fittings.

#### **[b] Brinell Hardness Test**

For checking the Brinell hardness the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and tensile test in accordance with IS:1500. The test shall comply with the requirements specified in IS:1500/ISO 6506.

#### **[c] Re-tests**

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements the lot shall be

accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

**[d] For hydrostatic test**

At works, the pipes and fittings shall be kept under test pressure as specified in the standard for a period of minimum 15 seconds during which the pipes shall be struck moderately with a 700 g hammer for confirmation of satisfactory sound. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before surface coating and lining.

**4.0 Quality Assurance**

The manufacturer shall have a laid down Quality Assurance Plan for the manufacture of the products offered which shall be submitted along with the tenders.

**MARKING :**

The methods of marking all the pipes to be delivered under scope of contract shall ensure that all the information will remain legible even after transportation, storage in open space etc. In general the legible and indelible marking upon the goods shall indicate the followings;

- i) ISI Certification mark on each pipe.
- ii) Manufacturer's brand name and/or trademark.
- iii) Purchaser's mark as "GWSSB" be painted / stenciled.
- iv) Diameter & Specified Wall Thickness
- v) Pipe Class (i.e. K-9 / K-7)
- vi) Any other important matter that the manufacturer deems fit to be inscribed
- vii) Batch No. Month & Year of Production

**INSPECTION**

Inspection of pipes and specials will be carried out by Executive engineer or his representative agency appointed by GWSSB. All the expenditure for inspection shall be borne by the contractor except inspection charges if any in case of inspection agency appointed by GWSSB shall be paid by GWSSB.

**PAYMENT**

As per payment schedule attached in price bid volume. Price Variation Clause as per Vol.-IB Clause No.59.

**TECHNICAL SPECTIFICATION FOR EPDM RUBBER RINGS :**

SPECIFICATION FOR SUPPLY & DELIVERY OF EPDM RINGS (EPDM RUBBER RINGS) SUITABLE FOR 80 TO 1200 MM DIA D.I. Pipe Joint

**1. GENERAL TECHNICAL SPECIFICATION**

The supply shall be covering supplying and delivering of "EPDM" rubber ring confirming to relevant Indian Standards.

**2. STANDARDS:**

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The EPDM rubber ring to be supplied and delivered (under the scope of this ra... contract) shall be manufactured in accordance and confirming to IS : 10222, 1000, specification followed to be IS : 5382 – 1985.

### **3. SCOPE AND FIELD OF APPLICATION:**

The standard defines requirement and test methods for rings made of solid rubber for joints or couplers in pipeline to be transport drinking water.

### **4. DIMENSIONS AND VOLUME:**

The nominal dimension and the nominal volume of the rubber rings and the permitted tolerance shall be same as per natural rubber rings. The stated value shall be such that the joints in which the rubber rings are used to meet the requirements to make the joint solid water tight.

### **5. MATERIAL**

EPDM rubber shall be used to produce the rubber ring. The manufacturer shall have to specify the blending components used for manufacturing the ring and it shall be strictly 100% EPDM.

### **6. REQUIREMENTS:**

#### **General Educational Requirement**

The rubber rings shall suit their purpose. The composition, the appearance, the form and the dimension shall be such that in view the type of application a good sealing of the joint under normal operating conditions during the use of the pipe system will be ensured.

#### **Influence on potable water**

The rubber rings shall not contain components under normal operating conditions that can have a negative influence on the quality of the potable water or can cause damage to the health. When tested, no taste and / or odor deviation compared with the blank beaker shall be detected.

#### **Resistance to Micro biological attack**

The rubber ring shall be resistant to Micro biological attack.

The supplier shall have to give guarantee in writing and if any attack is visualized or seen on ring within a period of 12 month, the supplier shall have to replace the same without any cost.

### **7. RESISTANT TO DEVIATING TEMPERATURES:**

The rubber rings shall be resistant to normally occurring temperatures in which the rings be used in a pipe system in which for longer period of the temperature of 60<sup>0</sup> C occurs, they shall be resistant to that temperature.

### **8. RESISTANT TO CHEMICALS:**

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The rubber rings shall be resistant to chemicals that can be found in potable water and in discharge water in concentration that are considered to be normal.

#### **9. APPEARANCE AND HOMOGENITY:**

When inspected, the rubber rings shall not contain foreign components and should be free of internal cracks, air inclusions and porosity which can be detected with the naked eye. The filling and other additives shall be distributed homogeneously in the rubber. The appearance of the rubber rings shall be smooth and clean (With exception of marking and splitliness)

During the tensile test, pieces shall maintain smooth appearance ( no contraction and / or thick ring)

#### **10. WELDER RINGS:**

In a ring made of previously vulcanized material only one weld is permitted. The weld shall be made with a vulcanization process.

#### **11. PHYSICAL AND MECHANICAL PROPERTIES :**

Physical and mechanical properties shall be as per type – 3 specified in table 1 & 2 of IS : 5382 – 1985 or its latest revision.

The material of entire lot shall be accepted on receipt of satisfactory test.

#### **1. TESTING:**

The manufacturer should specify the name of at least 3 vendors from whom they propose to purchase their requirements of EPDM rubber rings. The GWSSB shall have to right to verify the details like manufacturing capacity which they are supplying and may from time to time draw samples from their general lot and send the same for testing with laboratories of GWSSB's choice. For the purpose of capacities of the lot by the Inspecting Agency that test as per available facilities shall be carried out at manufacturer's premises and may be agreed between GWSSB and respective authority. However, the manufacturer's test certificate must accompany each of rubber rings. In short, the identifications of the vendors for EPDM rings shall test with GWSSB.

##### **1.1 TESTING PROCEDURE:**



For testing purpose, representative samples of uncured and cured blends prepared to the manufacture of EPDM rings shall be collected for physical and chemical analysis of the said lot.

For chemical analysis the samples shall be send to the laboratory specified by the Department at the cost of the manufacturer and the test results shall be supplied with the materials.

For physical analysis the laboratory facility available at the factory premises of the manufacturers shall be utilized. However at the discretions of the Engineer-in-charge the sample can also be tested at any other standard laboratory.

The sampling and physical test for the rubber rings shall be in accordance with test procedure shall be carried by the Engineer-in-charge.

## 2. MARKING

The rubber rings shall be marked in a clear and durable way with the following indications;

The used rubber type using the letter code as “EPDM”

The number, month and year of production should be mentioned on the label of the packed bag duly sealed.

## 3. COLOUR OF THE RINGS:

Colour of the ring shall be as specified in relevant Indian Standard.

### ITEM NO.4

Manufacture, Supply & Delivery of Ductile Iron flange socket spigot bends, tees, tees for air valves, reducers / enlarger or any other specials as per BS-EN-545/1995 Class-A series K12 suitable for use with D.I. pipes manufactured as per IS:8329. Delivery of specials to be made to GWSSB store or site of works anywhere in Gujarat including all taxes, loading, unloading, carting, stacking, insurance, inspection charges, octroi etc. complete. With external zinc coating minimum 400 g/m<sup>2</sup> & external finishing layer of epoxy minimum 200 micron thickness & Internal Cement Mortar Lining

1. 350mm dia & Above

Socket and spigot

Flanged ended

- Kindly refer specifications of Item 3
- DI Specials with all types of diameters suitable of K9 grade pipes with external zinc coating minimum 400 g/m<sup>2</sup> & external finishing layer of epoxy minimum 200 micron thickness & Internal Cement Mortar Lining
- The specials shall be provided as per IS 9523-2000 or its latest amendments.
- It shall be of best quality as per requirement including loading, unloading, carting, insurance and labour charge etc. complete.

**ITEM NO.5**

Providing and supplying ISI marked ductile iron (DI) body non-rising spindle sluice valve / scour valve with hand wheel / gear operated arrangement , having bronze seat and AISI SS 410 shaft, conforming to IS 14846 (latest edition), suitable for PN-16 pressure rating, with flange end connection as per IS 1538, of approved make and quality, of following class and diameter, including all taxes, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking, etc. complete.

(A) SLUICE VALVE

(B) SCOUR VALVE

**Sluice valve as per I.S: 780 & 2906/1984**

For 100mm,150mm, 200mm, 250mm ,300mm and 300mm dia. and quantity as per price schedule. The agency has to approve Quality Assurance Plan (QAP) as per Specification and latest IS Codal provisions before manufacturing.

Sluice valve as per IS: 14846 or its latest revision.

**1.0 GENERAL**

The contractor shall be covering manufacturing, supplying and delivery of:

Sluice valve conforming to IS: 2906-1984 & IS: 14846 or its latest revision (Specification for sluice valves (50 to 900 mm size) with ISI certification

**2.0 STANDARDS**

The C.I. sluice valves to be manufactured, supplied and delivered under the scope of this contract shall be manufactured in accordance with and conforming to Indian standard specifications as given below: with ISI certification mark on each sluice valves.

**3.0 TEMPERATURE VARIATION**

All sluice valves manufactured, supplied and delivered shall be subjected to drinking water under variable temperature condition ranging from 4<sup>0</sup> to 45<sup>0</sup> C.

**4.0 MARKING**

The legible and in deniable marking upon each valve shall indicate the following:

- (1) ISI certification mark on each sluice valve only.
- (2) Manufacture's brand name and/or trade mark.
- (3) Size of valve and nominal pressure of valve.
- (4) Serial number of cast.
- (5) Serial number in punch
- (6) Where a valve has been tested for only open and test, it should be marked 'O' distinctly and permanently.
- (7) Any other important matter that the manufacturer deems fit to be inscribed embossed

**5.0 TEST CERTIFICATE**

- 5.1 The contractor shall always provide manufacture's test certificate in accordance with every batch/ lot as valves so manufactured and supplied.
- 5.2 The contractor shall also produce; in addition to manufacture's test certificate the inspection certificate issued by the authorized person /agency appointed by Board for the same purpose. The inspection charges of the authorized person/agency as fixed by Board shall have to be borne by the contractor and the necessary payment to the inspecting agency shall be paid by the contractor as per the terms and condition of Board

## 6.0 NOMINAL PRESSURE

- 6.1 Sluice valves shall be designed by nominal pressure (PN) defined as the maximum permissible gauge working pressure in Mpa as "PN-II" ( Mpa= 10 kgf/m<sup>2</sup> approx.)
- 6.2 The nominal size shall refer to the nominal bore at any point, shall not be less than the nominal size required.

## 7.0

Class of Valve	Working pressure of body	Working pressure for seat
PN 0.6	5 kg/sq.cm	9 kg/sq.cm
PN 1.0	10 kg/sq.cm	15 kg/sq.cm
PN 1.6	16 kg/sq.cm	24 kg/sq.cm

## MATERIAL:

- 7.1 The materials for the different component parts of the sluice valve shall confirm to requirements given in Table

Materials for components parts of sluice valve

Sr. No.	Component	Material	Ref. to	Grade of designation
1	Body, bonnet wedge stuffing box, gland thrust plate, cap.	Grey cast iron	210-2009	
2	Steam	High tensile brass	320-1980	Ally 1 of 2
3	Wedge nut	Leaded tin bronze	318-1981(3)	2
4	Body seat ring, wedge facing ring	Leaded tin bronze	318-1981(3)	2
5	Bolts	Carbon steel	1367-1967(4)	Class 4.6
6	Nuts	Carbon steel	1367-1967(4)	Class 4
7	Bonnet gasket	Compressed fiber Board	2712-1998(5)	C
8	Gland packing	Jute & hemp	5414-1995(6)	--

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- (1) Specification for grey iron castings (third revision).
  - (2) Specification for high tensile brass rods and sections (revised).
  - (3) Specification for leaded tin bronze ingots and casting (revised).
  - (4) Specification for technical supply condition threaded fasteners (first revision)
  - (5) Specification for compressed asbestos fiber jointing (first revision)
  - (6) Specification for gland packing, jute and hemp.

## **8.0 MANUFACTURE**

Sluice valve bodies for 80 mm to 900 mm size valves shall be provided with double flanged ends connection.

## **9.0 FLANGES**

The flanges and their dimensions of drilling shall be in accordance with part IV and VI of I.S. 1538 (Part I to XXII) 1993 (Specification for cast Iron fittings for pressure pipes for water gas and sewage) or its latest revision.

## **10.0 TESTING:**

### **10.1 Hydraulic test:**

Each valve shall be subjected to hydraulic tests as described in Appendix – B of IS: 2906-1984 to the test pressure for a duration as specified in table – 7 of IS: 2906 and shall show no sign of leakage under these tests.

### **10.2 Liquid Penetration Test:**

The forged steel stems shall not show any sign of flaw when subjected to liquid penetration flaw detection test in accordance with IS: 3658-1981.

## **11 LOWERING AND JOINTING IN POSITION**

### **11.1 Supply of Material**

11.1.1 Cast iron double-flanged sluice valve with two tailpieces suitable to pipe conforming to the latest relevant IS shall be supplied and carted by the contractor to the site of work including loading, unloading and stacking at site.

11.1.2 The sluice valve and tailpieces shall be examined before laying for cracks and other flaws. They shall be undamaged in all respect.

11.1.3 The sluice valves shall be cleaned before laying.

11.1.4 All grits and foreign materials shall be removed from the inside of the valves before placing.

11.1.5 All the four faces shall be thoroughly cleaned and coated with a thin layer of mineral grease.

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11.1.6 The tightening of gland shall be checked with a pair of inside-calipers. Clearance between the top of stuffing box and the underside of the gland shall be uniform all the sides.

## **11.2 JOINTING MATERIAL**

11.2.1 The contractor shall provide all necessary jointing materials such as nuts bolts, rubber packing, white zinc, jute, lead wool etc.

11.2.2 All tools and instruments, which are to be required for installation of sluice valve shall be provided by the contractor.

11.2.3 All jointing materials shall be got approved from the engineer-in-charge before use. The nuts and bolts shall conform to the relevant IS. The rubber packing shall conform all specifications as narrated in respective IS.

## **11.3 INSTALLATION**

11.3.1 The sluice valve shall be lowered in to the trench carefully, so that no part is damaged during lowering operation.

11.3.2 If necessary tailpieces shall be fitted with sluice valve first outside the trench and then lowered in to the trench.

11.3.3 The rubber packing shall be three ply and of approved thickness. The packing shall be of full diameter of the flange with necessary holes and the sluice valve bore. It shall be even at both the inner and outer edges.

11.3.4 The flange faces thoroughly greased.

11.3.5 If flange faces are not free, the contractor shall use thin fibers of lead wool.

11.3.6 After placing the packing, nuts and bolts shall be inserted and tightened to make the joint.

11.3.7 The valve shall be tightly closed when being installed to prevent any foreign materials from getting in between the working parts of the valve.

11.3.8 Each flange bolt shall be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively.

11.3.9 The sluice valve shall be installed in such a way that its Spindle shall remain in truly vertical position.

11.3.10 The other end of tailpiece shall be fitted with pipes so that continuous lines can work.

11.3.11 Extra excavation required for facility of lowering and fixing sluice valve shall not be paid for.

## **11.4 TESTING**

11.4.1 After installation of sluice valve the same is tested to 1½ times of its test pressure.

11.4.2 The joints of sluice valve shall withstand the test pressure of pipelines.

11.4.3 Defects noticed during test and operation of sluice valve shall be rectified by the contractor at his own cost without any extra claim to the entire satisfaction of the Engineer-in-charge.

**12.0 MEASUREMENT AND PAYMENT:**

The rate shall be paid per number of valves fixed and tested as directed.

Payment shall be made as per Break up of schedule of Payment.

Item NO.6

Pressure relief valve P.N.1.6

**1. Scope**

Providing, supplying, installing, testing and commissioning of Pressure Relief Valve (PRV) complete with all accessories for protection of pumping mains and water transmission pipelines against excessive pressure, surge pressure and water hammer conditions.

**2. Type: Pilot Operated Hydraulic Pressure Relief Valve.**

Normally closed type.: Automatically opens when upstream pressure exceeds the preset value and closes gradually when pressure returns to normal.

**3. Standards**

Valve shall conform to relevant provisions of AWWA C530/C508, BS EN 1074, or equivalent international standards. Latest amendment shall be considered.

Face-to-face dimensions and flange drilling shall conform to IS 1538, ISO 7005, or equivalent. Latest amendment shall be considered.

**4. Material of Construction**

- Component
- Material
- Valve Body & Cover
- Ductile Iron Grade GGG-40 / GGG-50
- Trim Parts
- Stainless Steel SS 304 / SS 316
- Seat Ring
- Stainless Steel
- Diaphragm
- Reinforced EPDM/Nylon Fabric
- Seals & O-Rings
- EPDM/NBR
- Pilot System Tubing
- Stainless Steel / Copper

**5. Pressure Rating**

- 
- Valve body pressure rating shall be PN 16 unless otherwise specified.
  - For higher pressure systems, PN 25 rating shall be provided.
  - Hydrostatic test pressure shall be as per relevant standards.

## **6. Coating**

- Internal and external surfaces shall be coated with Fusion Bonded Epoxy (FBE) coating.
- Minimum coating thickness: 250 microns.
- Coating shall be suitable for potable water applications.

## **7. End Connections**

- Flanged ends conforming to PN16 drilling.
- Suitable for installation in DI/MS/HDPE pipeline systems.

## **8. Performance Requirements**

- Adjustable pressure setting range as specified by the Engineer-in-Charge.
- Valve shall relieve excess pressure without causing harmful vibrations.
- Smooth opening and closing characteristics.
- Suitable for continuous operation under potable water service conditions.
- Shall protect the system against surge and water hammer effects.

## **9. Accessories**

- The valve shall be supplied complete with:
- Isolation valves.
- Pressure gauges on inlet side.
- Pilot control assembly.
- Stainless steel tubing and fittings.
- Fasteners in stainless steel.
- Drain arrangement.

## **10. Testing**

- Hydrostatic body test.
- Seat leakage test.
- Functional operation test.
- Manufacturer's test certificate shall be submitted before dispatch.

## **11. Installation**

- Installed at locations shown in drawings or as directed by the Engineer.
- Complete with dismantling joint, sluice valve/butterfly valve and all necessary fittings.

- Testing and commissioning shall be carried out after installation.
- 12. Measurement
- The rate shall include:
- Supply, transportation, loading/unloading.
- Installation, testing and commissioning.
- All accessories, fittings, nuts, bolts, gaskets and incidental works.

**ITEM NO.7**

Supply, installation, testing and commissioning of Providing and supplying ISI mark DI D/F Butterfly Valves as per IS:13095 (Latest Edition) of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete. along with required spare parts as per data sheet and specifications.

**MANUAL GEAR & ELECTRICALLY OPERATED BUTTERFLY VALVE****General**

- This specification covers the design, engineering, manufacturer, transportation to site, installing, testing double flanged and wafer type of metal seated, dual eccentricity ductile iron electrically/manually operated butterfly valves.
- Valves covered under this specification are electrically and manually operated. Fabricated valve will not be considered.

**Design Criteria**

- (a) Butterfly valve shall be as per IS 13095 (ISI Marked)/BS EN 593.
- (b) Valves shall be double flanged type and the face shall be parallel to each other and flange face should be at right angles to the valve centreline.
- (c) The valve stem, thrust washers, screws, nuts and all other components exposed to the water shall be of a corrosion resistant grade of stainless steel and free from sharp projections.
- (d) The valve seat shall be of integrally cast or renewable design. When the valve is fully closed, the seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.
- (e) All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.
- (f) Valve shall be suitable for throttling purpose.
- (g) All valve, spindles and hand wheels shall be positioned to give good access for operational personnel.
- (h) All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

**Service Applications**

- (a) Valves shall be suitable for one or more of the following applications.



- 
- (b) Tight Shut off- A valve having no visible leakage on the disc in closed position under test conditions.
  - (c) Regulating – A valve intended for regulating purpose and which may have a Clearance between the disc and the body in close position.

**Nominal Pressures**

Valve shall be designated by nominal pressure PN – 16 at ambient temperature respectively.

**Body Ends****Double Flanged Body Ends**

- (a) The dimensions of flanged body ends and drillings shall be in accordance with the ISO 7005-1 (latest). Flanges as per any other specific requirements of the Owner may also be given “As Agreed” between the manufacturer and the Owner.
- (b) Flanges shall be at right angles to the axis of the bore and concentric with the bore. Flanges shall be drilled unless otherwise specified and bolt holes shall be off centres.

**Face to Face Dimension**

Face to face dimensions of double flanged and wafer types of valves shall be as per design standard.

**Bodies**

Bodies end ports shall be circular and the numerical valves of the diameter shall be as close as possible to the valve of DN.

**Disc and shafts**

The disc and shaft shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The shaft may be of one-piece design attached to the disc. Any means of attachment between the shaft and the disc shall be such as to preclude components becoming loose in service.

**Seating and linings**

Non-integral seating, and lining where used, and their means of attachment shall be such as to preclude their becoming loose in service.

**Bearings**

- (a) The bearings shall be suitable for the maximum loads imposed by the shaft during testing and in service.
- (b) For valves DN 350 and above, a bearing shall be provided to take the axial thrust; spring retaining clips shall not be used as thrust bearing. Suitable sealing shall be provided for the shaft where it passes outside the pressure containing enclosure.

**Operation****Electrically and Manually Operated:**

All valves shall be motorized electrical actuator operated with integral type starter and capable of operate at a differential pressure across the disc as marked on the valve.

## Testing

### Hydrostatic Test

All valves shall hydrostatically be tested by the manufacturer before dispatch. The pressure shall be obtained without any significant hydraulic shock. Testing shall be carried on before application of paint. There shall be no air entrapped within the part of the valves subjected to test pressure. Test pressure as per IS 13095.

### Performance Test

Each valve complete with operator shall be shop operated at least three (3) times from fully closed to fully open conditions and reverse, hold at intermediate positions under no flow condition, to prove the workability of the assembly.

### Body Test

Completely assembled valve shall be tested as follows:

- Testing as per IS 13095.
- The valve disc shall be in slightly open position and pressure equivalent to 1.5 times the maximum permissible working pressure shall be applied with water. (The duration of test shall be as per Table-1 below.)

### Seat Test

- Testing as per IS 13095.
- The seating surface of the valve shall be cleaned unless a surface treatment forms an integral part of the design, or the use of a temporary surface treatment has been agreed between the manufacture and the Owner to avoid the possibility of damage under the condition of the test.
- Each valve shall be shop tested for leaks in close position. The test shall be conducted with the body flanges in a horizontal position. Pressure shall be applied to the upstream end of the valve, the downstream being open to atmosphere. The duration of test shall be as per Table above. (The duration of test shall be as per Table-1 below.) There shall be no indication of leakage the valve disc during test and valves shall be drop tight. Seat test shall be carried out in the direction of valve.
- The seat pressure applied on upstream side shall be equivalent to 1.6 times the maximum permissible working pressure at 20°C and shall be applied with water.

**TABLE-1**

### Disc-Strength Test

Nominal Diameter (mm)	Minimum Test Duration in Minutes for	
	Body Test	Seat Test
Up to and including 50	0.25	0.25
65 to 150	1	1
200 to 300	2	2
350 to 1000	5	2
1200 to 2.000	5	3

- Testing as per IS 13095.

- 
- (b) The test shall be conducted with the body flanges in horizontal position. The test pressure shall be 1.5 times the maximum permissible pressure at 20°C With disc in closed position, hydro test pressure shall be applied to the lower face of the disc. The duration of test shall be as per Table-1 above. There shall be no damage to the valve disc nor shall any part of valve or disc be permanently deformed by the test. The purpose of this test is to provide evidence of the adequacy and structural integrity of disc and body.

**Positive material Identification (PMI Test)**

PMI test shall be checked witness at random for Stainless steel parts.

**Test Certificates**

When specified by Owner, the manufacturer shall issue a test certificate confirming that the valves have been tested in accordance with this standard and stating the actual pressures and medium used in the test.

**Marking**

Marking shall be cast integral on the body or on a plate securely attached to the body for 'DN' size, 'PN' rating, Heat Number and Serial number.

**Painting**

Each valve shall be drained, cleaned, prepared & shot blast cleaning of valve should be done before application of paint. Cast Steel parts shall be sand blasted to near white cleaning before painting. Edges, sharp covers etc. shall be ground to a curve before sand blasting. A primer coat of a zinc rich epoxy resin-based coating with at least 75 microns dry film thickness is to be provided. In addition, the parts are to be provided with adequate number of coats of RAL 5005 Grade epoxy coating to a dry film thickness of 175 microns including primer coating.

**Fixing of valves.**

Loading at store and unloading at site of works shall be done carefully using suitable mechanical handling devices such as crane, chain pulley etc. Valves used in pipeline shall be straight through type. Each valve or its operation equipment shall bear an approved name plate stating its function. All operation spindles, gears and head stocks shall be provided with adequate points for lubrications.

