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## **TECHNICAL SPECIFICATIONS – WATER SUPPLY**

### **A. Specification for Engineering civil Works**

1. General Specifications & requirements
  - 1.1 As far as applicable the requirements in these technical specifications should be read in conjunction with and be supplemented by “Specifications for Building and Road Works (SBRW) – 2005” or the latest edition as available. This document is published by the Standard and Quality Control Authority (SQCA), Ministry of Works and Human Settlement, Royal Government of Bhutan.
  - 1.2 The rates for all items, unless specifically stated otherwise in contract, must cover the cost of all materials, all taxes & duties in vogue, labour, tools, machinery, plant, explosives, scaffolding staging, shoring, props, bamboos, ropes, templates, pegs, and all appliances and operations whatever necessary for efficient execution and completion of the work. All works are to be executed in accordance with description in the schedule of item of works along with the specifications, terms, conditions provided elsewhere in the tender document.
  - 1.3 Item of works and their details, which are not covered by this specifications, shall be carried out as per those of Specifications for Building & Road Works, 2007, MoWHS, Royal Govt. of Bhutan. The specification of works not included above, should be carried out as per relevant provisions of the manual on Water Supply & Treatment published by CPHEEO, relevant I.S. code, I.S code of practices and other internationally accepted standards.
  - 1.4 The overall outline of works to be done by the contractor and the details has been mentioned in the item of works in the schedule and in the specification, drawings and elsewhere in the tender documents. Each schedule item has to be carried out and completed by the contractor at the accepted rate covering the full extent outlined in the schedule and specification and not withstanding any omission in mentioning of supply and execution of such component of works except in special case specially mentioned. Items indicated in the schedule are exhaustive. Yet if there be any short fall felt by the tenderer he may include the same while quoting his rate so as to make the item complete in all respect for successful operation of the plant.
  - 1.5 The contractor’s works shall be guided by the total requirement briefly outlined and shall include additional works other than those component of works mentioned in the items to complete the work. The tenderer or the contractor has to completely execute the full requirements ensuring performance guarantee of each components of the works, equipments and machinery so that all

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the individual components are up to the optimum condition for sustained and satisfactory operation individually and collectively.

- 1.6 Site Conditions: The contractor is to visit the site and ascertain local conditions, traffic restrictions, obstructions in the area before submission of tender paper to satisfy himself.
- 1.7 Setting out and leveling: The contractor is to set out and level the works, and will be responsible for the accuracy of the same. He is to provide all instruments and proper qualified staff required for checking the contractor's work.
- 1.8 Safety Code: The contractor shall take adequate precaution to provide complete safety for prevention of accident on the site.
- 1.9 Keeping works free from water: The contractor shall provide and maintain at his own cost, electrically or other power driven pumps and other plant and equipment to keep the site and foundation pits and trenches free from water and continue to do so till the site is handed over to the complete satisfaction of the E.I.C.
- 1.10 Clear site: The site during the execution of works should have sober and tidy appearance with everything necessary for the work neatly and systematically arranged.
- 1.11 Bench marks and ground Water Gauges: The contractor shall establish and protect the bench marks and base line marks from damage or movement during work at his cost.
- 1.12 Inspection: The contractor shall inspect the site of work and ascertain site conditions and the nature of soil to be excavated.
- 1.13 Contractor's staff: The contractor must provide at all times efficient staff of trustworthy, skillful and experienced assistants capable of carrying out the works in accordance with the drawings and specifications and to correct levels.
- 1.14 Unless otherwise specified the method of measurement for building work shall be as outline in SBRW -2007
- 1.15 Trade Name: Trade Names and Catalogue References are given solely as a guide to the quality and alternative manufacturers of the materials or goods of equipment quality may be approved by the Engineer-in-Charge
- 1.16 The Contractor's attention is drawn to the various provisions of the Specification regarding the use of "semi-mechanized" methods of construction including stone crushers and equipment for the batching, transport, placing and compaction of concrete. The Contractor shall in his Bid give a written description of his proposed methods of construction and shall not during the execution of the Contract deviate substantially from these tendered methods of construction without firstly obtaining the approval of the Engineer

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1.17 Temporary Roads: The Contractor shall provide, maintain and remove on completion all temporary roads, bridges and other work required for the construction of the works including access to quarries, borrow-pits, accommodation, etc. The Contractor shall provide and in his rates to allow for all necessary temporary traffic control signs, barricades, flagmen, lighting and watching required for normal control of traffic. Whenever the alignment of water / sewer mains crosses a public road, the Contractor shall well in advance of excavation, contact the relevant authorities and obtain the necessary permission to excavate across the road subject to any requirement these authorities may have and shall pay any royalties connected with this work. The Contractor shall provide a temporary detour road of a sufficient quality to the satisfaction of the Engineer-in-Charge. The cost of all work connected with road crossings, warning signs are deemed to have been included in the unit rates in the Bill of Quantities.

1.18 Sign boards: The Contractor shall erect signboards in prominent positions adjacent to the works to the satisfaction of the Engineer-in-Charge.

1.19 Site Office: The Contractor shall construct an office near the works at the site to be approved by the Engineer-in-Charge. The office shall be kept open all hours during which the work is in progress. Any notice to be given to or served upon the Contractor shall be deemed and taken to be effectively given or served upon by the delivery thereof at such office.

1.20 On the completion of the Contract, the Contractor shall take down and remove all structures connected with this camp, and shall take up all pipes, drains and culverts, backfill trenches, fill up all latrine pits, soakways and other sewerage disposal excavations, and shall restore the site as far as practicable to its original conditions and leave it neat and tidy to the satisfaction of the Engineer-in-Charge.

## **2. Approval of materials**

2.1 Sample of materials in sufficiently large quantity with descriptive thereof shall be furnished by the contractor to the Engineer-in-charge well before the collection of such materials and equipments so as to permit inspection, testing and approval. The sample shall be properly marked to show the name of materials, name of manufacturer, and place of origin and item for which it is to be used. After approval, the sample shall be available for inspection at all time.

2.2 Structural steel materials, DI, GI and uPVC pipes, all types of valves and other appurtenants to be supplied by the contractor shall conform to the requisite I.S. specification properly tested and duly certified. Those are to be approved by the Engineer in-charge before use.

## **3. Materials**

3.1 Materials shall be of approved quality. A list of materials of approved brand and manufacture can be obtained from SQCA. If the list of materials mentioned above stipulates two or more alternative brands/makes of any product, the decision as to which brand/make shall be used in the work shall

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be taken by the engineer-in-charge and the contractor shall provide the brand/make selected without any extra cost. Testing of materials even of approved brands shall have to be done by the contractor at their own cost, to ensure quality.

- 3.2 In case materials are required to be obtained from any manufacturer other than those listed on account of non availability or included in BoQ then prior approval from the Employer will be necessary supported by relevant test certificates qualifying the required standard. Further tests as directed by the Engineer-in-charge shall also be carried out by the contractor at his/her own cost, if required.

Contractor shall obtain approval of the Engineer-in-Charge on sample of all materials before placing order and the approved sample shall be carefully preserved in an appropriate manner at the site office for verification by the Engineer-in-charge. For standard bought out items, the sizes manufactured by the firms listed shall prevail in case of discrepancy with the sizes mentioned in the schedule without any financial adjustment.

