

CONTRACT NO.

**GUJARAT WATER INFRASTRUCTURE LIMITED
GANDHINAGAR**



Providing, supplying, lowering, laying, jointing, hydro-testing, and commissioning of Mild Steel (MS) pipeline, including all associated and allied works, for the onshore laying and offshore installation of the NC-9 bulk water pipeline including piling and encasing works in creek along the Surajbari Bridge, including all necessary crossings and structural supports at Maliya, Taluka Maliya, District Morbi.

**VOLUME – IIB
TECHNICAL SPECIFICATION CIVIL WORKS**

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SPECIFICATIONS

SECTION: 1 GENERAL AND MATERIAL

SECTION: 1

GENERAL AND MATERIAL

GENERAL

1.0 Employer's Drawings:

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:

- 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.
- Senior Manager: - Morbi, GWIL.
- Project name: - NC-9 MS Pipeline Works at Surajbari Bridge.
- 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.
- 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:

- 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.
- 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:

- The following shall be the procedure for submission and approval of drawings:
- The Contractor shall submit minimum 6 copies of the drawings to the Employer. All the drawings are to be signed by the Contractor or his authorized representatives.
- 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.
- 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 above and the same shall be repeated till the drawings are finally approved as per sub-clause above.
- If the submitted drawings/documents are not worth for review, the Contractor will be informed accordingly.
- On receipt of the approved drawings as per sub-clause above, the Contractor shall submit CD/Pen-Drive, Soft Copy and documents to the employer as and when demanded.
- After tests on completion, the Contractor shall submit, within 15 days of the conclusion of the tests, CDs/Pen-Drive, Soft Copy, Hard Copy of the "As Built Drawings" to the Employer.
- 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.
- No drawings, with corrections made after taking the prints, will be accepted.

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- 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:

- 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.
- The Contractor shall erect and maintain on the Site any temporary storage facility as required and approved by the Engineer.
- Multiple handling and movement of materials during storage and retrieval shall be avoided.

6.0 Spare Parts:

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

- Tools shall be delivered to site just prior to Tests on Completion.
- 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:**

- 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.

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- 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:

- 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.
- The Contractor may propose at no extra cost to the Employer, the use of any relevant authoritative internationally recognized Reference Standard.
- 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.
- 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:

- 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:

- Workmanship and general finish shall be of first-class quality and in accordance with best workshop practice.
- 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.
- 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:

- Welding shall comply with the latest revision of the BS 5135 Code.
- 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.
- 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.
- 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 place other than the welding, the area affected shall be ground flushed and examined by liquid penetration method.
- 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.
- 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.
- 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.
- 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.
- 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

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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.

- 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:

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

7.0 Electrodes:

- 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

- 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:

- 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.
- 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.
- Argon gas with purity 99.5% shall be used for shielding and purging. The purity of gas shall be certified by the gas manufacturers.
- Non-destructive examination of the welds shall be carried out to ensure quality of weld.
- 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:

- 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.
- 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:

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

12.0 Design Life:

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

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- Design shall be carried out as per following:
 - RCC footings: Limit state method of design
 - RCC columns: Limit state method of design
 - RCC beams and slabs: Limit state method of design
 - Retaining wall: Limit state method of design with limiting crack width of 0.2mm as per IS : 456-2000
 - Also provide the seismic design calculation of RCC Water retaining structures as per IS:1893 (Part – II, Draft Code).
 - Steel Structures: Limit state/Working Stress method of design.
 - RCC water retaining structure shall be designed as per Working Stress Method as per IS : 456-2000 and IS : 3370-2009.
 - Seismic Zone for Civil Structures as per IS 1893 : 2002
 - RCC structures shall be designed as per IS 456 and reinforcement details shall be done as per IS : 13920 (Ductile detailing).
- Foundation shall be designed to carry all the loads from equipment or super structure, which they support in accordance with the relevant codes.
 - Net safe bearing capacity of soil & Ground water table: As per geo-technical report
 - Type of foundation.
 - For buildings and structures: As per geo-technical report
 - Allowable increase in soil bearing capacity in event of storm(wind) 25%, Earthquake 25%, factor of safety as per IS 1904 against overturning 1.5, Sliding 1.5, and buoyancy 1.2.
 - As a general rule following features will be adopted, unless decided otherwise in a specific or exceptional case:
 - Top of footing will be horizontal and flat/Trapezoidal as case.
 - Minimum depth of foundation is considered as per latest geotechnical report for various locations of the proposed structure.
 - Foundation plinth for structural columns and equipment supports shall extend not less than 5 mm from the edge of base plate.
 - The clear distance between a standard mild-steel anchor bolt or anchor sleeve and the face of the foundation shall be not less than 75 mm.
 - Minimum thickness of lean concrete layer shall be 100 mm for building and 150 mm for water retaining structure, also extend 75 mm beyond the foundation edge.
 - For heavier loads and restricted settlements pile foundation may be considered as an alternative as per IS 2911.
 - Wherever columns are very near pedestals of footing are considered combined to take care of unbalance loading. Sufficient reinforcement is provided to take care of unbalancing load. Centre of footing and combined loading is match to nullify eccentricity in load.
 - Where stresses due to wind (or seismic) and temperature are combined with those due to other loads, the allowable stresses in concrete and reinforcement steel shall be increased by 33.33% in case of working stress design. However steels having definite yield stress, stress limited to yield stress, for steels without definite yield point, the stress will be limited to 80 percentage of ultimate strength or 0.2 percent proof stress whichever is smaller.
 - All building shall have a minimum 1.0 m wide, 100 mm thick plinth protection paving in M15 grade concrete or stone slabs/tiles. All plinth protection shall be supported on well compacted strata.
 - HFL of nearby dam & NGL shall be checked before finalizing the uplift pressure.
 - Contractor shall take HFL data from concerned authority & FGL shall be considered as 1.0 mt. above HFL.
 - If the compound wall is in contact with HFL/ FSL/ permanent water logged area than RCC compound wall shall be designed as Retaining wall.
- All underground or partly underground liquid containing structures shall be designed for the following conditions:
 - i. Liquid depth to be considered up to full height of wall and no relief due to soil pressure from the other side to be considered.
 - ii. RCC water retaining structures like storage tanks shall be leak proof and designed by working stress method. (Stress in steel limited to 130 N/mm²) or limit state method with limiting crack width 0.1 mm.

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- iii. Structure empty condition (i.e., empty of liquid, any material, etc.) : full earth pressure with saturation and surcharge pressure wherever applicable, to be considered.
 - iv. Partition wall between dry sump and wet sump: to be designed for full liquid depth up to full height of wall.
 - v. Partition wall between two compartments: to be designed as one compartment empty and the other full for both the directions.
 - vi. Structures shall be designed for uplift in empty conditions with no live load with the water table as per Geotechnical report or high flood level or rock level, whichever is maximum. If uplift pressure is more than 2000 Kg/m², use of pressure relief valves to reduce uplift pressure due to ground water table shall be allowed. In this case minimum thickness of raft shall with provision of under drainage arrangement (as per IS 4558) be kept as per below para viii.
 - vii. Walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads.
 - viii. Underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. A minimum factor of 1.2 shall be ensured against uplift or floatation and due to other loads shall be 1.5.
- The minimum clear cover to reinforcement in all R.C.C structures shall be as per IS: 456/IS: 3370 (Part –II), except as mentioned for following:
- The following minimum clear cover shall be provided for RCC (non-Water retaining) works.
- i. Slab (roof & floors, Canopies, Chajjas, lintels, waist slab in stair etc.) 25 mm
 - ii. Beams 40 mm
 - iii. Plinth beams 40 mm
 - iv. Columns, pedestals 40 mm
 - v. Dry pits / retaining walls
 - vi. Face in contact with earth 50 mm
 - vii. Free face 50 mm
 - viii. RCC Water / Liquid retaining structures
 - ix. Face in contact with liquid 50 mm
 - x. Away from liquid but in contact with earth 50 mm
 - xi. RCC Foundation
 - xii. Sides and top 50 mm
 - xiii. Bottom 60 mm

13.0 Name Plate:

- 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.
- 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.
- 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.
- 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.

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14.0 Nuts, Bolts, Studs and Washers:

- 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.
- 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.
- 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.
- 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, 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.
- 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:

- 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:

- 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.
- 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.
- 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:

- Steel and cast-iron parts shall be sand blasted to near white cleaning before painting. Edges, sharp corners 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:

- 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.

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- 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.
- 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 kg/cm². 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:

- 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
- 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:

- 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.

INSPECTION AND TESTING AT MANUFACTURER'S PREMISES

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/material for testing:

Equipment required for testing of all construction materials such as sieve analysis, cone for slump, concrete cubes casting and testing machine shall be available on site. All construction materials like sand, cement, aggregate etc. have to be tested on site in representative of engineer in-charge.

Testing of steel bars are to be installed at main H/W site or shall be tested in Government/NABL approved laboratory or as directed by engineer in-charge.

SECTION: 2 SURVEY & GEOTECHNICAL INVESTIGATION FOR DESIGN

Specifications for Minimum Investigations required for Project:**1.0 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.

2.0 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.

3.0 Survey work shall consist of the following:

- 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.
- 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 GWIL.

- 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.
- Detailed Longitudinal Section for each pipe shall be prepared and HGL marked on it for approval of GWIL. After marking of such data only, execution of pipeline shall be permitted.
- 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:

- 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, ϕ 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.

4.0 Specification for drilling, investigation, furnishing details of bore logs, laboratory testing and reporting:

- 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.
- 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.
- The disturbed samples shall be collected at every 1.5 Mt. Depth or at the points where the strata changes whichever is less.
- 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.
- 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.

- 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.
- 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.
- The rates quoted shall be inclusive for drilling in all kinds of strata including boulders, soft or hard rock.
- For every bore water level encountered shall be recorded together with variation in water level if during the period of boring.
- 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.
- 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.
- The disturbed samples are to be analyzed as per relevant clause of I.S. 2720 Part I to IV.
- 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.
- 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.

5.0 Specification for preparing and submitting the full technical report:

- 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.
- 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.
- 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.
- 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.
- 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.
- 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.

PERFORMA

PERFORMA 1																
Bore hole No.		Date of Start			Date of Completion			GTS Value			Revision no.					
Method	Casing	Bore dia (cm)	Core Recovery	Depth (m)	Thickness of layer (m)	Visual Soil Description	Penetration Test N-Value						Undisturbed Sample	Disturbed Sample	Remarks	

PERFORMA 2											
Borehole No		Date of Start		Date of Completion		Depth of Sample		Termination Depth		Revision No.	
Grain Size Analysis											
%Gravel	% Sand	Hydrometer		LL%	PL%	PI%					
		% Silt	% Clay								

PERFORMA 3: CHEMICAL ANALYSIS OF WATER				
Date of Collection:			Source:	
Date of Arrival at Lab:			Location:	
Lab Ref. No.:			Village:	
S. N.	Characteristics	Permissible Values as per IS 10500		Analytical value
		Desirable	Relaxation in absence of alternate source	
1	Color			
2	Odor			
3	Turbidity			
4	Dissolved solids			
5	pH			
6	Total hardness as CaCO ₃			
7	Calcium			
8	Magnesium			
9	Chloride			
10	Sulphate			
11	Nitrate			
12	Fluoride			
13	Manganese			
Signature:				
Date:				

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SECTION: 3 CONCRETE

SECTION -3: CONCRETE

1.0 Applicable Codes with latest revisions.

Materials :

- IS.269 Specification for 33 grade ordinary Portland cement.
- IS.455 Specification for Portland slag cement.
- IS.1489 Specification for Portland- Pozzolana cement (Part 1&2).
- IS:8112 Specification for 43 grade ordinary Portland cement.
- IS:12269 Specification for 53 grade ordinary Portland cement.
- IS:12330 Specification for sulphate resisting 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) wires for concrete reinforcement. (Part 1 and 2)
- IS:1786 Specification for high strength deformed steel bars and wires for Concrete reinforcement.
- IS:1566 Specification for hard-drawn steel wire fabric for concrete Reinforcement.
- IS:9103 Specification for admixtures for concrete.
- IS:2645 Specification for integral cement water- proofing compounds.
- IS:4990 Specification for plywood for concrete shuttering work.

2.0 Material Testing:

- IS.4031 Methods of physical tests for hydraulic cement (Parts 1 to 15)
- IS:4032 Method chemical analysis of hydraulic cement.
- IS:650 Specification for standard sand for testing of cement.
- IS:2430 Methods for sampling of aggregates for concrete.
- IS: 2386 Methods of test for aggregates for concrete (Parts 1 TO 9)
- IS:3025 Methods of sampling and test (physical and chemical) for water used in industry.
- IS:6925 Methods of test for determination of water-soluble chlorides in Concrete admixtures.

3.0 Material Storage:

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

4.0 Concrete Mix Design:

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

5.0 Concrete Testing:

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

6.0 Equipment:

- IS:1791 Specification for batch type concrete mixers.
- IS:2438 Specification for roller pan mixer.
- IS:4925 Specification for concrete batching and mixing plant.
- IS:5892 Specification for concrete transit mixer and agitator.
- IS:7242 Specification for concrete spreaders.

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- IS:2505 General Requirements for concrete vibrators: Immersion type.
- IS:2506 General Requirements for screed board concrete vibrators.
- IS:2514 Specification for concrete vibrating tables.
- IS:3366 Specification for pan vibrators.
- IS:4656 Specification for form vibrators for concrete.
- IS:11993 Code of practice for use of screed board concrete vibrators.
- IS:7251 Specification for concrete finishers.
- IS:2722 Specification for portable swing weigh batchers for concrete (Single and double bucket type).
- IS:2750 Specification for steel scaffoldings.