**Electric Actuator**

- (a) Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gearbox shall be oil or grease filled, and capable of installation in any position. All operating spindles, gears and head stocks shall be provided with adequate points for lubrication.
- (b) The valve actuator shall be capable of producing not less than 1½ times the required valve torque and shall be suitable for at least 15 minutes continuous operation.
- (c) The actuator starters shall be integrally housed with the actuator in robustly constructed and totally enclosed weatherproof housing. The motor starter shall be capable of starting the motor under the most severe conditions.
- (d) The starter housing shall be fitted with contacts and terminals for power supply, remote control and remote positional indication with positioner and shall also be fitted with internal heaters so as to provide protection against damage due to condensation. Heaters

shall be suitable for single phase operation. The heaters shall be switched "ON" when the starters are "OFF" and shall be switched "OFF" when the starters are "ON".

(e) Each starter shall be equipped as follows:

- A.C. electric motor.
- Reduction gear unit.
- Torque switch mechanism complete with set of torque switches.
- Limit switch mechanism complete with set of limit switches.
- Hand wheel for manual operation.
- Hand-auto changeover lever with suitable locking arrangement.
- Local control switch / push buttons
- 415 V / 240 V AC control transformer.

(f) The actuator shall be suitable for operation in the climate conditions and power supply conditions given in the specification. The actuator shall be capable of producing not less than 1½ time the maximum required torque and shall be suitable for at least 15 minutes continuous operation.

(g) All local controls shall be protected by a lockable cover.

#### Data Sheet of Butterfly Valve:

1	General Requirement	
1.1	Type	Both end flanged hand wheel, Gear operated, electrical actuator Operated as mentioned in BOQ
1.2	Rating of valves	PN 16
1.3	Manufacturing Standard	IS 13095 / BS 5155
1.4	Sizes and quantity	As per price bid
2	Materials of construction	
2.1	Body	ASTM A216 Gr. WCB
2.2	Disc	ASTM A216 Gr. WCB
2.3	Shaft	SS 410
2.4	Body Seat Ring	SS 304
2.5	Clamping Ring	SS 304
2.6	Disc Seal Ring	EPDM
2.7	Disc pin	SS 304
2.8	Nut Bolts	SS 304
2.9	Bush	Stainless steel Backed PTFE
2.10	Flange End	ISO-7005-1
12	Actuator	Electrically operated modulating duty with integral starter (As Applicable)

**Note: 50% Quantity shall be witnessed at Factory site at the time of final inspection**

**Item No.08:**

**Insertion Type Ultrasonic Flow Meter.**

Supply, Installation, Testing, Commissioning of Minimum Two Path Insertion Ultrasonic flow meter with RTU working on transit time principle, with factory calibrated and site verification, Regular Power Operated, Flow sensor, Indicator, transmitter and totaliser with all accessories viz. surge arrestor, associated cables, cabinets, hardwares, etc complete as per following specifications:

-Flow meter / Sensor: Minimum 4 nos insertion ultrasonic type sensor (Minimum 2 pair) with ball valve for online removal of sensors/ any other intersection/ retraction assembly, PN 16 pressure rating, SS304/SS304L/SS316/SS316L sensor MOC, IP 68 or NEMA 6P Protection.

-Flow Transmitter/ Converter: Microprocessor based, Modular design, Min. 2 line LCD for indication of actual flow rate, forward, reverse, sum totaliser display,  $\pm 1$  % accuracy at 0.3 to 4 m/sec velocity, 4 to 20 mA with HART/Modbus output, one scalable pulse output, Die cast aluminium with Anticorrosive Paint/ polycarbonate/ SS316 /SS304 / Polyamide finish with

glass window enclosure, Inbuilt EEPROM and Data Logger, cable length as per site requirement for sensor to transmitter communication etc along with wall mounted/ stand mounted cabinet.

-Worldwide transmission of measured data and events via e-mail and SMS by integrated GSM/GPRS modem, reliable data storage facility through integrated SD card etc. GSM/GPRS based trans receiver unit to be provided including sim card to send signals to centralized monitoring system in required data transmission protocol. Flow meter shall send signals to transmitter unit through digital output only.

-The contractor shall ensure full bore of the flow meter on site for accurate reading & make required arrangement for the same without any extra cost.

Minimum Two Path (Minimum 4 Nos Insertion sensor).

**ITEM NO.9**

Providing and supplying Ductile Iron Temper proof Air valves as per AWWA C512 with SS 304 float gun metal nozzle of approved make and quality of following class and diameter including companion flanges, fasteners and gasket and all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores/Contractor's own stack yard, stacking, stack yard to site transportation charges, etc. complete  
Temper proof Kinetic Air Valve with DI isolating sluice valve, PN-16 with hand wheel/cap operated (PD type Short body)

**Temper Proof Air Valve**

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**General:**

- (a) Single chamber, temper proof air valve with isolating sluice valve confirming to AWWA C 512, having outlet for admission and release of bulk volume of air during emptying and filling of the pipeline.
- (b) The ball sealed orifice shall always remain open while air is exhausting and is immediately closed when Water rises in the chamber, lifts the ball and seals the orifice. It shall also ensure that there are no recesses or pockets, sheltering, escaping air for the large orifice (low pressure) ball to drop into when the valve open. Turbulent air at the time of filling of pipe shall not circulate in such cavities and cause the ball to be blown into when the valve is open.
- (c) Turbulent air at the time of filling of pipe shall not circulate in such cavities and cause the ball to be blown into the discharging air streams, blowing the valve shut prematurely.
- (d) The cone angle of the lower pressure chamber shall be such that even at the critical velocity of all air escape at 300 m/sec.
- (e) The total impact force on the ball is less than the suction force on the angular area between the ball and the cone.
- (f) The design of the valve should be such as to allow maximum free air discharge at various pressure differentials.
- (g) The low-pressure cover shall be massive and designed to withstand full operating thrust in working Conditions.
- (h) The seat ring shall be held securely in place under the low-pressure cover by a joint support ring to prevent it from sagging when the ball is not sealing the orifice.

**Testing**

- (a) All valves shall be offered for visual inspection and dimensional check and performance testing. Valves shall be tested as per AWWA C512.
- (b) All valves shall hydrostatically be tested by the manufacturer before dispatch. The pressure shall be obtained without any significant hydraulic shock. Testing shall be carried on before application of paint. There shall be no air entrapped within the part of the valves subjected to test pressure. Test pressure as per AWWA C512.

**Positive material Identification (PMI Test)**

PMI test shall be checked witness at random for Stainless steel parts.

**Test Certificates**

When specified by Owner, the manufacturer shall issue a test certificate confirming that the valves have been tested in accordance with this standard and stating the actual pressures and medium used in the test.

**Marking**

Marking shall be cast integral on the body or on a plate securely attached to the body for 'DN' size, 'PN' rating, Heat Number and Serial number.

**Cleaning**

Prior to the factory inspection, all manufacturing waste such as metal chips, debris and all other

foreign material shall be removed from interior of valve. All mill scale, rust, oil, grease, chalk and all other deleterious material shall be removed from the interior and exterior surfaces.

### Painting

Each valve shall be drained, cleaned, prepared & shot blast cleaning of valve should be done before application of paint. Cast Steel parts shall be sand blasted to near white cleaning before painting. Edges, sharp covers etc. shall be ground to a curve before sand blasting. A primer coat of a zinc rich epoxy resin-based coating with at least 75 microns dry film thickness is to be provided. In addition, the parts are to be provided with adequate number of coats of RAL 5005 Grade epoxy coating to a dry film thickness of 175 microns including primer coating.

### Nominal Pressures

Valve shall be designated by nominal pressure PN-16 and to be designed at maximum ambient temperature.

### Specifications & M.O.C. of Tamper Proof Air Valve:

Sr. No	Component	PN-16 (For Pipeline BOQ)	PN-16 (For E&M BOQs)
1	Body	DI IS1865 Gr500/7	ASTM A216 Gr. WCB
2	Cover	DI IS1865 Gr500/7	ASTM A216 Gr. WCB
3	Float	SS 304	SS 304
4	Seat	EPDM	EPDM
5	Float Guide	SS 304	SS 304
6	Orifice	SS 304	SS 304
7	Gasket	EPDM	EPDM
8	Nut Bolt	Carbon steel	Stainless Steel
9	Flange End	IS 1538	ISO-7005-1

**Note: 50% Quantity shall be witnessed at Factory site at the time of final inspection**

#### ITEM NO.10

**Erection of air valve riser** by installing new M.S pipe of minimum 6mm thick and 3.2mt length with necessary fittings such as flange of appropriate size, nut bolts and embeded the pipe in R CC M;15 with offset of 10 cm around pipe with necessary steel etc complete

- The work of Air valve riser shall be carried out as per the approved drawing and as per the instruction of Engineer in charge
- The work shall be carried out as per the description of the Item
- The M.S pipe shall be up to 3.2 meter Long and of diameter as per price-bid.
- The 100 mm thick encasing around the vertical shaft shall be minimum in grade M-15 or as per approved drawings.
- Necessary reinforcement shall be placed in footing and column as per the instruction of Engineer in Charge
- Minimum TMT Fe-500 grade steel shall be provided.

- Necessary flanges , Nut, bolts, Clamp all type jointing materials shall be provided and fixed by agency
- Sluice valve shall be fixed by agency with jointing materials
- Item includes all type labors, excavation, refilling etc.
- Item includes necessary cost of form work etc.
- All the air valve shaft shall be painted as approved by Engineer in Charge and Air valve Number shall be painted with Radium Paint.
- Additionally this work shall be executed as Relevant general specification and as direct by Engineer in Charge.

#### **Item No.11: Expansion Bellow**

##### **Metallic Expansion Bellow:**

###### **General**

- Design, fabrication, testing and installation of metallic expansion bellows with necessary hardware have to be provided at delivery side of each pump. Expansion joint shall be a metallic flexible connector fabricated of plies of metal corrugation to provide stress relief in piping systems due to thermal, mechanical and other moments and movements. It provides flexibility and concurrent movements.
- Expansion bellows shall be designed as per the details furnished in the data sheet and shall be in accordance with the EJMA standard. All expansion bellows shall be free from dirt, moisture, grease, oil, etc. and all reports for hydrostatic test shall be furnished. The bellows shall be metallic corrugated design and shall have double flange. The material for Bellows shall be SS 304.
- In order to avoid pipe buckling, guide collars must be provided regularly along the pipe length. A guide collar must also be provided on either side of the SS Expansion Joint. Maximum service life depends on careful and correct installation. Transport Expansion Joints to area of installation in packed condition. Flange face of companion flanges in pipeline should be smooth and without any sharp edges.
- For large size of Expansion Joints installed in horizontal ducts, lifting lugs welded to flanges should be used to hoist joint in position. Joints should only be fitted after all work on the pipeline and flanges have been complete and anchors and supports have been established. This is to avoid any accidental damage due to welding splatter or sharp objects and to ensure that the joints are not overstressed. The bolts on the flanges must be tightened evenly. Uneven tightening may lead to hazardous leakage. Faulty fitting may lead to failure of the expansion joints.

##### **Operating Principal**

- Expansion Joints are flexible, reinforced bellows which are used in piping systems to meet the following major needs.
- To protect piping by absorbing any difference in dimension due to temperature



variation or line movement. It shall be protect equipment such as supports & anchors, pumps & valves etc., other equipment.

- It shall be useful for simple connection of misaligned pipes. Movement Accommodation. Expansion and contraction, as well as rapid movements (dynamic stresses), are absorbed multidirectional and often simultaneous deflections.

### Tests and Inspection

- Bellows shall be tested as per the relevant Standards with latest revisions.
- Bellows shall be offered for visual inspection and dimensional checks.
- The hydrostatic and water tightness testing of 50% quantity of each size shall be witnessed.
- Compression and expansion test of 50% quantity of each size shall be witnessed.

### Positive material Identification (PMI Test)

- PMI test shall be checked witness at random for Stainless steel parts.

### Test Certificates

- When specified by Owner, the manufacturer shall issue a test certificate confirming that the valves have been tested in accordance with this standard and stating the actual pressures and medium used in the test.

### Marking

- Marking shall be cast integral on the body or on a plate securely attached to the body for 'DN' size, 'PN' rating, Heat Number and Serial number.

### Painting

- Each valve shall be drained, cleaned, prepared & shot blast cleaning of valve should be done before application of paint. Cast Steel parts shall be sand blasted to near white cleaning before painting. Edges, sharp covers etc. shall be ground to a curve before sand blasting. A primer coat of a zinc rich epoxy resin based coating with at least 75 microns dry film thickness is to be provided. In addition the parts are to be provided with adequate number of coats of RAL 5005 Grade epoxy coating to a dry film thickness of 175 microns including primer coating.

#### ITEM NO.12

Excavation for pipe line trenches for water supply, sewerage line, manhole etc. all with shoring and strutting if required as per required gradient and line including safety provisions using site rails and stacking excavated stuff including dewatering and up to all required lead, cleaning the site etc. complete for all lifts and strata.

(A) FROM DEPTH 0.00 TO 1.50 MTR.

In all sorts of soil and Strata

(B) FROM DEPTH 1.500 TO 3.00 MTR.

In all sorts of soil and Strata

### Excavation

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**General**

The excavation for trenches will generally, refer to open excavation for trenches in wet/dry conditions for pipe laying work.

**Clearing Of Sites**

The site on which the pipelines are to be laid and shown on plan and the area required for setting out and other operations shall be cleared and all obstruction loose stones and materials, rubbish of all kinds, stumps, brushwood as trees shall be removed as directed the roots shall be entirely grubbed up.

The products of the clearing to restocked in such a place and in such a manner, as directed by the engineer in charge.

In jungle clearings, all trees not specially marked for preservation, bamboo's jungle wood and brushwood shall be cut down their roots grubbed up. All wood and materials from the clearing shall be the property of the Board shall be arranged as directed by the Board Engineer or his authorized agent, the material pronounced as useful by the Engineer will be conveyed and properly stacked as directed within the specified limit. Unless materials will be burnt or otherwise disposed off as directed.

All holes or hollows whether originally existing or produced by digging up roots, shall be carefully filled up with earth, well earth, well rammed leveled off, as may be directed.

**Setting Out**

The center lines of all pipe trenches etc. shall be given by the Engineer-in-charge and it will be the responsibility of the contractor to install substantial reference marks, bench marks, etc. and maintain them as long as required true to line, level curve and slopes. The contractor shall assure full responsibility for alignment, and dimension of trench.

The labor materials etc. required for setting out and establishing benchmarks and other reference marks shall be arranged by the contractor at his own cost.

**Excavation**

The excavation should be with a minimum 1.5 m clearance on both sides of the pipe and minimum top cover from pipe should be 1.0 m (minimum) including dewatering.

Item shall also include the providing and fixing of rock shield protection (in rock portion only)

The excavation incl. Bailing out of water for the pipe trenches shall also incl. Removal of all materials of whatever nature and whether wet or dry condition necessary for laying of pipelines exactly in accordance with alignment, levels grades and curves shown on the plans or as directed by the Engineer-in-charge. Trenches shall be excavated to the exact width and depth according to the size of pipe and the sides shall be left vertical as far as possible or according to the angle of repose of various soils. Unless there is a specific extra provision in the contract for shoring and strutting or for cutting side slopes the contractor shall at his own cost do the necessary shoring and strutting or cutting of slopes to a safe of repose or both approved by the Engineer-in-charge. As per Site condition if Extra width or depth require then prior permission of concern chief engineer is require. The contractor shall notify the Engineer before starting excavation to enable him to take cross sectional levels for purpose of measurements before the ground is disturbed. The bottom of the trenches shall be leveled both longitudinally and transversely or slopped as directed by the Engineer. The contractor shall at his own cost to remove such portions of boulders or rocks, as are rectified to make the bottom of the trench level. No filling shall be allowed to bring the trench to level. If by contractor's mistake excavation is made deeper than shown on the plans and if ordered by the Engineer the extra depth shall have to be made with selected excavated stuff only with watering, remedying etc. as directed, by the Engineer and at the cost of the contractor. Other hard excavation shall be cleared of all sorts and loose materials and cut to firm surface, either level,

stepped as directed by the Engineer. The Engineer may order such charges in the dimensions and alignment of pipe trench as may be deemed necessary to secure satisfactory cover over pipeline. The contractor shall, at his own expense, make provision for bailing out of draining water and the trenches shall be kept free of water, during laying work.

After each excavation is completed, the contractor shall notify the Engineer to that effect and no laying of pipeline will be allowed to laid until Engineer has approved the depth and dimensions of trenches level and measurements.

#### **Shoring And Strutting:**

Shoring & strutting and dewatering if required shall have to be carried out by the contractor, for which any extra charge will not be paid. During excavation if water connections, sewage connections, telephone lines khalkuva (soak pits) etc. are damaged by the contractor, the same shall have to be restored by the contractor without any extra payment.

#### **Protection**

The trenches shall be strongly fenced and red light signal shall be kept at night and arrangement of watchman to prevent accidents should be done, sufficient care protective measure shall be taken to see that the excavation shall not affect or damage the adjoining structure. The contractor shall be entirely responsible for any injury to life and damage to the properties etc. Necessary protection work such as guide ropes, crossing places, barricades, caution boards etc. shall be provided by the contractor.

The excavation in all sorts of soil, hard murram, soft rock or hard rock or any type of soil shall have to be carried out up to the required depth by the agency, no extra payment shall be given for soft/hard rock.

#### **Disposal Of Excavated Stuff**

No excavated stuff from trench are to be placed even temporarily nearer than 1.5 meter or greater distance up to 90 meter or as prescribed by the Engineer from the outer edge of trench. All excavated material will be the property of the board. The rate of excavated includes sorting out of useful materials and stacking then separately as directed within specified lead. The excavated stuff suitable and useful for refilling or for other use shall be stacked at convenient places. The materials not useful in any wet shall be disposal off as directed by the Engineer from the outer edge of trench. The site should be cleared off on completion of work.

#### **Additional Requirements**

At the joints of pipes, the trench shall be excavated to an additional depth of 15 cm. and width of 30 cm. And length of 15 cm. beyond the edge of collar on both the sides or as directed. The rate include for such extra excavation made at the joints. The trenches shall be excavated perfectly in straight line. The bottom of the trench shall be kept as per invert level or as directed. To maintain the proper slop the usual method of site rails and boning rods shall be adopted. The contractor shall have to provide and fix and maintain sight rails and boning rod without any extra cost.

If the contractor fails or makes delay to give hydraulic test of the pipe line laid in any of the section, without any genuine reason, he shall be responsible to get any part of the length trenches refill in such case i.e. before tasting for safety of pedestrian and/or vehicular traffic as found necessary by the engineer-in-charge without any extra cost. If found necessary any directed by the Engineer-in-charge. The contractor shall have to excavate the refilled trenches, during hydraulic test without any extra cost.

At all road crossings, trenches shall be excavated only for half width of the road and pipe shall be laid. The other half shall be excavated only after back filling over the laid pipeline is done so as to make it suitable for the traffic. The contractor shall provide direction when the pipeline is to be laid

along the road as required and shall maintain the diversion or any part of it, without any extra cost. At all road crossings, the pipe shall be laid below the crest of road. The contractor shall break the road surface by excavation chiseling to the exact width and length as shown on the drawing or as directed by the Engineer-in-charge. The excavated stuff shall be deposited in uniform layers to avoid mixing with other kind of materials at non-objectionable place or as directed by the Engineer-in-charge.

#### **Measurements And Payment**

As per Price bid or Payment Schedule.

This item of excavation shall include unless and otherwise mentioned.

- a) Clearing of site.
- b) Setting out work including all materials and labour.
- c) Providing and subsequently removing, shoring and strutting cutting slopes etc.
- d) Excavation and removal and staking of all excavated stuff as directed.
- e) Necessary protection including labour materials equipment etc. to ensure safety and protection against risk or accident.
- f) Providing facilities for inspection and damage to property if caused during progress of work.
- g) Compensation for injury to life and damage to property if caused during progress of work.
- h) Restoring of water supply connections, sewer connections, telephone lines, khalkuva soapiest etc. if damaged by contractor without extra payment.
- i) Dewatering of excavated pit trench during the progress of work.
- j) Clearing the site on completion of works directed by the Engineer.

Additionally Refer general specification for the Earthwork for detail technical Specification

#### **ITEM NO.13**

Lowering, laying, jointing & welding in position to correct line & level M.S. Pipe with outside 3 LPE coating & inside solvent free liquid epoxy lining on pedestal or chairs upon prepared formation or prepared bedding in trenches. The rates include conveyance from store to site of work, loading, unloading, heat shrink sleeve jointing, Epoxy Coating to bare pipe and specials, including hydro testing etc. complete.

#### **Lowering, Laying & Jointing Of Pipeline:**

##### **General**

The pipe shall be lowered into the trenches by removing only one or two struts at a time. It shall be seen that no part of the shoring is disturbed or damaged and, if necessary, additional temporary struts may be fixed during the lowering operations. It shall also be necessary to see that the outside coating of pipe is not damaged in anyway during the lowering and assembling.

After the pipe is lowered into the trench, it shall be laid in correct line and level by using the leveling instruments, sight rails, theodolite, etc. Care shall be taken to see that the longitudinal joints of two consecutive pipes at each circumferential joints are staggered by 90°. While assembling the pipes, the ends shall have to be brought close enough to leave a uniform gap not exceeding 4mm. If necessary, a marginal cut may be taken to ensure a close fit of the pipe faces. For this purpose, only

experienced cutters who can make uniform and straight cuts, shall be permitted to cut the faces of the pipes. No extra payment shall be made for such marginal cutting. There shall be no lateral displacement between the pipe faces to be joined. If necessary, spiders from inside and tightening rings from outside shall be used to bring the two ends in perfect contact and alignment. It may also be necessary to use jacks for this purpose. In no case shall hammering or longitudinal slitting be permitted. When the pipe is properly assembled and checked for correct line and level, it shall be firmly supported on wooden beams and wedges and tack welded. Some portion of the trench may be refilled at this stage so as to prevent the pipeline from losing its alignment. The tack welded circumferential joints shall then be welded fully. Only experienced welders, who shall be tested from time to time shall be permitted to carry out the welding work.

On completion of the pipe jointing and external protection, the trench shall be cleaned of outside coating rebound. The welding shall be filled and compacted in 150mm layers with the bedding material. Backfilling shall be carried out as detailed here under.

#### **Precautions against Floatation**

When the pipeline laid underground or above ground in a long narrow cutting gets submerged in water collected in the trench of cutting it is subjected to an uplift pressure due to buoyancy and is likely to float if completely or partly empty. In the design of pipelines, provision is to be made to safeguard against floatation providing sufficient overburden or by providing sufficient dead weight by means of blocks, etc. Factor of safety for calculations for check against floating shall be taken as 1.25.

In the case of works extending over one or more monsoon seasons, however, special care and precautions are necessary during the progress of work on this account. The Contractor shall close down pipe laying operations well in time for the monsoon. The work of providing blocks, refilling the earth to the required level, compacting the same, etc. shall always be done as soon as the pipeline in the cutting has been laid.

The Contractor shall see that the water shall not be allowed to accumulate in open trenches. Where work is in an incomplete stage, precautionary work, such as blank-flanging in the open ends of the pipeline and filling the pipeline with water etc. shall be taken up as directed by the Engineer.

Such works shall be to the Contractor's account and no separate payment shall be made for the same. The Contractor's rate for pipe laying shall be deemed to include such precautionary measures against floatation.

Protection of the pipeline against floatation during the Contract Period shall be the responsibility of the Contractor. Should any section of the pipeline float due to his negligence, etc. the entire cost of laying it again to the correct line and level shall be to his account.

#### **Cleaning, Disinfection and Commissioning of the Pipeline**

Upon completion of a newly laid main, the main shall be disinfected as directed by the Engineer.

The main shall be flushed prior to disinfection except when the tablet method is used. After initial flushing, the hypochlorite solution shall be applied to the water main with mechanically or electrically powered chemical feed pump designed for feeding chlorine solutions. For small applications, the solution may be fed with a hand pump.

In the case of main of large diameter, water from the existing distribution system or other approved source of supply shall be made to flow at a constant measured rate into the newly laid pipe line. The water shall receive a dose of chlorine also fed at a constant measured rate. The two rates shall be proportioned so that the concentration in the water entering the pipeline is maintained at no less than 300 mg/l. The chlorine shall be applied continuously and for a sufficient period to develop a solid column of 'Slug' of chlorinated water that will as it passes along the line expose all interior surfaces to a concentration of at least 300 mg/l. for at least 3 hours. As the chlorinated water flows past tees and crosses related valves and hydrants shall be operated so as to disinfect the appurtenances.