- 3.3 Materials shall be tested at site/any approved testing laboratory. The laboratory test certificate in original shall be submitted to the Engineer-in-charge and the entire charges connected with testing including charges for repeated tests, if ordered, shall be borne by the contractor. Test results are also to be recorded at site registers appropriately. It shall be obligatory for the contractor to furnish certificates, if demanded by the Engineer-in-charge from manufacturer or the material supplier, stating that the work has been carried out by using their materials.

- 3.4 All equipment and facilities for carrying out field tests on materials shall be provided by the contractors without any extra cost. Unless otherwise shown on the drawings or mentioned in the "Bill of quantities" or anywhere in the contract, the quality of materials, workmanship, dimensions etc. shall be as specified.

- 3.5 Stone Chips: These should be obtainable by the contractor, well graded conforming to the standard specification and approved by the Engineer-in-charge.

- 3.6 Sand: sand for construction purpose should be coarse, cleaned, screened and washed & of quality conforming to the standard specification and also to be approved by the Engineer-in-charge.

- 3.7 Bricks: Bricks shall be of first class quality, well burnt in Kiln, sound hard, true to shape and other standard dimensions and to be approved by the Engineer-in-charge before use.

- 3.8 Pipes, specials, valves, penstocks, equipments etc.: All pipes, specials, valves channel shutters, penstocks, mechanical and electrical equipments, instruments, weighing machines, R.S. Joist, hoists, air blowers etc. should conform to relevant specification.

#### **4. Excavation, Fill and backfill**

- 4.1 The scope of work covered under this specifications pertains to excavation of foundations, trenches, pits and over areas, in all sorts of soils, soft and hard rock, correct to dimensions given in

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the drawing including shoring, protections of existing underground utilities if any, such as water lines, electric cables etc., dewatering and shoring if necessary, stacking the useful materials as directed within the lead specified, refilling around the foundation and into the plinth with selected useful excavated earth and disposing off the surplus earth/materials within specified lead and finishing the surface to proper levels, slopes and camber etc., all complete.

- 4.2 Site Clearance: Before the earth work is started the area coming under cutting and filling shall be cleared of all obstructions, loose stones, shrubs, vegetation, grass, and rubbish and removed up to a distance of 50 meters outside the periphery of the area under clearance. The site clearance work to be carried out as specified in the Bill of Quantities. Any material obtained from the site will be the property of the Department and the useful materials as decided by the Engineer-in-charge will be conveyed and properly stacked as directed within the lead specified.
- 4.3 Setting Out and Making Profiles: Masonry or concrete pillars will be erected at suitable points in the area to serve as bench marks for the execution of the work. These bench marks shall be connected with G.T.S. or any other permanent benchmark approved by the Engineer-in-charge. The layout should be provided with necessary instrument like theodolite, dumpy level etc. as per instruction of the Engineer-in-charge in order to maintain accuracy of all dimensions as shown in the layout drawings. All instruments required for setting out to be provided by the contractor at no extra cost. Necessary profiles with pegs, bamboos and strings shall be made to show the correct formation levels before the work is started. The contractor shall supply labour and materials for setting out and making profiles and strings for the work at his own cost and the same shall be maintained during the excavation work. The Thimphu City Corporation (TCC) will show grid Co-ordinate or other reference points. It shall be the responsibility of the contractor to set out centre lines correctly with reference to the drawing and install substantial reference marks. Checking of such alignment by the Engineer in Charge will not absolve the contractor from his responsibility to execute the work strictly in accordance with the dimensions shown in the drawings.
- 4.4 Excavation: The contractor shall notify the Engineer-in-charge before starting excavation and before the ground is disturbed, to enable him to take exiting levels for the purpose of measurements. The ground levels shall be taken at 5 to 15 meters intervals in uniformly sloping ground and at closer distance where local mounts, pits or undulations are met with, as directed by the Engineer-in-charge. The ground level shall be recorded in field's book and plotted on the plans, which shall be signed by the contractor and the Engineer-in-charge, before the earth work is actually started. The labour required for taking levels, shall be supplied by the contractor at his own cost. The contractor shall perform excavation in all types of soils, soft and hard rocks, boulders etc., in foundation, over areas and in trenches to widths, lines, levels, grades and curves as shown in the drawings or lesser widths, lines and levels as directed by the Engineer-in-Charge and as per items in the schedule of quantities.
- 4.5 All excavated materials must be carefully deposited in spoil bank allowing the access to workers and plant machinery. The toe of the spoil bank shall be set at sufficient distance and should not be

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less than 3 to 4 times the depth of excavation. If so ordered by Engineer-in-charge, the excavated materials have to be carried away and placed within a lead of 50 m. Such quantity of extra materials as may be required shall be brought back to back-fill the trench with proper consolidation in layers of 200mm thickness, properly rammed. Flooding of trench pit during back filling may be resorted to if so directed by Engineer-in-charge.

- 4.6 Contractor must make good at his own cost, all damages or settlements sustained by any structure founded on the trench or adjacent to the trench.

## **5. Dewatering**

All water should be removed by pumping if required, which may accumulate in the excavation during the process of works such as mud mat concrete, R.C. footings, shuttering etc., either due to seepage, springs, rain or any other cause and diverting surface flow by bunds or means to make the ground surface dry and clean as practicable to the satisfaction of the Engineer-in-charge. Care shall be taken to ensure that the water discharged sufficiently away from the foundations to keep it free from nuisance to other works in the neighborhood.

## **6. Disposal of excavated Materials**

- 6.1 Antiquities: Any items of archaeological interest such as relics of antiquity, coins, fossils or other articles of value, found during excavation shall be delivered to the Engineer-in-charge and shall be the property of the Government.
- 6.2 Useful materials: Any materials obtained from the excavation which in the opinion of the Engineer-in-charge is useful shall be stacked separately in regular stacks as directed by the Engineer-in-charge and shall be the property the Government. No material excavated from foundation trenches of whatever kind they may be are to be placed even temporarily nearer than about 3 m from the outer edge of excavation. Discretion of the Engineer-in-charge in such case is final. Rate for excavation shall include sorting out of the useful materials and stacking them separately as directed within the specified lead.
- 6.3 Materials suitable and useful for backfilling or other use shall be stacked in convenient place but not in such a way as to obstruct free movement of materials, workers and vehicles or encroach on area required for constructional purposes. It shall be used to the extent required to completely backfill the structure to original ground level or other elevation shown on the plan or as directed by the Engineer-in-charge. Materials not useful in anyway shall be disposed off, leveled and compacted as directed by the Engineer-in-charge within a radius as specified lead. The site be left clean of all debris and leveled on completion.

## **7. Plain Cement Concrete (P.C.C)**

- 7.1 100 mm thick concrete of 1:3:6 shall be provided below R.C. foundations and structures as approved by the Engineer- in-charge.

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- 7.2 For plain cement concrete work, the specification for materials like cement, sand, fine and coarse aggregates and water shall be the same as that specified in reinforced concrete work specifications.
- 7.3 The proportion of mix will be nominal and the ratio of fine and coarse aggregate may be slightly adjusted within limits, keeping the total value of aggregates to a given volumes of cement constant to suit the sieve analysis of both the aggregates. Cement shall on no account be measured by volume, but it shall always be used directly from the bags (i.e. 50kg/bag).