7.0 Codes of Practice:

- IS:456 Code of practice for plain and reinforced concrete.
- IS:457 Code of practice for general construction of plain and reinforced Concrete for dams and other massive structures.
- IS:3370 Code of practice for concrete structure for storage of liquids (Part 1 to 4).
- IS:3935 Code of practice for composite construction.
- IS:2204 Code of practice for construction of reinforced concrete shell roof.
- IS:2210 Criteria for the design of reinforced concrete shell structures and Folded Plates.
- IS:2502 Code of practice for bending and fixing of bars for concrete Reinforcement.
- IS:5525 Recommendation for detailing of reinforcement in reinforced Concrete works.
- IS:2751 Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
- IS:9417 Specification for welding cold worked bars for reinforced concrete construction.
- IS:3558 Code of practice for use of immersion vibrators for consolidating concrete.
- IS:3414 Code of practice for design and installation of joints in buildings.
- IS:4326 Code of practice for earthquake resistant design and construction of building.
- IS:4014 Code of practice for steel tubular scaffolding (Parts 1 & 2)
- IS:2571 Code of practice for laying in situ cement concrete flooring.
- IS:7861 Code of practice for extreme weather concreting: Part 1 Recommended practice for hot weather concreting.

8.0 Construction Safety:

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

9.0 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.

10.0 Materials:**Cement:**

- Unless otherwise called for by the Engineer in charge, cement shall be ordinary Portland cement conforming to IS: 12269. However, in any case, cement grade shall not be lower than 53 grades.
- Fresh quality cement shall be procured only from approved manufacturer /Supplier and shall be subject to prior approval of the Engineer-in-charge.
- All cement used for the work shall ordinary Portland cement of 53 grade only. Ordinary Portland Cement shall comply with the requirements of the latest version of IS: 12269.
- 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.
- 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.
- The white cement shall conform to I.S. 8042-1978.

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.

Stone Grit:

Grit shall be consist of machined crushed stone and shall be hard, strong, tough, dense, durable, clean, of proper gradation and free from skin or coating likely to prevent proper adhesion of mortar. Grit shall generally be cubical in shape and as far as possible flaky elongated pieces shall be avoided. It shall generally comply with the provisions of I.S. 383-1970. Grit shall be obtained from the best black trap. The grit shall have no deleterious reaction with cement.

The grit shall conform to the following gradation as per sieve analysis:

Sr No	% by weight passing sieve	I.S. Sieve Designation	% by weight passing sieve
12.50 mm	100	4.75 mm	0 - 20
10.00 mm	85-100	2.36 mm	0 - 5

Sand:

Sand shall consist of natural sand, crushed stone sand or crushed gravel sand or combination of any of these. The sand shall be clean, well graded, strong, durable and gritty particles free from injurious amounts of dust, clay, kankar nodules, soft or flaky particles, shale, alkali, salts, organic matter, loam, mica or other deleterious substances and shall be got approved from the Engineer-in-charge. The sand shall not contain more than 3% of silt as determined by field tests. If necessary the sand shall be washed to make it clean.

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- FM of sand used for different work:

Sr No	Type of Work	IS Code	FM Range
1	For Cement concrete	IS 383 zone-I & II	2.11 to 4.0
2	For Masonry	IS 2116, Table:1	1.15 to 2.95
3	For plaster	IS 1542	1.20 to 2.20
4	For sand bedding below pipe	IS 383 zone-I & II	2.11 to 4.00

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.
- Water shall not be salty or brackish and shall be clean, reasonably clear and free from objectionable quantities of silt and traces of oil and injurious alkalis, salts, organic matter and other deleterious material, which will either weaken the mortar or concrete or cause efflorescence or attack the steel in R.C.C. Container for transport, storage and handling of water shall be clean.
- Water for curing mortar, concrete or masonry should not be too acidic or too alkaline. It shall be free of elements, which significantly affect the hydration reaction or otherwise interfere with the hardening of mortar or concrete during curing or those which produce objectionable stains or other unsightly deposits on concrete or mortar surfaces.
- Hard and bitter water shall not be used for curing.
- Potable water shall generally be found suitable for curing mortar or concrete.
- Permissible Limit for Solids

	Tested as per	Permissible Limit Max.
Organic	IS: 3025	200 mg/lit
Inorganic	IS: 3025	3000 mg/lit
Sulphate (as SO ₃)	IS: 3025	400 mg/lit
Chlorides (as Cl)	IS: 3025	2000 mg/lit for concrete work not containing embedded steel and 500 mg/lit for pre-stressed /reinforced concrete work.
Suspended Matter	IS: 3025	2000 mg/lit

Reinforcement:

- All reinforcement steel shall be CRS-FE-500 steel conforming to relevant I.S. for all RCC structure with 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.

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. When calcium chloride is permitted such as in mass concrete works, it shall be dissolved in water and added to the mixing water by

an amount not exceeding 1.5 percent of the weight of the cement in each batch of concrete. The designed concrete mix shall be corrected accordingly.

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.

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.

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.

11.0 Concrete:

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/mm² 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 RCC U/G Sump, Pump house, water channel etc.)

12.0 Design Mix Concrete:

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

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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 ³ 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	Slump in millimeters	
	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

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- Characteristic Compressive Strength Compliance Requirement (Table 11: IS 456).

13.0 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 at his own cost to have the cubes tested in an Government/NABL approved laboratory or in field with prior consent of the Engineer in charge. Prior to start the work as per approved Mix Design, the cubes shall be casted at site and it shall be sent to “GERI” for testing, confirmation and to compare the test results for 7 and 28 days with the approved Mix Design. Concrete work can be started after approval of testing results from GERI for 7 and 28 days. At least 10% of tests shall be carried out in Government engineering college or in the GERI. Sampling and testing of strength and workability of concrete shall be as per IS:1199, IS:516 and IS:456, IS 3370.

14.0 Nominal Mix Concrete**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.

15.0 Batching & Mixing of Concrete:

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

16.0 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:

- 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.
- Formwork shall be made of suitable materials as directed by engineer in-charge.
- Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.
- 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.
- Capable of easy striking out without shock, disturbance or damage to the concrete.

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- Soffit forms capable of imparting a camber if required.
- Soffit forms and supports capable of being left in position if required.
- 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.
- 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:

- Development of adequate concrete strength.
- Permissible deflection at time of striking form work.

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- Curing procedure employed - its efficiency and effectiveness.
- Subsequent surface treatment to be done;
- Prevention of thermal cracking at re-entrant angles;
- Ambient temperatures; and
- 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.

17.0 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.

18.0 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

19.0 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.

20.0 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:

- Continuously between construction joints and pre-determined abutments.
- Without disturbance to forms or reinforcement.
- 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.
- Without dropping in a manner that could cause segregation or shock.
- In deep pours only when the concrete and formwork designed for this purpose and by using suitable chutes or pipes.
- Do not place if the workability is such that full compaction cannot be achieved.
- 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.
- If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.
- Ensure that there is no damage or displacement to sheet membranes.
- 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.

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- 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.

21.0 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.
- At the time of placing concrete, thickness of layer shall not be more than 450 mm for vibrated concrete per layer and limiting height of concrete shall be applicable as per IS 457, clause 4.10.7 for particular component.

22.0 Curing:

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

- Premature drying out, particularly by solar radiation and wind;
- Leaching out by rain and flowing water;
- Rapid cooling during the first few days after placing;
- High internal thermal gradients;
- Low temperature or frost;
- 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.

23.0 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.**

24.0 Foundation Bedding:

- 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.

25.0 Finishes:**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.

26.0 Repair and Replacement of Unsatisfactory Concrete:

- Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces, rough patches, 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.

27.0 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.

28.0 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.
- Where directed by the Engineer in charge, the Contractor shall spray non-wax based curing compound on unformed concrete surfaces at no extra costs.

29.0 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.

30.0 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, gunniting 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.

Placing Concrete Underwater:

- Under all ordinary conditions all foundations shall be completely dewatered and concrete placed in the dry. However, when concrete placement under water is necessary, all work shall conform to IS:456 and the procedure shall be as described in the following paragraphs:
- Concrete shall be deposited underwater by means of tremies, or drop bottom buckets of approved type.
- All work requiring placement of concrete underwater shall be designed, directed and inspected with due regard to local circumstances and purposes. All underwater concrete shall be placed according to the plans or Specifications and as directed and approved by Engineer In-charge.

31.0 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.

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.

32.0 Grouting:**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
2. General mix	25mm and over but less than 50mm	One-part Portland Cement to 2 parts of sand	0.53
3. Stiff mix	50mm and over	One-part Portland Cement to 3 parts of sand	0.53

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.
- Properties of constituent materials;
- Characteristic compressive strength;
- Specified mix proportions;
- Minimum cement content;
- Maximum free-water/cement ratio;
- Workability;
- Temperature of fresh concrete;
- Density of fully compacted concrete;
- Cover to embedded steel;
- Curing;
- Tolerances in dimensions;
- Tolerances in levels;
- Durability;
- Surface finishes;
- Special requirements such as;

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- Water tightness
- Resistance to aggressive chemicals
- Resistance to freezing and thawing
- Very high strength
- Improved fire resistance
- Wear resistance
- 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.

33.0 Water stops:**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 ² minimum
c)	Ultimate elongation	:	300 % minimum
d)	Tear resistance	:	4.9 N/mm ² minimum
e)	Stiffness in flexure	:	2.46 N/mm ² minimum
f)	Accelerated extraction		
g)	Tensile strength	:	10.50 N/mm ² 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.

34.0 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

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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 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.

35.0 Preformed Fillers and Joint Sealing Compound:

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.

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/m². 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/m².
- 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.

Notes:

- Each pour to have separate cards, in triplicate one each for client, contractor & site office.
- Under remarks, indicate deviations from drawings. & 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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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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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

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IS:2074	-	Ready mixed paint, air drying, red oxide- zinc chrome, priming
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

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| IS:9197 | - | Specification for epoxy resin, hardeners and epoxy resin composites for floor topping |
| 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 ± 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 tested from approved laboratory and 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 GWIL for approval and bricks supplied shall conform to approved samples. If demanded by GWIL, brick samples shall be got tested as per IS: 3495 by Contractor. Bricks rejected by GWIL 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 GWIL. If so directed by the GWIL, 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 GWIL. 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 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 GWIL.

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 hrs 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 GWIL. 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 x 115mm x 75mm, 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.

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- 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.

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 GWIL 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 above.

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

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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 sqm 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.

Coursed Rubble Masonry (First Sort) for Superstructure:

Materials:

The Material specification for the work shall be as specified above.

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 1/3rd 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.

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- 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.

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 ± 5 mm and maximum variation in height or width of the units shall not be more than ± 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 GWIL.

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.

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- 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 above.
- 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 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, solid 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 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 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

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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, of 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 GWIL.
- 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.

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- 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 ± 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 GWIL.
- 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 GWIL. 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.

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- 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. 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 GWIL 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 skills 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/distorting. 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.

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- 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 $\pm 1.5\text{mm}$. 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 GWIL 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

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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 m², gear operated type (mechanical) for clear areas up to 35 m² and electrically operated type for areas up to 50 sqm. 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 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 specified in specifications or as per engineer in charge direction.
- 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/m².
- 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 ± 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.

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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 14N/mm².
- 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.

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- 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 m² 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.
- 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 ± 3 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 mentioned above.
- 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 center 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 m² 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/m². 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.

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- 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 $\pm 5\text{mm}$. This shall be $\pm 2\text{mm}$ 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:

- 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 mentioned above.
- Dado / skirting work shall be as per mentioned above. 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 mentioned above, 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/mm².
- 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/sqm 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 as mentioned above 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.

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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 m² 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 mentioned above. The surface shall be rough to provide adequate bond for the topping.

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- Mixing of concrete shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the GWIL. 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/m² 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 Troweling 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 mentioned above 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.

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- 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. 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 GWIL.
- 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.

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- 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.
- 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.

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- 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 GWIL.

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 GWIL.

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/sqm) 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 down take 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.

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- 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 GWIL.
- By mixing about 3 Kg of Jaggery and 1.5 Kg of BAEL fruit to 100 liters of water.
- 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 sqm 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 GWIL, 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 anti-glow 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.

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 GWIL. If so desired by the GWIL 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 sill faces etc. as shown in the drawing and as directed by the GWIL.

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 GWIL 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 GWIL.
- 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.
- 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.

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- 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 GWIL 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 GWIL.

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 GWIL.

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 GWIL.
- All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the GWIL 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 GWIL regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting. Painting of new

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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/m². 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 GWIL 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 GWIL. 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

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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 GWIL. When two coats of varnish are specified, the first coat should be a hard-drying undercoat or flattening 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 GWIL 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 GWIL.

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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 gm/sqm.
- 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/m² 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/m².
- 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 timber 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 GWIL.

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- 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 sqm. 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 GWIL. 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 GWIL.

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:

- The false ceiling grid work shall be carried out as per the approved drawings or as directed by GWIL. 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

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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 GWIL.

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 GWIL. 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).

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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/cum 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./sqm/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 m² 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

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for the supporting system with all relevant data assumed, to the GWIL 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 confirm 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 46mm 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.

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)

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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:

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

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

Steel Grade	Condition/Application
Fe 310-0 (St 32-0)	For general purposes such as door/window frames, grills, steel gates, handrails, fence posts, tee bars, and other non-structural use.
Fe 410-0 (St 42-0)	For structures not subjected to dynamic loading other than wind loads such as platform roofs, foot over bridges, buildings, factory sheds etc.
Fe 510-0 (St 42-0)	Grade steel shall not be used a) If welding is to be employed for fabrication b) If site is in severe earthquake zone c) 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

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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.
- 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.
- No welding shall be done on base metal at a temperature below –50 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

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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.
- 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.
- 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

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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

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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:

- Welding of stiffening angles/vertical stiffening ribs Cutting to size and making holes to required shape wherever necessary to allow service piping and/or cables to pass through Splicing as shown in relevant drawings.
- Smoothing of edges
- Fixing of chequered plates by tack welding or by countersunk bolts
- 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.