In the case of newly laid mains in which scrupulous cleanliness has been exercised the tablet method can be adopted and in this method, the initial flushing is dispensed with. The calcium hypochlorite tablets are placed in each section of pipe and also in hydrants, hydrant branches and other appurtenances. The tablets shall be attached by an adhesive and must be at the top of the main. The main shall then be filled with water and the water shall remain in the pipe for at least 24 hours.

After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the mains is not higher than that generally prevailing in the system or less than 1 mg/l.

After final flushing and before the water main is placed in service, a sample or samples of water shall be collected from the end of the line and tested for bacteriological quality and shall show the absence of coliform organisms. If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory, samples are obtained before the main is placed in service.

The Contractor is expected to carry out the disinfection work as a part of laying the pipes and his rates for laying the pipes should include the disinfection and other connected works till the main is placed in service, unless otherwise specified in the schedule.

Unless specified otherwise, the pipeline shall be buried with minimum cover at top, directed by Engineer-in-charge. No material shall be erected unless it has been previously passed by the Engineer.

Inspection and Test plan for Laying of Pipeline shall be approved before start of Laying work.

Pipe shall be protected from outside with rock shield mesh/soft murrum/Sand wherever required/as directed by Engineer-In -Charge. In such cases, the depth of soft murrum/sand shall be 300mm above top of pipe.

Erection of fabricated shells shall be carried out by the Contractor who shall equip himself, at his cost, with all necessary tools, machinery, labour etc. required for the purpose.

#### **Field Welded Joints**

Before Start of Laying of Pipeline, WPS/PQR/WPQ as per ASME SECTION IX shall be approved for welding of Pipeline.

Before starting of Welder qualification test, contractor have to submit Raw material test certificate for MS test piece for review.

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**Welding**

Except for routine welding of joints, no other work shall be done in the absence of Contractor's engineer, either during the day time or at night. Chipping shall not be kept in arrears for more than 15 joints.

**Field Welded Joint PAUT Test & Inspection:**

For Field welded joints, 100% length of each welded joint shall be examined by Phased array Ultrasonic Test. The PAUT test shall be conducted as (As per API 5L or ASME SECTION V or API 1104 ). The person who conducts the test shall have certificate of ASNT Level-2 as per SNT-TC-1A for Ultrasonic testing.

The acceptance criteria for PAUT shall be as per ASME SECTION V or API 5L or API 1104 latest  
All Welded Joints are to be Examined in accordance with

- i) ASTM E-2700-09 : Standard Practice for Contact Ultrasonic Testing of Weld using Phased arrays
- ii) ASME SEC V- Article -4 : Ultrasonic Examination Methods for Weld
- iii) ASTM E 2491 latest: Standard Guide for evaluating performance characteristics of Phased

**Array Ultrasonic Testing Instruments and System.**

A complete Set of PAUT Records shall be retained by the contractor and keep of file for a period of five years. PAUT operator/Technician shall be qualified in accordance with PCN Level-II/SNT-TC- 1A with Prior Demonstration of PAUT testing.

PAUT equipment shall be as per ASTM - E 2700

All Joints PAUT records must be submitted in digital and printed format for permanent record for witness by the client/TP.

The personnel performing testing in accordance with this written procedure shall be qualified Level-2. He will set up and verify the PAUT equipment, perform the tests, interpret and evaluate the results, organize and report the same. The personnel performing testing in accordance with this written procedure shall be qualified Level-2. He will set up and verify the PAUT equipment, perform the tests, interpret and evaluate the results, organize and report the same.

The contractor have to submit calibration certificate for PAUT equipment and probe before starting of scanning work for welded joint. The calibration check shall be performed for PAUT equipment before starting of scanning work.

The couplant used shall generally of appropriate viscosity which is capable of providing a constant transmission of Ultrasonic Waves between the Probes and the material of examination. It shall provide an optimum wetting, adequate resistance to corrosion and shall be easily removable.

The temperature of the material under test shall not be more than 50°C. The temperature of the material under test and the calibration block temperature shall be similar and the difference shall not exceed 10°C. The scanning surface shall be even, free from loose rust, foreign particles, dust ,dirt, grease etc. Freedom from weld spatter, notches and grooves shall be ensured before conducting the test.

Preparation for DAC (Distance Amplitude Correction/TCG (Time calibrated gain)

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All individual beams used in the examination shall be calibrated to provide measurement of Distance Amplitude correction over the sound path employed in the examination. This shall also include applicable compensation for wedge sound path variations and wedge attenuation effects. The objective of this calibration is to automatically produce an equal signal amplitude from a reference reflector irrespective of their sound path travelled.

Distance Amplitude Correction graph shall be plotted on a 3-point gain level using a 3 mm dia. SDH in the single reference block (EN 1712) of the same material as that of weld with 3 holes at different depths. For plotting the DAC curve, the gain shall be set to a reference level of 80% of the Full Screen Height. The DAC must cover entire area of scan used for examination. The dB displayed after plotting the DAC shall be used as Standard Sensitivity level for the PAUT. The results of the DAC calibration shall be stored in the system for all future references and verified prior to commencement of the test every shift and the results recorded.

The contractor have to submit PAUT procedure method for site welded joints.

Immediately after the PAUT examination, evaluation and the documentation, the tested area shall be cleaned while ensuring that the parts are not adversely affected.

On site Reporting- A report containing brief summary of the weldment inspected, results obtained, defect indications observed shall be provided on site.

Final Report- The final report shall consist of printed images of each scan with adequate information to facilitate traceability of the weld. These reports shall be compiled and submitted to the GWSSB Authority & TPIA on a periodicity decided mutually. All original data shall be supplied on soft copy at the end of inspection. All repairable indications shall be supplied in PDF format for reference.

### **Testing of Site Welded Joints**

The welded joints at site shall be tested for Tensile test and Bend test in accordance with procedure laid down in as per the latest edition of IS 3600 "code of procedure for testing of fusion welded joints and weld metals in steel".

Test pieces shall be taken by the contractors from the welded joints at the position on fabricated pipes pointed out by the Engineer in-charge.

The sample so taken shall then be cut to the exact shape and dimensions and machined as described below and handed over to the Engineer-in-charge for testing. All the work up to and including machining and arranging for test shall be done by the contractors.

### **Field Destruction Test**

Contractor shall perform destruction test of any section of MS Pipeline which Engineer selects at every 5 KM pipeline laid and shall submit its result to him. The testing shall be done in the NABL approved laboratory in the presence of representative of the employer.

### **Temperature**

The components of the pipeline such as base Coils, top Coils and pedestals have been so designed that the centres of the Coils and pedestals shall coincide at the Mean Temperature (30°C).



For this reason, all works such as fixing flanges, base plate etc. in true alignment and in correct position and tack welding pipes shall be done at the mean temperature.

For ascertaining the temperature, the Contractor shall provide mercury cups and fix them to the pipe shell from outside and shall also provide thermometers of the required type and range. No extra payment shall be made for this.

### **Saddle supports**

Unless otherwise specified pipeline shall be underground. However at unavoidable reaches it shall be on R.C.C. saddles spaced at about 6 m centre to centre. The material and construction of R.C.C./Steel structures such as saddles, anchor blocks, crossings etc. associated with the work of pipe line shall conform with the relevant I.S. codes, good engineering practice and as directed by the Engineer. The pipes to be laid on saddle supports shall be erected at mean temperature. Saddle supports shall either be sliding type or fixed type. For both the types of supports a 10mm thick double plate shall be welded to the part circumference of the pipeline that will make contact with the saddle and another similar plate shall also be embedded in the concrete saddle with necessary arrangement to facilitate welding it to the double plate welded to the pipe, in case of fixed support. In case of sliding support, the pipe shall be allowed to slide freely over the plate embedded in the saddle. Alternatively to achieve fixity, the pipe shall be anchored by providing suitable anchor block. The rate for laying the pipe on saddle support shall include for laying, aligning, tack welding, provision of rigging screws with screw eyes etc., complete.

In addition to above, the pipe shall be held in position on saddles with two numbers 50mm x 8mm thick holding down traps fixed to the saddles with holding down bolts and nuts.

### **Erection of Shells**

The erection shall be true to position, lines and grade of the trench prepared or as modified by the Engineer. The Contractor shall provide at his cost necessary saddles, pads, spider etc., all necessary instruments and other materials and labour required for proper erection of shells in position and for the Engineer in checking the correctness of the erection.

Alignment of sections at edges to be butt welded shall be such that the maximum offset is not greater than the values given below:

Thickness 't' (mm)	Offset in longitudinal joints (mm)	Offset in Girth joints (mm)
Up to 12	0.25 t	0.25 t
12 to 20	3 mm	0.25 t
20 to 40	3 mm	5 mm
40 to 50	3 mm	1/8 t
Over 50	Lesser of 0.0625 t or 10 mm	Lesser of 0.125 t or 20 mm

The best of welders as selected from their work in the Contractor's workshop shall be selected for in-situ welding of the shells. The relevant provision under welding such as qualification standard for welding procedures, tests on welder's work and removal of defects etc., shall also apply to in-situ welding.

### **General Sequence of Operations**

Before commencing the work of pipe laying, the Contractor shall study the L-section of the pipeline for the section concerned. He shall also study the details of laying i.e. underground or aboveground.

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The underground pipeline shall be laid on sand cushioning/ bedding as shown on the drawing. The difference in depth due to uneven excavations shall be made up by sand cushioning.

Pipe laying shall generally start from the fixity points on either side, the expansion joints if required for pipeline aboveground being provided last. Fixing points are at all anchor blocks. Where such blocks are not required for long lengths, fixity shall be achieved by fixing the pipeline to the special type of R.C.C. or steel saddles as specified. The distance between successive fixity points shall not exceed 300 m.

Thrust and Anchor blocks shall be constructed before commencing the pipe laying work in any section. The construction of the blocks shall be carried out in 3 stages: in the first stage the lower part up to 150 mm below the invert of the pipeline including concrete chairs to support it shall be constructed; in the second stage the pipeline on this part of the block shall be laid; and lastly, the remaining block around and over the pipeline shall be constructed.

The fixity saddles and ordinary saddles if the pipeline is aboveground shall be cast-at least 3 weeks before the pipeline is laid on them. After all saddles between successive fixity points have been cast, a line plan showing the actual position thereof shall be prepared, after taking levels and measuring distances. In case of any errors in casting the pedestals, corrections shall be applied. The pipe laying work shall then start from the fixity points and shall proceed towards the expansion joints. The method of jointing the pipes and erecting them on previously cast R.C.C. saddles shall be determined by the Contractor depending upon the type of plant equipment and personnel available with them.

The pipe strakes shall be assembled in position on the saddles either by the cranes, portable gantries, shear legs or any other equipment approved by the Engineer. Normally, not more than two pipes shall be aligned, tacked and kept in position on temporary supports. The Contractor shall not proceed with further work, until the circumferential joints of these pipes are fully welded. During assembly, the pipeline shall be supported on wooden sleepers and wedges, with the free end of the pipeline held in position by slings to avoid deflection due to temperature variations during the day. In general, the assembly of pipe strakes and one run of welding shall be done during the day time while full welding including the external gouging and sealing runs shall be done after 5 p.m. or so. The Contractor shall maintain the continuity of the work by adding two more pipes on the second day in a similar manner, after full welding of the previous joints is completed during the night. While this new work is being done, the Contractor shall proceed with the work of providing permanent supports for the pipeline assembled and welded previously.

### **Fixing Expansion Joint**

The work of laying pipeline at above the ground, laying starts from the fixity points and proceeds towards the expansion joints. It shall be continued until the gap between the pipe ends is less than the lengths of the expansion joint plus pipe strake length. At this stage, the exact gap between the pipe ends shall be measured at mean temperature of that locality. Let it be 'X'. Similarly, the exact length of the pipe strake and the expansion joint bought at site shall be measured at the same temperature let these be 'Y' and 'Z' respectively. Normally, the length of the expansion joint ('Z') is standard.

Case when 'Y' plus 'Z' is more than 'X' or equal to 'X' (i.e. fixing of expansion joint without strip)

At mean temperature the exact gap between pipes shall be measured. Free ends of pipes shall be brought in a correct line and level; lateral movement, if any, shall be corrected. Then the gap between the free ends shall be made equal to the exact length of the expansion joint by cutting one of the pipe ends. Choice of the end to be cut must be made from the point of view of bringing the expansion joint to a central position.

The expansion joints are normally supplied without packing. The normal length of the expansion joint shall be reduced by about 100 mm by cutting the inside locks and inserting the inner strake by means of turn buckles. At mean temperature this expansion joint shall be inserted inside the gap (care being taken to keep the tapered portion on the down-stream side), and both ends shall be tack welded to the pipe ends, after pulling the expansion joint. (Tacks of these two joints shall be of longer length, approximately 100 mm long).

Welding of these two joints of the expansion joints shall be started only after it is ascertained by taking observations that the expansion joint is functioning properly. The procedure to be followed for taking observations as specified .

(b) Case when 'Y' plus 'Z' is less than 'X' (i.e. fixing of expansion joints with strap) The expansion joint shall be laid in locked position. Before laying the pipes adjacent to the expansion joint, the exact gap between the pipes shall be calculated by taking measurements of the first pipe (upstream of the expansion joint), and the second pipe (downstream of the expansion joint) at Mean Temperature.

If the gap is less than 100 mm, the second pipe shall be cut to make the desired gap of at least 100 mm. If the gap is more than 200 mm, suitable distance piece of not less than 600 mm shall be inserted after cutting necessary length of the first pipe.

The second pipe shall then be laid in position. Then a strap of length equal to three times the gap length shall be welded to the pipe, overlapping the second pipe by the gap length. The other end of the strip shall be kept free.

At mean temperature the other end of the strap shall be tacked to the first pipe, after checking of the line and level. Simultaneously, all the locks of the expansion joint shall be removed and chipped off properly.

Welding of the joints between the strap and the first pipe shall be started only after observations are over and it is ascertained that the expansion joint is functioning properly.

### Observations

Before fixing the expansion joint, two mercury cups - one on the left and the other on the right side - shall be fixed on the pipe near the upstream side of the expansion joint.

Immediately after the expansion joint in case (a) above or the strap in case (b) above is tack welded, observations for total expansion or contraction shall be started and continued for 48 hours round the clock. Similarly, the central and end fixity pedestals shall be kept constantly under observation.

The expansion and contraction shall be measured by making a temporary marking on the inner strake (on the upstream side) and measuring the distance between this mark and the edge of the gland of the expansion joint.

The observations shall be recorded in the following Performa;

Reading No.	Time	Shell temp on upstream side	Shell temp on	Atmospheric	Dist. Between edge of gland and marking
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			Downstream side	Temperature	
1	2	3	4	5	6

In case the pipeline is laid in trenches as shown on the drawing, after welding and field testing, the trench shall be filled with selected material up to 300 mm above pipes. This backfill shall be provided in layers not more than 150 mm, with a density more than 70 to 80% of the standard proctor density. Samples shall be tested as directed by the Engineer. Remaining depth of trenches shall be filled with ground backfill material.

### **Specials**

#### **General**

Specials, such as tees, Y-pieces, bends (single or composite), tapers, etc. shall necessarily be in steel and shall be manufactured as per standards and tested and laid in the same manner as the pipes. Small branches, single piece bends, etc. may be fabricated at site, care being taken to ensure that the fabricated fittings have at least the same strength as the pipeline to which they are to be jointed.

#### **Bends**

Bends shall be fabricated taking into account the vertical and horizontal angles for each case. The bends shall have welded joints and the upstream and downstream ends of each bend shall have a straight piece of variable lengths as required.

Bends shall be designed with deflection angle of maximum 10 deg. between segments.

When the point of intersection of a horizontal angle coincides with that of a vertical angle, or when these points can be made to coincide, a single combined or compound bend shall be used, designed to accommodate both the angles. The combined bend should have a pipe angle equal to the developed angle, arrived at from appropriate formula.

All joints in bends shall be thermally stress relieved as specified.

Details of thrust collars anchor bolts, holding down straps, saddle Coils should be furnished together with full specifications in Contractor's fabrication drawing.

#### **Manholes**

Manholes of 750-mm dia shall be provided at both the sides of butterfly valves and as directed by Engineer-In-Charge. Manholes in the pipeline shall be placed in suitable position in the top quadrant.

The Contractor shall fabricate different parts of manhole in conformity with relevant IS Specification, well-established practices and as directed by the Engineer.

#### **Closing or Make up sections**

Closing or make up sections shall be furnished at appropriate locations on the line to permit field adjustments in pipeline length to compensate for shrinkage in field welded joints, differences between actual and theoretical lengths and discrepancies in measurements.

#### **Heads**

Test heads may be ellipsoidal, standard dished as per ASME code or hemispherical heads. They shall be welded in the shop and removed after the test. Allowance should be made in the length of the pipe section receiving the test head for the welding and removal of the head and preparation of the plate edges for the final weld after testing.

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No separate payment will be made for such test heads. The rate quoted for the hydraulic test shall be deemed to cover the cost of such installations.

**Walkways, Stairs, Ladders, Hand Rails etc.**

Walkways, stairs, rungs, ladders, hand rails, etc. shall be provided as shown in the drawings and/or as directed by the Engineer. They shall conform to well established design and construction for each accessory concerned.

**Flanges**

Flanges shall be provided at the end of pipes or special where sluice valves, blank flanges, tapers, etc. have to be introduced. The flanges received from the manufacturers will have necessary bolt holes drilled. The Contractor shall assemble the flanges in the exact position by marginal cutting, if necessary, so as to get the desired position of the sluice valves, etc. either vertical or horizontal and shall then fully weld the flanges from both sides in such a way that no part of the welding protrudes beyond the face of the flanges. In case the welding protrudes beyond the flanges and if the Engineer orders that such protrusions shall be removed, the Contractor shall file or chip them off. If required and when ordered by the Engineer, the Contractor shall provide and weld gusset stiffeners, as directed on site. The drilling pattern shall be matching with the drilling pattern of flanges of valves.

**Blank Flanges**

Blank flanges shall be provided at all ends left unattended for the temporary closure of work and also for commissioning a section of the pipeline or for testing the pipeline laid. For temporary closures, non-pressure blank flanges consisting of mild steel Coils, tack welded at the pipe ends may be used. For pipes subjected to pressures, the blank flanges or domes suitably designed as per Engineer's requirements shall be provided.

**Stiffener Rings**

The Contractor shall provide stiffener rings wherever required by design. The Contractor shall weld the same to the pipes with one circumferential run on each side.

All fillet welds shall have a throat thickness of not less than 0.7 times the width of welding.

**Field Joint Coating : Heat Shrink Sleeve (HSS) Scope**

This specification establishes the minimum requirements of materials, equipment and installation of field joint anti-corrosion coating of buried onshore pipelines with factory coated three layer polyethylene coating by three layer, heat shrink wraparound sleeves conforming to AWWA C216 or EN 12068 -latest version or as modified/replaced by specification which shall remain fully applicable and complied with.

Prior to procurement of coating materials, Contractor shall furnish the following information for qualification of the Manufacturer and material. This specification shall be read in conjunction with the conditions of all specifications and documents included in the Contract between Company and Contractor. Unless specified otherwise, all sections of this specification shall apply to all specifications referred in this specification.

After abrasive blasting of Welded joint for application of heat shrinkable sleeve as per EN 12068 or / power tool cleaning as per SSPC-SP 3 / hand tool cleaning as per SSPC-SP 2, As recommended by the manufacturer, of welded joint for application of heat shrinkable sleeve as per AWWA C216, Dust contamination test should be checked by Engineer/TPIA as 1 joint per 10 joints and

after completion of Heat shrinkable sleeve of welded joint, Peel test should be done as 1 joint per 10 Joints.

Holiday Test done at field for pipe end and field joint coating shall be done as per instruction of Engineer-in-Charge.

### Reference Documents

Reference has also been made to the latest edition (edition enforce at the time of issue of enquiry) of the following standards, codes and specifications:

a)	ISO 8502-3	Preparation of Steel Substrates before Application of Paints and Related Products – Part 3 – Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure Sensitive Tape Method)
b)	ISO 8503-1	Part 1 Specification and definitions for ISO surface profile comparator for the assessment of abrasive blast cleaned surfaces
c)	ISO 8503-4	Part 4: Methods for calibration of ISO surface profile Comparator and for the determination of surface profile -Stylus instrument procedure.
d)	SIS 055900	Pictorial Surface Preparation Standard for Painting Steel Surfaces.
e)	SSPC-SP1	Steel Structure Painting Council
f)	ASTM D149	Standard Test Method for Dielectric Breakdown Voltage & Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
g)	ASTM D257	Standard Test Methods for DC Resistance or conductance of Insulating Materials
h)	ASTM D570	Standard Test Methods for Water Absorption of Plastics
i)	SSPC SP2	Surface Preparation Standard No. 2 Hand Tool Cleaning
i)	SSPC SP3	Surface Preparation Standard No. 3 Power Tool Cleaning

In case of conflict between the requirements of this specification and that of above referred Documents, the requirements of this specification shall govern.

The CONTRACTOR shall be familiar with the requirements of these documents and shall make them readily available at the site to all personnel concerned with carrying out the works specified in this specification.

### Materials And Equipment

Field joint anti-corrosion coating material shall be heat shrinkable wraparound sleeve suitable for a maximum operating temperature of (+) 60°C (max. T) and shall conform to designation EN 12068-C-HT-60 UV or shall comply to AWWA C216 Type II. In addition, the field joint anti-corrosion coating shall comply with the requirements of this specification.

### Heat shrinkable wraparound sleeves:

Heat shrinkable wraparound sleeve shall consist of radiation cross-linked, thermally stabilized, ultraviolet resistant semi- rigid high density polyolefin backing with a uniform thickness of high shear strength thermoplastic adhesive for heat shrink sleeve conforming to EN 12068-latest version or butyl rubber adhesive for sleeves conforming to AWWA C216/latest version. The high density polyolefin backing layer either for heat shrinkable sleeve conforming to EN 12068 or AWWA C216-latest version shall be provided with suitable means PCI (thermochromic paint, dimple, or other means) to indicate the desired heat during shrinking in field is attained. The

sleeve shall be supplied either in Type-II (as per A WWA 216 C) or Class-C, Class HT, Class UV (As per EN 12068) pre-cut sizes to suit the pipe diameter and the requirements of overlap.

The total thickness of heat shrinkable wraparound sleeve conforming to EN 12068 -latest version in the "As Applied" condition shall be as follows:

Pipe size (specified outside diameter)	Thickness (mm)	
	On Pipe Body	On Weld Bead
	Min	Min.
<30" (762.0mm)	2.5	2.0
>32" (813.0mm)	3.3	2.6

The total applied thickness of heat shrinkable wraparound sleeve conforming to AWWA C216 Type II shall be as per Table 1 of AWWA C216-latest version standard. The minimum applied thickness shall be measured at the apex of the weld seam.

The heat shrink wraparound sleeve shall have the required adhesive properties when applied on various commercial pipe-coating materials. The pre-heat and application temperatures required for the application of the shrink sleeve shall not cause loss of functional properties of the pipe coating.

#### Functional Requirements of Field Joint Coating:

Properties of the PE backing shall be as follows:

Sr. No.	Properties	Unit	Requirement	Test Method Std.
a.	Tensile Strength @ +25° C	N/mm <sup>2</sup>	≥12	ISO 527-3
b.	Ultimate Elongation @ +25° C	%	≥250	ISO 527-3
c.	Dielectric withstand with 1000 Volts/Sec	kV	≥30	ASTM D149
d.	Water absorption @ +25° C for 24 hours	%	≤0.05	ISO 62
e.	Electrical Volume Resistivity @ +25° C	Ohm-cm	≥1015	ASTM D257
f.	Hardness @ + 25°C	Shore D	55 min.	ASTM D 2240

Functional Properties of Joint Coating System (As supplied)

As applied field joint coating system shall comply the requirements of DIN EN 12068 /AWWA C 216 Table 1 & 2, except as modified below:

Cathodic Disbandment Resistance at Tmax i.e. 60°C shall be 20mm when tested as per Annexure K of EN 12068 / Sec 5.2.8 of AWWA C 216 Test shall be carried out at (+) 60°C.

Peel Strength confirming to EN 12068 on SA 2½ surface:

Peel Strength		Unit	Requirement for Mech Resistance	Test Method
To Pipe Surface	@23° C	N/mm	3.5	

		@Tmax	N/mm	1.0	Annex B of DIN EN 12068
To Factory Coating		@23° C	N/mm	3.5	
		@Tmax	N/mm	1.0	
Peel Strength confirming to AWWA C 216 on ST-3 surface					
To Pipe Surface		@23° C	N/mm	2.6	Annex C of DIN EN 12068
		@Tmax	N/mm	0.26	
To Factory Coating		@23° C	N/mm	2.6	
		@Tmax	N/mm	0.26	

- **PEEL MODE:**

Peel mode separation shall occur cohesively within the adhesive layer on pipe body and 3LPE coating overlap. In case the heat shrink sleeve disbonds from primer/steel or 3LPE surface, the same shall constitute a failure even if the peel values mentioned above are achieved.