## **8. Brick Work**

- 8.1 The work covered under this specification pertains to procurement of best quality available bricks and workmanship in buildings, walls of various thickness, in strict compliance with the specifications and applicable drawings.
- 8.2 Materials: Bricks shall be best quality locally available bricks and shall be got approved by the Engineer-in-charge before incorporation in the work. The contractor shall get the sample and source of bricks approved from the Engineer- in-charge before procurement on large scale and shall maintain the same for the entire work.
- 8.3 Bricks shall generally conform to IS 1077-1970. In any case minimum crushing strength shall not be less than 350Kg/cm<sup>2</sup>. And water absorption shall not more than 25% by the weight. The Engineer-in-charge shall have the right to reject the bricks obtain from any field where the soils have an appreciable quantity of sulphates and chlorides. The specification for cement, sand and water shall be same as described herein before under cement concrete. Bricks shall be thoroughly soaked in water before using till the bubbles cease to come up. No half or quarter brick shall be used except as closer. The closer shall be cut to required size and used near the end of the walls. The walls shall be raised truly to plump. The type of bond to be adopted shall be decided by the Engineer-in-charge, but vertical joints shall be laid staggered.
- 8.4 Workmanship: Four courses of brick work with four joints should not exceed by more than 40 mm of the same bricks piled one over the other without mortar.
- 8.5 Brick work shall not be raised more than 10 courses a day unless otherwise approved by the Engineer-in-charge. The brick work shall be kept wet for at least 7 days. Brick work shall be uniformly raised around and no part shall be raised more than 1.0 meter above another at any time.
- 8.6 All joints shall be thoroughly flushed with mortar of mix as specified at every course. Care shall be taken to see that the bricks are bedded effectively and all joints completely filled to full depth not less than 10 mm, as the work proceeds. The surface of brick work shall be cleaned down and watered properly before the mortar sets.

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- 8.7 The adhesion between the brick masonry surface and the concrete surface of columns, beams, sunshades, lintels etc. should be proper by ensuring that the concrete surface coming in contact with brick masonry is hacked/chipped/keyed, clean and cement slurry is applied so that proper bond is achieved between the two dissimilar materials. It is the responsibility of the contractors to ensure that there will not be any cracks/fissures anywhere in the brick masonry.
- 8.8 In case the cracks appear subsequently in those areas, they should be made good by cement grouting or epoxy putty grouting/poly sulphide compound grouting or as per standard modern specifications/methods with the prior approval of the Engineer-in-charge, at the cost of the contractor.
- 8.9 No brick work shall be carried on during frosty weather except with the written permission of the Engineer-in-charge who will give special directions as to the manner in which the work is to be performed. All brick work laid during the day, shall, in seasons liable to frost, be properly covered up at night as directed by the Engineer-in-charge. Should any brick work be damaged by frost, the brick work shall at the discretion of the Engineer-in-charge, be pulled down and made good at the cost of the contractor.
- 8.10 Concrete surfaces of columns, beams, lintels; sunshades etc. coming in contact with masonry work shall be properly chipped, washed and given a thick coat of cement slurry before start of work. The rate quoted shall include wire brushing and cleaning brickwork covered with fungus or deleterious materials.
- 8.11 Brick work shall be well watered/ cured throughout the day for at least a week from the date of building and the work shall be protected from sun and rain.

## **9. Masonry**

- 9.1 The work covered under this specification consists of supplying and erecting stone masonry walls with available best quality of stone in strict compliance with this specification and applicable drawings.
- 9.2 Materials: The rubble shall be of the best quality trap/granite/ballast stones obtained from the approved quarry. The sample of the stone, to be used shall be got approved from the Engineer-in-charge. All stones shall, generally, be freshly quarried and shall be sound, dense, hard, free from segregation, cracks, weathered portions and other structural defects or imperfections, tending to off set soundness and strength. The percentage of water absorption shall generally not exceed 5 % by weight. All stone shall be wetted before use. Stones shall be neatly worked to requisite sections and forms and shall have fully dressed beds and joints. No hollow space shall be left out and inter spaces of stones being filled with mortar and stone chips, driven hard and not with mortar only.
- 9.3 All mortar to be used shall be of the type and proportion mentioned in the item. Cement, sand and water to be used shall conform to their relevant specification as describe under cement concrete.

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The masonry shall be laid to plumb, lines levels, curves, shapes as shown in drawings. All required holes for passage of water or pipes are to be embedded during construction as specified.

- 9.4 When practicable, the whole masonry in any structure shall be carried out upto a uniform level throughout. But when breaks are unavoidable in carrying the work continuously in uniform level, sufficiently long steps shall be left. All junctions of walls shall be formed at the time when walls are being built. Cross walls should be carefully bonded into the main walls. All masonry built in cement mortar shall be kept continuously wet for 14 days from date of laying. Should the mortar perish i.e. becomes dry, white or powder through neglect of watering and if the masonry shows hollow joints or non adherence of mortar to the stones or if the work does not conform to drawing and specifications, the work shall be pulled down and rebuilt by the contractor at his own cost and risk. All masonry shall be thoroughly cleaned and washed down on completion and all stains, adhering mortar removed from the surface and racking of joints carried out as the scaffolding is being lowered and removed. Holes left in masonry for supporting scaffolding shall be filled and made good before pointing/plastering.

## **10. Formwork**

- 10.1 The form work shall consist of shores, bracings, sides of beams and columns, bottom of slabs etc, including ties, anchors, hangers, inserts etc. complete which shall be properly designed and planned for the work. The false work shall be so constructed that up and down vertical adjustment can be made smoothly. Wedges may be used at the top or bottom of shores, but not at both ends, to facilitate vertical adjustment of dismantling of form work.
- 10.2 Type of form work: Unless otherwise specified, all forms in contact with concrete must be of metal or steel plate/sheet and phenol bonded plywood panel forms. Steel forms shall be with prior approval of the Engineer-in-charge and shall be plane and unbent. Plates shall be closely and properly jointed. No plugs, bolts, ties or any appliances whatsoever for supporting the shuttering shall be fixed permanently in the structure, in such a manner to avoid the damage to the structure upon their removal at the time of striking the forms and supports. Forms for beams should be laid with a camber of  $1/480^{\text{th}}$  of the span. Phenol boned Plywood panel forms may be permitted to use for rectangular columns with adequate strengthening by timer battens of 40mm x40mm in cross-section. Likewise, for circular columns, metal sheets built in to shape with adequate strengthening by timer battens shall be used. For special finishes, the form work may be lined with plywood, steel sheets, oil tempered hard board etc. Sliding forms and slip forms may be used with the approval of the engineer-in-charge.
- 10.3 The formwork shall be so constructed that it is rigid enough to remain free from any bulging, sagging or any movement during the placing of the concrete and that it can be subsequently removed without damaging concrete. The formwork shall be sufficiently watertight to prevent loss of liquid from the concrete. All formworks shall be fixed to proper elevation. No concreting work shall be undertaken by the contractor until the level, size, suitability etc. is approved by the

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engineer-in-charge. Whenever considered essential the contractor shall submit in triplicate the design for the shuttering they propose to use, together plan of operation.