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Columns:

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 ± 5 mm.

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 $\pm 1/1000$ of column height in mm or ± 15 mm whichever is less
 (b) For columns exceeding $\pm 1/1000$ of column height in mm or ± 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 ± 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 ± 10 mm

Width of building prior to connecting trusses/beams with respect to true distance ± 10 mm

Deviation in any bearing or seating level with respect to true level ± 5 mm

Deviation in differences in bearing level of a member on adjacent pair of columns both across and along the building ± 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 ± 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 ± 15 mm whichever is less

Lateral shift in location of truss from its true vertical position ± 10 mm

Lateral shift in location of purlin true position ± 5 mm

Deviation in difference of bearing levels of trusses or beams from

1. ± 20 mm for trusses
2. For beams: the true difference

Depth < 1800mm: ± 6 mm

Depth > 1800mm: ± 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 ± 5 mm

Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point ± 1 mm

Difference in alignment of crane rail in plan measured between any two points 2 meters apart ± 1 mm

Deviation in crane track with respect to true gauge

For track gauges up to and Including 15 meters ± 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 real level at any point from true level $\pm 1/1200$ of the gauge distance or ± 10 mm whichever is less

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Difference in the crane rail actual levels between any two points 2 meters apart along the rail length	±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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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
- 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

- 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 cm². 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.
- 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:

- 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
- 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 give 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

Spigot and Socket Joint (Bituminous Joint):

- The general requirements for this type of joint shall be as specified in 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 molds.

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, 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.

Top concrete:

- Precast reinforced concrete slab shall be casted on top of chambers in pieces as directed.

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 center to center. 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 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.

Bridge

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 1m³ or 0.25m³ 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 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.

- xii) 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.
- xiii) 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:

- 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 rammed 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 15 cm, 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 in above and elsewhere unless otherwise indicated below.
- 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 above, 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 cm 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.

Field 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.

- The contractor shall arrange for necessary temporary works/ diversion works / coffer dam at his own cost enabling excavation where pipe crosses river/nallah.

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 PILE WORKS SPECIFICATIONS

SECTION – 8: PILE WORKS SPECIFICATIONS

1. SCOPE

This specification covers the technical requirements for setting and layout, supply of materials and installation of bored cast in situ concrete piles, concrete pouring and compaction, pile cut-off, pile testing and extraction of test piles and associated earthwork.

In case of defective work on quality of pile shaft or failure of load test, Contractor shall be responsible for doing remedies for the same without any additional cost.

All work required for successful completion of the contract in professional manner should be carried out by the Contractor according to standards and codes of practice or best engineering practice and Contractor's Quality Assurance- Quality Control plan as approved by Engineer in Charge.

Contractor should fully acquaint himself with work scope and site data and information provided by Owner prior to bid submission. No claim on account of change in actual conditions will be entertained.

Contractor should keep work area clean and dry and provide clear access to work areas. Removal of overground or underground obstructions and remediation of the ground.

1.1. APPLICABLE CODES AND SPECIFICATIONS

The pertinent clauses of the following minimum listed Indian Codes, Standards and Specification and reference standards indicated therein should apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification should govern.

The codes and standards mentioned herein should be latest as on the day of award of contract of the works unless otherwise specified.

IS 2911: part 1: Sec 2	Design and construction of pile--foundations -code of practice part 1 concrete piles--section 2 bored cast in- situ concrete piles
IS 2911: part 4	Design and Construction of Pile foundations – Code of Practice: Part 4 Load Test on piles
IS 2131	Method of Standard Penetration Test for Soils
IS 456	Plain and reinforced concrete - code of practice
IS 269	Ordinary Portland cement - specification (sixth revision)
IS 383: 2016	Coarse and fine aggregate for concrete - specification (third revision)
IS 2386	Methods of Test for Aggregates for Concrete – Part 1 to Part 8
IS 432	Specification for Mild Steel and Medium Tensile Steel Bars and Hand Drawn Steel Wire for Concrete Reinforcement – Part 1 and 2
IS 1786	High strength deformed steel bars and wires for concrete reinforcement - specification
IS 3764	Code of safety for excavation work
IS 1200: part 23	Method of measurement of building and civil engineering works: part 23 piling
IS 8041	Specification for rapid hardening portland cement
IS 455	Portland Slag Cement – Specification (FIFTH REVISION)
IS 12600	Specification for Low Heat Portland Cement
IS 12330	Specification for Sulphate Resisting Portland Cement
IS 5121	Piling and other deep foundations - code of safety
IS 7293	Safety Code for Working with Construction Machinery
IRC 78:2014 Section VII	Foundations and substructures

2. GEOTECHNICAL INVESTIGATIONS

The available geotechnical investigation report needs to be provided for reference and study to the CONTRACTOR. Further, ground water level in boreholes to be properly accounted for planning of piling work.

3. TYPE OF PILES

This specification covers bored cast-in-situ concrete piles of circular cross-section only.

The inner diameter of temporary casing or permanent liner to achieve nominal diameter of the cast concrete pile shaft. Detrimental material encountered in pile bore should be removed before placement of reinforcement and concrete.

4. SETTING OUT

The CONTRACTOR will be furnished with one reference benchmark and with two mutually perpendicular reference axes. Based on these, the CONTRACTOR should establish and maintain in good working condition minimum four (4) "Mother Pillars" for marking the co-ordinates and levels for the entire works at no additional cost. The CONTRACTOR should locate accurately the position of piles, temporary casings or permanent liners and install stakes as required. These should be confirmed with the pile coordinates from the drawing by the Engineer in Charge. Defective work due to erroneous layout should be made good to the satisfaction of the Engineer in Charge.

5. CONTINUITY OF CONSTRUCTION

Temporary stoppage of work is permitted only during boring. However, no halt/stoppage to be permitted during activities of boring or chiseling to the final portion of the length of the pile, followed by subsequent activities of flushing, lowering of reinforcement cage, lowering of tremie, pre-concrete flushing and up to concreting. Stoppage of work during concreting through contractor's act of commission or emission will result in abandoning of pile. The contractor will bear cost of remedial measures to be adopted.

6. MATERIALS

6.1. CONCRETE

6.1.1.General

All concrete work should conform to the stipulations stated herein. All aspects of concrete work including material specifications, preliminary mix designs, workability, inspection, testing, etc. should be as specified in subsequent sections.

All concrete for both piles should be produced only by weigh-batching based on the ingredients as specified and approved mix design.

6.1.2.TEMPORARY STEEL GUIDE CASINGS

Temporary steel guide casings for bored cast-in-situ concrete piles should have an internal diameter equal to the nominal diameter of the pile. The thickness of the guide casing should be of adequate strength to withstand driving without damage. Length of each casing component should be maximum possible. Joints should be welded, lock seamed or screwed. Temporary casings of length exceeding 5m below working ground level should not be used for forming the pile bores.

Guide casings should be free from any distortion and buckling and of uniform cross-section throughout. The inside of the guide casings should be free from projections and encrusted concrete.

6.2. PERMANENT LINERS

Permanent mild steel liners only should be used for bored cast-in-situ concrete piles where specified. The inner diameter of permanent liners should correspond to the specified nominal diameter of the pile. Thickness of the liner should be at least as specified, or more if required to withstand handling,

driving, etc. without any damage, denting, distortion or buckling and approved by Engineer in Charge. Liners which are damaged, distorted, dented or buckled in any manner should not be used.

The inside surface of the liners should be clean and free of any loose scales, rust, soil, debris, encrusted concrete or any projections.

Liner joints should be welded with matching vertical lines and no eccentricity.

Where specified, the outer surface of the permanent liner should be coated or treated accordingly.

6.3. DRILLING FLUID

6.3.1. Bentonite

Bentonite is an ultrafine natural clay whose principal mineral constituent is sodium cation montmorillonite. Bentonite Suspension (Bentonite Slurry) is a colloidal mixture of bentonite and water. The action of bentonite in stabilizing the sides of bore holes is primarily due to thixotropic property of bentonite.

Bentonite powder and bentonite suspension fluid should conform to requirements specified in IS:2911 (Part 1/Sec.2) Annexure D. Each consignment should carry manufacturer's test certificate and each batch, and the suspension made from it should be tested and approved by the Engineer in Charge.

Bentonite slurry should be prepared and stored in adequately sized tank. The temperature of bentonite fluid should be maintained below 50°C, pH range between 9.5 to 11.5 and liquid limit and Marsh velocity tested in accordance with IS 2720 (Part 5). The suspension should be tested regularly as per agreed sampling procedure.

Bentonite suspension should be handled in a closed system with appropriate tanks / ponds to avoid unnecessary loss of bentonite suspension and / or unnecessary mixing of bentonite suspension with soil. Two tanks are required; one is a bentonite mixing tank and the other is a settling tank.

If the density of the bentonite suspension does not conform to the standards, preferably the excess solids should be removed from the bentonite suspension (settlement ponds and slurry recycling) or the bentonite suspension should be replaced with fresh one.

Bentonite suspension designated to not be used again must be prevented from entering open water ways at site. It should be kept in appropriate tanks / ponds for intermediate storage. The bentonite slurry should be allowed to dewater (evaporation). Bentonite on drying shrinks to its original volume, therefore, reducing the volume of slurry to be disposed. The dewatered bentonite slurry together with any earth materials which has become mixed up with bentonite suspension (inert material) should be taken off site in suitable tipper trucks and disposed of.

A suitable bentonite slurry mixing, and recirculation plant should be designed and installed at site. The recirculation should be carried out in safe and non-hazardous manner which will not pose any environmental problems.

After the end of piling works, disposal of bentonite should be away from the site in a safe and non-hazardous manner as instructed by Engineer in Charge at site or Contractor should reuse the same for other projects.

6.3.2. Polymer Fluids

As an alternate to bentonite, polymer drilling fluid may be used for borehole stabilization. Synthetic polymers used shall be hydrocarbon-derived family partially hydrolyzed polyacrylamide (PHPA) polymer, also simply referred to as polyacrylamides (PAM) or engineered polymeric materials that involve combinations of acrylamide molecules with other chemicals to form new molecules whose properties are designed to optimize their performance as drilling slurries. High molecular weight PHPA's are preferred for use in bored pile construction.

PHPA/ PAM slurries are especially sensitive to the presence of free calcium and magnesium in the mixing water or groundwater. The total hardness of the slurry mixing water shall be reduced to a value in the range of 50 parts per million or less (varies with the specific product used) unless the polymer has been modified chemically to remain stable in high-hardness conditions. PHPA/ PAM slurries are not effective in water having chloride content greater than about 1500 parts per million. And shall not be used in presence of sea/ brackish water.

Slurry mixing procedures with PHPA shall be according to manufacturer's recommendations. High-shear mixing of polymers that result in "chopping" of the long-chain molecules rendering the slurry ineffective shall be avoided. Emulsified PHPA products can be mixed by circulating between tanks or inline mixing. Polymer slurries cannot be cleaned like mineral bentonite slurry by reverse circulation. In boreholes in sandy soil, the polymer fluid shall be allowed to stand till the sand particles stabilize to less than 1% by volume. After lifting out the sediments at bottom of borehole by bucket, the slurry recovered by rising column of fluid concrete shall be stored to allow particles to settle out and can be reused after testing. In presence of soils with high silt content fresh slurry shall be used in each bore unless special agglomerates are used for settling out the silt and the slurry tested to meet the required properties.

The properties of polymer slurries shall meet the following standards from AASHTO:

Slurry property	Units	Value	Test Method (API 13B-1)
Density	kg/m ³	≤ 1025	Mud weight density balance
Viscosity	quart/sec	32 - 135	Marsh funnel and cup
	m ³ /sec	0.03 – 0.13	
pH		8 – 11.5	pH meter, pH paper strips
Sand content before concrete placement	% vol.	≤ 1.0	Sand content

7. PILE BORING

7.1. FORMATION OF PILE BORES

Pile bores should be executed by any of the following methods:

- Using the Direct Mud Circulation or Reverse Mud Circulation Methods with bentonite slurry as drilling mud and appropriate equipment.
- Using percussion type of drilling and bentonite slurry to stabilize the hole.
- Using permanent rigid liners of steel or any other material approved by the Engineer in Charge and boring through the liners.
- Using Hydraulic Rotary Drilling Method.

Boring method to be adopted should be agreed between Contractor and Engineer in Charge. Bores should be cylindrical without overcutting. Water cavities should not form behinds temporary casings. Boring should be avoided within 48 hours of concrete casting of a pile within a zone five times the pile diameter. Piling sequence may be governed by construction schedule of structures.

7.2. BORE LOGS AND EXTRACTED MATERIAL SAMPLES

7.3. A complete log of the subsurface profile during execution of boring for every pile shaft should be submitted to Owner for approval prior to concrete work. Soil or rock cuttings taken at every 0.5m to 1m depth intervals and preserved as labelled samples. DIRECT MUD CIRCULATION METHOD

In this method, bentonite slurry is pumped through API specification compliant chisel rods and flows out of ports under high pressure. The slurry and cutting rise to surface and collect in a settling tank from where the cleaned slurry is recirculated. Contractor should also include cost of site clearing, dressing, rig setting and shifting in his quoted rates.

7.4. REVERSE MUD CIRCULATION METHOD

Reverse Mud Circulation Method should be adopted only where adequately strong strata is encountered and approved by the Engineer in Charge. In this method the bentonite slurry should be sucked through the chisel instead of being pumped through it.

7.5. BAILER BORING USING BENTONITE SLURRY

In this process all boring should be done by flap valve bailer or flap valve bailer and chisel up to the founding stratum. Fresh bentonite slurry is added in the casing to keep the guide cage always filled with slurry. Other specifications for Direct Mud Circulation Method should apply to Bailer Boring also.

7.6. BORING WITH HYDRAULIC ROTARY RIG

In this process, boring is carried out by using Hydraulic Rotary Rigs. Fresh bentonite slurry is added through flexible pipes to keep the guide casing always filled.