- **VISUAL EXAMINATION OF PEEL / VOIDS TEST:**

To establish voids adjoining the circumference girth and chamfer area of 3LPE factory coating, examination via stripping 50 mm x 200 mm long strip shall be carried out. No voids shall be permitted.

Contractor shall obtain prior approval from Employer regarding the Manufacturer of the joint coating material and the specific grade of the joint coating system. Complete technical details along with test certificates complying with the requirements and shall be submitted to Employer for this purpose. The Contractor shall furnish test certificates from an independent DIN recognized/approved laboratory for all the properties required for the specified EN designation of field joint coating and the requirements of this specification. For AWWA C216 designated heat shrink sleeve, tests certificate from NABL approved laboratory shall be furnished for approval.

### **Cut back**

Cut back length of the percolated pipes shall be 150mm ±10mm, protected by PVC end seal tape from approved vendor after surface preparation from factory to preserve surface cleanliness and prevent surface rusting.

Field joint coating system shall be of suitable width considering an overlap to the factory coated pipe coating by minimum 50 mm after application on each side 3LPE coated pipes.

### **Application Procedure General**

The application procedure shall be in accordance with manufacturer's instructions and the minimum requirements specified below whichever are the most stringent and shall be demonstrated to and approved by the Employer. Manufacturer's expert shall supervise the application and shall be available at site upon request during qualification of application procedure and during construction at Contractor's cost.

Operators for coating application shall be given necessary instructions and training before start of work, by the Contractor. To verify and qualify the application procedures, all coating applied during the qualification test, shall be removed for destructive testing as detailed subsequently in



this specification. Contractor shall only utilize those operators who have been approved/pre-qualified by the field joint coating manufacturer.

Oil, grease and salt shall be removed from steel surface by wiping with rags soaked with suitable solvents such as naphtha or benzene. Kerosene shall not be used for this purpose. Solvent cleaning procedure according to SSPC-SP1 shall be followed.

Each field joint where heat shrink sleeves conforming to EN12068-latest version is to be used shall be blast cleaned using a closed cycle blasting unit or an open expendable blasting equipment. With the first equipment type, steel or chilled shot and iron grit shall be used and Garnet material with the second one (in case the authority having jurisdiction have no objection, the contractor may adopt sand blasting instead of garnet material). During blast cleaning the pipe surface temperature shall be simultaneously more than 50C and more than 30C above ambient Dew Point, while the ambient Relative Humidity shall not be greater than 85%. Prior to surface cleaning the surfaces shall be completely dry. The surface shall be cleaned to a grade Sa 2½ in accordance with Swedish Standard SIS- 055900 with a roughness profile of 50-70 microns. Surface roughness profile shall be measured using an approved profile comparator in accordance with ISO 8503-1 and shall be calibrated prior to the start of the work in accordance with ISO 8503 or ISO 8503-4. The blast cleanliness shall be checked on every joint and the roughness profile shall be checked 1 every 10 joints.

- Each field joint where heat shrink sleeves conforming to AWWA C216 Type II is to be used shall be power tool cleaned as per SSPC-SP 3 / hand tool cleaned as per SSPC -SP 2, As recommended by the manufacturer.

Dust, grit or foreign matter shall be removed from the cleaned surface by an industrial vacuum cleaner. The dust contamination allowed shall be of a rating max 2 as per ISO 8502-3.

The frequency of checking for dust contamination shall be 1 every 10 joints.

Blast cleaned field joint shall be coated with 2-4 hours according to the conditions below:

- Relative Humidity (RH) >80% - 2 hours
- Relative Humidity (RH) 70-80% - 3 hours
- Relative Humidity (RH) <70% - 4 hours

Pipes delayed beyond this point or pipes showing any visible rust stain, shall be blast cleaned again.

The field joint surface shall be inspected immediately after blast cleaning / power tool cleaning as per SSPC-SP 3 / hand tool cleaning as per SSPC -SP 2, As recommended by the manufacturer ,depending on the type of sleeve to be used, and any feature of the steel surface such as weld spatter, scabs, laminations or other imperfections considered injurious to the coating integrity, made visible during blast cleaning / power tool cleaning as per SSPC-SP 3 / hand tool cleaning as per SSPC -SP 2, As recommended by the manufacturer, shall be reported to the Company Representative and on permission from Company Representative, such defects shall be removed by filling or grinding. Pipes affected in this manner shall be then re-blasted / power tool cleaned as per SSPC-SP-3 / hand tool cleaned as per SSPC-SP-2, as recommended by the manufacturer, if the defective area is larger than 50mm in diameter.

The ends of existing pipe protective coating shall be inspected and chamfered. Unbounded portions of the coating shall be removed and then suitably trimmed. Portions where parent coating is removed shall be thoroughly cleaned as specified. The adjacent chamfered areas of the line pipe coating up to a distance of 100 mm shall be cleaned and abraded using 60 mesh sanding disc, to expose a clean uniform fresh surface of uncontaminated factory applied coating.

All steel joint surfaces shall be thoroughly examined before the application of the coating in order to ensure the surfaces are free of oil, grease, rust, mud, earth or any other foreign matter. All these substances shall be removed before coating, to the procedures herein described.

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Protection coating shall be applied on the joints immediately after the completion of cleaning operation.

**Application Procedure for Heat Shrink Wraparound/Sleeves**

In addition to the requirements stated above, following shall be complied with:

The wraparound sleeve shall be of a size such that a minimum overlap of 50mm is ensured (after shrinking) on both sides of the yard applied corrosion coating of pipes.

In the cases where carrier pipe is installed by direct boring/jacking, the overlap on the mill coating for the leading edges of the joints shall be minimum 200mm. When this extra overlap is achieved by providing an additional patch of heat shrink tape/wraparound, it shall be applied in such a manner that the square edge of the patch on the joint coating is in the direction opposite to the direction of boring/jacking.

Before centering the wraparound sleeve, the bare steel surface shall be preheated either with a torch moved back and forth over the surface or by induction heating. The minimum pre-heat temperature shall be as recommended by manufacturer and shall be checked by means of contact type temperature-recording thermometer (Digital Pyrometer with flat probe type contact). Temperature indicating crayons shall not be used. Pre-heat temperature shall be checked on every joint. Care shall be taken to ensure that the entire circumference of the pipe is heated evenly. Temperature measuring instruments shall be calibrated immediately before the start of the works and thereafter at intervals recommended by the manufacturer of the instrument.

Upon pre-heating, the pipe surface shall be prepared as per manufacturer's recommendation along with primer (as recommended by manufacturer) ) both for heat shrinkable sleeves conforming to EN 12068 & AWWA C216 applied to thickness of 75 micron or as specified by manufacturer whichever is higher, to cover the exposed bare metal of the welded field joint and 10mm min. onto the adjacent pipe coating. The wet film thickness of the primer if applied shall be checked on every joint with a wet film thickness gauge prior to installation of sleeve. Thickness gauge shall be calibrated once per shift.

Immediately after application of compatible primer, the wraparound sleeve shall be entirely wrapped around the pipe as per manufacturer recommendation. Sleeve shall be positioned such that the closure patch is located to one side of the pipe in 10 or 2 O'clock position, with the edge of the undergoing layer facing upward and an overlap of min. 50mm. Gently heat by appropriate torch the backing and the adhesive of the closure and press it firmly into place.

A heat shrinking procedure shall be applied to shrink the sleeve in such a manner to start shrinkage of the sleeve beginning from the center of the sleeve and heat circumferentially around the pipe. Continue heating from the center towards one end of the sleeve until recovery is completed. In a similar manner, heat and shrink the remaining side. Shrinking has been completed when the adhesive begins to ooze at the sleeve edges all around the circumference. The complete shrinking of the entire sleeves shall be obtained without undue heating of the existing pipe coating and providing due bonding between pipe, sleeve and pipe coating. The installed sleeve shall not be disturbed until the adhesive has solidified.

The joint coating application shall be done under supervision of the manufacturer's personnel during the field trial demonstration and testing work. Presence of manufacturer's representative is a mandatory requirement and bidders are required to furnish specific commitment to this. Minimum 50 (fifty) field joint coating to be carried out under supervision of the joint coating supplier's representative. Application procedure and environment protection methodology demonstrated at the time of field trial shall be strictly followed during the entire work.

### **Repairs**

If a field joint is detected to be unacceptable after testing as per relevant QA section of this specification the Contractor shall, at his own cost:

Determine the cause of the faulty results of the field coating.

Mobilize the expert of manufacturer, if required.

Test to the complete satisfaction of Company, already completed field coatings.

Stop the field coating works until remedial measures are taken against the causes of such faults, to the entire satisfaction of the Company.

Contractor shall replace all joint coating found or expected to be unacceptable as per relevant section of this specification.

Contractor shall, at his own cost, repair all areas where the coating has been removed for testing by the Company.

After the coating work on welded joints and repairs to the coating have been completed the coating as a whole shall be tested with a spark-tester at voltage 20 KV before lowering or jacking the pipeline.

Employer shall be entitled to check the coating on buried pipelines or parts of pipelines with equipment such as the "Pearson Meter" or Current Attenuation ACVG meter and DVC meter. If coating defects are established, the Contractor shall be responsible for excavation at such points, repairing the coating, spark testing and backfilling the excavations without extra charge.

### **Documentation**

Prior to procurement of coating materials, Contractor shall furnish the following information for qualification of the Manufacturer and material.

Complete information as per clause Field Joint Coating (HSS) Scope and Functional Requirements of Field Joint Coating and DIN EN 12068 or AWWA C216 along with descriptive technical catalogues.

Test certificates and results of previously conducted tests, for all properties listed in clause Functional Requirements of Field Joint Coating of this specification.

Reference list of previous Heat Shrink Sleeves supplies, in last 5 years, of the similar material indicating the project details such as diameter, quantity, operating temperature, year of supply, project name, contact person and feedback on performance.

Once the Employer's approval has been given, any change in material or Manufacturer shall be notified to Employer, whose approval in writing of all changes shall be obtained before the materials are manufactured.

Prior to shipment of materials from the Manufacturer's Works, Contractor shall furnish the following documents:

Test certificates/results as per Manufacturer's Quality Control Procedure for each batch of material.

Specific application instructions with pictorial illustrations.

Specific storage and handling instructions.

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All documents shall be in English language only.

### **Specification For External Coating For Special Sections, Connections & Fittings Of Buried Steel Pipelines For Water**

#### **General:**

Special sections, miter bends, tees, connections, vent/drain pipe, fittings in buried steel pipeline network shall be coated externally, with prefabricated polyolefin tape coating as per AWWA C 209- comprising of butyl rubber primer , inner tape which is of 3ply construction and outer PE tape which is of 2 ply construction. The tapes will be applied in spiral configuration using hand tension or hand wrapping machine.

The Contractor shall perform all work in accordance with these specifications and the latest pipeline coating practices, and shall complete the work in all respects to the full satisfaction of the Owner / Owner's Representative. The entire coating operation starting from cleaning and surface preparation till coating shall be performed under the supervision of skilled personnel who are well conversant with the work. Pipes which have been cleaned and primed, or cleaned, primed and coated, without having been inspected and approved shall be rejected.

This specification is not intended to be all inclusive and the use of guidelines set forth here does not relieve the Contractor of his responsibility for the quality and performance of the applied coating system, and to supply coating material capable of performing its intended service.

#### **Referenced Standards:**

- The following standards (latest revision) referenced below are a part of this specification. In case of conflict between this specification and the referenced standards, this specification shall apply.
- ANSI/AWWA C209 - Standard for Cold Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
- ANSI/AWWA C214 - Standard for Tape Coating Systems for the Exterior of Steel Water Pipelines
- SSPC-SP 1 - Solvent Cleaning
- SSPC-SP 6/NACE No. 3 - Commercial Blast Cleaning
- SSPC SP 2 Hand Tool Cleaning
- SSPC SP 3 Power Tool Cleaning

#### **General:**

- The buried steel pipeline special sections shall be protected with hand or manual machine applied cold applied tape protective coating conforming to AWWA C209 - 00 (Cold Applied Tape Coating Systems for Exterior of Steel Water Pipelines).
- Protective coating shall consist of a coating system consisting of primer, inner - layer tape and outer-layer tape. Work or material that fails to conform to this standard may be rejected at any time before final acceptance

#### **Coating system**

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The pre-fabricated polyolefin tape coating system shall consist of the following layers to provide an applied coating system thickness of 100 mils (2.5mm) on the exterior of the special sections of steel pipes.

A liquid butyl rubber based adhesive layer- 50 to 75 microns.

An inner-layer tape 3 ply construction for corrosion protection having thickness of 30mils and applied with 50% overlap

An outer-layer tape for mechanical and UV protection having thickness of 20mils and applied with 50% overlap.

**Liquid Adhesive layer:**

The liquid adhesive layer shall consist of a mixture of suitable rubber and synthetic compounds and solvent. The liquid adhesive layer shall be brush applied to the abrasive blasted / power tool cleaning as per SSPC-SP 3 / hand tool cleaned as per SSPC -SP 2, As recommended by the manufacturer. prepared pipe surface before application of the inner-layer tape. The function of the liquid adhesive is to provide a bonding medium between the pipe surface and the inner-layer tape.

The liquid adhesive shall be supplied by the manufacturer that supplies the inner-layer tape. The liquid adhesive shall not settle in the container forming a cake or sludge that cannot be easily mixed by hand or mechanical agitation and it shall have good machine-application properties.

**Inner-layer tape:**

The inner-layer tape shall be a three-layer tape consisting of a polyolefin backing layer with a laminated butyl- based adhesive layer on the both sides. The inner tape shall be compatible with the liquid adhesive. The manufacturer shall certify that the backing material shall be polyolefin only, containing not more than 3.5 percent, by weight, of non- polyolefin material consisting of carbon black and antioxidants. The inner-layer tape shall be applied after the liquid adhesive and before the outer-layer tape.

The backing and adhesive shall be made from materials that provide high electrical resistivity, resistance to corrosive environments, low moisture absorption and permeability, and shall provide an effective bond to a primed steel surface. The inner-layer tape shall be of material that will resist excessive mechanical damage during normal application operations and shall be sufficiently pliable for the intended use. The inner-layer tape shall withstand, without tearing, the tensile force necessary to obtain a tightly wrapped inner coating free of voids. The inner-layer tape shall be supplied in roll form wound on hollow cores with a minimum inside diameter of 38mm.

The thickness of the inner tape shall be 30mils.

To ensure a proper smooth coating by hand or by manual hand wrapping machine, the inner-layer tape shall be provided in standard widths of 4" or 6" as per manufacturer recommendations consistent with the pipe diameter.

**Outer-layer tape:**

The outer-layer tape shall be a two-layer tape consisting of a polyolefin backing layer with a laminated butyl adhesive layer. The manufacturer shall certify that the backing material shall be polyolefin only containing not more than 3.5 percent, by weight, of non-polyolefin material consisting of pigments, antioxidants and stabilizers. The outer layer shall be compatible with the

inner-layer tape The primary function of the outer tape layer is to provide mechanical protection to mechanical and outdoor weathering (UV) protection to the tape system, and secondarily, to contribute to the overall corrosion-protection properties of the system. The outer- layer tape backing shall be compounded so that it will be resistant to outdoor weathering.

The outer-layer should be of suitable quality for the local environment, as follows:

Storage Temperature : 0 to 50 °C.

Overground Condition : 0 to 60 °C.

Underground Condition : 7 °C to 35 °C.

Ultraviolet-ray Protection : Required in outer layer.

Materials used in the outer-layer tape shall have high electrical resistivity, low moisture absorption and permeability, and shall provide mechanical protection during handling and outdoor storage. The outer-layer tape shall be sufficiently pliable for normal application operations by hand or by manual hand wrapping machine and shall form an effective bond to the inner- layer tape. The outer-layer tape shall be supplied in roll form wound on hollow cores with a minimum inside diameter of 38mm The thickness of the outer-layer tape shall be 20mils.

To ensure a proper smooth coating by hand or by manual hand wrapping machine, the outer-layer tape shall be provided in standard widths of 4" or 6" as per manufacturer recommendations consistent with the pipe diameter.

#### Coating-system Thickness:

The installed coating system thickness shall not be less than 100 mils (2.5mm) and shall comprise of the following.

liquid adhesive layer (50-75 microns)

An inner-layer tape (Nominal 30 mils i.e. 0.75mm) applied with 50% overlap

An outer-layer tape (Nominal 20 mils i.e. 0.50mm) applied with 50% overlap

The properties of the tape & coating system shall conform to the following requirements.

Table- Physical Properties of Total System:

Property	Requirement	
	Minimum	Maximum
Thickness 100 mil, nominal	95 mil	105 mil
Dielectric breakdown	400v/mil	
Water-vapor transmission, max.	0.25 perms (1.44ng/(Pa.s.m <sup>2</sup> ))	
Insulation resistance	500,000 mega ohms (min)	
Adhesion to Primed Steel	20 ozf/inch	

#### Coating Application

##### General:

The coating application shall be a manual operation starting with properly abrasive blasted pipe surface.

Longitudinal & spiral welds of the pipe shall not exceed a height of 3/32 inch (2.4mm) above the pipe surface and shall be ground flush a full 18 inch (450mm) along the length of the pipe from both ends prior to the coating process.

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Steps, which shall be performed consecutively, shall consist of (1) liquid adhesive application by brush; (2) application of the inner-layer tape directly onto the prepared pipe surface with 50% overlap; and (3) application of the outer-layer tape directly on top of inner-layer tape with 50% overlap.

**Pipe preparation:****Metal surface condition:**

Bare pipe shall be free from mud, mill scale, mill lacquer, wax, coal tar, asphalt, oil, grease, or any other foreign material. Before blast cleaning, surfaces shall be inspected and pre-cleaned according to SSPC-SP 1 to remove oil, grease, and loosely adhering deposits. Visible oil and grease spots shall be removed using a solvent. Only solvents that do not leave a residue shall be used. Preheating to remove oil, grease, and mill scale may be used provided that all pipe is preheated in a uniform manner to avoid distortion.

After drying and removing all loosely adhering foreign materials, the pipe surface shall be cleaned by blasting with grit to achieve a surface preparation at least equal to that specified in SSPC:SP6/NACE3. The blast anchor pattern or profile depth shall be 1 mil to 3 mils (25  $\mu$ m to 75  $\mu$ m) measured in accordance with ASTM D-4417.

The cleaned exterior pipe surface shall be inspected for adequate surface preparation. Surface imperfections, such as slivers, scabs, burrs, weld spatter, and gouges, shall be removed by hand filing or grinding if necessary to prevent holidays.

Blast-cleaned pipe surfaces shall be protected from conditions of high humidity, rainfall, or surface moisture.

No pipe shall be allowed to flash rust before coating. To ensure a dry pipe surface at the time of liquid adhesive application, the minimum steel substrate temperature shall be 21°C and at least 3°C above the dew point.

**Coating Application:****Liquid adhesive application:**

The liquid adhesive shall be applied in a uniform thin film at the coverage rate recommended by the manufacturer. The liquid adhesive shall be thoroughly and continuously mixed and agitated during application to prevent settling. The liquid adhesive shall be applied to the entire exterior surface of the pipe by brush to cover the entire exterior surface of the pipe. The liquid adhesive coat shall be uniform and free from floods, runs, sags, drips, or bare spots. The liquid adhesive-coated pipe surface shall be free of any foreign substances, such as sand, grease, oil, grit, rust particles, or dirt.

Before applying the inner-layer tape, the liquid adhesive layer shall be allowed to touch dry in accordance with the manufacturer's recommendation.

**Application of inner-layer tape:**

The inner-layer tape shall be applied directly onto the prepared pipe surface by manual tape coating machine.

When applied to spirally welded pipe, the direction of the tape spiral shall be generally parallel to the weld spiral. The minimum overlap shall not be less than 50%. When a new roll of tape is started, the ends shall be overlapped at least 150 mm measured circumferentially.

**Application of outer-layer tape:**

The outer-layer tape shall be applied over the inner-layer tape using the same type of manual tape coating machine used to apply the inner layer tape. The overlap of the outer- layer tape shall not coincide with the overlap of the inner-layer tape. The minimum overlap shall not be less than 50%. When a new roll of tape is started, the ends shall be overlapped at least 150 mm measured circumferentially.

**Material acceptance**

Acceptance of the proposed coating materials shall be approved by the Owner / Owner's representative.

The tape manufacturer proposed by the Contractor should have supplied at least 30% quantity of tape required for this project and as per this specification in a single contract for pipe diameter  $\geq 900\text{mm}$  in the last five years.

Work completing certificates from End User & coating applicator will be submitted by the Contractor while submitting credentials of the proposed tape manufacturer to the employer for approval.

**Coating repair in field:**

All holidays visually or electrically discovered either at the coating plant or in the field shall be repaired by peeling back and removing the outer and inner layers from the damaged area. The exposed areas shall then be coated with liquid adhesive and either (1) a length of inner-layer tapes shall be wrapped around the pipe to cover the defective area; or (2) a patch of inner- layer tape shall be applied directly to the defective area as specified by the Owner's Representative. The minimum over-lap at the damaged area shall be 100 mm all around. The repaired area shall be tested with a holiday detector as per specifications after the repair is completed. If holidays are not found, the repaired area shall be covered with the outer-layer tape with a minimum over-lap of 100 mm beyond the inner-tape patch.

**Field Welded Joint Internal Coating: Solvent Free Food Grade Epoxy Coating**

All steel pipes welded joints shall be internally lined with a spray applied solvent free epoxy approved for contact with potable water under the United Kingdom Water Regulations Advisory Scheme authorized for use under Regulation 31 (4)(a) of the water supply (Water Quality) Regulations 2000 for contact with potable water. The applicable specifications for the coating system shall be in accordance with BS 6920/NACE RP-01- 75/AWWA C210-97/CAN-CSA Z 245:21 or clients specifications.

**Internal coating system**

The internal food grade solvent free epoxy coating system of chemically cured resin(epoxy) & hardener(curing agent) mixed in the ratio as recommended by the manufacturer and applied to a dry film thickness of minimum 406 micron.

Quality assurance Plan shall be submitted by agency for approval prior to Coating application started.

Physical properties of internal coating material as follows.

Sr No	Property	Requirement	Test method
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1	Long term contact with potable water	Long term contact with potable water. No effects for human consumption as certified by NSF	NSF/ANSI 61
2	Thickness	406 micron min.	SSPC-PA-2
3	Dielectric strength	450 V/mil	ASTM D149
4	Hardness shore D	85 min.	ASTM D2240
5	Adhesion to steel	800 psi min.	ASTM D4541
6	Tabor abrasion	1560 cycles/min	ASTM D4060
7	Compressive strength	70 Mpa	ASTM C109

**General:**

All internal epoxy lining work for pipe welded joint shall be done at site using spray/ brush applied two component or by manual spray applied.

Pipe Preparation Internal surface of the pipe shall be free from mud, mill scale, mill lacquer, wax, oil, grease or any other foreign material.

The cleaned interior pipe joint surface shall be inspected for adequate surface preparation.

Surface imperfections such as slivers, scabs, burrs, weld spatter and gouges shall be removed by hand filing or grinding if necessary to prevent holidays.

To ensure a dry pipe joint surface at the time of liquid epoxy application, the minimum steel substrate temperature shall be 10°C and at least 3°C above the dew point.

**Coating Application:**

Application temperature The temperature of the mixed coating material and of the pipe at the time of application shall be not lower than 10°C. Application of epoxy shall be applied directly to the MS pipe welded joint using spray/ brush applied two component or by manual spray applied with all necessary ancillary equipment.

Curing After application of epoxy, curing of the epoxy shall be natural air convection. Typical dry time of the epoxy at ambient temperature of 25 - 40°C shall be between one hour to three hours. The coating shall have a minimum DFT (Dry Film Thickness) of 406 microns. As per instructions of Engineer in charge, the internal coating of Field joint test must be carried out at site.

**Field Hydraulic Test**

After erection at site and after the concrete Thrust/anchor blocks have been constructed, the pipeline shall be subjected to a 100% hydraulic test. The pressure test shall be conducted in as per IS-5822.

The Pipeline after lying at site shall be subjected to 100% Hydro testing. The test pressure shall be 1.5 times working pressure or 6 kg/cm<sup>2</sup> whichever is higher. The pressure shall be maintained for a period of 24 hours. The length of pipe for hydro testing shall be generally 5 km as directed by Engineer-In-Charge.