- 10.4 Surface of forms in contact with concrete shall be properly planned. All rubbish shall be removed from the interior of the forms and the surface of formwork to come in contact with concrete shall be cleaned and thoroughly treated with oil. The oil shall be applied before the reinforcement is placed, and care shall be taken that no oil comes in contact with steel while it is being placed in position. The joints of forms shall be made water tight by plugging them with good clay jute or by other approved means before applying oil. The forms shall be so fixed that only slight marks are visible on the surface of the concrete after stripping the forms. Approved form emulsions shall be used for application to the form surfaces in such a way as to prevent discoloration of original cement color.
- 10.5 Design of Form Work: The design of form work as well as its construction shall be the responsibility of the contractor. If so instructed, the drawings and calculations for the design of the form work shall be submitted well in advance to the Engineer-in-charge for approval before proceeding with work, at no extra cost to the TCC. Engineer-in-charge approval shall not however, relieve Contractor of the full responsibility for the design and construction of the form work. The design shall take into account all the loads vertical as well as lateral that the forms will be carrying including live and vibration loadings.
- 10.6 Formwork requirements: Form shall conform to the shapes, lines, grades and dimensions including camber of the concrete as called for in the drawings. Ample studs, braces, straps, shores etc. shall be used to hold the forms in proper position without any distortion whatsoever until the concrete has set sufficiently to permit removal of forms. Forms shall be strong enough to permit the use of immersion vibrators. In special cases, form vibrators may also be used. The shuttering shall be close boarded. Faces coming in contact with concrete shall be free from adhering grout, plaster, paint, projecting nails, splits or other defects. Joints shall be sufficiently tight to prevent loss of water and fine material from concrete. Plywood shall be used for exposed concrete surfaces, where called for. Inside faces of forms for concrete surfaces, which are to be rubbed finished shall be planed to removed irregularities or unevenness in the face. Form work with lining will be permitted.
- 10.7 Shores supporting successive stories shall be placed directly over those below or be so designed and placed that the load will be transmitted directly to them. Trussed supports shall be provided for shores that cannot be secured on adequate foundation.
- 10.8 Formwork during any stage of construction showing signs of distortion or distorted to such a degree that the intended concrete work will not conform to the exact contours indicated on the drawings. Shall be repositioned and strengthened. Poured concrete affected by the faulty formwork, shall be entirely removed and the form work corrected prior to placing new concrete.
- 10.9 Excessive construction camber to compensate for shrinkage settlement etc. that may impair the structural strength or members will not be permitted.

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- 10.10 Forms for substructure concrete may be omitted when, in the opinion of Engineer-in-charge, the open excavation is firm enough to act as the form. Such excavations shall be slightly larger than the required by the drawings to compensate for irregularities in excavation and to ensure the design requirement.
- 10.11 Forms shall be so designed and constructed that they can be stripped in the order required and their removal do not damage the concrete. Face formwork shall provide true vertical and horizontal joints, conforming to the architectural features of the structure as to location of joints and be as directed by Engineer-in-charge.
- 10.12 When exposed smooth or rubbed concrete finishes are required, the forms shall be constructed with special care so that the desired concrete surfaces could be obtained which require a minimum finish.
- 10.13 Bracings, Struts and Props: Shuttering shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due to movement of men and other materials. Steel tube or pipe shall be used as props or cross bracings.
- 10.14 The shuttering for beams and slabs shall be so erected that the shuttering on the sides of beams and under the soffit of slab can be removed without disturbing the beam bottoms.
- 10.15 Re-propping of beams shall not be done except when props have to be reinstated to take care of construction loads anticipated to be in excess of the design load. Vertical props shall be supported on wedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the shuttering.
- 10.16 If the shuttering for a column is erected for the full height of the column, one side shall be left open and built upon sections as placing of concrete proceeds, or windows may be left for pouring concrete from the sides to limit the drop of concrete to 1.0 m or as directed by Engineer-in-charge.
- 10.17 Inspection of Form Work: Following points shall be borne in mind while checking during erection of form work and form work got approved by the Engineer-in-charge before placing of reinforcement bars:
- Any member which is to remain in position after the general dismantling is done should be clearly marked.
  - Materials used should be checked to ensure that, wrong items/rejects are not used.
  - If there are any excavations nearby which may influence the safety of form works, corrective and strengthening action must be taken.
  - Safety measures to prevent impact of traffic; scour due to water etc. should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.

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- Bracing, struts and ties shall be installed along with the progress of form work to ensure strength and stability of form work at intermediate stage. Steel sections (especially deep sections) shall be adequately restrained against tilting, over turning and form work should be restrained against horizontal loads. All the securing devices and bracing shall be tightened.
  - The stacked materials shall be placed as catered for, in the design.
  
  - When adjustable steel props are used, they should:
    - i) Be undamaged and not visibly bent.
    - ii) have the steel pins provided by the manufacturers for use.
    - iii) be restrained laterally near each end.
  - Screw Adjustment of adjustable props shall not be over extended.
  - Double wedges shall be provided for adjustment of the form to the required position wherever any settlement/elastic shortening of props occurs. Wedges should be used only at the bottom end of single prop.  
Wedges should not be too steep and one of the pair should be tightened/clamped down after adjustment to prevent their shifting.
  - No member shall be eccentric upon vertical member.
  - Cantilever supports shall be adequate.
  - Props shall be directly under one in multistage constructions as far as possible.
  - Guy ropes or stays shall be tensioned properly.
  - There shall be adequate provision for the movement and operation of vibrators and other construction plant and equipment.
  - Required camber shall be provided over long spans.
  - Supports shall be adequate, and plumb within the specified tolerances.
- 10.18 Form Oil: Use of form oil shall not be permitted on the surface which requires painting. If the contractor desire to use form oil on the inside of formwork of the other concrete structures, a non staining mineral oil or other approved oil may be used, provided it is applied before placing reinforcing steel and embedded parts. All excess oil on the form surfaces and any oil on metal or other parts to be embedded in the concrete shall be carefully removed. Before treatment with oil forms shall be thoroughly cleared of dried splatter of concrete from placement of previous lift.
- 10.19 Reuse of Forms: Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes that may leak suitably plugged and joints examined and when necessary repaired and the inside retreated to prevent adhesion, to the satisfaction of Engineer-in-charge. Warped lumber shall be replaced. Contractor shall equip himself with enough shuttering to complete the job in the stipulated time.

10.20 Striking removal of Forms: No forms shall be removed or staging struck until it is safe to do so and approved by the Engineer-in-charge. All vertical centering members or supports/props shall be sufficiently braced with stiff members.

10.21 All formwork shall be removed without shock or vibration and without damaging the new concrete. The side forms shall be so fixed that while removing the supporting forms and posts are not disturbing to any extent. In no circumstances should the supporting forms be struck until the concrete reaches strength of at least twice the stress to which the concrete may be subject at the time of striking. In case of horizontal members it is desirable that the supports or props should be kept for sufficiently long period in order to prevent sagging of the members. Striking shall be done slowly with utmost care to avoid damage to arise and projection and without shock or vibration, by gently easing the wedges. If after removing the formwork, it is found that timber has been embedded in the concrete, it shall be removed and made good as specified earlier. Work damage due to premature or careless removal of forms shall be re-constructed at contractors cost.

10.22 After the placing of the concrete, forms may be struck after expiry of the following minimum periods in days.

Type of formwork		Form				Support			
Type of structure		Footings, wall, sides of columns & beams		Underside of slab & beam		Slab		Beam	
Type of cement		OPC	PPC/PSC	OPC	PPC/PSC	OPC	PPC/PSC	OPC	PPC/PSC
Temperature	Above 15°C	3 days	5	6	8	17	28	28	28

	5°C ~15°C	5 days	7	10	12	25	28	28	28
	Below 5°C	8 days	10	16	18	28	28	28	28
Compressive strength		5MPa		50% of 28		85% of 28		100%	

10.23 The contractor shall record the date upon which each part of the work is concreted together with the date upon which the shuttering is removed. No shuttering or cantering shall be removed until an approved period has elapsed since the last date on which the concrete was placed in the parts of the work concerned. Notwithstanding the approval of the Engineer-in-charge any damage or other consequences arising there shall be the contractor's entire responsibility.