7.6.1. Boring Tools

(a) Size and Diameter of Tools:

For new tools (auger, bucket, chisel) diameter should not be less by more than 25mm of pile nominal bore; tools should not be used when this tolerance exceeds 50mm.

(b) Types of Tools

- I. Boring in Clay/ Sand or Silty Clay, Highly Weathered Rock/ Murrum: Soil Auger with teeth.
- II. Boring in Coarse Sand, Non-Cohesive Soil: Tapered soil bucket (1 H to 10-20 V) should be used to minimize suction or alternate use of auger and suction bucket.
- III. Boring in Weathered Rock and Rock
 - Rock auger with 32mm spikes/ bits/ billets or bucket with spikes in harder strata.
 - Percussion drilling in hard rock, initially with 100~150mm diameter boreholes spaced at 20 to 25 cm, chiseling and boring by rock auger or bucket.

(c) Torque

- i. For weathered rock with $N > 200$, boring should be carried out by using 18 tm torque machine.
- ii. For rock with $N > 300$, boring should be carried out by using 28 tm torque machine.

7.7. BORING FOR PILES WITH PERMANENT LINERS

The permanent liners should be installed with flap-valve bailer boring simultaneously as the boring for the pile progresses. The liner should be driven ahead of boring or kept 300mm above bottom where SPT is to be conducted.

7.8. LOSS OF DRILLING MUD WHILE BORING

In the event of a rapid loss of drilling mud in a pile bore, the CONTRACTOR should immediately draw the attention of the Engineer in Charge and take necessary action as approved by the Engineer in Charge.

7.9. FINAL POST-BORE FLUSHING AND CLEANING

On completion of the total length of the pile bore, the bore should be thoroughly cleaned and flushed as specified in section 8.3 of IS 2911 Part 1 Sec 2.

7.10. BOREHOLE INSPECTION

On completion of the total length of the pile bore, the bore shall be inspected, if desired by Engineer in Charge, using a downhole shaft inspection device.

8. PLACEMENT OF REINFORCEMENT CAGE

Immediately after successful completion of final post-bore flushing and cleaning, the reinforcement cage should be lowered into the pile bore. All care should be taken during transporting, lifting, and lowering of the cage that the cage does not twist or distort out of alignment. Reinforcement cage should be carefully lifted and lowered vertically without force into the pile bore without causing twist or distortion. Jointing of sections where required should be done outside the bore maintaining vertical alignment of bars. Reinforcement extended beyond pile bore into the pile cap should not be bent more than 5 degrees to vertical keeping design cover to concrete inside bore unaltered.

9. FINAL PRE-CONCRETING FLUSHING

The procedure for flushing should be the same as that indicated in Clause 7.9 above to ensure complete removal of bentonite suspension from bottom of bore. Flushing should be continued till the density of the suspension sampled from the pile bore bottom does not exceed 1.2 gm/ cm^3 .

10. PILE CONCRETING

10.1. GENERAL

Concreting of pile bores should be executed only through a tremie system or concrete pump over the entire length of the pile in accordance with section 8.4 of IS 2911 Part 1/ Sec 2.

10.2. DESIGN MIX CONCRETE

The concrete mix should be designed as per IS 456.

10.3. READY MIXED CONCRETE

All specification as per IS: 4926 – “Specification for Ready Mixed Concrete”

10.4. TREMIE CONCRETING SYSTEM

Tremie pipe concreting should be done as per Clause 14.2.4 of IS:456 and Clause 8.4 of IS:2911 (Part 1/ Sec.2).

10.5. LIFTING OF TEMPORARY CASING

The temporary casing should be carefully withdrawn only after the concrete surface in the pile bore has risen to not less than two meters above the bottom of the casing or not less than one meter above the level of ground water whichever is higher. The casing should be lifted only to the extent that there is minimum one meter of concrete above the casing bottom. Adequate precautions should be exercised to ensure that reinforcement cage, or concrete is not lifted and that no necking or wasting occurs in the pile shaft.

10.6. COMPLETION OF CONCRETING

Irrespective of the specified pile cut-off level, concrete should be poured into the pile bore until all the contaminated concrete at the top of the bore overflows the top of the pile bore and neat concrete appears continuously as overflow. Concreting should then be terminated after permission of the Engineer in Charge.

As per IS 2911 Part-1 Sec-2 Clause 8.4.4 wherever cut-off level is less than 2.5 m below the ground level, concrete shall be cast to a minimum of 600 mm above cut-off level. For each additional 0.3 m increase in cut-off level below the working level, additional coverage of minimum 50 mm shall be allowed.

The actual concrete quantity poured shall be more than the required quantity in range of 0.3-0.5 cum for most piles.

To ensure that proper amount of concrete is used in the piling process we must ensure that pile bore depth is adequate and it is ensured by:

- Digital display in the rigs
- By means of chainage once boring is terminated.

- By means of Reinforcement cage after flushing.
- By means of Tremie length after insertion of Reinforcement of Cage.

After placement of concrete, top level of concrete shall be checked with respect to ground level. This will ensure that pile length has been correctly installed. This would ensure that proper amount of concrete has been used. The concreting work of pile should be recorded in the format given below:

Sr. No.	Pile Dia. (m)	Pile I.D.	Pile casting Date	EGL	Pile cutoff level	Termination level from EGL (m)	Toe level	Concrete and steel (rm) (m)	Theoretical quantity	Actual quantity (As per borelog)	Diff.	Excess pile height required due excess concrete	Req. top level	Present concrete top level	Excess concrete above cutoff over and above 1m over cast	Length of pile required below cutoff as per pile data	Suspected actual length of pile below cutoff level
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	

11. PILE CUT-OFF AND EXTENSION

Pile cut-offs and excavation for safe working area should be done by the CONTRACTOR with adequate side slopes/ shoring.

All pile cut-offs to specified levels should be done using percussion tools or specified devised methods. Any cracked or defective concrete should be cut away and the pile repaired in an approved manner to provide a full and sound section at the cut-off level. Minimum chipping of the pile should be 600mm or till sound concrete is met with or specified cut off level, whichever is greater. If the specified cut-off level is less than 600mm below the ground level (which, is the concrete overflow level after all temporary casings are withdrawn) or if the cut-off level is above the ground level, the concrete shaft should be chipped by minimum 600mm or till sound concrete is met with, whichever is greater. Thereafter, if found necessary, additional reinforcement should be jointed and the pile built up to the specified cut-off level.

In case defective pile is stripped below cut-off level, the pile should be built up with the good concrete of specified grade for the pile shaft up to the specified cut off level by the CONTRACTOR at no extra cost to the OWNER.

On completing pile cut-off for any pile, all exposed reinforcement surface should be coated with cement wash at no extra cost to the OWNER. Excavation for pile cutting should be restored to original working level.

12. TOLERANCES

12.1. POSITIONAL

The deviation/ tolerance should be as per IS: 2911 (Part 1/ Sec 2).

12.2. CORRECTIVE MEASURES

No forcible corrections to piles to overcome errors of position or alignment should be attempted. Cost of replacement piles and pile cap modification to offset piles in defective position should be borne by Contractor.

13. ABANDONED PILE BORES AND REJECTED PILES

Abandoned pile bores should be filled with fine aggregate of concrete. Temporary liner if installed should be withdrawn progressively as the sand is poured in. No attempt should be made to forcibly extract a rejected pile shaft. Rejected piles should be cut off as directed by the Engineer in Charge.

14. PILE CAPACITIES

Allowable capacity of the pile should be as per geotechnical investigation.

The negative skin friction should be determined using results of the pull-out test of short piles. Skin friction component of total load carrying capacity should be determined by conducting initial cyclic pile load tests on piles installed to full length. Also, the capacity of piles to resist uplift forces should be determined by conducting pull-out tests on piles installed to full length.

Pile load tests on both initial piles as well as working piles should be carried out to establish and prove these capacities.

15. TERMINATION CRITERIA

15.1. SOIL

15.1.1. Standard Penetration Test (SPT) in Pile Bore

The piles should be terminated if three consecutive Standard Penetration Test (SPT) values are equivalent or higher than designed SPT values mentioned in IS 2131. Contractor should carry out SPT as per IS 2131 at every one meter starting 3m above termination level through 100mm diameter.

16. PILE LOAD TESTS

16.1. GENERAL

Load tests should in general be carried out as per IS: 2911 (Part IV) except as modified herein or directed otherwise by the Engineer in Charge. The CONTRACTOR should provide everything necessary including equipment, measuring devices, jacks, structural framework, kentledges, test piles, and pile cap. Piles to be load tested should be so designated on the drawings or specified/selected by Engineer in Charge in the field.

16.1.1. Remote Monitoring by Using Web Cam

Pile load test should be remotely monitored by using separate Webcam for each dial gauge and connected to a computer. The precautions during remote monitoring are as follows:

- a) The Test Area should be barricaded at safe distance from all the four sides. No one should be allowed to enter inside the Test Area till the test is completed and load is released.
- b) Sufficient and proper type of lighting should be provided at the location of Dial Gauges to ensure proper visibility in the Computer Monitor.
- c) The Loads above the Beams should be well secured by Wire mesh or suitable rope/slings.
- d) Measures to prevent toppling of the main beams are mandatory.
- e) Dial Gauges to be checked for their calibration. Settings of Web Cam in front of Dial Gauges should be checked prior to start of test.

16.2. CALIBRATION OF EQUIPMENT

The CONTRACTOR should ensure, that all the equipment/ instruments are properly calibrated, at the start of the tests, to reflect the correct values. Specific calibration of instruments if required by Engineer in Charge at approved laboratory including witnessing of such tests should be arranged by Contractor at his cost.

16.3. INITIAL LOAD TESTS

Immediately on mobilization to site, the CONTRACTOR should prepare to install piles or/ and group of piles. For conducting initial vertical load (downward and pull-out) and lateral pile load tests. The general preparation should be as specified in IS 2911 Part 4.

While executing the pile bore for all test piles, a record of bore log and Standard Penetration Tests should be maintained over the continuous length of boring in an approved format. Subsoil samples and rock cuttings should be collected and systematically preserved.

16.4. LOAD TESTS ON WORKING PILES

These tests should be carried out on piles selected by the Engineer in Charge after they have been cast. Tests to be carried out on working piles should be as per the requirements specified in IS 2911 Part 4.

16.5. RECORDS OF LOAD TEST RESULTS

Within 48 hours of completion of each test, the CONTRACTOR should furnish a copy of all recorded test data to the Engineer in Charge. Upon completion of pile load tests, the CONTRACTOR should furnish to the Engineer in Charge, at no extra cost, with a pile test report in triplicate and this should include the following information where applicable.

Identification of working pile/test pile as per drawing.

Co-ordinate axes of pile, elevation of bottom of pile, cut off level of pile, type of pile and pile size.

- a) Pile Bore log Records.
- b) SPT results.
- c) Deviation from designated location/ alignment.
- d) Jack gauge calibration curves from approved Test House.
- e) Tabulation of loads and settlement readings during the loading and unloading of the pile.
- f) Graphic representations of the test results in the form of time-load-settlement curves.
- g) Graphic analysis of Initial Cyclic test results to separate skin friction and end bearing as set out in IS: 2911 (Part-IV).
- h) Remarks concerning any unusual occurrences during installation or test loading of the working piles/ test piles.

17. NON-DESTRUCTIVE TESTS ON PILES

17.1. LOW STRAIN NON-DESTRUCTIVE TESTING

All piles should be subject to low strain non-destructive testing by an approved agency as indicated in the bid including a report giving the interpretation of the test results. The tests should be conducted as per IS 14893.

17.1.1. Report Submission

The report on completion of field testing should indicate:

- a) Location of site.
- b) Pile types including size, material.
- c) Number of piles to be tested.
- d) Piles with toe response and no defect apparent should be classified as acceptable.
- e) Piles with no toe response and significant reduction or defect above the pile toe should be rejected and replacement or any other remedial action should have to be considered. The testing agency should specify the approximate location of defect in such a case.
- f) Piles with a sudden major increase in resistance or impedance may not show toe response and are termed as inconclusive and a typical such pile can be selected for static/ high strain dynamic test at the discretion of the Engineer in Charge.

- g) Piles that show toe response but some impedance reduction/ defect maybe under-rated/ replaced/ repaired/ or subjected to additional high strain dynamic or static testing at the discretion of the Engineer in Charge.
- h) A local decrease (neck) would have a positive reflection followed by a negative reflection (positive negative cycle). A local increase (bulb) would have a negative reflection followed by a positive reflection (negative positive cycle).
- i) Information on date of casting of concrete piles or concrete filled pipe piles. The pile to be tested shall be achieved minimum 75% of its compressive strength.
- j) Sudden changes in soil strata including rock socket, if any.
- k) Concrete quality in terms of wave speed.

Acceptance/ rejection of piles should also be based on construction records (concrete consumption, geotechnical data, construction method amongst others) that will provide valuable help in interpretation of results.

17.1.2. Interpretation of velocity records

The velocity trace from Pulse Echo Method subjected to further analysis in a computer to quantify better the extent of an apparent anomaly.

Such further use and interpretation of the data is a matter of engineering judgment and experience. The following factors shall be considered during interpretation of PIT results:

- 1) The length and diameter of the pile shall be verified with the standard documents/drawings.
- 2) The length to diameter ratio of the test pile shall be less than 50.
- 3) The Magnification Delay (MD) shall generally always be a default value of 20% and under no circumstances MD shall exceed 50% of pile length. An exception maybe allowed only when the pile has a large free-standing length more than 50% of its total length.
- 4) The Magnification Factor (MA) shall be chosen such that its value is at least equal to the length of the pile or a multiple of the pile length. Magnification greater than 100 is not recommended.
- 5) Also, for piles of different lengths at the same site, the MA shall be chosen such that they produce the same multipliers at the same depths.
- 6) High pass filters and low pass filters are used to eliminate the low and high frequencies respectively.
- 7) In practice there is usually shaft friction which, by absorbing energy, shifts the velocity record negative after the initial impact. Hence, the immediate negative peak after the first impact shall be ignored.
- 8) A local decrease (neck) would have a positive reflection followed by a negative reflection (positive negative cycle). A local increase (bulb) would have a negative reflection followed by a positive reflection (negative positive cycle).