During the test, the pipe shall be struck sharp blows with 1 Kg hammer. Water shall not spout, ooze or sweat either through joints-welded or bolted or the body of the pipe. If any leakage noticed shall be repaired by the Contractor, which shall include coating and repairing of the damaged portion. Repairs and replacements and further testing including the cost of the Coils

and other raw materials shall be carried out by the Contractor at his own cost. If any leakages are observed during the defects liability period due to defective workmanship or material supplied by the Contractor, he shall repair the same to the entire satisfaction of the Employer, at his own cost.

GWSSB/GWSSB shall assist the contractor in identifying the source & in obtaining permission for drawl of water for field-testing of pipe. The contractor shall pay for the water and carry the water to the test location at his cost. The cost of hydraulic testing of the installation by providing necessary testing equipment, pumping the water, creating and maintaining pressure, and the necessary bulk heads and their fixtures, and their subsequent removal and restoring the installation to working trim shall be included in the rate for laying and testing of the pipe.

If water provided by GWSSB then Rs. 15 per Kilo liter shall be recovered from the Agency.

### **Progress in Laying**

The tenderer shall submit along with the tender his detailed bar chart for manufacturing and laying of the pipeline. While preparing his bar chart, the tenderer shall plan his activities such that the laying of pipes shall closely follow the manufacturing schedule and no pipes shall remain stacked in factory or at site for a period more than two months.

It is mandatory that he shall submit an approach note on how he will carry out this Work within the contractual period and on the compatible resources in terms of construction equipment and other facilities that he shall utilize to complete the tendered Work.

### **Connection of Pipeline**

Contractor shall carry out connection work of new laid pipeline with existing pipeline at both end in such a way that there is no obstruct in flow . Generally connection shall be “Y” type manner so that water flow divert easily in new pipeline. Necessary protection like thrust block shall be cast at both end connection for preventing pipeline from damage. Contractor also repair outside geniting of old pipeline after connecting with new one.

### **Distance Indicators and Markings**

The Contractor shall supply and fix indicators on either side of major crossings along the buried pipe line. Indicators shall consist of 10 cm x 10 cm precast concrete posts 1.25 meter long, set 0.75 meter into the ground and painted white above ground level. The description shall be written in blue at one face of the precast post.

In case of the pipeline laid above ground details such as chain age, Invert levels of pipe, appurtenance number, pedestal / saddle number, culvert number, anchor / thrust block number etc., shall be suitably marked either on the pipeline or the supporting structure etc., in distinct color. The Bidder / Contractor shall include the cost of this in his rates for the other items.

### **Marking**

All field welded joints should be marked with KM No, Welder No, Joint No for identification with Yellow paint.

### **Crossing: General Specifications (If Required)**

At public highways, or at such other crossings as are shown in the construction drawings issued by the company the pipeline shall be installed in MS casing pipe conforming to the specifications given herein.

The casing pipes shall be installed in accordance with the details given in drawing and the casing, bushing and insulators, etc., shall be installed on the carrier pipe as detailed in drawings. Casing pipe size shall be as per approved drawing of sanctioning authority, Casing shall be installed with even bearing throughout its length and shall slope towards one end, as specified or desired by the engineer-in-charge. The ends of the casing shall be sealed to outside of carrier pipe in accordance with the details given in drawing.

Before installation, holes for installing vent pipes shall be cut and burrs if any shall be removed. The welding of both carrier pipe and casing pipe shall be done in accordance with the welding specifications, given herein. Before installing the casing pipe, it should be cleaned of all internal obstructions and during installation care should be taken to keep the inside clean.

The section of carrier pipe to be placed in any casing shall be closed at each end, hydrostatically tested preferably with dead weight tester for at least two hours. Only on successful completion of this test, shall the carried pipe section be inserted in the casing pipe. The installation of casing may open cut as circumstances may permit or require as directed by the engineer-in-charge.

The installation of casing in bended section of the carrier pipe shall be performed by meter bends of the casing pipe provided that the length of each meter cut out of casing pipe shall be such as to provide a clearance of at least 1-1/2" between the inside of the casing pipe and the outside of the coated carrier pipe.

Excavation for casing installation shall be immediately backfilled at the completion of the work with suitable solid matter and packed thoroughly to prevent seepage of water into the excavation.

Payment shall be made as per Break up of schedule of Payment.

**ITEM NO.14**

Lowering Laying and jointing C.I. S.& S.spun /Ductile Iron pipes suitable for tyton joints/mortar lined D.I. all class pipes of various classes with CI/MS specials of following diameters in proper position, grade and alignment as directed by engineer In charge

**GENERAL:**

The pipes & joints shall be procured, supplied by the Contractor at work site at his own cost. Every care shall be taken in carting them to site. During transportation any damage shall be occurring to pipes for fittings the replacement of pipes given by the contractor at his own cost.

The trenches shall be well leveled so that pipes are laid evenly among them. The pipes shall be fixed within two rubber rings to be supplied by department at the place shown in schedule A, if directed by the Engineer-in-charge or mentioned in item of schedule

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B. The specification for titan joints i.e. Rubber Rings shall be as per details specification material section.

The contractor shall make his own arrangement for obtaining permission for storing & stacking of pipes etc. from land boards whether they are Government, Municipal Local Bodies or Private land owner.

Every pipes before lowering into the trenches shall be got checked and thoroughly cleaned and the beds of the trenches shall be properly graded and leveled as required on the line, without any claim for extra cost whether it is required. The pipe shall be carefully lowered into the trenches with the help of a suitable type of chain pulley blocks, which shall first be approved by the Engineer-in-Charge. Each pipe shall be properly jacked and the spigot perfectly fixed into the socket. No jointing operation shall be started unless the gradients levels are approved by the Engineer-in-Charge or his representatives.

The pipes shall be laid complete in centerline ranged accurately by means of a string attached to both marked center of site rails and no deviation shall be permissible without the permission of Engineer-in-Charge. The pipe shall be laid in reasonably dry trenches and no circumstances on slushy bedding.

The pipes shall be brushed before lowering any laying or remove any soil or dirt etc. that may have accumulated.

The inside socket and outside of the spigot-shall be carefully cleaned. The pipe shall be lowered carefully with socket and toward and the flow of water or up till or as directed and spigot and should be carefully inserted into the socket and the space shall be filled with the joint.

#### **TESTING OF WATER PIPES:**

After each section of the pipeline has been completed it shall be tested for water tightness before being covered. The contractor shall at his own cost fill up water in pipe line and given necessary hydraulic test section by section and the pipe line shall stand the pressure which shall stand the pressure which shall exceed the working pressure by (a) 50% of the highest pressure in the section.

(b) 30m whichever is less without showing any leakage or sweating anywhere in the pipes joints specials valves etc. if any defect are found the contractor shall be made good the same at his own cost.

Any leaking joints shall be made good and above test pressure in to be lowered gradually after satisfactory test is & over.

GWSSB will not be able to provide water for testing of the pipelines & water containers of the project. This shall have to be managed by the contractor at his costs and risk.

The hydraulic test shall be given again if considered necessary by the Executive Engineer or his representative to show that no further leakages or sweating is there. The contractor shall have to make necessary arrangements for water testing as well as plugging the opening of pipes etc. as directed without claiming any extra cost. The pipelines shall be kept filled with water for a work lines shall be kept filled with water for a week or till it is situated for testing is done.

If the pipe lines are laid in detached sanctioned & not in continuous length due to any reasons such as non-availability of specials or due to obstacle etc. The contractor shall see that no end of pipes length is kept open-ends are immediately covered up either by suitable blank flange or cap slug or by means of double layer gunny bags clothes tied properly by mild steel wire without any claim for extra-cost.

The rate shall be per meter of pipe line laid including all specials and fitting jointly etc. Cutting and waste shall not be paid separately. The length shall be measured not on the straight line and curves along the center line over the pipe and specials correct up to 1 cm.

Payment shall be as per Rmt basis.

#### **ITEM NO.15**

Lowering laying and jointing in position following D.I. /D.F.(Double Flanged) reflux valve, sluice valve and air valves including cost of all labour, jointing materials including nut bolts and giving testing etc. complete.

- (A) SLUICE VALVE
- (B) SCOUR VALVE
- (C) Pressure relief valve
- (D) Butterfly Valve
- (E) AIR VALVE

### **Lowering, Laying and Jointing of Valve**

#### **Jointing Material**

The contractor shall provide all necessary jointing materials such as nuts bolts, rubber packing white zinc jute lead wool, C.I. tailpiece etc.

All tools and plant required for installation of sluice valve shall be provided by the contractor.

All jointing materials shall be approved from the engineer-in-charge before use.

The nut and bolts shall conform to specification of materials.

The rubber packing shall conform all specifications as narrated in Specifications of materials.

#### **Installation**

The sluice valve/butterfly valve shall be lowered in to the trench carefully, so that no part is damaged during lowering operation.

If necessary tailpieces shall be fitted with sluice valve first outside the trench and then lowered in to the trench.

The rubber packing shall be three ply and of approved thickness. The packing shall be of full diameter of the flange with necessary holes and the sluice/butterfly valve bore. It shall be even at both the inner and outer edges.

The flange faces thoroughly greased.

If flange faces are not free, the contractor shall use thin fibers of lead wool.

After placing the packing, nuts and bolts shall be inserted and tightened to make the joint.

The valve shall be tightly closed when being installed to prevent any foreign materials from getting in between the working parts of the valve.

Each flange bolt shall be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively.

The sluice valve/butterfly valve shall be installed in such a way that its Spindle shall remain in truly vertical position.

The other end of tailpiece shall be fitted with pipes so that continuous lines can work.

Extra excavation required for facility of lowering and fixing sluice valve shall not be paid for.

#### **Testing**

After installation of sluice valve/butterfly valve the same is tested to 1.5 times of its test pressure.

The joints sluice valve/butterfly valve shall withstand the test pressure of pipelines.

Defects noticed during test and operation of sluice valve shall be rectified by the contractor at his own cost without any extra claim to the entire satisfaction of the Engineer-in-charge.

#### **ITEM NO.16**

Providing C.C.M.100 for encasing pipes using trap metal size 12 mm to 50 mm form work curing consolidation etc. complete. Using trap metal 20 mm nominal size

#### **Workmanship General:**

Before starting concrete the bed of foundation trenches shall be cleared of all loose materials, leveled, watered and rammed as directed.

Proportion of Mix:

The proportion of cement, sand and coarse aggregate shall be one part of cement, 3 parts of sand and 6 parts of stone aggregates and shall be measured by volume.

#### **Mixing:**

The concrete shall be mixed in a mechanical mixer at the site of work. Hand mixing may however be allowed of smaller quantity of work if approved by the Engineer in charge. When hand mixing is permitted by the Engineer in charge in case of breakdown of machineries and in the interest of the work. It shall be carried out a water tight platform and care shall be taken to ensure the mixing is continued, until the mass is uniform in colour and consistency. However in such cases 10% more cement than otherwise required shall have to be used, without any extra cost. The mixing in mechanical mixer shall be done for a period 1 ½ to 2 minutes. The quantity of water shall be just sufficient to produce a dense concrete or required workability for the purpose.

Transporting & placing the concrete:

The concrete shall be banded from the place of mixing to the final position in not more than 15 minutes by the method of as directed and shall be placed in to its final position, compacted and finished within 30 minutes of mixing with water i.e. before the setting commences the concrete shall be laid in layers of 15 cm. to 20 cm.

Compacting:

The concrete shall be rammed with heavy iron rammers or vibrator and rapidly to get required compaction and to allow all the interstices to be filled with mortar.

Curing:

After the final set, the concrete shall be kept continuously wet, if required for a period of not less than 7 days from the date of placement.

Mode of measurements & Payments:

The concrete shall be measured for its length, breadth and depth. Limiting dimensions to those specified on plan or as directed. The rate shall be for a unit of one cubic meter.

**ITEM NO.17**

Providing and casting in situ C.C. in grade M-20 (proportions as per mix design or as per Table 9 of IS 456:2000 in masses by weight batching) using granite/quartzite trap metal of size 6 mm to 20 mm for RCC work, including Excavation, scaffolding, centering & formwork, needle vibrated consolidation, curing, Refilling and restoration at site etc., complete up to 6 m depth (excluding cost of reinforcement) with centering, shuttering/deshuttering etc. complete for structure other than water retaining.

For Thrust Block

Refer general specifications of Concrete for Detail technical Specifications.

**Thrust Block**

RCC thrust blocks of adequate size and shape in required grade shall be provided on bend for anchorage as per design requirement to transmit the hydraulic thrust / force to the ground, spreading over a sufficient area, depending upon the type of soil met with.

Thrust blocks shall be provided for both horizontal and vertical bends wherever required in the pipeline to effectively transfer the hydrostatic thrust developed to the surrounding ground. The Contractor has to submit his own design with steel reinforcement details and getting approved before executing the work.

Grade of concrete to be kept minimum 20 N/mm<sup>2</sup>.

The minimum 45kg/Cum. Steel shall be provided for thrust block.

**ITEM NO.18**

Providing CRS Bar FE 500D reinforcement for R.C.C. work including bending, binding and placing in position complete up to floor two level.

For Thrust Block & Pipe Encasing

**1.0. Materials :** **1.1.** CRS Bar FE 500D shall conform shall as per general specification. Mild steel binding wires shall conform as per general specification.

**2.0. Workmanship :**

2.1. The work shall consist of furnishing and placing reinforcement to the shape and dimensions shown as on the drawings or as directed.

2.2. Steel shall be clean and free from rust and loose mill scale at the time of fixing in position and subsequent concreting.

2.3. Reinforcing steel shall conform accurately to the dimensions given in the bar bending schedules shown on relevant drawings. Bars shall be bent cold to specified shape and dimensions or as directed using a proper bar bender, operated by hand or power to attain proper radius of bends. Bars shall not be bent or straightened in a manner that will injure the material. Bars bent during transport & handling shall be straightened before being used on me work. They shall not be heated to facilitate bending. Unless otherwise specified, a 'U' type hook at the end of each bar shall invariably be provided to main reinforcement. The radius of the bend shall not be less than twice the diameter of the round bar and the length of straight part of the bar beyond the end of the

curve shall be at least four times the diameter of the round bar. In case of bars which are not round and in case of deformed bars, the diameter shall be taken as the diameter of circle having an equivalent effective area. The hooks shall be suitably encased to prevent any splitting of the concrete.

2.4. All the reinforcement bars shall be accurately placed in exact position shown on the drawing and shall be securely held in position during placing of concrete by annealed binding wire not less than 1 mm. in size, and by using stay blocks or metal chair spacers, metal hangers, supporting wires or other approved devices at sufficiently-close intervals. Bars shall not be allowed to sag between supports nor displaced during concreting or any other operations of the work. All devices used for positioning shall be of non-corrodible material. Wooden and metal supports shall not extend to the surface of concrete, except where shown on drawings. Placing bars on layers of freshly laid concrete as the work progresses for adjusting bar spacing shall not be allowed. Pieces of broken stone or brick and wooden blocks shall not be used. Layers of bars shall be separated by spacer bars, precast mortar blocks or other approved devices. Reinforcement after being placed in position shall be maintained in

a clean condition until completely embedded in concrete. Special care shall be exercised to prevent any displacement of reinforcement in concrete already placed. To prevent reinforcement from corrosion, concrete cover shall be provided as indicated on drawing. All the bars protruding from concrete and to which other bars are to be spliced and which are likely to be exposed for a period exceeding 10 days shall be protected by a thick coat of neat cement grout.

2.5. Bars crossing each other where required shall be secured by binding wires (annealed) of size not less than 1 mm. in such manner that they do not slip over each other at the time of fixing and concreting.

2.6. As far as possible, bars of full length shall be used. In case this is not possible, overlapping of bars shall be done as directed. When practicable, overlapping bars shall not touch each other, but be kept apart by 25 mm. or 1.25 times the maximum size of the coarse aggregate whichever is greater by concrete between them. Where not feasible, overlapping bars shall be bound with annealed wires not less than 1 mm. thick twisted tight. The overlaps shall be staggered for different bars and located at points along the span where neither shear nor bending movement is maximum.

2.7. Whenever indicated on the drawings or desired by the Engineer-in-charge, bars shall be joined by couplings which shall have a cross-section sufficient to transmit the full stresses of bars. The ends of the bars that are joined by coupling shall be upset for sufficient length so that the effective cross section at the base of threads is not less than normal cross-section of the bar. Threads shall be standard threads. Steel for coupling shall conform to I.S. 226.

2.8. When permitted or specified on the drawings, joints of reinforcement bars shall be butt welded so

as to transmit their full stresses. Welded joints shall preferably be located at points when steel will not be subject to more than 75 per cent of the maximum permissible stresses and welds so staggered that at any one section not more than 20 percent of the rods are welded. Only electric arc welding using a process which excludes air from the molten metal and conforms to any or all other special provisions for the work shall be accepted. Suitable means



shall be provided for holding bars securely in position during welding. It shall be ensured that no voids are left in welding and when welding is done in two or three stages, previous surface shall be cleaned properly. Ends of the bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before welding. Only competent welders shall be employed on the work. The M.S. electrodes used for welding shall conform to I.S. 814. Welded pieces of reinforcement shall be tested. Specimen shall be taken from the actual site and their number and frequency of test shall be as directed.

### **3.0. Mode of Measurement and Payment:**

**3.1.** For the purpose of calculating consumption, wastage shall not be permitted beyond 5 percent. Excess consumption over 5% will be charged at penal rate.

**3.2.** Reinforcement shall be measured in length including overlaps, separately for different diameters as actually used in the work. Where welding or coupling is resorted to, in place of lap joints, such joints shall be measured for payment as equivalent length of overlap as per design requirement. From the length so measured, the weight of reinforcement shall be calculated in tonnes on the same basis of as per M-18 even though steel is supplied to the contractor by the department on actual weight. Length shall include hooks at the ends. Wastage and annealed steel wire for binding shall not be measured -and the cost of these items shall be deemed to be included in the rate for reinforcement.

**3.3.** The rate for reinforcement includes cost of steel binding wires its carting from Department a store to work site., cutting, bending, placing; binding and fixing in position as shown on the drawings and as directed. It shall also include all devices for keeping reinforcement in approved position, cost of joining as per approved method and all wastage and spacer bars.

**3.4. Mode Of Payment:-** The rate-shall be for a unit of one Kg as per Price Bid.

#### **ITEM NO.19**

##### **RCC Valve Chamber**

Construction of RCC Valve Chamber including Site clearance, excavation, shoring, strutting, maintaining line and gradient, stacking and disposal of excavated material, followed by refilling with available earth in layers with proper compaction; providing and laying PCC M-15 as foundation; providing and casting RCC M-20 including centering, shuttering, vibration and curing; providing and placing FE-500D reinforcement steel as per design; and providing and fixing CI/MS/ PVC encapsulated Rungs for steps with anti-corrosive paint, top cover of RCC Precast slabs & cover in pieces of required size with necessary nuts, bolts, etc complete as directed by Engineer-in-charge.

### **TECHNICAL SPECIFICATIONS:**

#### **RCC Valve Chamber**

The contractor has to construct Valve Chambers for all types of Valves of minimum dimensions as per Price-Bid.

The Contractor has to submit his own design and getting approved before starting the work. No additional payment shall be made for this.

The Valve chambers shall be RCC. The Minimum grade shall be as mentioned in the Price-Bid.

The base slab of valve chambers shall slope towards a sump pit from which water can be pumped to keep the chamber dry.

Precast Reinforced cement concrete top slab shall be casted in pieces for covering the chamber. The size of the pieces of Precast top slab shall be such that a single person can easily open the chamber and go inside for inspection purpose.

The thickness of precast slab shall be 150 mm.

Necessary keyholes shall be provided at appropriate place for operation of spindle of valve.

All valve chamber Cover shall be painted with Radium Paint.

Interior and Exterior side 20 mm thick finish plaster shall be done.

Internal & External side oil paint shall be done as approve by Engineer in Charge.

The minimum thickness of slab shall be 200mm and same shall be casted in C.C. of M20 grade.

Necessary locking arrangement shall be provided.

Chambers shall have opening & locking arrangements.

The PVC encapsulated rungs shall be provided with all necessary fixtures of standard quality or as approved by Engineer-in-charge. No additional payment shall be made for any fixtures use for PVC encapsulated rungs.

The top slab of valve chamber shall be minimum 30 cm above nearby G.L. or 30 cm above nearby pond/ drain F.R.L.

Additionally general specification of concrete work shall also be applicable.

#### **ITEM NO.20**

Refilling the pipeline trenches including ramming, watering, consolidating and disposal of surplus stuff as directed by Engineer-In-Charge for all leads .

#### **Refilling Of Trenches:**

- On completion of the pipe laying operations in any section, for a length of about 100m and while further work is still in progress, refilling of trenches shall be started by the Contractor with a view of restricting the length of open trenches. Pipe laying shall closely follow the progress of Trench Excavation and the Contractor shall not permit unreasonably excessive lengths of trench excavation to remain open while awaiting testing of the pipeline. If the Engineer considers that the Contractor is not complying with any of the foregoing requirements, he may prohibit further trench excavation until he is satisfied with the progress of laying and testing of pipes and refilling of trenches. The excavated material nearest to the trench shall be used filling. Care shall be taken during backfilling, not to injure or disturb the pipes, joints or coating. Filling shall be carried out simultaneously on both sides of the pipes so that unequal pressure does not occur. Walking or working on the completed pipeline unless the trench has been filled to height of at least 30cm over the top of the pipe except as may be necessary for tamping etc., during backfilling work.
- The remaining portion of the trench may be filled in with a mixture of hard and soft material free from boulders and clods of earth larger than 150mm in size if sufficient quantity of good earth and murrum are not available. The trench shall be refilled so as to build up to the original ground level, keeping due allowance for subsequent settlement likely to take place. The top 300mm layer or fertile agricultural soil shall be kept aside

during excavation and shall be laid in layers near ground level during refilling.

- To prevent buckling of pipe shell of diameters 1200mm and above, pipes shall be strutted from inside while the work of refilling is in progress, for which no separate payment shall be made.
- Strutting shall be done by means of strong spiders having at least 6 arms which shall be sufficiently stiff to resist all deformation. Spiders shall be provided at a maximum interval of 2m & shall be welded in such a way that internal coating does not get burnt.
- The Engineer shall, at all times, have powers to decide which portion of the excavated materials shall be for filling and in which portion of the site and in what manner it shall be so used.
- If any material remains as surplus it shall be disposed of as directed by the Engineer, which includes loading, unloading, transporting and spreading as directed within all lead. If the Contractor fails to remove the earth from site within 7 days after the period specified in a written notice, the Engineer may arrange to carry out such work at the Contractor's risk and cost or may impose such fine for such omission as he may deem fit. Particular care shall be taken to keep the trench dry during the entire refilling operation.
- If suitable material for refilling is not available for excavation the Contractor shall bring selected soil from outside incl. all lead and lift as approved by Engineer-in-charge .
- No mechanical plant other than approved compacting equipment shall run over or operate within the trench until backfilling has reached its final level or the approval of the Engineer has been obtained.
- Subsidence in filling in : Should any subsidence take place either in the filling of the trenches or near about it during the maintenance period of 12 months from the completion of the Contract Works, the Contractor shall make good the same at his own cost or the Engineer may without notice to the Contractor, make good the same in any way and with any material that he may think proper, at the expense of the Contractor. The Engineer may also, if he anticipates occurrence of any subsidence, employ persons to give him timely notice of the necessity of making good the same, and the expenses on this account shall be charged to the Contractor.

#### **ITEM NO.21**

##### **Surge Protection Device**

Detailed Surge Analysis & Report Submission: Surge Analysis and designing of surge protection devices as per the actual working survey to protect the pipe against the surge pressure. The surge analysis report shall be submitted for approval of competent authority with clearly mentioning the surge protection device name, chainage, device size, bypass size (if applicable), pressure rating etc. Providing, supplying, installing, testing and commissioning surge protection device (as per above approved design) on raw water rising main to protect pipeline and pumps against water hammer due to pump trip/power failure. Device comprising DI/CI body PN16, SS internals, pilot operated, with interconnecting pipe, isolation valves, pressure gauges, foundation, chamber and discharge piping. Complete with design, erection, setting and demonstration as directed by Engineer-in-charge.

For Both the Rising Main of both intakes Well

Detailed Technical Specification for Surge Analysis, Design, Supply, Installation, Testing and Commissioning of Surge Protection System for Raw Water Rising Main.