**11. Reinforcement of R.C.C. Work**

11.1 Reinforcement Bars: Steel reinforcement bars, if supplied or arranged by the contractor, shall be deformed high strength T.M.T. (Thermo Mechanically Treated) of Fe 415 yield strength and minimum percentage elongation of 14.5% conforming strictly to I.S. 1786 latest version, as shown and specified on the drawings. Substitution of reinforcement will not be permitted except upon written approval from Engineer-in-charge.

11.2 Reinforcing rods shall be fabricated to shapes and dimensions as shown in the drawings and shall be placed where indicated on the drawings. Before being placed, reinforcement shall be thoroughly inspected and cleaned. Reinforcement shall not be bent or straightened in manner injuries to the material. Bars with kinks or bends not shown on drawings shall not be placed. The reinforcement shall be cleaned of rust and scales at all stages of work without extra cost to the TCC. Reinforcement shall not be spliced at points of maximum stress. Laps of the spliced shall be 50 times diameter of the bar in beam and slabs and 40 times diameters in columns and walls, unless otherwise specified on the drawings. The intersections of 4 rods crossing each other shall be bound with 16 SWG binding wire such that joints will not be displaced in the process of placing concrete. The contractor shall submit bar bending schedule for approval by the Engineer-in-charge and reinforcement shall be placed as per approved bar bending schedule.

11.3 The cost of steel used by the Contractor in the reinforcement of walls, beam, slabs and columns etc. will be paid as per rate for reinforcement only up to the extent shown in the drawings. Any laps and hooks provided by the Contractor for his own convenience shall not be measured for payment. Splices in adjacent bars shall be staggered. The reinforcing bars shall be placed as

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- directed by the Engineer-in-charge and shall be kept rigidly in position while the concreting is being done.
- 11.4 **Storage:** The reinforcement steel shall not be kept in direct contact with ground but stacked on top of an arrangement of timber sleepers or the like. Reinforcement steel shall be coated with cement wash before stacking to prevent scale and rust.
- 11.5 **Quality:** All steel shall be graded 1 quality unless specifically permitted by the Engineer-in-charge. No roll material will be accepted. If demanded by the Engineer-in-charge, Contractor shall submit the manufacturers test certificate for steel. Random test on steel supplied by contractor may be performed by TCC as per relevant Indian standards. All costs incidental to such test shall be at contractor's expense. Steel not conforming to specification shall be rejected. All reinforcement shall be clean, free from grease, oil, paint, dirt, loose mill, scale, loose rust, dust, bituminous material or any other substances that will destroy or reduced the bond. All rods shall be thoroughly cleaned before being fabricated. Pitted and defective rods shall not be used. All bars shall be rigidly held in position before concreting. No welding of rods to obtain continuity shall be allowed unless approved by the Engineer-in-charge. If welding is approved, the work shall be carried as per I.S. 2751, according to best modern practices and as directed by the Engineer-in-charge. In all cases of important connections, tests shall be made to prove that the joints are of the full strength of bars welded.
- 11.6 **Laps:** Laps and splices for reinforcement shall be shown on the drawings. Splices in adjacent bars shall be staggered and the locations of all splices, except those specified on the drawings, shall be approved by the Engineer-in-charge. The bars shall not be lapped unless the length required exceeds the maximum available lengths of bars at site.
- 11.7 **Bending:** All bars shall be accurately bent according to the sizes and shapes shown on the detailed working drawing/bar bending schedules. They shall be bent gradually by machine or other approved means. Reinforcing bars shall not be straightened and re-bent in a manner that will injure the materials. Bars containing cracks or splits shall be rejected. They shall be bent cold, except bars of over 25mm in diameter which may be bent hot if specifically approved by the Engineer-in-charge. Bars which depend for their strength on cold working shall not be bent hot. Bars bent hot shall not be heated beyond cherry red colour (not exceeding 645°C) and after bending shall be allowed to cool slowly with out quenching. Bars incorrectly bent shall be used only of the means used for straightening and re-bending be such as shall not, in the opinion of the Engineer-in-charge injure the material. No reinforcement bar shall be bent when in position in the work without approval, whether or not it is partially embedded in hardened concrete. Bars having kinks or bends other than those required by design shall not be used.
- 11.8 Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position, care should be taken to ensure that at no time the radius of the bend is less than 4 bar diameters for plain mild steel or 6 bar diameters for deformed bars. Care shall
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also be taken when bending back bars to ensure that the concrete around the bar is not damaged.

11.9 **Fixing/Placing and Tolerance on Placing:** Reinforcement shall be accurately fixed by any approved means maintained in the correct position as shown in the drawings by the use of blocks, spacers and chairs as per I.S. 2502 to prevent displacement during placing and compaction of concrete. Bars intended to be in contact at crossing point shall be securely bound together at all such points with number 16 gauge annealed soft iron wire. The vertical distances required between successive layers of bars in beams or similar members shall be maintained by the provision of mild steel spacer bars at such intervals that the main bars do not perceptibly sag between adjacent spacer bars.

11.10 **Cover to Reinforcement:** The cover shall in no case be reduced by more than one third of specified cover or 5 mm whichever is less. Unless indicated on the drawings, clear concrete cover for reinforcement shall not be less than the following thickness:

For footings, the cover to reinforcement is 50mm. for slabs and walls 20mm, for beams and girders 25mm and tied columns 40mm. For exterior side of reinforced concrete wall, the cover shall be 40mm. The cover to reinforcement should be as specified in relevant drawings.

11.11 The correct clearance from the formwork shall be maintained by using either precast blocks or metal chairs to be provided by the Contractor without any extra charge. The precast blocks used for spacing will be properly cast and cured and will be of the same mix, as of the concrete. Spacers and supporting chairs provided for correct positioning of various layers of reinforcement will be provided without any extra charge.

## **12. R.C.C. Works**

12.1 Specifications covers the proportioning, mixing and placing of reinforced cement concrete. The cement concrete may be mixed in required proportions as specified in the drawings by volume. The reinforced cement concrete to be mixed in accordance to the design mix. The design mix of concrete to be prepared prior to commencement of concrete to be certified and approved by the Engineer-in-charge. The contractor shall make arrangement with necessary equipment to carry out crushing strength of 150 cm. Cube concrete block for 7 day's & 28 day's of proper curing.

12.2 The R.C.C works are generally to be conducted on the concept of design mix and shall be as per specification of I.S codes, and stated elsewhere in the specification and schedule of this work. Water cement ratio is to be determined by proper slump test or as per provision of relevant I.S. codes. In case of slump test the slump cones 30 cm high 20 cm dia. at bottom & 10 cm at top are to be kept at site at the cost of contractor. If the surface of the concrete is found uneven or spongy in the appearance, the contractor will have to rectify or reconstruct the same at his own cost.

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12.3 All the R.C.C works shall be done in M30 & M25 grade of concrete as per I.S. 456 with cement concrete not less than 400 kg/cu.m. of concrete. The water cement ration should not exceed 0.45 or as per design mix. Joint in concrete structure, type of joints, spacing of joints, use of all jointing materials and other features pertaining to the provision of movement joints in liquid retaining structures shall be as per relevant I.S.