17.1.3. Report

A final report for each testing stage should be presented not later than three working days after completion of test. The report should consist of a printout of the original output, as well as a summary table including, for every panel tested, the depth and the Engineer's interpretation regarding its integrity. The report should also recommend the suitable corrective measures for the identified defects.

17.2. HIGH STRAIN DYNAMIC LOAD TEST

This procedure should be used to replace static routine vertical load test up to maximum 40% based on the designer discretion due to limitation of interpretation of test results. It will not be used for conducting initial load test.

Routine vertical load test by means of High Strain Dynamic Load Test as per ASTM D4945-2000 should be conducted for one and half times safe load carrying capacity.

The testing includes mobilization of all the equipment and work site preparation required for carrying out the test.

The output from the test result should include:

- a) Static capacity of the pile at the time of testing.
- b) Simulated static load test curve.
- c) Total skin friction and end bearing of the pile.
- d) Skin friction distribution along the length of the pile.
- e) Compressive and tensile stresses developed in the pile during testing.
- f) Net and total displacement of the pile.
- g) Pile integrity.

The testing and interpretation should be carried out by the Engineer having expertise and thorough understanding of wave mechanics. The test method should be used after successful co-relation of the results with static load tests to establish the reliability of the test method.

The details of pile head, test preparation, conducting the test and reporting should be in line with provisions of ASTM D 4945.

17.3. BI-DIRECTIONAL STATIC LOAD TEST

17.3.1. General

Bidirectional static-load testing method is an instrumentation method of testing bored piles. The mobilization of Skin friction and end bearing can be verified with the help of this test. The BD cell is a hydraulically driven, calibrated, sacrificial jacking device installed within the foundation unit. Working in two directions, upward against side- shear and downward against end-bearing.

17.3.2. Instrumentation and material requirements

Bidirectional Cell for each test to be performed.

Steel reinforcing cage or carrying frame, piping to approximate levels.

Two circular steel plates per BD cell assembly, which shall be 2 inches thick and approximately equivalent diameter of steel reinforcing cage. The plates are welded to top and bottom of the BD cell. Centralizers to ensure centralizing of the load test apparatus, instrumentation and reinforcing steel. Steel pipes which shall be ½-inch diameter used as conduit for telltales from above working level to the top of the BD cell assembly.

Materials such as angle or channel steel or rebar needed to protect BD cell assembly, hydraulic fittings and instrumentation during installation and concreting procedures.

Materials such as rebar used to construct an apparatus for funneling of the concrete slickline or tremie through the BD cell assembly for concrete placement.

Linear Vibrating Wire Displacement Transducers (LVWDT's) having a range of at least 6 inches, with signed certificates of calibration. Transducers shall be capable of reading to within 0.001-inch of displacement.

Sister Bar Vibrating Wire Strain Gauges, with signed certificates of calibration.

Telltale extensometer assemblies having a range of at least 1 inch with signed certificates of calibration. Transducers shall be capable of measuring movement within 0.001-inch.

Embedded compression telltale assemblies shall be used when typical surface measuring methods are impractical.

Clean water from an approved source to mix with water-soluble oil contained within the BD cell, to form the hydraulic fluid used to pressurize the O-Cell.

Materials sufficient to construct a protected work area, including provisions such as a tent or shed for protection from inclement weather for the load test equipment and personnel.

Stable electric power source as required for lights, instruments, tools, etc.

Air compressor (minimum 185 cfm, 125 psi) with hose and Chicago-type fitting for pump operation during the load test.

Air-driven hydraulic pump to be used as BD cell pressure source and accompanying pressure gage. Tripods, automated survey levels and related equipment to measure upward top of shaft displacement.

All necessary data acquisition equipment.

17.3.3. Procedure

Once the borehole excavation has been completed, tested, inspected and accepted by the Engineer in charge, the BD Cell and reinforcing steel assembly shall be lowered into the excavation.

A seating layer of concrete shall be placed by an approved method in the base of the shaft to provide a level base and reaction for the BD cell.

After the BD Cell and steel assembly have been set, confirm the proper elevation of the reinforcing cage has been attained. The shaft shall then be further concreted by an approved method.

The BD cell testing shall not begin until after a minimum of one week after completion of pile construction.

The BD cell load test is performed in general compliance with ASTM D1143-07 Standard Test Method for Deep Foundations Under Static Axial Compressive Load using Procedure A: Quick Test loading schedule.

Ultimate test load= 3*Pile capacity.

Skin friction at each depth is calculated by 3*SPT N.

The BD cell is positioned above pile toe such that the ultimate skin friction above the cell and below the cell is more than half of the test load.

Actual mobilization of skin friction is measured by several strain gauges placed above and below the BD cell which can be provided at different levels.

Load – displacement graph is plotted for the displacement of plate above and below the BD cell, so tell-tale rods are provided to measure these displacements.

The load test is carried out as per IRC 78-2014 Amendment (Appendix 9).

For every one-minute interval the data from strain gauge & LVDT is recorded in data logger.

The load increment for which the rate of settlement gets reduced shows the

mobilization of end bearing. From top plate movement graph, the data after load increment at which there is some abnormality is neglected for further analysis.

From this curve, an equivalent top-down curve is plotted as per procedure given by Osterberg, (1998) and to this curve the elastic settlement of top and bottom portion also added.

From the above equivalent top-down curve, the safe load of the pile is obtained and compared with the calculated geotechnical capacity of the pile.

From the strain gauge data, the unit skin friction mobilized for the applied test load is calculated.

17.3.4. Report

Summary of the load test procedures.

Tabulated data of all embedded and surface instrument readings.

Load vs. upward top of O-cell and downward base of O-cell displacement plots.

Equivalent top-loaded load settlement plot.

Load distribution plot based on strain gage data.

Provide net unit side shear curves, and unit end bearing vs. displacement curves (t-z and q-z curves), if applicable.

Calibration documentation for all instrumentation and O-cell(s) used during the load test.

Summary of test shaft details and schematic as-built drawing of test shaft indicating locations of O-cell, instrumentation, and soil stratigraphy.

18. INSTALLATION RECORDS

The CONTRACTOR should submit each working day, detailed pile installation records in duplicate for each pile installed in the enclosed formats. The Engineer in charge 's piling plans will show all piles serially numbered as per the piling layout plans. The cost of all labour, materials and services called for herein should be included in the CONTRACTOR's unit rates.

The details of the record should include but not be limited to the list below:

18.1. PILE INSTALLATION RECORD

18.1.1. Basic Data

- (a) Piling Layout Drawing No.
- (b) Pile Number.
- (c) Location Co-ordinates.
- (d) System/ Structure.
- (e) Pile Location vis-a-vis Pile Group (Draw dimensioned sketch with reference axes and shade the pile).
- (f) Pile Type: Vertical/ Raker, 1:
- (g) Pile Nominal Diameter.
- (h) Pile Tip Elevation.
- (i) Pile Cut-off Elevation.
- (j) Ground Level at Pile Location.
- (k) Grade of Concrete Specified.
- (l) Reinforcement Details (Draw sketch if complex).
- (m) Safe Capacity of Pile Specified.

18.1.2. Pile Bore Data

- (a) Date and Time of Start.
- (b) Date and Time of Completion.
- (c) Method of Boring.
- (d) Inner Nominal Diameter of Temporary Casing/Permanent Liner.
- (e) Length of Temporary Casing/ Permanent Liner.
- (f) Material of Permanent Liner.
- (g) Method of Jointing Temporary Casing/Permanent Liner.
- (h) Treatment to Permanent Liner.
- (i) Length Bored in Soil.
- (j) Length Bored in Rock (The rock should be as defined in Data Sheet-A or Notes to Schedule of Quantities for purpose of measurement).
- (k) Bore Log (Draw sketch or refer to separate sheet).
- (l) Details of Standard Penetration Tests.

- (m) Number of Subsoil Samples/ Rock Cuttings collected.
- (n) Ground Water Elevation.
- (o) Any Artesian Conditions.
- (p) Any Bore Collapse and Details.
- (q) Any Loss of Drilling Mud and Details.
- (r) Any Other Details or Phenomena Observed.

18.1.3. Flushing Record

- (a) Date and Time of Start of Final Post-bore Flushing.
- (b) Date and Time of Completion of Final Post-bore Flushing.
- (c) Remarks on inspection of Wash of Post-bore Flushing.
- (d) Date and Time of Start of Final Pre-concreting Flushing.
- (e) Date and Time of Completion of Final Pre-concreting Flushing.
- (f) Remarks on Inspection of Wash of Pre-concreting Flushing.

18.2. CONCRETING RECORD

- (a) Date and Time of Start of Concreting.
- (b) Date and Time of Completion of Concreting.
- (c) Grade of Cement and Name of Manufacturer.
- (d) Date of Manufacture of Cement.
- (e) Grade of Concrete as Mixed.
- (f) Grade of Concrete Specified.
- (g) Slump of Mixed Concrete at Pile Head.
- (h) Cube Test Results.
- (i) Method of Concrete Placement in Pile Bore.
- (j) Theoretical Volume of Concrete:(Pile Tip to Top of Pile as Cast).
- (k) Actual Volume of Concrete:(Pile Tip to Top of Pile as Cast).
- (l) Ratio of Actual Volume to Theoretical Volume of Concrete: (Express as Percentage).
- (m) Any Delays during Concreting and Reasons.
- (n) Overflow Quantity.
- (o) Any Other Details.

19. CLEAN-UP

All throughout the work, the Contractor should take all steps to prevent spillage of bentonite slurry on the site in areas outside the immediate vicinity of boring. The slurry should not be allowed to flow into any water courses, nallahs, site drains or any public drains.

Any discarded and/or used bentonite should be removed from the site without any undue delay.

Upon completion of piling work, all casings, equipment, construction tools, protective coverings and any debris resulting from the work should be removed from the premises.

All debris, empty containers, scrap timber, etc. should be removed as directed by the Engineering In-charge.

Exposed and finished concrete and dowel surfaces should be left in a clean condition satisfactory to the Engineering In-charge.

SECTION: 9 ITEMWISE SPECIFICATIONS

SCHEDULE B-1

Item No. 1 to 2 :

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/GWIL 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.

- i. 1829 mm dia. (OD), 14.2 mm minimum thickness
- ii. 1300 mm dia (OD), 12.5 mm minimum thickness

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/GWIL 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 μm (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
SIS	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

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 or 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

- Adhesive shall have the following properties.

Sr. No.	Properties	Unit	Requirement	Test Method
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	0c	100 0c minimum	ASTM D 1525

- Properties of Polyethylene Compound

Sr. No.	Properties	Unit	Requirements	Test Method
a.	Tensile Strength @ + 25 °C	N/mm ²	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 ¹⁵ min.	ASTM D 257
g.	Dielectric Volt/sec rise @ + 250C	Volts/mm	30,000 min.	ASTM D 149
h.	Vicat Softening Point	0c	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 ²	10^8 min.	DIN 30670- Latest Version
f.	Heat Ageing (*)	-	Melt Flow rate shall not deviate by more than 35% of original value Melt flow rate shall not deviate by more than 35% of original value.	DIN 30670- Latest Version
g.	Light Ageing (*)	-		DIN 30670- Latest Version

h.	Cathodic Disbondment - @ + 65°C after 30 days - @ + 65°C after 48 hrs	Minimum radius of disbandment (**)	15 (Max) 7 (Max)	ASTM G42- Latest Version
i.	Degree of Cure of Epoxy - Percentage Cure, ΔH - ΔT_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

- 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 stripped 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 μm	Each pipe
	Chloride test	2 mg/cm ²	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 \pm 5°C & Maximum 0.3mm at 70 \pm 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
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PRODUCTION TESTING

➤ 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 ²	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 $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and $70^{\circ}\text{C} \pm 2^{\circ}\text{C}$) in accordance with DIN 30670
- Indentation depth shall not exceed 0.2mm at $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$ or 0.3mm at $70^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

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 +/- 2°C as a pre-qualification test - 28 days duration at 23 +/- 2°C
- As a production test - 48 hours duration, at the frequency of one test per 50D coated pipes at 65 +/- 2°C
- 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 +/- 2°C and the 2 days test at 65 +/- 2°C.
- 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

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 mm²

- 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 mm² up to < 250 mm²

- 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 mm² up to 625 mm²

- 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.

Repair areas of sizes exceeding 625 mm²

- No single defect shall exceed an area of 625 mm². Pipes with a coating defect exceeding 625 mm² 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 0C.

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 (+) 800C 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 cm² 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 20cm² 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, MANUFACUTRER 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 ≤ 100 cm² 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 μ m to 75 μ 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 or 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
- 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.
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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. 3 to 4 :

Lowering, laying, jointing & welding in position to correct line & level M.S. Pipe with outer side 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, field joint coating, 3mm thick heat shrink sleeve conforming to EN 12068/AWWA C216 incl. hydro testing etc. complete.

- i) 1829 mm dia. (OD) and 14.2 mm minimum thickness
- ii) 1300 mm dia. (OD) and 12.5 mm minimum thickness

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.

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)
- 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 GWIL 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. 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 stake 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 stake 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 stake 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 Downstream side	Atmospheric Temperature	Dist. Between edge of gland and marking
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.
- 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
j)	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 ²	≥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	≥10 ¹⁵	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	Annex B of DIN EN 12068
	@Tmax	N/mm	1.0	
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 \pm 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.
- 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.
- 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

- 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 ²))	
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.
- 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 µm to 75 µm) 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
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/cm² 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/GWIL 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. 5:

Providing and supplying Cast Steel D/F Butterfly Valves confirming to IS 13095 or equivalent international standards with bypass arrangement 250mm sluice valve of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, lowering, laying, Installation charges, loading, unloading, conveyance to departmental stores/Contractor's own stack yard, stacking, stack yard to site transfer etc. complete, including companion flanges, nut bolts and giving satisfactory hydraulic testing, etc. complete.