The Contractor shall carry out a detailed hydraulic transient (surge/water hammer) analysis for the complete raw water pumping system of both Intake Wells, including pumps, rising mains, valves, manifolds, and all associated hydraulic components. The analysis shall be performed considering the actual site conditions, pipeline profile, pump characteristics, operating water levels, flow rates, pipe material properties, and all probable operating scenarios likely to occur during the life of the system.

The surge analysis shall specifically evaluate transient conditions arising from sudden pump trip due to power failure, simultaneous stoppage of pumps, planned pump shutdown and startup, valve opening and closing operations, emergency shutdown conditions, pipeline filling and emptying operations, air valve operation, and any other abnormal operating conditions that may generate excessive positive or negative pressures within the pipeline system. The objective of the analysis shall be to identify maximum and minimum transient pressures throughout the rising main and to determine the most suitable surge protection measures required for safe and reliable operation of the pumping system.

The surge analysis shall be carried out using internationally accepted and proven hydraulic transient analysis software such as Bentley HAMMER, WANDA, AFT Impulse, KYPIPE Surge, or equivalent approved software. The software model shall accurately represent the actual pumping system and shall be capable of simulating all critical transient events. The Contractor shall submit complete design calculations, modelling assumptions, pressure envelopes, transient pressure profiles, hydraulic grade line plots, and surge mitigation recommendations for review and approval by the Engineer-in-Charge and competent authority before procurement or installation of any surge protection equipment.

Based on the approved surge analysis, the Contractor shall design and provide a complete surge protection system adequate to protect the pumps, pipelines, valves, fittings, and associated infrastructure from water hammer effects and transient pressure fluctuations. The type, number, size, capacity, pressure rating, and location of surge protection devices shall be selected strictly on the basis of the approved hydraulic transient analysis. The surge protection arrangement may comprise surge anticipation valves, surge relief valves, hydropneumatics surge vessels, air vessels, air release and vacuum valves, non-slam check valves, pump control valves, surge tanks, vacuum breakers, or any combination thereof, as required to ensure safe operation of the system.

The Contractor shall submit a detailed surge protection design report indicating the type of surge protection device proposed, chainage/location of installation, device size, bypass size wherever applicable, design discharge capacity, pressure class, operating pressure range, opening and closing characteristics, foundation requirements, discharge arrangements, and all relevant technical parameters. The report shall also include general arrangement drawings, piping and instrumentation diagrams, equipment data sheets, manufacturer's technical literature, and detailed installation drawings. Approval of the surge protection design by the competent authority shall be obtained prior to execution of the work.

Where surge anticipation valves or surge relief valves are recommended, such valves shall be hydraulically operated pilot-controlled automatic valves specifically designed for water hammer protection. The valve body shall be manufactured from Ductile Iron conforming to IS 1865, EN 1563 Grade GJS-500-7, ASTM A536 or equivalent approved standard. The valves shall be flanged and suitable for a minimum pressure rating of PN16 or higher as determined by surge analysis.

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All internal moving components, stems, seats, fasteners, pilots, tubing, and wetted metallic parts shall be manufactured from Stainless Steel SS304 or SS316. The diaphragm shall be reinforced EPDM or NBR suitable for potable or raw water service.

The surge anticipation valve shall be capable of sensing pressure fluctuations associated with pump trip or power failure and shall automatically open before the return surge wave develops, thereby dissipating excess pressure safely to atmosphere or a designated discharge system. The valve shall close gradually after stabilization of the hydraulic conditions without generating secondary surges. The pilot control system shall be factory assembled, calibrated, and tested for reliable operation under all anticipated service conditions.

Where hydropneumatics surge vessels are recommended by the approved surge analysis, the vessel shall be designed and manufactured in accordance with IS 2825, ASME Section VIII, or equivalent approved standards. The vessel shall be fabricated from high-quality carbon steel plates and shall be designed for the maximum surge pressure anticipated in the system. Internal surfaces shall be protected with fusion bonded epoxy or approved epoxy coating not less than 300 microns dry film thickness, while external surfaces shall be coated with an approved anti-corrosive coating system. The vessel shall be complete with pressure gauges, level indicators, air charging arrangement, isolation valves, drain valves, safety valves, and all accessories necessary for proper operation and maintenance.

All surge protection devices shall be supplied complete with pilot assemblies, pressure gauges, pressure switches, isolation valves, strainers, interconnecting stainless steel tubing, fittings, supports, anchorages, bypass arrangements where required, and all accessories necessary for satisfactory operation. The Contractor shall ensure that all equipment supplied is suitable for continuous outdoor operation under local environmental conditions and is capable of withstanding vibration, humidity, temperature variations, and exposure to raw water service conditions.

The Contractor shall provide all associated civil works required for installation of the surge protection system, including reinforced cement concrete foundations, valve chambers, equipment pedestals, pipe supports, anchor blocks, thrust blocks, drainage arrangements, manholes, access ladders, and protective covers. The foundation design shall be based on equipment loads and site conditions and shall be approved by the Engineer-in-Charge. Concrete used for foundations shall not be of grade less than M25 unless otherwise specified.

The discharge piping connected to surge relief or surge anticipation devices shall be designed to safely convey the maximum discharge flow generated during surge events without causing flooding, erosion, or damage to surrounding structures. The discharge piping shall be of suitable diameter and pressure rating as determined by the approved design and shall be fabricated from Mild Steel or Ductile Iron with approved internal and external protective coatings. The discharge arrangement shall terminate at a safe location approved by the Engineer-in-Charge.

All equipment shall undergo factory inspection and testing prior to dispatch. Factory tests shall include hydrostatic pressure testing, seat leakage testing, functional operation testing, material verification, and any additional tests specified by the relevant standards. Certified test reports shall be submitted for approval prior to shipment of equipment.

After installation, the Contractor shall carry out complete testing and commissioning of the surge protection system in the presence of the Engineer-in-Charge. Site testing shall include operational checks, pilot setting verification, simulated pump trip tests, power failure simulations, pressure monitoring, and performance evaluation of the surge protection devices under actual operating conditions. Any modifications required to achieve satisfactory performance shall be carried out by the Contractor at no additional cost.

The complete surge protection system shall be designed and guaranteed to prevent excessive positive pressures exceeding the allowable design pressure of the pipeline and to prevent occurrence of damaging negative pressures, vacuum conditions, column separation, pipe collapse, or structural damage under all anticipated operating conditions. The Contractor shall remain fully responsible for the adequacy of the surge analysis, correctness of equipment sizing, proper installation, successful commissioning, and long-term satisfactory performance of the surge protection system.

The rate quoted for this item shall include detailed surge analysis, preparation and approval of design reports, supply of all surge protection devices, valves, vessels, accessories, interconnecting piping, civil works, foundations, chambers, coatings, erection, testing, commissioning, performance testing, demonstration, labour, transportation, tools and tackles, and all materials and works necessary for complete and successful operation of the surge protection system for both raw water rising mains of the Intake Wells.

Complete work shall be carried out as per GWSSB specifications and as directed by the Engineer-in-Charge.

### **Schedule B-3 Construction of Pro. 13 ML Sump at Palej H/W Including Pump House above Sump Top Slab**

#### **Item No.01**

#### **Construction of Pro. Sump 13 ML Capacity & pump room above sump At Palej H/W**

##### **1.0 GENERAL:**

1.1.0 Capacity of the container of the tank shall be the volume of the water it can store between the designed full supply level (F.S.L) and lowest supply level (L.S.L) i.e. the level of the lip of the outlet pipe. Due allowance shall be made for 20 mm. thick plastering the tank from inside, while calculating the capacity of the tank.

1.2.0 Freeboard is the vertical distance between F.S.L. and Soffit of covering slab or dome or beam supporting the cover. In any case the free board shall not be less than 300 mm from bottom of beam.

1.3.0 Height of the staging or height of the tower shall be the vertical difference between L.S.L. of the tank and the average ground level at the site of tank.

1.4.0 Dead storage shall be the storage capacity of water below L.S.L. depth of dead

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storage shall be the vertical distance between the top outlet level and wash out level. The washout pipe level shall be at the lowest portion of the container.

- 1.4.1 Minimum depth of water for dead storage shall be 100 mm even for flat bottom slab and not more than 300 mm for inlet i.e. bottom dome slab type tank.
- 1.5.0 Water depth in the tank shall be the vertical distance between L.S.L. and F.S.L. of tank.
- 1.6.0 The allowable bearing pressure or the safe bearing pressure on the strata as specified in the table of IS 1004-1978 or its latest revision, whichever is less shall be considered and design of foundation shall be based on this unit pressure unless specified.
- 1.6.1 Notwithstanding anything mentioned above regarding S.B.C. whenever the Engineer-in-charge of design directs that bearing capacity shall be determined by carrying out actual soil exploration and tests due to conditions as mentioned in para 2.0 of IS 1992-1969. The same shall be carried out by a Government laboratory or any other approved laboratory and allowable bearing capacity so arrived shall be taken as the basis of design. The factor of safety adopted in case of actual test shall be as per clause 6.1 (A) of IS 6403-1971.
- 1.7.0 RCC stair case minimum 1 m wide with necessary landing as per requirement hand rail and safety cage & painted with 3 coats of oil paint for access of the sump maintenance.
- 1.8.0 D.I / MS pipe shall be used as per relevant IS code. The Dimensions of Inlet, Outlet, Overflow & Washout pipes are to be considered as per design for a maximum velocity constrain of 1.5 m/s. including inter connection of existing sump and new sumps

## 2.0 GENERAL REQUIREMENTS:

- 2.1.0 Cement concrete shall be in accordance with IS 456-2000 fine and coarse aggregates shall be confirming to IS 383-1963 or its latest revision. The selection of the type of fine and coarse aggregate to be actually used shall be as directed by the Engineer-in-charge.
- 2.2.0 For parts of the tank in contact with stored water and closing vapour above FSL shall be in concrete grade M300 or in richer grade.
- 2.3.0 Inlet, Outlet, Overflow and Washout pipe:  
Materials:  
DI/MS pipe of appropriate class shall only be used.
- 2.3.1 Inlet Pipe:  
The size of inlet pipe shall be same that of rising main.
- 2.3.2 Outlet Pipe:  
The outlet pipe shall be of one diameter higher as that of inlet pipe.
- 2.3.3 Overflow pipe:  
The size of overflow pipe shall be one diameter higher than that of inlet pipe.
- 2.3.4 Washout Pipes:  
Outlet cum washout arrangement shall be provided with sluice valves at GL. Detailed drawing showing all the pipes, duck foot bends, chamber, sluice valves and other necessary connection shall be furnished in the plan. Plain concrete

block in M-150 for duck foot bands shall be of minimum depth of 600 mm. The width of the block shall have an offset minimum of 150 mm.

#### 2.4.0 Water Level Indicator:

A water level indicator shall be provided for the tank reading depth of water in meters with least count of 10 cm. The system shall consist of uncorrodable material and shall be simple and easy to maintain. The water level indicator shall be provided and fixed as approved and directed by the Engineer-in-charge.

2.4.1 Access to roof for an entry to the inside of the tanks shall be provided. At roof level of the tank the access to roof manhole from the ladder or stair shall be properly provided with parapet or railing. At ground level or at walkway level the access forgoing up shall be provided with a door and locking arrangement. Railing at roof level and at gallery level shall be provided.

2.4.2 At least two manhole with frame and cover of CI medium type shall be provided with ladder for entering into the container for maintenance purpose. The size of manhole frame shall be 0.9 x 0.6 meter 75 kg.

#### 2.5.0 Lightning Arrestor:

Lightening arrestors shall be provided on the roof of the tank as per IS 2309-1969. Position and height of lighting arrestors shall be such that the whole structure shall be enclosed within dome having its apex at top and of the arrestors and generated by a line inclines at  $60^{\circ}$  to the vertical. The arrestors shall be suitably earthed. Copper strip shall be covered with GI pipe 25-mm dia up to 4-meter height from GL.

2.6.0 The roof of the tank shall be ventilated by providing cowls or ventilators with mosquito proof met for ventilators. They shall be fixed with proper framing. Ventilation area shall not be less than of (A) 0.04% of the free water surface when

cowl type ventilators are provided. (B) Cross sectional area of the inlet pipe. (C) Cross sectional area of the outlet pipe.

2.7.1 All tanks shall be checked for seismic forces confirming to IS 1893-1975 or its latest revision and wind forces also.

2.7.2 Water tank in vicinity of mines, galleries and blasting sites or in areas which may be subjected to blasting sites or in areas which may be subjected to blast or shock, shall be designed for the dynamic forces developed due to blast equipment.

2.7.3 Members of towers, which are primarily subjected to dynamic stresses, shall be checked for ductility of the members at the joint.

2.7.4 Staircase and all columns shall be tied together just above foundation level by structural members such as a braced or a tie ring beam.

2.8 Following shall be the minimum thickness of various members of the tank container.

Bottom slab	200 mm
Top Slab	200 mm
Vertical wall	230 mm
Inclined wall or shell requiring shuttering of one side	200 mm
(i) Slope with horizontal more than $30^{\circ}$	200 mm



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(ii) -Do less than 30°	200 mm
Bottom slab of pumping station	900 mm

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2.9.0 Error up to 2 % in weights, forces, moments etc. in the design calculations may be neglected.

### 3.0 LOADS:

3.1.0 For all RCC and PCC component unit weight shall be taken as  $25000 \text{ N/m}^3$ ,  $24000 \text{ N/m}^3$  respectively, allowance of platter up to 20 mm. Inside surface of container shall be taken in to consideration of in normal circumstances.

3.2.0 Water load shall be taken as  $10000 \text{ N/m}^3$ .

3.3.0 Live load and snow load shall be taken as per IS: 875-1987 or its latest revision.

3.3.1 No live load may be assumed while designing the staging (or tower) and foundation for seismic loads.

3.3.2 Live load on gallery all round the elevated tank shall be considered as  $1500 \text{ N/m}^2$ .

3.4.0 Wind load as per Fig. i.e. basis maximum wind pressure or Indian including winds of short duration as per IS 875- 1987 or latest revision shall be considered.

3.5.0 Seismic forces on the tower shall be as per IS 1893-1975 or its latest revision. Wind and seismic forces shall not be assumed to act simultaneously.

### INCREASES IN PERMISSIBLE STRESSES:

Where stresses due to wind or earth quack temperature & shrinkage effects are combined with those due to dead, live and impact loads the stresses specified in table 13, 16 & 17 of 456-1978 may be increased up to a limit of 33.33%.

### 4.0 DESIGN:

#### 4.1.0 General:

4.1.1 Shape of the structure shall be as directed by Engineer-in-charge and shall be selected depending upon site condition from the standard shape.

4.1.2 General description and salient feature as mentioned below of the design shall be not approved by the Engineer-in-charge and shall be mentioned in the design before detail design calculations starts.

4.2 Sketch showing dimensional section, elevation with plan shall be given.

4.3.0 In Design uplift pressure must be consider.

**4.3.1 In sump design proposed VT pumps for Palej WTP and future requirement for the Vadodara section pumping machinery loads shall be considered in design.**

4.3.2 The safety against overturning of structure shall be computed quite accurately.

4.3.3 Design shall be based on the worst possible combination of various loads, moments, shears and resultant stress in the tank for the following two cases.

(i) Tank Full 'A'

(ii) Tank Empty

Tank full means depth of water inside the container up to full height of the container without consideration of free board.

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Or safe bearing capacity of soil based on actual soil investigation report of the laboratory.

Position of sub soil water level.

Chemical analysis require if sub soil water and soil where possibility of brackish/saline water is ascertained.

Location of site on index plan with respect to latitude and longitude.

- 4.3.4 Design shall be based on accepted basis and methods of design as well as the provision of IS 3370-1965, IS 456-1978, IS 1343-1960, IS 2210-1962, IS 2204-1962 etc. and their

latest revision. However methods based on experimental investigation as mentioned in para 18.2 % "C" in IS 456-1978 shall not be entertained.

- 4.4.0 The parts of the structure neither in contact with the liquid on any face more enclosing the space above the liquid as in the case of stages of a tower shall be designed on working stress method on accordance with the requirement of IS 456-1978. Staging may be designed on limit method as per IS 456-1978.

- 4.5.0 Design of members other than these excluded by above (i.e. roof, walls, floor etc. of the container) shall be based on consolidation of adequate resistance of cracking as well as adequate strength calculation of stresses shall be para s per 3.2.2 of IS 3370 (part-II) 1965 or its latest revision.

- 4.5.1 PERMISSIBLE STRESS IN CONCRETE FOR RESISTANCE TO CRACKING:

For calculations relating to the resistance of members to cracking the permissible stresses in tension (direct and due to bending) and shear shall confirm the values specified in Table-I of IS 3370 (part-II 1965)

The permissible tensile stresses due to bending apply to the fact of the member in contact with the liquid. In members less than 225 mm thick and

in contact with the liquid on one side, these permissible stress in bending apply to the face remote from liquid.

- 4.5.2 FOR STRENGTH CALCULATION:

In strength calculation, the permissible concrete stresses shall be in accordance with para-44 of IS 456-1978. Where the calculated shear stress in concrete alone exceeds the permissible value reinforcement acting in conjunction with diagonal compression in the concrete shall be provided to take the whole of the shear.

- 4.5.3 Permissible compressive stress (Directly only) in walls (i.e. Top Dome, Conical Wall ) and shall be reduced by 43% for 10 cm thick walls. For thickness more than 30 cm, the compressive stress shall be reduced by 50% and for inter media thickness 10 cm. to 30 cm. linear interpolation shall be done.

- 4.6 PERMISSIBLE STRESSES IN STEEL:

- 4.6.1 For resistance to cracking the steel and the concrete are assumed to act together. For checking the tensile stresses in un cracked concrete for avoidance of cracks, the tensile stress in the steel shall be the product of the modular ratio and the corresponding allowable tensile stress in concrete as per IS 3370(part-II) 1965 or its latest revision. Modular ratio "M" for different concrete mix shall be taken as under:

Grade of Concrete	Modular Ratio "M"
M-150	18.66
M-200	13.33
M-250	10.98
M-300	9.33

- 4.6.2 For strength calculation (concrete assumed to be cracked), the permissible stresses in reinforcement shall be as per Table -2 of IS 3370(part-II) 1965 or its latest revision. For steel, the stresses shall be as per IS 1139-1966 or its latest revision.
- 4.7.1 The analysis of staging of the tank shall be done by using any established method such as portal method etc. The staging shall be analyzed from combination of dead, dead live loads and wind seismic loads. The effect of continuity of beams of the junction shall be properly accounted and column reaction worked out, for different condition of loading, axial force, shear force, bending moments.
- 4.8.1 Modules of elasticity of concrete MEC shall be taken as  $5000 \times F_{ck}^{1/2}$  where equal to characteristic cube strength of concrete in  $N/m^2$  as per IS 456-2000.
- 4.8.2 Columns shall be checked for tensile stress for both the conditions as mentioned in para 4.3.2 in combination with axial tension and bending due to wind or seismic loads, and shall be checked for bond for maximum tensile stress arrived.
- 4.8.3 Columns may be assumed to be fixed at the top of footing.
- 4.8.4 Water Tower in seismic zone (V) of IS 1393-1975 twin diagonal (crossed) backing of steel in vertical plane in addition to the horizontal bracing may be provided.
- 6.0 DETAILING:
- 6.1 MINIMUM REINFORCEMENT FOR WATER RETAINING MEMBER:
- 6.1.1 The minimum reinforcement in walls, floors, roofs, in each of two directions at right angle shall have an area of 0.3% of the concrete selection in that direction for sections up to 100.00 mm thick. For section for thickness greater than 100 mm and less than 450 mm thick, minimum reinforcement each of two directions shall be nearly deducted from at 0.3% for 100 mm thick sections or greater two layers of reinforcing steel shall be place one near each face of the section to make up to minimum reinforcement specified in this clause.
- 6.1.1 The minimum reinforcement specified in this 6.1 above may be decrease by 20 % in case of high yield strength bars confirming to IS 1786-1976 or IS 1139-1966.
- 6.2.1 Minimum clear cover to reinforcement under normal conditions shall be as per para 26.4 of IS 456-2000 or latest revision
- 6.2.2 For liquid faces of parts of members either in contact with the liquid or enclosing the space above the liquid shall be as per para 7.2 IS 3370 (part-I 1965) or as per its latest revision.
- 6.2.3 In case of Raft Foundation, the cover to reinforcement shall be as per 4.6.2 of IS 2950 (part-I) 1973 or as per its latest revision.
- 6.2.4 In case of "shaft" the cover to reinforcement shall be as under;

Vertical 25 mm

Horizontal 15 mm

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- 6.3 For members of structure in contact with water, effective cover shall not be more than 60 mm. Even bars subjected to bending stress, or bars subjected to tension due pure tension in the member the effective cover shall not more than 75 mm.
- 6.4.1 Spacing of reinforcement shall be as per para 26.3 IS 456-2000.
- 6.4.2 Spacing of lateral ties for column shall satisfying provision of para 25.3.2 'C' of IS 456-2000.

**Specification For Pump House/Control Panel room :**

1. The contractor has to submit his own design and getting approved before starting work.
2. Contractor has to design RCC frame structure of pump house/Control Panel room.
3. Minimum 15% opening should be provided in the pump house/control Panel room.
4. Windows and ventilation shall be as per Data sheet.
5. The Minimum grade of concrete shall be mentioned in the Data-sheet.
6. The steel should be CRS FE-500D as per IS standard for all types of diameter including all lead and lift.
7. The cost of binding wire included in this.
8. All required machinery and form work will be included in the cost no additional shall be made for any height.
9. Contractor has to make sure all safety precautions like helmets, Safety Belts, Safety shoes, Safety net etc.
10. While installing the machineries, contractor has to make sure that no structure element should damage. If any damage same shall be rectify by the contractor. No additional shall be paid.
11. The cost of internal lighting included in this.
12. All standard codes shall be applicable for designing of pump house.
13. Refer detail Specifications in building section for plastering work, flooring work, painting work, rolling shutter work etc.
14. Plinth protection work included.
15. Interior and exterior plaster shall be as per data sheet or engineer in charge directed.
16. Interior and exterior paint shade shall be as per approved by engineer in charge.
17. Flooring shall be as per Data sheet.
18. Additionally refer section general specification RCC work and building work for detail specifications.

**Schedule B-4 Road, Railway, Canal, Gas & Bund Crossing****Item 01**

Drilling of Horizontal bore hole for water main pipeline under the Railway / Road tracks/Embankment in all strata with required length including fixing of M.S. (or as specified by Railway / Road/ Irrigation authority) casing pipe of suitable size and Thickness. Rate includes the cost of Drilling of bore hole, Casing pipe & welding pushing etc. complete but excluding the cost of water main, valves and other items. Entire work should be as per Approved Drawing and as per instruction of Railway / Road /Irrigation authority for Following diameter of Bore hole. At various Location along the alignment of Pipeline.

Relevant general specification to be followed and further Guidance as given below.

**In General following sequence shall be adopted in carrying out the job:**

Pushing of the completed segments of the pipe shall be commenced as per the procedure described in above paras till the entire length of the pipe in the embankment is built up.

Permission for Highway & Canal crossing shall be procured by agency/department from competent authority of the concerned department. Necessary letter of recommendation shall be given by department.

At canal, public state highways, at such other crossings as are shown in the construction drawings issued by the company the pipeline shall be installed in MS casing of as recommended by canal / state highway authority casing pipes conforming to the specifications given herein.

The casing pipes / box shall be installed in accordance with the details given in drawing and the casing, bushing and insulators, etc., shall be installed on the carrier pipe as detailed in drawings. Casing pipe size shall be as per Engineer in charge instruction to facilitate the insertion of the later without disturbing the casing pipe and to provide adequate drainage, Casing shall be installed with even bearing throughout its length and shall slope towards one end, as specified or desired by the engineer-in-charge. The ends of the casing shall be sealed to outside of carrier pipe in accordance with the details given in drawing.

Before installation, holes for installing vent pipes shall be cut and burrs if any shall be removed. The welding of both carrier pipe and casing pipe shall be done in accordance with the welding specifications, given herein. Before installing the casing pipe, it should be cleaned of all internal obstructions and during installation care should be taken to keep the inside clean

The section of carrier pipe to be placed in any casing shall be closed at each end, hydrostatically tested preferably with dead weight tester for at least two hours. Only on successful completion of this test, the carrier pipe shall be inserted in the casing pipe. The installation of casing may open cut as circumstances may permit or require as directed by the engineer-in-charge.

The installation of casing in bended section of the carrier pipe shall be performed by meter bends of the casing pipe provided that the length of each meter cut out of casing pipe shall be such as to provide a clearance of at least 1-1/2" between the inside of the casing pipe and the outside of the coated carrier pipe.

Excavation for casing installation shall be immediately backfilled at the completion of the work with suitable solid matter and packed thoroughly to prevent seepage of water into the excavation.