Water Tightness: All the liquid retaining structures must be made completely water tight as per specifications contained in I.S for water retaining structure.

12.4 Materials: Except as otherwise called for in this specification all materials for concrete shall comply with the latest Indian Standard Specifications.

12.5 Cement: Cement shall confirm to relevant I.S., grade OPC – 53. Cement tests shall have to be carried out at contractor's expenses as and when directed. The cement shall comply with the requirement of I.S. 269 – latest revisions. Cement shall be delivered to site in unbroken bags sewn by the manufacturer. Cement reclaimed from cleaning bags or leaking containers shall not be used, cement shall be used in the sequence of receipt of shipment unless otherwise directed. Cement should be stacked as per recommendation of Indian Standard Code of practice. The contractor, shall, when required by the Engineer-in-charge, furnish the manufacturer's test certificate for the cement.

12.6 Aggregate: The fine and coarse aggregate shall confirm to relevant I.S. The aggregate shall be stored at site in such a manner that inter mixing of materials in separate stock piles is not possible and so as to prevent contamination of the stock piles from the ground or rubbish or wind blown dust.

12.7 To get effective control on quality, materials which do not confirm to I.S. specification shall not be brought to site of work. If required, necessary sieve analysis of the coarse aggregate should be performed at site to verify the required size and grade of the material to the satisfaction of the Engineer-in-charge.

12.8 Sand/Fine aggregate: The sand to be used shall be obtained from a source approved by the Employer/Engineer-in-charge. Sand shall be natural sand, crushed gravel or crushed stone. It shall be graded, course in texture, clean gritty to the touch, hard, strong, durable and free from salt, silt, mica, clay earth, coal, any animal vegetable and bituminous matter, any soluble sulphate, gypsum and any other harmful material. Unless initially clean, all sand shall be thoroughly and carefully cleaned by screening and washing in fresh and clean water to remove all objectionable foreign matter to meet the specifications and standards.

12.9 Sand/fine aggregate shall conform to the grading specified in 'fine aggregates class 'A' in IS code No. 383 latest revision.

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- 12.10 Coarse Aggregate: Coarse aggregate shall consist of hard, strong durable particles of crushed stone and shall be free from thin elongated soft pieces, vegetable matter or other deleterious matter. It shall have no adherent coating.
- 12.11 The contractor shall arrange to supply aggregate in single sizes. The single sizes shall be obtained in suitable proportions to get desired overall grading of aggregate. The nominal maximum size of aggregate to be considered for plain and reinforced is 20mm. The aggregate shall conform to the grading from fine to coarse in accordance with I.S. 383 latest version:
- 12.12 Water: The water shall be clean and free from deleterious matter, such as oils, acids, alkalis, sugar and vegetable matter. Every attempt shall be made to use potable water that is fit for drinking and wherever possible water shall be used direct from the supply mains. Water stored for construction shall be kept clean at all times, and adequate storage to last for 24 hours at least shall be arranged at site by the contractor.
- 12.13 Admixtures: Admixtures, if required, shall be used in concrete only with the approval of the Engineer-in-charge.
- 12.14 Transport and Placing: No concreting work shall be started until the surface on which it is to be deposited shall be checked and approved by the Engineer-in-charge. Concrete shall be transported from the mixer to the place of final deposit as rapidly as practicable, and by methods, which will prevent segregation or loss of ingredients. Equipment for cutting, pumping and pneumatically conveying concrete shall be of such sizes and design as to ensure a practically continuous flow of concrete at the delivery and without any separation of the materials. The chute shall be of metal lined over wood, with slope not less than 1 vertical to 3 horizontal and not more than 1 vertical to 2 horizontal. The discharge end of the chute shall be provided with a baffle plate to prevent segregation.
- 12.15 Concrete shall be deposited as nearly as practicable in its final position without segregation due to re-handling or flowing. The concreting shall be placed at such a rate that concrete flows slowly into the space between the reinforcement bars. No concrete that has partially hardened or been contaminated by foreign materials shall be deposited on the permanent construction work.
- 12.16 Then concrete once started, shall be carried on as a continuous operation until the placing of any panel or section is completed. Necessary construction joints should be provided wherever joints are to be left in concrete during progress of construction work.
- 12.17 The top surface shall generally be made level as far as practicable. In foundation trenches or such other situation, it shall be carefully deposited and not thrown from a height. Water shall be removed from excavated pit before placing of the concrete. No flow of water shall be diverted through over freshly deposited concrete. Dewatering should not continue after commencement of the concrete work such that cements slurry from the concrete flows out.

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- 12.18 Before fresh concrete is deposited upon or against concrete, which has already hardened, the surface of the hardened concrete shall be well roughened, if necessary by chipping, all laitance removed and the surface shall then be swept clean with wire brushes, thoroughly wetted, and covered with the thin layer of mortar composed of equal volumes of cement and sand. An excess of cement shall be provided in the concrete in contact with the old work. The rate for concrete shall be inclusive of various surface preparations, as detailed above and no extra claim would be admitted on this account.
- 12.19 Compaction: The concrete shall be fully compacted through out the full extent of the mass and it shall be thoroughly worked against formwork and around any reinforcement and other embedded items without displacing them. Successive layers of the same lift shall be thoroughly worked together. Each layer shall be compacted by mechanical internal vibrating equipment supplemented by hand spading, rodding and tamping as directed. Vibrators shall in no case be used to transport, concrete inside forms. Use of form vibrators will not be permitted. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing objectionable segregation. The vibrator shall not be inserted into lower course that have begun to set. Concrete shall be poured in lifts to avoid formation of voids around embedded items. The contractor shall have required number immersion type vibrators of varying needle sizes with frequencies not less than 7000 RPH for R.C.C. work. In addition to above, sufficient numbers of petrol vibrators shall be kept available at site at all times in good condition.
- 12.20 Grouting: Grout for anchor bolt, sleeves and other items shall be composed of equal parts of sand and cement, with sufficient water to produce required consistency.
- 12.21 Curing and Protection: Curing of concrete shall start after 8 hours of placement and in hot weather within 4 hours of placement. All cement concrete after laying shall be covered with a layer of sack, canvas, hessian or similar absorbent material and kept wet for continuously not less than fortnight. In case of Portland pozzolana cement the curing is required to be continued for 21 days from date of concreting. For curing of concrete in slabs/floors, flat roofs or other level surfaces the ponding method of curing is preferred. All water used both in the preparation and final wetting is to be clean, free from sediment of any kind and generally fit for drinking. The work shall be protected from drying winds and direct sun rays.
- 12.22 Finishing of concrete: Slight honey comb and minor defects shall be patched after chiseling out loose material with cement mortar of 1 part cement to 2 parts fine aggregates, with approval of the Engineer-in charge. The patches will be square/rectangular and will be properly finished to match with the surface. The rate of concrete shall include all finishing.
- 12.23 Concrete quality: In proportioning the concrete of various grades the quality of cement shall be determined by weight. The quantities of fine and coarse aggregates will be either by batched or mixed in approved weigh batching system or by equivalent volume batching. Where ordinary concrete with nominal mixes are specified, batching of materials may be done by volume.