- i) 1800 mm dia., PN 20 (Manually Operated Butterfly Valve) + 250 mm dia DI bypass Sluice Valve, PN 20 with hand/wheel cap operated (PD type Short body) with Bypass arrangement.

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 – 20 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:

- (a) Testing as per IS 13095.
- (b) 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

- (a) Testing as per IS 13095.
- (b) 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.
- (c) 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.
- (d) 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

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

Disc Strength Test

- (a) 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 $1\frac{1}{2}$ 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 $1\frac{1}{2}$ 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 20
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
2.11	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. 6 :

Lowering, laying and jointing in position following Cast Steel D/F Butterfly valves, including cost of all labour, jointing material, including nut bolts and giving satisfactory hydraulic testing, etc. complete.

- i) 1800 mm dia (Butterfly Valves IS 13095 or equivalent international standards PN 20)

Lowering, Laying and Jointing of Valve**Supply Of Material**

- Cast steel double-flanged sluice valve/butterfly valves with two tailpieces suitable to pipe shall be supplied and carted by the contractor as per latest IS. The rate shall include loading, unloading and stacking at site.
- The sluice valve/butterfly valves and tailpieces shall be examined before laying for cracks and other flaws. They shall be undamaged in all respect.
- The sluice valves/butterfly valves shall be operated before laying.
- All grits and foreign materials shall be removed from the inside of the valves before placing.
- All the four faces shall be thoroughly cleaned and coated with a thin layer of mineral grease.
- 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.

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. 7 :

Supply, installation, testing & commissioning of PN 20 flange ends Expansion Bellow as per EJMA standards with companion flanges, accessories erection hardware, necessary mounting supports etc. designed for 15 mm axial compression and 5 mm axial extension with tie rods etc. of following MOC & pressure ratings.

MOC: Bellows: SA 240 Gr. 304; Internal Sleeve: SA 240 Gr. 304; Weld ends: IS 2062 Gr. B; Flanges: IS 2062 Gr. B, Flanges machined faced and having Dimensions- PCD, OD, Thickness, Holes as per ISO-7005-1 & Limit Rods & Nuts: CS - IS 1367.

- i) Size- NB 1800 mm, PN-20 and 450 mm minimum width

General

- (a) Design, fabrication, testing and installation of metallic expansion bellows with necessary hardware have to be provided at delivery side of each pump.
- (b) 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.
 - Compensate Lateral, Axial, Torsion and Angular movements.
 - Low movement forces
 - Reduced fatigue factor
 - Reduced heat loss
- (c) It provides flexibility and concurrent movements.
- (d) Expansion bellows shall be designed as per the details furnished in the data sheet and shall be in accordance with the EJMA standard.
- (e) All expansion bellows shall be free from dirt, moisture, grease, oil, etc. and all reports for hydrostatic test shall be furnished.

- (f) The bellows shall be metallic corrugated design and shall have double flange. The material for Bellows shall be SS 304.
- (g) 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.
- (h) 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.
- (i) 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.
- (j) 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

- (a) Expansion Joints are flexible, reinforced bellows which are used in piping systems to meet the following major needs.
- (b) To protect piping by absorbing any difference in dimension due to temperature variation or line movement.
- (c) It shall be protecting equipment such as supports & anchors, pumps & valves etc., other equipment.
- (d) It shall be useful for simple connection of misaligned pipes.
- (e) Movement Accommodation.
- (f) Expansion and contraction, as well as rapid movements (dynamic stresses), are absorbed multidirectional and often simultaneous deflections.

Test & Inspection

- (a) Bellows shall be tested as per the relevant Standards with latest revisions.
- (b) Bellows shall be offered for visual inspection and dimensional checks.
- (c) The hydrostatic and water tightness testing of one of each size shall be witnessed.
- (d) Compression and expansion test shall be offered for one no. for each size and to be witnessed.

Positive material Identification (PMI Test)

PMI test shall be checked at random for Stainless steel parts.

Test Certificates

When specified by Owner, the manufacturer shall issue a test certificate confirming that the bellows 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 factory inspection, all manufacturing waste such as metal chips debris and all other foreign material shall be removed from interior of bellows. All mill scale, rust, oil, grease, chalk and all other deleterious material shall be removed from the interior and exterior surfaces.

Painting

Each bellow shall be drained, cleaned, prepared & shot blast cleaning of bellow 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.

Tender Drawing

The Dimensional drawings with material of construction shall be submitted by Contractor along with their offer.

Nominal Pressures

Expansion Bellow shall be designated by nominal pressure PN-20 and to be designed at maximum ambient temperature.

Specifications & M.O.C. of Expansion Bellow:

Sr. No.	Component	Requirement (PN-20)
1	Bellows	SA 240 Gr. 304
2	Internal Sleeve	SA 240 Gr. 304
3	Weld ends	IS 2062 Gr. B
4	Lugs	IS 2062 Gr. B
5	Limit Rods and Nuts	CS - IS 1367
6	Flange End	ISO-7005-1

Note: 50% Quantity shall be witnessed at Factory site at the time of final inspection

Item No. 8 :

Providing & supplying Ductile Iron D.F. Scour valves with ISI mark as per IS:14846 (Latest Edition) or equivalent international standards including companion flanges, hardware, 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, including supply, installation and joint of drain pipe main for pipeline to river/nala etc. complete..

- i) 600 mm dia. Scour Valve, PN 20 with hand wheel/cap operated (PD type Short body)

General

- This specification covers the design, engineering, manufacturer, transportation to site, installing testing double flanged manually operated Sluice valves.
- Valve covered under this specification are manually operated. Fabricated valve will not be considered.

Design Features

- (a) Sluice Valves shall confirm to IS 14846 (ISI Marked) or equivalent latest standard. Except pump house, these valves are to be installed in valve chamber.
- (b) The valves shall be free from sharp projections, which are likely to catch and hold stringy materials.
- (c) Valves shall close with clockwise rotation of the hand wheel. The direction of closing and opening shall be marked on the hand wheel.
- (d) Necessary joining materials viz. bolts, nuts, washers, packing etc. shall be provided by the contractor at his cost. The valves shall be fixed so as to have axis perfectly horizontal.

- (e) If required, the contractor shall also carry out drilling of holes of appropriate diameter in flanges in required numbers.
- (f) A hand wheel shall be provided for emergency operation. The hand wheel drive shall be mechanically independent.
- (g) The valve design shall take care of the pressure drop across the valve disc in case of partial opening of the valve and shall take care of the erosion and cavitation effect on the body and disc during such operation.
- (h) Valve(s) subjected to back pressure shall have the valve seat, disc and the operator suitably designed to ensure trouble-free operation.
- (i) The shaft diameter shall take into consideration, the maximum torque required for the valve operation, the maximum differential pressure across the valve disc when the valve is closed and the shock load due to accidental closure of the valve disc.
- (j) The disc shall be designed for maximum differential pressure across the valve as well as the shock load due to accidental closure of the valve. Disc design shall offer minimum head loss. Disc shall also offer minimum resistance to flow Disc shape shall be contoured.
- (k) Valve seats shall be of a design that permits removal and replacement at site and shall be securely clamped on the body or disc of the valve.
- (l) Seat material shall be suitable for the operating conditions and handling fluid and may be suitably reinforced, if required.
- (m) The seat design shall permit easy removal for replacement purposes without the need for removing the valve from the line. No deposited or welded seat rings permitted.
- (n) The valve bearings shall be of 'self-lubricated' type and shall not have any harmful effect due to handling fluid.
- (o) Adjustable thrust bearing(s) shall be provided to hold the valve disc securely in the centre of the valve seat.
- (p) Each sluice Valve shall be provided with a hand wheel for manual operation. For the valves located at inaccessible position, it shall be provided with extension spindle and floor stand or hand lever / round chain to facilitate manual operation.

Testing

Hydrostatic Test

Each valve body shall be subjected to hydrostatic test (Body and Seat) as per IS 14846. For valves subjected to back pressure condition, leakage test shall be carried out on both sides of the disc.

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.

Positive material Identification (PMI Test)

PMI test shall be checked 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 factory inspection, all manufacturing waste such as metal chips debris and all other foreign matter 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.

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.

Nominal Pressures

Valve shall be designated by nominal pressure PN-20 and to be designed at maximum ambient temperature.

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 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.

Specifications & M.O.C. of Sluice Valve:

1	General	Requirements	
1.1	Type	Both ends flanged, Non-Rising Type, Metal Seated, hand wheel / Gear operated / Actuator Operated as mentioned in BOQ	
1.2	Rating of valves	PN 20	
1.3	Manufacturing Standard	IS 14846 / Equivalent Standard	
1.4	Sizes and quantity	As per price bid	
2. MATERIAL OF CONSTRUCTION			
Sr. No	Component	PN-20 (For Pipeline BOQ & Pipeline BFV Bypass Valve)	PN-20 (For Pumping Station)
1	Body	DI IS1865 Gr500/7	ASTM A216 Gr. WCB
2	Bonnet	DI IS1865 Gr500/7	ASTM A216 Gr. WCB
3	Wedge	DI IS1865 Gr500/7	ASTM A216 Gr. WCB
4	Gland	DI IS1865 Gr500/7	ASTM A216 Gr. WCB
5	Stem	SS 410	SS 410
6	Body Ring/Wedge Ring	IS 318 Gr LTB-2	IS 318 Gr LTB-2
7	Packing	EPDM	Graphoil Filler with SS 304 wire winding
8	Nut Bolts	Carbon steel	Stainless steel
9	Wedge Nut and Stem Nut	IS 318 Gr LTB-2	IS 318 Gr LTB-2
10	Hand Wheel	Ductile Iron	Cast Steel
11	Flange End	IS 1538	ISO-7005-1
12	Actuator		ON-OFF Duty with integral starter (As Applicable)

Note: 50% Quantity shall be witnessed at Factory site at the time of final inspection

Item No. 9 :

Lowering, Laying and jointing in position following D/F Ductile Iron Scour valve including cost of all labour, jointing material, including nut bolts and giving satisfactory hydraulic testing, etc. complete.

i) 600 mm dia. Scour Valve, PN 20 with hand wheel/cap operated (PD type Short body)

Lowering, Laying and Jointing of Valve**Supply Of Material**

- Cast steel double-flanged sluice valve/butterfly valves with two tailpieces suitable to pipe shall be supplied and carted by the contractor as per latest IS. The rate shall include loading, unloading and stacking at site.
- The sluice valve/butterfly valves and tailpieces shall be examined before laying for cracks and other flaws. They shall be undamaged in all respect.
- The sluice valves/butterfly valves shall be operated before laying.
- All grits and foreign materials shall be removed from the inside of the valves before placing.
- All the four faces shall be thoroughly cleaned and coated with a thin layer of mineral grease.
- 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.

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. 10 :

Providing and supplying 200 mm dia. 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.

- i) 200 mm dia Temper proof Kinetic Air Valve, PN-20 with 200 mm dia. DI isolating sluice valve, PN-20 with hand wheel/cap operated (PD type Short body)

Temper Proof Air Valve**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-20 and to be designed at maximum ambient temperature.

Specifications & M.O.C. of Tamper Proof Air Valve:

Sr. No	Component	PN-20 (For Pipeline BOQ)
1	Body	DI IS1865 Gr500/7
2	Cover	DI IS1865 Gr500/7
3	Float	SS 304
4	Seat	EPDM
5	Float Guide	SS 304
6	Orifice	SS 304
7	Gasket	EPDM
8	Nut Bolt	Carbon steel
9	Flange End	IS 1538

Note: 50% Quantity shall be witnessed at Factory site at the time of final inspection

Item No. 11:

Lowering, laying and jointing in position following Ductile Iron D/F Temper Proof Air valve with isolating sluice valves including cost of all labour, jointing material, including nut bolts and giving satisfactory hydraulic testing, etc. complete.

- i. 200 mm dia Temper proof Kinetic Air Valve, PN-20 with 200 mm dia. DI isolating sluice valve, PN-20 with hand wheel/cap operated (PD type Short body)

Air Valve Installation

- The air valve shall be lowered in to the trench carefully, so that no part is damaged during lowering operation.
- 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 air 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.
- Extra excavation required for facility of lowering and fixing air valve shall not be paid for.

Item No. 12 :

Providing, supplying and delivery of 300 mm Air cushion valve as surge control device with 300 mm isolating sluice valve 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.

- i. 300 mm (Air cushion with MS Body), PN-20 + 300 mm dia DI Isolating Sluice Valve, PN 20 with hand/wheel cap operated (PD type Short body)

Air Cushion Valve

Design, supplying Installation, Testing, Commissioning of 300 mm Dia- (PN-20) Air Cushion Valve as per relevant standard with MS Body including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete.

General

- The valve consists of a 'Main Body' and 'Top Housing'. On the side of main body, two 'Air Inlet Valves' loaded with a light spring are fitted. The 'Inlet' is protected by a cover.
- The 'Top Housing' has an opening for air escape. A spring loaded 'Poppet' with a brass seat and Neoprene 'Sealing Ring' covers the top of the opening. The spring pressure on the valve is adjustable by a screw (S.S. as per AISI-304).
- The 'Housing' has a tapered outlet, the opening of which is adjustable by a tapered plug and Screw (S.S. as per AISI- 304). The outlet is protected by a cover. On its lower side a cage holding a ball float is fitted. 'Main Body', 'Top Flange', are fabricated from M.S. (as per I.S.2062/I.S.1239). The 'Top Housing' is made from high grade cast iron.
- Main body, float ball and air inlet flange are hydraulically pressure tested. Stems of valves are in stainless steel (as per AISI-304), and work in 'Brass Bushes'. Sealing rings are of good quality rubber and seats are of brass
- Thickness of all flanges will be as per I.S. Thickness of pipes Strength of steel pipes is verified to check effect of positive and negative pressures during transients due to power failure and surge protection devices shall be provided to avoid any damage to the pipeline integrity, shape and structure.