#### **Road, Railway and Irrigation Canal Crossings:**

At road, canal and railway crossings the work shall be performed to the specifications of local authorities or such public bodies as may be in charge (S) of roads, railways and canals to be crossed.

In case, however the minimum requirements of the governing agencies are less than those set out in the drawing or the specifications given herein, then the requirements given in the drawings and the specifications given for encased line shall be followed.

Whereas the casing pipe in the case of encased line to be laid normal by boring, tunneling, engineer-in-charge may at his discretion permit open-cuts to be made for the installation of casing provided, however, that the TENDERER shall procure the necessary permit / license for the same from competent authority. At locations wherein the open cut methods are permitted, the TENDERER shall pass the carrier pipe through the casing located in the trench after the approval of the engineer-in-charge in writing and care shall be exercised to avoid damage to pipe coating and wrapping during this operation. The TENDERER shall produce a certificate in writing from concerned authorities for its satisfactory restoration and payment therefore.

At all crossings the carrier pipe shall be laid straight without bends so that if necessary the pipe at a later date may be replaced without cutting the casing. The carrier pipe shall extend at least 2 meters beyond the end of casing pipe at either end.

At railway crossings the TENDERER shall eliminate unnecessary bending of pipe to conform to the contour of ground by gradually deepening the ditch at such approaches as directed by the engineer-in-charge. Where the installation of the casing has been made by open cut TENDERER shall install suitable temporary bridge work ensuring the safety of the traffic aids and safeguards for protection of the public safety, or he shall provide suitable diversions as desired by the engineer-in-charge.

At all railways pipeline crossings shall be bored with horizontal boring machine. The method of carrying out a cased crossing by boring for various crossings on this pipeline route shall be jointly inspected by the representative of the COMPANY and TENDERER for each category of work prior to commencement of actual work.

Pipeline under railway track and irrigation canal an applicable portion of the right-of-way shall be encased in accordance with the specification. This item of work shall include, necessary clearing and grading required therefore, trenching to the depths and widths required, welding of casing and carrier pipes, testing, lowering in, installation of vent assemblies, end seals, insulator and all other fittings that may be required, backfilling, clean up, complete restoration to the original condition and further strengthening and protective works as may be required. The work shall be carried out in accordance with the drawings and as directed by the engineer-in-charge. For various operations mentioned above, the specifications pertaining to these operations shall apply in addition to the specifications given herein.

The TENDERER shall be permitted to use William Sons type Neoprene seals in place of concrete end seals for the crossings. The item shall be procured by the TENDERER himself as per the provisions under the appropriate head of work in case TENDERER so desires. The representative of the COMPANY may also be associated to determine the quality of the material and its delivery schedule from the open market. However, the particular work defined under the proper head shall not be delayed on account of non-availability of Neoprene end seals. In such case, concrete seals may be provided.

On both ends of pushing concrete supports are to be provided as per direction of engineer in-charge.

#### **ITEM NO.2**

Designing, providing and casting reinforced concreting M.35 design mix box of clear Size 4m X 4m in to in , including providing and casting steel cart ring edge for front shield, MS rear shield RCC M-20 thrust bed for pushing the box below, railway embankment under railway/Bund, SH, NH roads under running traffic condition as per contractors own design drawing including arrangement tor intermediate jacking station with provision of intermediate shield and its connection with the box drag sheet as may be required for smooth controlled pushing etc complete in all respects including cost of necessary excavation in all strata with its all lead and lift for construction thrust bed at designed level as directed by Engineer-In-Charge Including providing all temporary works as required and approved by Railway or statutory authority, required protection of existing road pavement/Railway tracks including providing water tight

Joins in RCC box segments using CC Grout with epoxy paint on exposed facing and providing RCC saddles in the box for supporting pipe in the box as directed, including all plants, machinery, Equipments, all labours, materials and all temporary works in all respects, dismantling and removal of temporary work, restoring ground to its original profile on completed work. Rate is inclusive of construction of pushing pit, receiving pit and intermediate pit if required and inclusive of all tools & tackle etc complete.

Appropriate Length as per Site conditions for the various crossing at various locations (Length not more than 100 meters at single location) for MS pipe Dia 2641mm (Carrier Pipe)

- Providing and casting reinforced concrete approved design mix design mix Box of the size as per GAD, including providing and casting steel cutting edge for front shield, MS rear shield R.C.C. M 35 for thrust bed, thrust wall for pushing the box below railway embankment under railway / roads under running traffic condition as per contractors own design / drawing including arrangements for intermediate jacking station with provision of intermediate shield and its connections with the box drag sheets as may be required for smooth controlled pushing etc. complete in all respects, including cost of necessary excavation with its all lead & lift for constructing thrust bed at designed level as directed by Engineer in Charge including providing all temporary works as required & approved by Railways authority, required protection of existing road pavement / railway tracks including providing water tight joints in R.C.C. box segments using CC grout with epoxy paint on exposed facing and providing R.C.C. saddles in the box as per details given with drawing for supporting pipe in the box as directed, including all plans and machinery, equipment, all labour, materials & all temporary works in all respects, dismantling and removal of temporary work, restoring ground to its original profile on completion of work.
- The work also includes sealing of box at both ends after completion etc. as directed by engineer in charge.

#### Specifications For Casting RCC Box & Pushing Through Embankment

- In order to avoid interference to railway traffic / excavation on existing roads intercepted on pipeline alignment, BOX PUSHING technique is envisaged in preference to any other conventional methods for the laying of pipeline through such railway & road crossings intercepted.
- The R.C.C. box segments shall be cast using concrete grade of approved design mix in suitable segments as per the approved design, and pushed across the embankment by hydraulic jacks, of suitable capacities excavating manually the soil under the FRONT SHIELD of the box.
- The thrust bed required for box pushing shall be of required width and of length and thickness as per design approved and laid along the longitudinal axis of proposed box. The thrust bed is envisaged in reinforced concrete using grade M-35 and designed to resist the reaction induced due to jacking force while pushing the box inside the embankment. The reaction due to jacking force shall mainly be resisted by frictional resistance between thrust bed and the earth. However, additional keys provided at the bottom of the bed shall be made use of to develop more resistance due to passive pressure of the earth.
- The concrete below the bottom of each pin pocket shall be done first for positioning them. Aligning these pin pockets is very important aspect while



casting the thrust bed in order to avoid any lateral shifting of the box with respect to its axis. Therefore, these boxes shall be held in position by welding MS bars between boxes in longitudinal and lateral directions. While concreting for entire thrust bed is carried out, two recesses shall be left along the entire length of the thrust bed at top for housing rails. Leveling of these rails shall be done by providing suitable MS packing Coils at suitable spacing. These recesses shall then be filled with screed mortar. Also, 50 mm thick screed shall be laid on top of the thrust bed and leveled such that the top of rails shall remain 2 mm protruding above top level of the thrust bed. The pin pockets shall be covered with precast cover slab before screeding. The thrust bed shall be laid in a slope of 1:700 to avoid lifting of box during pushing.

- In order to facilitate jacking and steering, it is envisaged to cast the box in segments of suitable lengths. The first box shall be provided with FRONT SHIELD and REAR SHIELD. The front shield shall consist of M.S. Plate with suitable stiffeners. Anchor bars, welded to the Plates shall be embedded in the concrete of the box. The front shield shall be 1.0 M wide on all four faces with 0.50 M width embedded in box concrete. Similarly, rear shield shall be provided at the rear end of each box. Half the width of rear shield shall be embedded in box concrete with outer face being flush with outer surface of the box. For the front 0.50 M length of box, the thickness of top and bottom slab and both sides shall be reduced by 30 MM. so that rear end of the first box and at front end of remaining box pockets, suitably lined with 6 mm thick M.S. Coils shall be provided to house hydraulic jacks for intermediate jacking. Two pockets shall be provided in the side walls of box, just below top Haunches and two shall be provided in bottom slab of box, next to Haunches.
- The box is designed as a normal box but subject to longitudinal thrust while pushing.
- 8 mm thick M.S. Plates shall be laid over rails placed in thrust bed to form bottom of box along the length. The bottom surface of these Coils shall remain flush with the bottom of the box. These Plates shall be anchored in bottom slab concrete with welded anchor bars. With this arrangement, while pushing the box over the thrust bed, the contact between steel to steel surface shall reduce friction. Before casting the box, polythene sheets suitably greased shall be laid on the top of thrust bed & bottom of box to prevent contact between thrust bed and bottom of box and facilitate pushing with very smooth, frictionless surface between the thrust bed and bottom of the box.
- To withstand reactions of jacking force, jacking pins are provided with M.S. bar handle to facilitate the lifting when required. The overall dimensions of the pins shall ensure smooth insertion and lifting inside pin pockets.
- A jacking rig, fabricated from M.S. Plates and structural steel shall be provided to ensure proper alignment of jacking force. One end of the jacking rig shall have saddles to house hydraulic jack. The clear width inside rig shall be more than pin pocket to ensure smooth sliding of rig. Spacers fabricated from M.S. Plates shall be used for filling gaps between hydraulic jack and jacking pin while pushing. These spacers shall be meant to rest against jacking pin at one end and jack ram at the other end.
- After completion of casting of box, pushing operation shall commence with the rigs laid on top of the thrust bed with one end of the rig resting against face of the rear end of bottom slab of the first box. The hydraulic jacks shall be properly housed in the rig so that one end of jack shall rest against the end plate of the rig.

The other, ram side of the jack shall rest against face of jacking pin. When the jack shall be operated, the ram shall be pushed against the jacking pin. This will make the box to move in the direction of thrust away from jacking pin. When the full displacement of ram be obtained, the jacks shall be closed and spacers shall be inserted between the jacking pin and the jacks. the jacks shall be operated again and the box shall be pushed in the direction of thrust. When the rig travel to expose next row of pin pockets, the jacking pin shall be removed and installed in the next row of pin pockets. This process shall be repeated till the front shield shall cut into the embankment for about 1.0 M.

- The excavation at the front end of the box shall be carried out manually within front shield. the muck shall be removed from the box. When about 0.50 M of excavation shall be done, the jacks shall be operated again so that front shield shall be pushed for 30 or 40 cms further inside the embankment. Again, the excavation shall be continued till the entire length of first box is fully pushed inside the embankment. When rear end of the first box shall be very close to the embankment, the second box shall then be cast and after adequate curing, pushed to lock inside the rear shield of the first box. Hydraulic jack shall be housed in intermediate jacking pockets and an intermediate jacking station shall be opened up. The operation of the jacks in the intermediate jacking station shall be similar to that in the initial stage. However, in this case, the ram shall rest against plate lining in pockets. After opening the intermediate jacking station, the intermediate jacks shall be operated while the rear end of 2nd box shall be made to anchor against the jacking pin through the jacks.

**In General following sequence shall be adopted in carrying out the job :**

- After casting thrust bed, polythene sheets suitably greased shall laid on the top of thrust bed as above explained to prevent contact between thrust bed and bottom of box.
- The reinforcement cage required for base slab with reinforcement for side walls shall be placed in position on bed. The precast blocks or chairs for provision of cover shall be provided under the cage.
- The base slab and side walls up to top of bottom haunch would be concreted with M-35 grade concrete in one operation leaving the top of side wall rough.
- The reinforcement cage for side wall shall be laid in proper position. The lap length shall be provided properly. The side walls shuttering shall be provided by proper checking of alignment & vertically up to bottom of top haunch.
- The surface of hardened concrete shall be thoroughly hacked, swept clean, wetted and covered with a layer of neat grout. The neat grout shall be applied to the top and this shall be followed by a 10 mm thick layer of mixed the same proportion as that of and sand in concrete and concreting shall be resumed immediately thereafter. The first batch of concrete shall be rammed against the old work to avoid formation of any stone pockets particular attention being paid to corners and closed spots and the concreting of side walls shall be carried out up to the bottom of top haunch.
- The reinforcement cage for top slab shall be laid properly on centering and chairs or precast units for providing cover shall be laid under cage. The centering shall be checked in alignment and props shall be of sufficient strength.
- Concreting of top slab shall be carried out in the same manner as per 5 above.
- Pushing of the completed segments of the box shall be commenced as per the

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procedure described in above paras till the entire length of the box in the embankment is built up.

After completion of jacking, pressure grouting of concrete shall be carried out of fill joint between segments to make then water tight and the inside face of the joint treated with smooth finishing and box indicators shall be placed at both ends of box showing necessary details of box and communication. Both ends shall be closed with BB Masonry keeping provision of air vents.

#### **Schedule B-5 Construction of Steel Bridge for Rivers, Canal and Nala Crossings**

##### **ITEM NO.1**

Providing and executing canal crossing arrangement for pipeline by steel bridge structure, including all civil works such as excavation, concrete, reinforcement, and structural steel, complete as per approved design and drawing. Minimum Width of the bridge shall be 4.5 m. The floor level of the bridge shall be above HFL/FSL+FB of the Corresponding Canal/ Nala/ River. Construction of Steel Bridge for Rivers, Canal and Nala Crossings with Steel Bridge.

Materials:

The structural steel work shall conform to M-14. Red lead paint primer shall conform to I. S.: 102-1962.

Workmanship:

The steel sections as specified or required shall be cut, square and to correct lengths, as per drawings and design. The cut ends exposed to view shall be finished smooth. No. two pieces

shall be welded or otherwise jointed to make up the required length of member, except as indicated

in the drawings or as directed. All straightening and shaping to form shall be done by application of pressure and not by hammering. Any bending or cutting shall be carried out in such a manner

as not to impair the strength of the metal. All operations shall be done in cold state unless otherwise directed/permitted

Steel riveted or bolted in built up sections, frame work.

The steel structure as shown in the drawings or as per direction of the Engineer-in-charge shall be laid out on one level platform to full scale and to full size or in parts. A steel tape shall be used for measurements to ensure maximum accuracy.

Wooden templates 12 mm to 19 mm thick or metal sheet template shall be made to correspond to each connecting gusset plate and rivet holes shall be accurately marked on them and drilled. The template shall be laid on the steel members, and holes of the steel members shall also be

marked for cutting. The base of steel columns and the position of anchor bolts shall be carefully set out.

All stiffeners shall be formed by pressure and where practicable, the metal shall not be cut and welded in making these. In major works or where so specified shop drawings giving complete details and information for the fabrication of the component parts of the structure, including location type size, length and details of rivets, bolts, or weld shall be prepared in advance of the actual fabrication and as approved. The drawings shall indicate the shop and field rivets and bolts.

The steel member shall be distinctly marked or stenciled with paint with the identification mark as given in the shop drawings

The bars shall be thickened at the ends, so as to provide for screwed threads and gradually tapered off to meet their normal section.

Great accuracy shall be observed in fabrication of various member, so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true and free from twist, bends, buckles, or open joints. Before making holes individual members for fabrication, the steel work intended to be riveted or bolted together shall be assembled or clamped properly and tightly so as to ensure close abutting or lapping of the different members. All stiffeners shall bear tightly both at top and bottom without being drawn or caulked. The abutting joints shall be cut or dressed true and straight and fitted close together.

Web splice plates and flanges under stiffeners shall be cut to fit within 3 mm of flange angles, web plates of girders shall have not cover plates, shall have their ends flush with the top of angles forming the flanges unless otherwise required. The web plates when spliced shall have clearance of more than 6 mm.

The erection clearance for cleared ends of members connecting steel to steel shall preferably be not greater than 1.5 mm. The erection clearance at the ends of beams without web cleats shall be more than 3 mm at each end but where for a practical reason greater clearance is necessary, suitably designed seating shall be provided.

Pins and rollers shall be accurately turned to gauge. These shall be straight and smooth and free from flaws. The roller bearing shall be provided with adequate arrangement for holding the girders or truss resting on it. In column caps and bases, the ends of shafts together with the attached gusset angles, channels etc., after riveting together shall be accurately mechanized so that the parts connected butt against each other over the entire surfaces of contact

connecting angles or channels shall be fabricated and placed in position with greater accuracy so that they are not unduly reduced in thickness by machining.

The ends of bearing stiffeners shall be machanised or ground to fit tightly both at the top and bottom. All holes shall generally be drilled to the required size and at the required position. Sub punching shall be permitted, provided it is done 3 mm or less in diameter and remade thereafter to the required size. The holes for rivets and bolts shall be larger by 0.4 to 6 mm than the nominal diameter of rivets or black bolts depending up on the diameter of rivets.

Holes shall have their axis perpendicular to the surface bored through. The drilling or reamering shall be free form butts, and the holes should be clean and accurate. Holes for counter shunk bolts shall be made in such a manner that their heads fit flush with the surface after fixing. The fabrication work shall be completed in workshop as far as it is practicable to do so. Site joints shall be done with rivets and fitted bolts or black bolts, as shown in the drawings or as directed. Generally the following principles shall govern the use of rivets turned and fitted bolts, and black bolts.

(i) Rivets and turned and fitted bolts shall be used where the connection is such that slip under load has to be avoided.

(ii) Black bolts may be used very sparingly where a force is carried through a connection without impact, vibration or reversal of stresses.

The parts assembled for riveting shall be in close contact with each other and the bearing stiffeners shall bear tightly both at top and bottom without being drawn or caulked. Members to be riveted shall be properly pinned or bolted and rigidly held together while riveting. Drifting of holes shall not be permitted except to draw the parts together and the drifting tools so used shall have maximum diameter not exceeding the nominal diameter of rivets or bolts. Drifting done during assembling shall not distort the metal or enlarge the holes.

The shanks of rivets shall project beyond the plate surface sufficiently so as to fill the hole thoroughly and from the required head after riveting.

The riveting shall be done by hydraulic or pneumatic process. However where such facilities are not available, hand riveting may be permitted. The rivet shall be heated red

-hot, care being taken to control the temperature of heating so as not to burn the steel.

Riveting of diameter less than 10 mm may be fitted cold. Rivets shall be of heat finish with heads full and of equal size. All loose, burnt or badly formed rivets with concentric or deficient heads shall be cut out and replaced. The heads of rivets shall be central to shanks and shall grip the assembled members firmly. In cutting out rivets, care shall be taken so as not to injure the assembled members, caulking or recouping shall not be permitted.

For testing rivets, hammer weighing approximately 0.25 kg. Shall be used of the rivets shall be tapped, slack rivets will give a hollow sound and a jar.

All rivet heads shall be painted with red lead paint within a week of their fixing.

Bolting all bolt heads and nuts shall be hexagonal and of equal size unless specified otherwise.

The screwed heads shall conform to I.S.: 1363:1960 and the threaded surface shall not be tapered.

The bolts shall be of such length so as to project two clear threads the nuts, when fixed in position and these shall fit in the holes without any shakes. The nut shall be fit in the threaded ends of bolts properly. Where turned and fitted bolts are required to be used in place of rivets they shall be provided with washers not less than 6 mm thick so that the nut when tightened shall not bear on the unthreaded body of the bolt. Tapered washers shall be provided for all heads and nuts bearing on leveled surfaces. The threaded portion of the bolts shall not be within the thickness of the parts bolted together. The faces of the bolt and nuts abutting against steel members shall be machine finished. Where there is a risk of the nut being

removed or becoming loose due to vibrations or reversal of stresses, these shall be secured from slackening by the use of locknuts, spring washers, cross cutting or hammering down of threads as directed.

Bolts, nuts and washers shall be thoroughly cleaned and dipped in double boiled linseed oil before use. The whole steelwork shall be painted with a coat of priming coat of red lead, as per relevant specifications of painting.

Mode of measurement and payment:

The steelwork shall be measured in general as under.

- (a) All work shall be measured on the basis of finished dimensions as fixed at site and measured net unless specified otherwise.
- (b) The weight of steel sections, steel strips in finished work shall be calculated from standard weight on the same basis on which steel is supplied to the contractor by department or those given in relevant I. S. if steel is arranged by the contractor.
- (c) The weight of steel plates and strips shall be taken from relevant I. S. based on 7.85 kg/sq. meter for every millimeter sheet thickness if steel is supplied by the contractor; otherwise the weight shall be calculated on the basis on which steel is supplied to the contractor by department.
- (d) Unless otherwise specified weight of clearest, brackets, packing pieces, bolts, nuts, washers, distance pieces, separators, diaphragm gusset (taking over all square dimensions) fish plates etc. shall be added to the weight of respective items.
- (e) In riveted work allowance to be made of weight of rivet hands. No deductions shall be made for rivet or bolt holes excluding holes for anchor or holding down bolts
- (f) For forged steel and steel casting weight shall be calculated on the basis of 850 kg/cum.
- (g) Unless otherwise specified an additional of 2.5 percent of the weight of structure shall be made for shop and site rivet heads in riveted steel structure.
- (h) Unless otherwise specified no allowance shall be made for the weld metal in case of welded steel structure.
- (i) Dimensions other than cross sections and thickness of plates shall be measured to nearest 0.001 m
- (j) Mill tolerance shall be ignored when weight is determined by calculation.

The rate includes cost of all material, labour, erection, hoisting, scaffolding protective measure, required for proper completion of the item of work. This shall also included conveyance and delivery handling, loading, unloading and storing etc. required for completing the item described above including necessary wastage involved.

The rate shall be for a unit of rmt.

### Schedule B-6 Construction of Compound Wall at Palej H/W & Vadva Intake Well Campus

#### Item No.1

Construction of RCC and Brick masonry compound wall

Construction of 2.0 mtr height (above FGL) compound wall in B.B. Masonry in C.M. 1:3 with R.C.C. columns M-20 at 3.0 m c/c & R.C.C. Beam M-20 below F.G.L. including reinforcement TMT steel all diameter Fe 500D grade minimum confirming to relevant IS with 20 mm thick Cement plaster to all exposed concrete and masonry structure at top in coping of compound wall including excavation in all strata, P.C.C. M-10, form work for R.C.C. work, plastering, applying two coats of weather proof exterior emulsion paint, removal of all debris with lead & lift etc. complete

**Wire Fencing for compound wall:** Providing and fixing 600 mm dia hot dip galvanised cross spiral type razor edge concertina coil having 150 mm c/c loops with 6 m stretch, made of 2.6 mm dia high tensile core wire conforming to IS 4454 (Part-1, Grade-II) with 230–250 GSM galvanisation and 0.5 mm thick, 19 mm wide razor strip conforming to IS 513 DD quality with minimum galvanizing coating of 12 microns, with series of barbs punched along the length at regular intervals, supported and tied with four rows of GI barbed runner wires, fixed over Y-type MS angle posts of size 50×50×6 mm, 0.75 m height at 3.0 m c/c, mounted on compound wall with suitable fasteners, including GI clips, U-nails, binding wire and all necessary fittings, complete as per specification and direction of Engineer-in-Charge.

Refer general specifications for detail specifications item shall be executed as per Engineer-in-charge direction.

**Entry Gate:** Providing & Fixing Iron gates for compound wall of required size & specification with 2 No of R.C.C. M-20 column size 0.45 x 0.45 m including reinforcement TMT steel all diameter Fe 500 grade minimum confirming to relevant IS with 15 mm thick cement plaster to all exposed surface including excavation in all strata, P.C.C. M-10, form work for R.C.C. work (M-20), painting to all Iron exposed surfaces (incl. brushing, cleaning & priming coat) and cleaning the site etc. the site etc. complete as per the detailed drawing attached. (MS Gate size 5.00 mtr long and average 2.5 mtr height), and construction of wall (at front side at MS gate) in B.B. Masonry in C.M. 1:6 with 20 mm thick Cement plaster to all exposed concrete and masonry structure. Min. 2 nos for lighting Providing & erecting approved make CFL outdoors type Post top lantern/flying saucer type fittings cast Aluminium/M.S. Powder Coated pole mounting type with BS lamp holder & Clear acrylic diffuser with CFL lamp complete with necessary cabling. (b) with One no. 36 Watt CFL

Payment shall be as per payment schedule.

#### Item No.2

Construction of RCC compound wall

Construction of RCC Compound wall with 3 mtr Height and R.C.C. columns M-20 at 3.0 m c/c & R.C.C. Beam M-20 below F.G.L., wall also shall be designed in RCC including reinforcement TMT steel all diameter Fe 500D grade minimum confirming to relevant IS with 20 mm thick Cement plaster to all exposed concrete at top in coping of compound wall including excavation in all strata, P.C.C. M-10, form work for R.C.C. work, plastering, applying two coats of weather proof exterior emulsion paint, removal of all debris with lead & lift etc. complete

**Wire Fencing for compound wall:** Providing and fixing 600 mm dia hot dip galvanised cross spiral type razor edge concertina coil having 150 mm c/c loops with 6 m stretch, made of 2.6 mm dia high tensile core wire conforming to IS 4454 (Part-1, Grade-II) with 230–250 GSM galvanisation and 0.5 mm thick, 19 mm wide razor strip conforming to IS 513 DD quality with minimum galvanizing coating of 12 microns, with series of barbs punched along the length at regular intervals, supported and tied with four rows of GI barbed runner wires, fixed over Y-type MS angle posts of size 50×50×6 mm, 0.75 m height at 3.0 m c/c, mounted on compound wall with suitable fasteners, including GI clips, U-nails, binding wire and all necessary fittings, complete as per specification and direction of Engineer-in-Charge.