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- 12.24 Consistency: Slumps in the standard slump test shall not be more than 50mm for all R.C.C. works and shall be approved by Engineer-in-charge. To determine the required quantity of water per bag of cement for the proper consistency the slump tests shall be carried out at site with a standard slump cone whenever desired by the Engineer-in-charge. The concrete shall be of such consistency that it can be readily worked into the corners and angles of the framework and around reinforcement without segregation of the materials or bleeding of free water at the surface. On striking the formwork surface should be uniform, free from honey combing or excessive dusting.
- 12.25 Cube test: Samples of concrete shall be taken as often as considered necessary by the Engineer-in-charge and work test carried out in accordance with the procedure laid down in I.S. code of practice (I.S. 516). Sample shall be taken from each 50 cum. of concrete made during the progress of the work, or when a days concrete work does not amount to 50 cum from each day's pour. Six cubes 150 mm x 150 mm shall be made tested after 7 days, and the remaining three after 28 days. 90 percent of the test samples shall show strength higher than the prescribed strength. All the materials and labour for making necessary tests will be at the cost of the contractor. The result of the test conducted by the TCC or arranged by the TCC in any of the recognized laboratories shall be taken final and binding on the contractor. In case the compressive strength obtained from the test sample of concrete is less than the minimum specified strength the work is liable to be rejected.
- 12.26 The Contractor shall submit his proposed design mixes for the approval of the Engineer-in-charge. Once approved, he has to strictly adhere to the same. In case of change in the materials he will have to submit fresh design for the mixes for the approval of the Engineer-in charge. If in actual practice, the strengths obtained are less than the specified one, the work will be rejected. If, however, the strengths are higher than the specified ones due to excellent control or otherwise, the Contractor will have no claim for extra payment.

### **13. Plastering**

#### **13.1 Cement Plaster:**

Cement: It should be fresh Portland cement as specified in relevant I.S. codes. Different types of cement shall not be mixed together. In case more than one type of cement is used, a record shall be kept showing the location and types of cement used.

Sand: It shall be hard, durable, clean and free from adherent coatings and organic matter and shall not contain the amount of clay, silt and fine dust more than 5% by mass. It shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal or other organic impurities, mica, or similar laminated materials, soft fragments, adversely the hardening, strength or durability of the mortar. The grading of sand for use in plaster shall be conforming to I.S.: 1542-1977.

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In case the sand is damp at the time of preparation of mortar, its quantity shall be increased suitably to allow for bulking in conforming to I.S. 2386.

Preparation of mortar: The materials shall be at first mixed dry thoroughly in suitable proportion as stated in the schedule till uniform colour reaches and then shall be mixed wet adding water slowly and gradually for at least four times to give a uniform paste. The mix as prepared shall be used within 30 minutes.

Preparation of Surface: The surface of wall shall be brushed, cleaned, washed, watered and wetted with water before plastering. All the projections extending more than 13 mm from the general face of the masonry should be knocked off so as to maintain thinner plaster layer.

Laying: In order to maintain uniform thickness of the plaster, the screeds are formed on the prepared wall surface before actual plastering is started.

Curing: The plastered surface shall be kept wet by sprinkling water after 12 hours for at least 7 days and shall be protected from rain or sun.

#### **14. Flooring**

14.1 Concrete flooring: Providing and laying 20mm aggregate, 50mm thick cement concrete flooring 1:3:6, finished with floating coat of neat cement. The concrete shall conform to specifications given under the head "Concrete Works".

14.2 Sub-grade: The sub-grade shall be provided in lime concrete with suitable slope to drain off water and shall be cured for seven days. The flooring shall be laid in the next three days. Before laying the flooring the sub-grade shall be wetted and smeared with a coat of cement slurry with 2 Kg of cement spread over an area of one sq.m. so as to get a good bond between the sub-grade and concrete floor.

14.3 If the cement concrete flooring is to be laid directly on the R.C.C. slab, the surface of R.C.C. slab shall be cleaned and the laitance shall be removed and a coat of cement slurry at 2kg of cement per sq.m. shall be applied.

**15. Roofing:** As specified in SBRW-2007

#### **16. Doors & Windows**

16.1 Wooden Doors: All shutters of wooden doors shall be of mixed conifer wood as per relevant code and must be approved by the Engineer-in-charge.

16.2 Other Materials: Materials required for the purpose of erection of door frame complete in all respect are to be supplied by the contractor and they must conform to specification & also to be approved by the Engineer-in-charge. Other materials to be supplied by the contractor also must conform to relevant schedule of specification.

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- 16.3 For fixing steel hinges in “side hung windows” slots shall be cut in the fixed frame and hinges inserted inside and welded to the frame at the back. The hinges shall be of projecting type, non projecting type hinges may be allowed if approved by Engineer in Charge. The hinge pin and washer shall be of galvanized steel or aluminum alloy of suitable thickness. The handle of side hung shutter shall be of pressed brass, aluminum or steel protection against rusting and shall be mounted on a steel plate. The handle plate shall be welded screwed, and/ or riveted to the opening frame in such a manner that it should be fixed before the shutter is glazed.
- 16.4 The handle shall have a two point nose which shall engage with a brass or aluminum alloy striking plate on the fixed frame in a slightly open position as well as close position. The boss of handle shall incorporate as friction device to prevent the handle from dropping under its own weight. In case of no friction type hinges are provided, the windows shall be fitted with peg-stays which shall be either black oxidized steel, pressed or cast brass, or as specified, 300 mm long with steel peg and locking brackets. The peg stay shall have three holes to open the side hung casement in three different angles. Side hung shutter fitted with friction hinges shall not be provided with a peg stay.

**17. Grills**

All windows ventilators and railings where specified, shall be provided with suitable M.S. grills of approved design. The clear openings between two bars shall not exceed 100mm. The entire grill work including fitting, fixing shall have to be done as per specification in SBRW-2007.

**18. Mode of Measurement:**

The measurement for all types of work shall be carried out as per the methods prescribed in SBRW 2007.

**B. Water supply Pipes, Valves and Fittings**

**1. Specification for Supply of Pipes, Valves and Fittings**

**1.1 General**

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The Contract includes the procurement of pipes, valves and fittings complying with the respective IS codes as mentioned in the specification and BOQ, including the transportation of the same to the site, with installation and testing complete, which is required for the proper execution of the works as stipulated on the drawings, in the bills of quantities and any other specifications. The actual quantity of fittings in BOQ is an estimate only. The actual quantity shall be the responsibility of the contractor.

## **1.2 D.I Spun Pipes**

### **General**

Socket & Spigot Ductile iron spun pipes with push-on-joint shall conform to ISO 2531 / IS 8329-2000 /

Non-standard specials shall be avoided.

### **Manufacturer**

The pipes should be purchased from the manufacturer having the manufacturing experience of D.I pipes as per IS 8329:2000 with latest amendments for the last three years or more and their pipe laid in any project in Bhutan are performing satisfactorily for a period of last 2 years or more. The centrifugally cast (Spun) D.I pipes shall be manufactured, tested and supplied as per IS 8329:2000 with up to date amendments. All the pipes shall be class K-9(rubber gasket) jointing arrangement. Manufacturer must have license with BIS & ISO certification.

Therefore in conformity to latest engineering practice /norms and IS standard, use of D.I pipes as per IS 8329:2000 and D.I fittings as per IS 9523:2000 be considered. Sampling and test procedures as enumerated in IS codes and IS 12288:1987 "Code of practice for use and laying of D.I pipes" shall be adhered to.