Testing

All valves shall hydrostatically 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.

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.

Specifications & M.O.C. of Air Cushion Valve:

Sr. No	Component	Requirement-PN-20
1	Body	MS
2	Float	SS 410
3	Stem	SS 304
4	Spring	SS 304
5	Plug	MS
6	Adjustable Screw	SS 304
7	Mounting Flange	MS
8	Isolation Valve	DI
9	Flange end	ISO 7005-1

Note: 50% Quantity shall be witnessed at Factory site at the time of final inspection.**Mode Of Measurement And Payment**

- Measurement shall be paid on number basis as per relevant dia. of the item in schedule 'B' of the tender.

Item No. 13:

Lowering, Laying and jointing in position Air cushion valve & isolating sluice valve with devices including cost of all labour, jointing material, including nut bolts and giving satisfactory hydraulic testing, etc. complete.

- i. 300 mm (Air cushion with MS Body), PN20 + 300 mm dia DI Isolating Sluice Valve, PN20 with hand/wheel cap operated (PD type Short body)
- For Lowering, laying Refer specification of Item no. 9 & 11 of Schedule B-1 in Section 9.

Item No. 14 & 15 :

Providing and fixing in position air valve shaft including providing & fixing 219.1/323.9 mm dia. (OD) 4.5 mm minimum thick M.S. pipe shaft 6.0 m long over main pipe, providing 150 mm thick encasing to vertical shaft in RCC M-20 as shown in type design, and fixing MS plates and stiffeners over main pipe welding, coating as shown in drawing as per type design and as directed by engineer-in-charge for following diameters of pipeline.

- i) 219.1 mm (OD) pipe; 6.0 m length - Air Valve
- ii) 323.9 mm (OD) pipe; 6.0 m length - Air Cushion Valve

Air valve Shaft

- 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 6.0 mtr Long and of diameter as per price-bid.
- The 150 mm thick encasing around the vertical shaft shall be minimum in grade M-20 or as per approved drawings.
- Necessary reinforcement shall be placed in footing and column as per the instruction of Engineer in Charge
- CRS Fe-500 grade steel shall be provided.
- Necessary flanges , Nut, bolts, Clamp all type jointing materials shall be provided and fixed by agency
- Air cushion 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 cushion valve shaft shall be painted as approved by Engineer in Charge and Air cushion valve Number shall be painted with Radium Paint.
- Additionally this work shall be executed as Relevant Section 1 to 8 and as per Engineer in Charge Direction.

Item No. 16 :

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 up to all required lead cleaning the site, including all type of dewatering (water incoming in pipeline trenches due to seepage, uplift ground water, rain, surrounding water bodies, etc.) complete for all lifts and strata as specified, including soil, soft murrum, Hard Murrum, boulders incl. macadam road, Soft Rock and/or masonry in CM or LM or Lime Concrete, hard rock and/ or in C.C. 1:2:4 or with blasting and chiseling or by chiseling only.

Excavation

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 0.60 m clearance on both sides of the pipe and minimum top cover from pipe should be 1.25m (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 outing 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 Section 7 Earthwork for detail technical Specification

Item No. 17 :

Refilling the pipeline trenches incl. ramming, watering, consolidating, disposal of surplus stuff as directed within a radius of 3 Km.

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. 18 :

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 weigh batching) using granite, quartzite trap metal of size 6 mm to 20 mm for RCC work, including scaffolding centering, formwork, needle vibrated consolidation, curing complete up to 6 meter depth or height, including Supplying, cutting, bending, binding and placing in position steel as per plan and design and as per IS 2502 and binding wire for all diameters. CRS Fe-500 minimum grade for all diameters for **Thrust block**.

- Refer Section 3 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/mm².
- The minimum 40kg/Cum. Steel shall be provided for thrust block.

Reinforcement

- All reinforcement steel shall be CRS FE-500 conforming to relevant I.S. for all RCC structure with conforming to IS.
- 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.
- Additionally Refer Section 1 to 8 for detail technical Specification

Item No. 19 :

Providing and casting in situ C.C. in grade M-15 (proportions as per mix design or as Table 9 of IS 456 (2000) in masses by weigh batching) using granite, quartzite trap metal of size 6 mm to 20 mm for RCC work, including scaffolding cantering, formwork, needle vibrated considerations, curing complete up to 6 m depth or height, including supplying, cutting, bending, binding, and placing in position steel as per plan and design and as per IS 2502 and binding wire for all diameters. CRS Fe-500 minimum grade for all diameters for **Pipe Encasing**.

- For Pipe Encasing Refer Section 3 Concrete for Detail technical Specifications.

Encasing Pipeline

- Encasing of pipeline with the reinforced concrete of desired grade as shall be done as per design requirement wherever adequate cover on pipeline is not available as per site condition.
- Encasing of pipeline shall also be done for all the nallah crossing/River crossing/minor road crossings as per indicative drawing and to the design requirement and as directed by the Engineer In-charge.
- The Contractor has to submit his own design with steel reinforcement details and getting approved before executing the work.
- The PCC shall be in M-15 grade.
- The minimum 20kg/Cum Steel shall be provided for pipe encasing.

Reinforcement

- All reinforcement steel shall be CRS FE-500 conforming to relevant I.S. for all RCC structure with conforming to IS.
- 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.
- Additionally Refer Section 1 to 8 for detail technical Specification

Item No. 20 & 21 :

Construction of RCC valve chambers of different sizes for different valve. The rates shall include construction of RCC valve chamber in M 20 concrete. Excavation, foundation concrete(PCC) in M-10 (approx. corresp. to prop. 1:3:6), pedestal and vertical wall in CC M20, CRS steel all diameter Fe 500 grade minimum confirming to relevant IS, top cover of RCC Precast slabs & cover in pieces of required size with necessary nuts, bolts, locking arrangement, PVC encapsulated Rungs etc. complete as per drawings & specification and instruction of Engineer-In-Charge/Consultant.

- i) Size of 5 m X 4 m X 4 m deep for BFV
- ii) Size of 3 m x 2.5 m x 3.5 m deep for Scour valve

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 section 1 to 8 shall also be applicable.

Item No. 22 :

Job Connection Works:

Providing and executing interconnection of existing MS pipeline with new MS pipeline, including cutting, alignment, jointing by welding and/or bolted flanged connections, supply and fixing of required MS fabricated specials, flanges, bolts, nuts, gaskets, and all other necessary accessories to achieve a secure and leak-proof connection, as per the instructions of the Engineering In-charge. The work shall include dewatering (if required), testing and commissioning of the interconnected pipeline, epoxy painting to all MS pipes and specials, taking all safety measures, and completion of all allied works. After completion of the interconnection, the excavated area shall be backfilled, compacted and restored to original/natural ground level, complete in all respects, as per specification and to the satisfaction of the Engineering In-charge.

After completion of Job Connection Works, the bare area of pipe shall be coated with Heat Shrink Sleeve [HSS].

Connection of 1829 dia pipeline with new 1829 mm dia pipeline at upstream and connection of 2 nos. of 1300 mm dia pipeline with new 1829 mm dia pipeline at downstream.

- Refer specification of Item no. 3, of Schedule B-1 in Section 9.
- Relevant Section 1 to 8 to be followed for the completion of the work.

Item No. 23 :

Providing, fabricating, supplying, and fixing/welding **MS Blind Flanges with companion flange** suitable for existing 1829 mm dia and 1300 mm dia MS pipelines, complete with bolts, nuts, gaskets, and all other necessary accessories required to achieve a secure and leak-proof connection. The work shall include cutting, edge preparation, fit-up, welding, grinding, testing, surface preparation, epoxy painting, handling, transportation, labour, tools and tackles, safety provisions, and all incidental works necessary for complete installation, in accordance with the specifications and as directed by the Engineer-in-Charge, complete in all respects.

The **blind flange** installation at the end of the existing 1829 mm dia and 1300 mm dia pipelines shall be executed during connection work of the new 1829 mm dia pipeline with the existing 1829 mm dia pipeline.

General:

- (a) SITC of Blind Flanged Type Fabricated MS Specials for existing 1829 mm dia and 1300 mm dia pipelines.
- (b) Flanges machined faced and having Dimensions - PCD, OD, Thickness, Holes as per ISO 7005-1 (PN 20).
- (c) M.S. pipe 168.3mm OD and above should be conforming to IS-3589/2001 and MS Pipe below 168.3 mm OD should be heavy duty as per IS-1239 Part-1/2004 or latest.
- (d) All specials & pipes should be painted by epoxy paint.
- (e) All the flanges shall be confirming to ISO 7005-1 for relevant pressure rating of Valves/Expansion Bellows etc.

- (f) The item shall be executed as per relevant IS or international standard and as per instructions of Engineer in Charge.

Item No. 24 :

Diversion of watercourse by providing cofferdam:

Design, Providing and constructing cofferdam, including excavation to required alignment and section, supplying and placing approved soil brought from outside filled in empty cement/gunny bags to form the impervious core, properly stacked, interlocked and compacted, including slope dressing and protection to ensure stability against water current and hydraulic pressure, complete with all labour, materials, tools and plants. Minimum Top width of cofferdam shall be 0.6 m and minimum slope shall be 1V : 1.5 H and minimum free board shall be 0.5 m from the high water level or as per design. The cofferdam shall be designed and constructed in a phased manner to ensure continuous and unobstructed flow of the watercourse while enabling safe diversion and execution of work in dry conditions. The cofferdam shall be designed and executed to maintain a minimum working width of 6 m to facilitate installation, handling, and laying of encased MS pipeline as well as execution of pile works. The scope shall include continuous maintenance of the cofferdam in sound and watertight condition during the execution period, attending to leakages, damages, and settlement, including dewatering operations as required. The work further includes dismantling and complete removal of the cofferdam after completion of works and restoration of the riverbed to its original condition, work completed as directed by the Engineer In-Charge.

1. General:

- The work shall consist of providing, constructing, maintaining, and dismantling cofferdam(s) for diversion of watercourse to facilitate execution of pipeline laying, encasing work and pile works in dry conditions.
- The cofferdam shall be designed and executed to ensure:
 - Continuous and unobstructed flow of watercourse
 - Safe diversion of flow
 - Creation of a dry, stable, and safe working area
- The work shall be carried out as per approved drawings, specifications, and instructions of the Engineer in Charge.
- Prior to commencement, the Contractor shall submit detailed design, drawings, staging methodology, and diversion plan for approval.
- Measurement of the cofferdam shall be carried out on a linear basis in meters, along the perimeter of the cofferdam.

2. Scope of Works:

The scope shall include, but not be limited to:

- Diversion of watercourse using cofferdam construction.
- Construction of cofferdam with required alignment and working zone.
- Ensuring minimum 6.0 m working width for:
 - Lowering and laying of MS pipeline
 - Handling and installation activities
 - Execution of cast-in-situ pile works
- Formation of impervious core using soil/sand filled bags brought from outside.
- Providing stable section with stacking, interlocking, and compaction
- Ensuring continuous water flow during execution
- Maintenance of cofferdam in watertight and stable condition
- Dewatering to maintain dry working conditions
- Dismantling and restoration after completion.

3. Cofferdam Construction:

3.1 Materials and Formation

- Cofferdam shall be constructed using approved earth/sand filled in cement/gunny bags.
- Filling material shall be sourced externally and shall be free from organic impurities.
- Bags shall be properly filled, stitched, stacked, interlocked, and compacted to form a dense and stable structure.
- Impervious core shall be provided at centre using closely packed bags; polyethylene sheet or other lining may be used to control seepage if required.

3.2 Alignment, Stability and Protection

- Cofferdam shall be constructed to required alignment, levels, and cross-section.
- The cofferdam shall be designed to withstand water current, tidal variations, and hydraulic pressures.
- Proper side slopes, berms, and crest levels shall be maintained.
- Necessary slope protection measures (additional bag layers, pitching, etc.) shall be provided.
- Continuous monitoring shall be done to avoid erosion, piping, settlement, leakage, or failure.

4. Dewatering

- Contractor shall provide and operate adequate dewatering systems to keep the enclosed work area dry.
- Pumps, pipelines, standby arrangements, fuel/power, and manpower shall be included.
- Dewatering shall be maintained continuously during:
 - Pipeline lowering and positioning
 - Jointing and anchoring works
 - Cast in situ pile construction
- Discharged water shall be directed to approved locations without causing erosion or pollution.

5. Execution Requirements

- Cofferdam shall be constructed prior commencement of pipeline and piling works.
- Adequate access, working platforms, and safety arrangements shall be ensured inside the cofferdam area.
- The arrangement shall allow safe execution of:
 - Pipeline lowering and alignment.
 - Jointing operations.
 - Construction of RCC supports/anchor blocks with cast in situ piling at Pipelines joints.

6. Maintenance During Execution

- Cofferdam shall be maintained in sound, stable, and leak-proof condition at all times.
- Any damage, leakage, settlement, or breach shall be repaired immediately at Contractor's cost.
- Continuous surveillance and strengthening shall be carried out during entire execution period

7. Dismantling and Restoration

- After completion of pipeline laying, encasing works and piling works, cofferdam shall be carefully dismantled.
- All sandbags, temporary materials, and debris shall be removed from site.
- The river/creek bed shall be restored to original condition or as directed, without obstruction to natural flow.