Refer general specifications for detail specifications item shall be executed as per Engineer-in charge direction.

**Entry Gate:** Providing & Fixing Iron gates for compound wall of required size & specification with 2 No of R.C.C. M-20 column size 0.45 x 0.45 m including reinforcement TMT steel all diameter Fe 500 grade minimum confirming to relevant IS with 15 mm thick cement plaster to all exposed surface including excavation in all strata, P.C.C. M-10, form work for R.C.C. work (M-20), painting to all Iron exposed surfaces (incl. brushing, cleaning & priming coat) and cleaning the site etc. the site etc. complete as per the detailed drawing attached. (MS Gate size 5.00 mtr long and average 3 mtr height), and construction of wall (at front side at MS gate) in RCC in C.M. 1:6 with 20 mm thick Cement plaster to all exposed concrete structure. Min. 2 nos for lighting Providing & erecting approved make CFL outdoors type Post top lantern/flying saucer type fittings cast Aluminium/M.S. Powder Coated pole mounting type with BS lamp holder & Clear acrylic diffuser with CFL lamp complete with necessary cabling. (b) with One no. 36 Watt CFL.

Payment shall be as per payment schedule.



## Schedule B-7 Restoration of Existing Road Works- RCC & Bituminous

### Item 01:

#### RCC Road

Demolition including stacking of serviceable materials and disposal of unserviceable materials with all lead and lift. (i) R.C.C. work

RCC Road cutting

### Technical Specification for Road Restoration

#### (A) Demolition of R.C.C. Work

Demolition including dismantling of existing reinforced cement concrete work by mechanical/manual means, including breaking, cutting, removal of reinforcement steel, stacking of serviceable materials at designated locations, and disposal of unserviceable materials/debris outside the site with all leads and lifts complete, conforming to relevant IS Codes, IRC Guidelines, and MORTH Specifications.

### Technical Specifications

The work shall include:

- Careful dismantling of RCC structures, pavements, foundations, slabs, drains, chambers, pedestals, and other concrete members.
- Cutting/removal of reinforcement bars using approved mechanical tools.
- Barricading, traffic diversion, safety arrangements, and precautionary measures during demolition.
- Segregation of reusable and unserviceable materials.
- Loading, unloading, transportation, and disposal of debris at approved dumping locations.
- Cleaning and dressing of dismantled surfaces and surrounding area.
- Protection of nearby structures, utilities, pipelines, cables, and services from damage.
- Applicable Codes & Standards

### The work shall conform to:

IS 456 : 2000 — Plain and Reinforced Concrete Code of Practice

IS 1200 — Method of Measurement of Building and Civil Engineering Works

IS 3764 — Safety Code for Excavation Work

MORTH Specifications for Road and Bridge Works (Latest Revision)

IRC Guidelines and relevant local authority specifications

Labour safety regulations and Engineer-in-Charge instructions

### Item 02

Providing and casting in situ C.C. in grade M-15 (approx. corresp. to prop. 1:2:4) (proportions as per mix design or as per Table 9 of IS456 2000 in masses by weigh batching ) using granite, quartzite trap metal of size 6 mm to 20 mm for RCC work, including scaffolding centering, form work, needle vibrated consolidation, curing comp. up to 6 meter depth or height (excluding cost of reinforcement and neat finishing) with centering and shuttering/deshuttering etc. comp. for

structure for other than water retaining.  
RCC Road Restoration

Refer Detailed Technical Specification of concrete work and Engineer –in-charge.

**Item 03**

Providing, cutting, bending, binding and fixing in position as per drawing TMT BAR, reinforcement for R.C.C. works and anchor bars incl cost of black annealed 16 to 18 BWG M.S. Wire etc. Complete with all lead and lift. (B) Fe-415

**1.0. Materials :**

- 1.1. TMT bars shall conform to M-18 and shall be of grade Fe-415.
- 1.2. Black annealed mild steel binding wire (16 to 18 BWG) shall conform to M-21.

**2.0. Workmanship :****2.1. General:**

2.1.1. The work shall consist of supplying, cutting, bending and placing reinforcement in position as per drawings and directions of Engineer-in-Charge.

**2.2. Cleaning of Steel:**

2.2.1. Reinforcement shall be clean and free from loose rust, oil, grease, paint or other deleterious substances at the time of fixing.

**2.3. Bending of Bars:**

2.3.1. Bars shall be bent cold to the required shape and dimensions as per bar bending schedule.

2.3.2. Bending shall be done using proper bar bending machine or approved tools.

2.3.3. Bars shall not be heated for bending.

2.3.4. Radius of bend shall not be less than twice the diameter of the bar.

**2.4. Placing in Position:**

2.4.1. Reinforcement shall be accurately placed as per drawings.

2.4.2. Bars shall be firmly held in position using binding wire not less than 1 mm thick.

2.4.3. Suitable spacers, chairs and cover blocks shall be used to maintain proper cover.

2.4.4. Bars shall not be allowed to sag or get displaced during concreting.

**2.5. Binding:**

2.5.1. Bars crossing each other shall be tied securely with annealed binding wire.

2.5.2. Binding shall be tight enough to prevent movement during concreting.

**2.6. Lapping of Bars:**

2.6.1. Lapping shall be done as per IS:456 or as directed.

2.6.2. Laps shall be staggered and shall not occur at points of maximum stress.

2.6.3. Overlapping bars shall be kept apart or properly tied as directed.

**2.7. Anchor Bars:**

2.7.1. Anchor bars shall be provided as per drawing and properly embedded in concrete.

2.7.2. Proper development length shall be ensured.

**2.8. Welding/Coupling (if required):**

2.8.1. Welding shall be carried out only when permitted and shall conform to IS standards.

2.8.2. Only skilled welders shall be employed.

2.8.3. Mechanical couplers, if used, shall be of approved make.

**2.9. Protection:**

2.9.1. Reinforcement placed shall be protected from displacement and contamination before concreting.

2.9.2. Projecting bars shall be coated with cement slurry if exposed for long duration.

**3.0. Mode of Measurement and Payment :**

3.1. Reinforcement shall be measured in length for different diameters as per drawings and converted into weight (Kg/tonne) as per standard tables (M-18).

3.2. Length shall include hooks, bends and overlaps.

3.3. Wastage shall not be permitted beyond 5%. Excess consumption shall be recovered at penal rate.

3.4. Binding wire shall not be measured separately and its cost shall be included in the rate.

3.5. The rate shall include cost of:

- Supplying reinforcement steel
- Cutting, bending and placing
- Binding with wire
- Chairs, spacers and supports
- All labour, tools, plant and incidental charges

3.6. Mode Of Payment:- The rate shall be for a unit of one Kg as per Price Bid.

**Item 04****Asphalt Road**

Earthwork for embankment including breaking clods, dressing with all lead and lift (excluding watering and consolidation) (A) From Borrow pits within land width

Refer general specification of earthwork and road and building for details.

**Item 05**

Providing & laying of Granular sub base (GSB) of graded granular material consisting of gravel, pabbles (80%) and crushed stone aggregate (20%) as per grading given in table 400-1 of the specification MORT&H and compactor to the required density with 8 - 10 tonne vibratory roller with plain drum or heavy pneumatic tyred roller of minimum 200 to 300 KN weight in all seasons as per MORT&H , maintaining the required slope & grade during the operation as approved by the engineer in charge & watering to the proper moisture content and sprinkled with the help of truck mounted water tank fitted with suitable arrangement. (fully saturated having CBR value greater or equal to 30)

As per general specification and instructed by Engineer In Charge

**Item 06**

Providing, laying, spreading and compacting graded stone aggregate to wet mix macadam specification including premixing the Material with water at OMC in mechanical mix plant carriage of mixed Material by tipper to site, laying in uniform layers with hydrostatic sensor paver in sub-base / base course on well-prepared surface and compacting with vibrator roller to achieve the desired density.

As per general specification and instructed by Engineer In Charge

**Item 07**

Consolidation of 2.5cm. Thick premixed asphalt carpet with power roller including cost of fuel hire charges of roller etc. complete.

As per general specification and instructed by Engineer In Charge

**Item 08**

Consolidation of liquid / premixed seal coat with power roller including cost of fuel hire charges of roller etc. complete.

As per general specification and instructed by Engineer In Charge

### Schedule B-8 Construction of RCC - Approach Road

#### Item No.01

RCC Road: Construction of RCC approach road for required length as per site conditions, with minimum clear carriageway width of 4.50 m, ensuring proper geometric alignment and smooth connectivity complete in all respects; preparation and compaction of subgrade, construction of pavement comprising 150 mm thick Granular Sub-Base (GSB), 150 mm thick Wet Mix Macadam (WMM), Plain cement concrete sub-base, polythene sheet and RCC pavement of M20 grade with TMT Fe-500D reinforcement, finished to required camber and slope, including providing kerb, providing proper surface and subsurface drainage arrangements including cross-drainage works as required, all materials including aggregates and concrete shall be tested as per relevant codal provisions and approved specifications before and during execution, and the contractor shall be responsible for quality, submission of drawings and calculations for approval, methodology, safety, stability and performance of the plant road and the entire work shall be executed in accordance with approved drawings and relevant IRC and MoRTH specifications, complete as directed by the Engineer-in-Charge.

RCC Road :- Construction of RCC Approach Road incl. ramming, watering, levelling, consolidating etc. PCC works 15 Cm - Providing and casting in situ mass cement concrete In grade M-10 using granite quartzite trap metal of size 12 mm to 25 mm incl. consolidation curing etc. complete. RCC works 25 Cm - Providing and casting in situ mass cement concrete In grade M-20 using granite quartzite trap metal of size 6 mm to 20 mm for RCC work, including reinforcement (minimum steel TMT Fe-500D - 25 kg/cum), scaffolding Cantering, formwork, needle vibrated consolidation, curing complete. Providing and casting in situ ordinary cement concrete M- 150 for Kerbs / kerb blocks including formwork, curing and finishing complete.- Kerb both side of road. Distempering (Two coats) with oil bound distemper of approved brand and manufacture and of required shade on wall surfaces to give an even shade, over and including a priming coat with distemper primer of approved brand and manufacture after thoroughly brushing the surface free from mortar dropping and other foreign matter and also including preparing the surface even and sand papered smooth.

- Refer general Specifications.
- Contractor has to submit and get approved his own design before starting the work.
- Excavation for road all with shoring and strutting if required as per required gradient and line including safety provisions using site rails and stacking excavated stuff including up to all required lead cleaning the site etc. complete for all lifts and strata.
- Minimum width shall be 4.5 m.

### Schedule B-9 Construction of Staff Quarters at Vadva Intake Well & Palej H/W

#### Item No.01

Designing & constructing Staff quarters including drawing room, bed room, kitchen, soakpit, water supply arrangement, drainage arrangement toilet block, outside staircase, All electrical works, plumbing and all finishing items as per data sheet and detailed Specification.

#### General:

Designing (aesthetically), and Constructing Earthquake Resistance R.C.C. Frame Structure of staff Quarter with all material & labour and opening details in drawing room, bed room, kitchen, toilet and bath room etc., providing soakpit, water supply arrangement, drainage arrangement, outside stair case, all electrical, plumbing work including all finishing items. Schedule for staff quarters including painting (inside and outside), plastering- (inside and outside) etc. with brick masonry in CM 1:4 and cement plaster in CM 1:3 and design shall be earthquake Resistance.

The scope of work includes supply, installation, testing, and commissioning of complete electrical works comprising distribution boards, light fittings, sockets and plug points, exhaust fans, ceiling fans, and point wiring for all equipment in the Staff Quarters and Toilet Block also as per Electrical Specification.

#### Specification For staff quarters-building :

The contractor has to submit his own design and getting approved before starting work.

Contractor has to design RCC frame structure of staff quarters.

Minimum 15% opening for ventilation should be provided in the room.

Windows and ventilation shall be as per Data sheet.

Building with flush door including sun mica and windows of aluminium section and window grill of aluminium anodized should be provided (Included in Cost).

Flooring and skirting for living room/drawing room, dining area, kitchen, balcony lobby/ corridor, staircase, kitchen platform, washbasin area, WC, bath etc. shall be provided as per data sheet and as per instructions of Engineer-in-charge.

The cost of Plumbing and Sanitary Works including Overhead Water Storage Tank, Water distribution pipelines, Drainage Pipelines, Water Closet, Septic Tank etc. are included in this. The type and MOC of all components of Plumbing and Sanitary Works shall be as per data sheet and as per engineer in charge directed.

The Minimum grade of concrete shall be M-25.

The steel should be TMT FE-500D as per IS standard for all types of diameter including all lead and lift.

The cost of binding wire included in this.

All required machinery and form work will be included in the cost no additional shall be made for any height.

Contractor has to make sure all safety precautions like helmets, Safety Belts, Safety shoes, Safety net etc.

While installing the furniture, contractor has to make sure that no structural element should be damaged. If any damage happens it shall be rectified by the contractor. No additional cost shall be paid for the same.

The plinth level shall be as per datasheet.

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All standard codes shall be applicable for designing of Staff Quarters.

Refer detail Specifications in building section for plastering work, flooring work, painting work, rolling shutter work etc.

Opening details exposed to Outer periphery of the unit including Ventilation shall be provided with chhajja.

Plinth protection work included.

Necessary basic furniture as directed by EIC

**Additionally refer general specification for details.**

**Schedule B-10 Construction of Security Cabin****Item No.01**

Designing & constructing Security Cabin including All electrical works and all finishing items as per data sheet and detailed Specification.

1. General The Security Cabin shall be a weatherproof structure suitable for deployment at project sites, pumping stations, treatment plants, offices, and other utility installations.

2. Dimensions

External Size: Minimum 3 m × 3 m × 3 m (or as approved by the Engineer-in-Charge).

The contractor has to submit his own design and getting approved before starting work.

Contractor has to design RCC frame structure of security cabin.

Minimum 15% opening for Ventilation should be provided in the security cabin.

Windows and ventilation shall be as per Data sheet.

The Minimum grade of concrete shall be mentioned in the Data-sheet.

The steel should be TMT FE-500 as per IS standard for all types of diameter including all lead and lift. The cost of binding wire included in this.

All required machinery and form work will be included in the cost no additional shall be made for any height.

Contractor has to make sure all safety precautions like helmets, Safety Belts, Safety shoes, Safety net etc.

While installing the machineries, contractor has to make sure that no structure element should damage. If any damage same shall be rectify by the contractor. No additional shall be paid.

The cost of internal lighting included in this.

Plinth level of security cabin should be min. (1) min 2.0 meter above GL

All standard codes shall be applicable for designing of pump house.

Refer detail Specifications in building section for plastering work, flooring work, painting work, rolling shutter work etc.

Plinth protection of minimum 100 mm thick and minimum 1000mm wide of M 15 grade.

Interior and exterior plaster shall be as per data sheet or engineer in charge.

Interior and exterior paint shade shall be as per data sheet or engineer in charge.

Flooring shall be as per Data sheet.

Opening details exposed to Outer periphery of the unit including Ventilation shall be provided with chhajja.

Exhaust Fan should have an outside bend pipe with a screen. This should be shown in GAD.

The main entry door width should be 1.2m.

**Additionally refer general specification**



## Schedule B-11 Construction of Combined Panel Room at Vadva Intake for Both Intake well

### Item No.1

#### Construction of panel room

1. General The Panel room shall be a weatherproof structure suitable for deployment at project sites, pumping stations, treatment plants, offices, and other utility installations.

#### 2. Dimensions

External Size: Minimum 40 X 20 m (or as approved by the Engineer-in-Charge).

The contractor has to submit his own design and getting approved before starting work.

Contractor has to design RCC frame structure of Panel room.

Minimum 15% opening for Ventilation should be provided in the Panel room.

Windows and ventilation shall be as per Data sheet.

The Minimum grade of concrete shall be mentioned in the Data-sheet.

The steel should be CRS FE-500 as per IS standard for all types of diameter including all lead and lift. The cost of binding wire included in this.

All required machinery and form work will be included in the cost no additional shall be made for any height.

Contractor has to make sure all safety precautions like helmets, Safety Belts, Safety shoes, Safety net etc.

While installing the machineries, contractor has to make sure that no structure element should damage. If any damage same shall be rectify by the contractor. No additional shall be paid.

The cost of internal lighting included in this.

Plinth level of Panel room should be min 2.0 meter above HFL.

All standard codes shall be applicable for designing of pump house.

Refer detail Specifications in building section for plastering work, flooring work, painting work, rolling shutter work etc.

Plinth protection of minimum 100 mm thick and minimum 1000mm wide of M 15 grade.

Interior and exterior plaster shall be as per data sheet or engineer in charge.

Interior and exterior paint shade shall be as per data sheet or engineer in charge.

Flooring shall be as per Data sheet.

Opening details exposed to Outer periphery of the unit including Ventilation shall be provided with chhajja.

Exhaust Fan should have an outside bend pipe with a screen. This should be shown in GAD.

The main entry door and rolling shutter size as approved by EIC.

**Additionally refer general specification**

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**Schedule B-12 Pumping Machinery Including all Electro-Mechanical-Instrumentation and SCADA works at Vadva Intake well and various Headworks**

For the details please refer the volume IIC –Mechanical, Electrical and Instrumentation.

### Schedule B-13 ROU, Crop Compensation and Land Compensation Works

#### Item No.1 to 3

- I. To obtain Right of Use (ROU) of 25m width under Gujarat Water and Gas Pipelines (Acquisition of Right of Use in land) Act, 2000 for laying transmission pipelines including 3(1), 6(1), Notification, Hearing, Final award to farmers and including all formalities
- II. Crop compensation for width of 25 mt on pipeline alignment.
- III. Payment for Land compensation for obtaining ROU having width 25 mt for proposed pipeline alignment.

To carry out survey work Co-ordination liaison for "Standing crop compensation" in land for laying water supply pipeline along the alignment of Bulk Pipeline including shifting of center line marking it on village map and Hissa to be taken for Standing crop compensation and submission of drawing in 4 sets drawn in the scale of 1 cm=25 mt. along with original tracing showing and marking their own survey numbers with CD 4 nos. etc. and defining Standing crop compensation strip of 25.00 m. along the cross country in width on the map and showing revenue survey number wise area and other details as per required.

For Job work for legal formalities including getting copy of 7/12, 6-A, form of particular land non judicial Stamp paper, & all required activities with all documents. For Job work for legal formalities including getting 7/12, 6-A, non-judicial Stamp paper, & all required activities with all documents.

The route map shall be provided by GWSSB and agency shall strictly follow the route. The section for which ROU is to be carried out as under.

Field survey to ascertain details of Private land and Government land with length and alignment of the route marked on village map.

To collect village record 7/12, records of Rights no. 6 and village form 8A of concerned land, for which acquisition of Right of Use in land is to be obtained from concerned authority.

Obtain sales statistics for last five years and other related information necessary to decide the amount of an award.

The Agency, on completion of field work shall prepare the detailed map marking thereon survey number including recording of measurements and design R.O.U. stripes, which varies from 25 meters.

Agency will prepare compensation award serve them to every person who is entitled to get compensation as per the latest revenue record.

Cross cheque of compensation are to be prepared and before issuing cross cheques, notice is to be served to concerned persons i.e. legal owner or occupier of the land as per concerned village revenue record and to maintain records thereof.

All correspondence to be prepared as per instruction of Engineer in-charge.

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To prepare all relevant papers on behalf of GWSSB as per instruction of the Engineer- In-charge of project.

The agency shall be plot center line of the pipeline on the revenue village map and then survey along the route of pipeline shall be carried out. The width of the strip for "Right of Use" purpose will be 25 m along road boundary and the cross country.

The scale of drawing shall be 1cm= 25 m.

The agency will show all existing structures within ROU strip toward field side like Building, well, Water kundi, electrical Line/Pole, Telephone pole, Underground pipe line, river roads survey nos. with their parts etc.

Revenue record relating to ROU strip will have to be compared with district land record office and statement be prepared by the agency.

The agency on completion of field work, shall prepare the detailed statement of all survey (field) number with ROU strip wise involved ,name of owner /owner's tenant's name of village, taluka, district as per 7/12.

Preparation of ROU notice on behalf of authority empowered to take ROU rights and also calculation of crop compensation based on APMS /Agriculture office rates.

Preparation of typical drawing for pipeline to be laid crossing like National Highway, Railway, Canal River etc.

Cross cheque of compensation are to be prepared and before issuing cross cheques, notice is to be served to concerned persons i.e. legal owner or occupier of the land as per concerned village revenue record and to maintain records thereof.

All correspondence to be prepared as per instruction of Engineer in-charge.

To prepare all relevant papers on behalf of GWSSB as per instruction of the Engineer- In-charge of project.

**Schedule B14-Project Supporting****Item No. 1:**

**Procurement of Electric Four-Wheeler Vehicle (EV) with all necessary accessories for site supervision work, Vehicle having minimum 200 mm ground clearance, battery pack capacity minimum 75 kWh, including certified driving range 550 km on a single 100% charging.**

All vehicles should be new and of the latest model.

Procurement of vehicle shall be done after approval from GWSSB.

After completion of the project, the vehicle must be handed over to the department in working condition, including replacement of new battery pack in the vehicle.

Provision of electric charging station [Charging facility infrastructure] for the vehicle shall be provided by contractor with no extra cost.

Driver of the vehicle is to be provided by contractor for the period up to completion of project or 24 months whichever is later. Accommodation for driver and all other allowances shall be made by the contractor. No extra payment shall be made for same.

This vehicle will be used by GWSSB staff for project supervision of the project anytime and anywhere.

Regularly maintenance [including battery replacement] of the Vehicle shall be done by contractor. No additional amount shall be paid.

The insurance shall be borne by the contractor till the completion of the project.

The other specifications shall be as per manufacturer's standard.

Vehicle shall be equipped with Level 2 ADAS (Advance Driver Assistance System) with Blind spot Detection / Blind spot Monitoring System.

Vehicle shall be equipped with Rear Cross Traffic Alert (RCTA).

Vehicle shall be capable of DC fast charging capability of minimum 120 kW.

**Item No. 2:****Desktop PC:**

**Processor: 13th Gen Intel® Core™ i7-1355U (10 cores, up to 5.0 GHz), Display: 27" FHD WVA, Non-Touch, Graphics: Intel® Iris® Xe Graphics, Memory: 16 GB DDR5 (5200 MT/s), Storage: 1 TB PCIe NVMe SSD, Design: Pearl White finish with molded speaker grill, triangle stand, Connectivity: Wi-Fi 6E, Bluetooth, multiple USB 3.2 ports, HDMI-in/out, RJ45, SD card slot, Extras: Microsoft Office Home 2024 + 1-year Microsoft 365 Basic, McAfee LiveSafe (1-year),**

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**Wireless Keyboard & Mouse, OS: Windows 11 Home, Power: 90W AC adapter – including all accessories complete.**

Procurement of computer shall be done after approval from Executive Engineer.

After completion of the project, desktop and printer should be handed over to the department in working condition.

All the desktop should be new and latest with extended warranty period.

All the desktop will be used by GWSSB staff for project purpose.

All the desktop shall be provided with all accessories like Wireless mouse, wireless key board, etc.

**Item No. 3:****Printer:**

**Multi-Function Direct Wireless Network Laser Printer having connector type App, Wi-Fi, USB, Ethernet, Network including compatible to connect with smartphones, PC, tablets etc. The printer shall have facility to Print (2 side print), Scan, Copy etc. including all accessories complete.**

Procurement of printer shall be done after approval from Executive Engineer.

After completion of the project, printer should be handed over to the department in working condition.

All the printer should be new and latest with extended warranty period.

All the printer will be used by GWSSB staff for project purpose.

All the printer shall be provided with all accessories like Power cord; Ink caution flyer; Setup guide; Reference guide; Regulatory flyers; Warranty flyers, etc.

**Schedule C- Operation & Maintence for 10 years**

For the details please refer the volume V – Operation & Maintence.

**Vendor List**

Latest Gujarat Water Supply and Sewerage Board (GWSSB) Approved Vendor List Shall Be Made Applicable. Can Be Downloaded From Below Given Web Address:

1. <https://watersupply.gujarat.gov.in/vendors/approved-vendor-list-171>(as on 06.04.2026)

Deputy Executive Engineer  
P.H.Sani.Sub.DN  
Bharuch

Executive Engineer  
P.H.Works. Division  
Bharuch