8. Safety and Environmental Measures

- Provide barricading, life jackets, safety ropes, and rescue arrangements.
- Ensure safe operation of pumps and equipment, including proper earthing and insulation.
- Prevent pollution, turbidity, and contamination of water body.
- Emergency preparedness for flooding, overtopping, or cofferdam breach is mandatory

9. Measurements and Rate Inclusiveness

- Measurement of the cofferdam shall be carried out on a linear basis in meters, along the perimeter of the cofferdam.

The rate for cofferdam shall be inclusive of:

- Providing and placing sand/soil filled bags (including supply of bags and material)
- Construction, shaping, and stabilization of cofferdam
- Dewatering and pumping arrangements
- Maintenance throughout execution period
- Temporary access, platforms, and working arrangements
- Dismantling and removal of cofferdam
- Restoration of river/creek bed
- Labour, materials, Fuel, tools, plants, and all incidental works
- No additional payment shall be made for any ancillary, incidental or temporary work required for successful completion of the work as per instructions and satisfaction of the Engineer In-charge.
- Additionally the relevant section 1 to 8 to be followed for the details specifications.

Item No. 25 :

Pile works for supporting R.C.C. Encased 1829 mm dia MS water Pipeline near Surajbari Bridge Section:

Design, supply, fabrication, erection, and construction of pile for supporting the R.C.C. encased MS pipeline at Surajbari Bridge, complete in all respects, including construction of cast in situ bored piles of minimum 500 diameter or as per approved design whichever is higher for Surajbari bridge portion with 16 m minimum depth or as per approved design whichever is higher, depth shall be consider from pile cap bottom. Pile shall be cast with sacrificial M.S. liner of minimum 6 mm thickness, Pile and pile cap in M30 grade concrete suitably configured to connect and support the encased MS pipeline; providing and placing reinforcement using minimum CRS Fe-500 grade steel; including formwork, centering, shuttering, staging, vibration, curing and finishing. The scope shall include dewatering, all labour, materials, transport, machinery, fuel, temporary works, handling of site conditions, alignment, safety measures, and obtaining statutory permissions wherever required, and the work shall be completed in all respects as per specifications and directions of the Engineer In-charge.

All piles shall be provided at maximum 12 m interval. Each pile support shall be securely embedded and connected to the encased MS pipeline through properly designed pile caps, ensuring structural stability and enabling the system to withstand differential settlement, lateral movements, uplift forces, and other external loads.

- For Pile Works Refer Section 8: Pile Works Specification for Detail technical Specifications.
- Relevant Section 1 to 7 to be followed for the completion of the work.

General Scope & Design

- The work comprises design, supply, fabrication, erection and construction of bored cast in situ RCC pile foundation for supporting pipelines across water channel.
- The support system shall ensure proper alignment, gradient, stability and safety of the pipeline under all loading conditions.
- Maximum spacing between two pile shall be 3 times diameter of the pile.
- Minimum dimensions of pile shall be:
 - i) 0.5 m Diameter or as per design whichever is higher
 - ii) Depth of pile shall be minimum 16 m below from the bottom of pile cap or as per approved design, whichever is higher
- The contractor shall obtain all statutory permissions/clearances for river crossings, waterlogged areas and other crossings.

- All works shall confirm to approved drawings, specifications and relevant IS codes.

Survey & Setting Out

- Detailed survey, alignment fixing and marking of Pile locations shall be carried out prior to execution.
- Benchmarks, reduced levels and control points shall be established and approved by the Engineer-in-Charge.

Excavation Works

- Excavation shall be carried out in all types of strata, including saturated and waterlogged conditions, to required depths.
- The work shall include:
 - i) Dewatering arrangements
 - ii) Shoring/strutting where required
 - iii) Sorting and stacking of useful materials
 - iv) Disposal of surplus material with all leads and lifts
- Excavation shall be done carefully to avoid disturbance of surrounding strata and existing structures.

Foundation & Piling Works

- Bored cast-in-situ RCC piles shall be provided:
 - i) Minimum 500 mm diameter or as per design, whichever is higher
 - ii) Minimum 16.0 m depth from the bottom of pile cap or as per design, whichever is higher.
 - iii) Minimum pile cap thickness shall be 500 mm or as per design, whichever is higher.
- Boring shall include:
 - i) Drilling in all types of soil/rock strata
 - ii) Maintaining bore stability
 - iii) Removal of excavated material
- Sacrificial M.S. liner:
 - i) Minimum 6 mm thickness.
 - ii) Provided in waterlogged/unstable strata as required
- Concreting of piles:
 - i) Minimum M-30 grade concrete.
 - ii) Tremie method shall be adopted wherever required
- Proper quality control shall be maintained for verticality, integrity and continuity of piles.

Plain Cement Concrete (PCC)

- PCC of minimum M-15 grade shall be laid below: Foundations and Pile caps
- PCC shall include: Surface preparation, Machine mixing, Proper compaction and curing

RCC Substructure

- RCC works shall include: Pile, Pile cap.
- Concrete grade: Minimum M-30 grade for all RCC
- Work shall include: Centering, shuttering and staging, Mixing, placing, compaction and vibration, Finishing and curing
- Structural geometry shall be as per approved design and site requirements.

Reinforcement Steel

- Reinforcement shall be CRS Fe-500 grade steel.
- Steel shall be: Cut, bent and fixed as per design and IS codes, Properly tied with binding wire
- Necessary cover blocks shall be provided to maintain durability.
- Reinforcement quantity shall be as per design requirements.

Surface Finishing & Protection

- All RCC surfaces shall be: Smoothly finished and Free from honeycombing and defects.
- All steel components: Shall be cleaned and coated with anti-corrosive treatment/paint.
- Protective measures shall be taken against corrosion due to waterlogged conditions.

Dewatering & Water Control

- Adequate dewatering systems shall be implemented during execution.
- Proper drainage channels/pumps shall be arranged to keep working area dry.
- No extra payment shall be made for dewatering operations.

Execution Requirements

- The work includes:
 - i) All materials, labour, tools, machinery and plants
 - ii) Boring, concreting, fabrication, erection
 - iii) Handling, transport, leads and lifts
- All temporary arrangements including staging, access platforms and safety measures shall be provided.
- Work shall be executed strictly under supervision and as per directions of the Engineer-in-Charge.

Completion & Site Clearance

- After completion: All debris and waste materials shall be removed and Site shall be restored to original condition
- The work shall be handed over in complete and functional condition.
- No extra payment shall be made for incidental works required to complete the item.

SCHEDULE B-2**Item No. 1 to 2 :**

- To carry out survey work Co-ordination liasation for "Standing crop compensation "In land for laying water supply pipeline along the alignment of for NC-09 Surajbari Bridge Pipeline including shifting of centre line marking it on village map 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 GWIL 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 User 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.
- To prepare all relevant papers on behalf of GWIL 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 User" 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 Electric Poll, Creek Portion, 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.

SCHEDULE E

Item No. 1:

Contractor to pay back to Employer (GWIL) for Existing Steel Truss and MS Pipeline Dismantled at Surajbari Bridge:

Dismantling, demolition, cutting, safe removal, handling, stacking, loading, transportation and clearance of the existing Steel Truss support structure and existing MS Pipeline system installed on Surajbari Bridge, including all associated specials, fittings, valves, flanges, joints, supports, hangers, anchor arrangements, brackets, fasteners and appurtenant works, complete in all respects, after successful completion, testing, commissioning and satisfactory operation of the new pipeline system. The Contractor shall plan, coordinate and execute the entire work in accordance with the requirements of the Tender Documents, Conditions of Contract, Technical Specifications and directions of the Engineer-in-Charge, ensuring complete safety and protection of the existing bridge structure, carriageway, utilities, personnel and public property, without causing damage to any part of the bridge or disruption to existing vehicular traffic and public movement. The Contractor shall take all necessary precautions and make adequate arrangements for safe execution of the work with minimum hindrance to bridge operations and surrounding activities. Upon completion of dismantling activities, the Contractor shall remove all debris, scrap, temporary works and surplus materials and leave the site, bridge structure and surrounding area in a neat, clean and serviceable condition to the satisfaction of the Engineer-in-Charge. This include all labour, supervision, tools and tackles, cranes, equipment, temporary supports, traffic management arrangements, handling, dismantling, cutting, stacking, loading, transportation, unloading, storage, site clearance, buy-back value, compliance with tender requirements.

The Bidder shall carry out above mentioned works with Consultation of NHAI and getting all permissions from NHAI. The Bidder shall have to provide NOC from NHAI after the demolition works.

The details of Existing Steel Truss and MS pipeline items are as follows:

- (1) Existing Steel Truss on each side of Surajbari Bridge for supporting the existing MS pipeline.
- (2) Existing MS Pipeline on each side of Surajbari Bridge, including removal of all associated specials, fittings, valves, flanges, and jointing materials. The MS pipeline shall be considered between the blind flanges installed at the upstream and downstream ends of the existing pipeline, after its disconnection and integration with the new pipeline system.

Scope of Work

- The work shall consist of dismantling / demolition, safe removal, handling and transportation of the existing MS pipeline and pipe supporting steel truss at Surajbari Bridge. This shall include removal of all associated specials, valves, fittings, flanges, jointing materials, structural members, connections, bolts, plates and all related components.
- The dismantling shall be executed strictly in accordance with tender specifications, approved methodology and safety standards, ensuring minimum hindrance to traffic movement on the bridge and without causing damage to existing structures.
- The Contractor shall get permissions for Traffic Management before starting the works from competent authority.
- The Contractor shall carry out cutting, dismantling, lowering, loading, unloading, transportation, stacking, disposal and site clearance, complete in all respects.
- The MS pipeline shall be considered between the blind flanges installed at the upstream and downstream ends of the existing pipeline, after its disconnection and integration with the new pipeline system.
- The Bidder shall carry out work with Consultation of NHAI and getting all permissions from NHAI. The Bidder shall have to provide NOC from NHAI after the demolition works.

1. Planning, Methodology & Approval

- Prepare detailed dismantling methodology, lifting plan, and Traffic Management Plan (TMP) and obtain approval/permissions prior to commencement from competent authority.
- The Bidder shall carry out work with Consultation of NHA and getting all permissions from NHA. The Bidder shall have to provide NOC from NHA after the demolition works.
- Conduct joint site inspection to identify constraints, utilities, bridge conditions, and access.
- Plan work in phases / shifts (including night work if required) to minimize disruption.

2. Traffic Management & Safety

Since works are on an active bridge, the Contractor shall ensure safe traffic movement at all times:

2.1. Traffic Control Measures

- Provision of barricades, cones, retro-reflective signage, blinkers, and warning lights.
- Deployment of flagmen/marshals for traffic regulation.
- Lane closures/diversions as per approved TMP.
- Adequate night illumination for safe execution.

2.2. Safety Requirements

- Mandatory PPE: helmets, harnesses, reflective jackets, safety belts, etc.
- Provide lifelines, safety nets and fall protection systems.
- Prevent falling debris on carriageway/waterway.
- Maintain emergency access at all times.

3. Method of Dismantling

3.1. Pipeline

- Dismantling by cutting welded joints or loosening flanged connections using mechanical/gas cutting tools.
- Controlled cutting with fire safety arrangements.
- Removal of all jointing materials, bolts, gaskets, etc.
- Pipe sections to be lowered safely using cranes or lifting devices.

3.2. Steel Truss

- Dismantling in a systematic and sequential manner ensuring structural stability.
- Disconnect members without sudden load release.
- Controlled lowering using cranes, chain pulleys, slings, etc.

4. Lifting & Handling

- Provide suitable Hydra/Crane, lifting tackles, slings, spreader beams.
- Submit load calculations and lifting plans for approval.
- Lifting operations to be carried out under qualified supervision.

5. Material Handling, Transportation & Stacking

- If required all dismantled materials shall be carefully handled and transported to GWIL Headworks or any designated location as directed by Engineering In-charge.
- Contractor shall arrange transport vehicles including loading/unloading.

6. Dewatering (if required)

- Carry out dewatering to facilitate safe dismantling.
- Provide pumps, pipelines, and standby arrangements.
- Ensure safe disposal of water without environmental damage.

7. Protection of Existing Structures

- Ensure no damage to bridge structure, utilities, or surroundings.

- Provide protective measures such as padding and temporary supports.
- Any damage shall be repaired by the contractor at their own cost.

8. Site Clearance

- Remove all debris, scrap, and dismantled remnants.
- Maintain cleanliness and restore site to a safe and traffic-ready condition after each phase.

9. Safety & Environmental Compliance

- Comply with statutory safety regulations, IRC guidelines, and labour laws.
- Control dust, noise, and debris.
- Ensure no obstruction to drainage/water flow.
- Maintain emergency response arrangements.

10. Rate Inclusiveness

- Dismantling of pipeline and steel truss including all components.
- Cutting, handling, lowering, stacking and removal.
- Providing cranes, hydra, tools, plants, labour, fuel, consumables.
- Traffic management arrangements.
- Dewatering (if required).
- Transportation, loading/unloading, stacking.
- Protection of structures and safety provisions.
- Site clearance and all incidental works.

11. Documentation for Dismantled Materials

- Contractor has to provide weigh bridge slip of dismantled materials comprising MS pipeline, valves, steel truss, and associated structural components
- The Contractor shall maintain proper weighbridge slips, records, and registers, duly submitted to the Engineer-in-Charge.

12. Buy-Back and Payment to GWIL

- The dismantled MS pipeline, steel truss, and associated materials shall be considered as buy back items. The Contractor shall pay back to Employer (GWIL) for these materials as per the Price Bid.

VENDOR LIST FOR EQUIPMENTS/INSTRUMENTS

- The approved Vendor list for the Civil/Mechanical/Electrical/Instrumentation and other equipments is available on GWSSB's official website at <http://www.gwssb.gujarat.gov.in>. At the time of approval of QAP, the latest or amended vendor list shall be applicable & considered for executing the job.
- Bidder must have to provide electro-mechanical equipment including pumps & motors from approved vendor list only having "A" category as published on GWSSB website at the time of approval of QAP.