### **Composition**

The metallurgical composition of the ductile iron shall conform to the following requirements (ISO):

- 1.7% to 5% Carbon,
- 1.5 to 3% Silicon,
- Minimum tensile strength: 420 (MPa) for pipes,  
400 (MPa) for fittings,
- Minimum elastic limits: 300 (MPa) for pipes and fittings
- minimum elongation at failure: 10% for pipes  
5% for fittings
- maximum hardness: 230 (HB) for pipes.

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250 (HB) for fittings.

#### **D.I Pipes**

D.I pipes should be of socket & spigot Ductile Iron Spun Pipes as per IS:8329/2000 class K9 with rubber gasket joint (push-on-joint) with inside cement mortar lining and outside zinc/bitumen coating in standard length of 5.5 mts.

#### **D.I Fittings**

D.I fittings are available with push-on-joints and to be supplied as per IS specifications 9523. Working test pressure for fittings as per IS 9523 should be not less than 25 kg/cm<sup>2</sup>. These fittings should have internal cement mortar lining and externally with a zinc rich paint & bituminous finishing coat with synthetic rubber gaskets. The deflection at push on joints should not exceed five degree.

#### **Internal Lining Pipe**

The pipes shall be internally lined in the factory with a sulphate resisting blast furnace cement mortar. The thickness and the lining shall be in accordance with ISO-4179 /IS: 8329. Prior to application of the lining the internal surfaces shall be shot blast cleaned to acceptable standard. The lining shall be applied centrifugally. The cement composition shall conform to BS-4027. The Colebrook roughness coefficient of the lining shall be less than 0.03 mm.

#### **Internal Lining –Fittings**

The fitting shall be internally lined in the factory with an epoxy coat suitable for potable water by test certificate form an international health institute, shall be abrasion resistant, and shall be subject to the approval of the Engineer-in-Charge. The thickness of the lining shall be not less than 0.3 mm. Prior to application of the lining the internal surfaces shall be shot blast cleaned to acceptable standard. The lining shall be applied in layers by spraying method. The Colebrook roughness coefficient of the lining shall be 0.02 mm.

#### **External Coating – Pipes and Fittings**

The pipes and fittings shall be externally coated in the factory with a metallic zinc coat as primer and a black bituminous or black coal tar based anticorrosive varnish in accordance with ISO: 8180 or synthetic resin or equivalent approved external surfaces to be applied with coatings shall be thoroughly cleaned and prepared immediately prior to the application of the primer paint. After the prime coat application, tests shall be carried out for misses or pinholes on the painted surface. The zinc for the coat shall be an electrolytic pure zinc of more than 99.9%. The zinc coat shall be applied by arc gun and the bituminous /tar based coat by an airless gun in at least 2 layers.

#### **G.I Pipes and fittings**

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The contractor should follow the Specifications for Building and Roads- 2007 for the specifications for G.I pipes and fittings.

### 1.3 Joint Accessories

**Push on Joint-** The jointing process is easy and quick. Deflection and disengagement is easy. The gasket has two sections having different hardnesses. The harder heel of the gasket locks perfectly into the groove provided in the socket. The softer bulb gives the positive seal when the spigot is pushed in, to give a permanent water tight joint.

Type of rubber & hardness:

Push on joint	Type of Rubber IS:5382	Shore Hardness
Bulb	2	50(+5,-4)
Heel	5	80±4

As per IS: 8329/2000 the socket profile and compatible rubber gasket are to be designed by the manufacturer. Therefore, ISI marked push-on-joint EPDM rubber gasket as per above specifications preferably to be sourced from manufacture as per the socket profile to ensure leak –tight joint through type test. The spigot ends shall be suitably chamfered for smooth entry of pipe in the socket fitted with rubber gasket.

### 1.4 Valves

The sluice valve/Gate valves shall be of double flanged generally confirming to the concerned I.S. 2906 and I.S. 780. The P.N rating shall be PN 1.6. The sealing faces and operating nut shall be either of gunmetal or leaded tin bronze. The spindle shall be inside screw non rising type of stainless steel AISI – 410. The seat and body to be tested hydrostatically @ 9 kg/sq.cm. respectively.

The air valve should be double acting Air valves with double balls inside the valve chamber, body & plate made of fine grained cast iron, small orifice fitted with rubber ball and large with vulcanized ball, flange inlet, tested to 16 bar for shell and 10 bar for seat at every locations as shown in the L-Section of pipe line drawing to the satisfaction of the Engineer-in Charge.

Scour valves- The scour valves are used to drain out water from pipe. These are installed at lowest point and effluent is disposed in to drains/streams. The outlet of valves should be above the high flow level of scheme. If it is below high water level a check valve should be provided to prevent back flow.

### 1.5 Support

Valves, meters, strainers and other devices mounted on the pipe work shall be supported independently of the pipes to which they are connected.

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Thrust Block-To resist the outward thrust due to water pressure pipes should be firmly fixed near the joints by strong brackets or concrete blocks. Pipe joints do not take tensile force readily. Thrust blocks are installed on opposite side of the direction from which thrust is expected wherever the pipeline changes.

In order to keep pipeline intact, thrust block have been designed and to be constructed as per drawing.

#### **1.10 Shop Testing and Inspection**

The inspection of pipes, fittings, valves and accessories will take place on the manufacturer's premises. The third party inspection to be carried out by reputed organizations such as RITES on payment of extra charges to be borne by contractor.

Inspection of external appearance, shape, dimensions and weight shall be carried out for each pipe and fitting. Pipes and fittings will be straight and shall be stripped with care to avoid warping. All pipes and fittings shall be sound and free from surface defects.

Each pipe and fitting shall be subjected to an approved hydrostatic pressure test. Any pipe lining that does not withstand the test pressure shall be rejected. Mechanical tests of hardness, tensile strength and elongation shall be performed on test pipes selected at random out of batches grouped in lot. The test certificates should be submitted.

#### **1.11 Handing and Storing**

Pipes and fitting shall be unloaded and stocked by the contractor at the store approved by the Engineer-in Charge and up to such height which prevents the lower layers from deformation or other damages.

The first layer will be placed on beams, large enough to give sufficient isolation from the ground, and the pipes will be secured by wedges. Each layer will be separated from the next by an adequate number of beams (at least two).

Care shall be taken during loading, transporting, and unloading to prevent damage to the pipes, fittings or coatings.

Special handling of pipes and fittings shall be in accordance with the manufacture's instruction.

All pipes shall be bundled or packed in such a manner as to provide adequate protection for the end, threaded or plain, during transportation.

Loading, unloading and handling shall be carried out using special hooks with a curved plate to fit the curvature of the pipes or webbing slings not less than 30 cm wide or other means approved by the Engineer. Coated pipes shall be transported on trucks or trailer fitted with approved padded timber or as shaped to fit the curvature of the pipes and adequate dimensions so as to prevent any damage to the pipe coating.

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Particular care shall be taken during unloading, loading, handling and transportation to avoid distortion, flattening, denting, scalping or any other damage to the pipes, fittings and any damage to the external or internal coating or lining of the pipes, fittings etc.

All components shall be packaged, finished or otherwise prepared such that they may safely be stored outdoors for an extended period in the project environment. Prior to shipment all unpainted surfaces, including bolts and nuts, machined surfaces, tapped holes and studs, and all other exposed ferrous surfaces, shall be protected with a heavy coat of suitable grease or other easily removed corrosion protective material.

Any materials which, in the opinion of the Engineer are delivered damaged or are damaged by the contractor in the process of stockpiling at the delivery site shall be promptly removed from the site. The contractor shall receive no compensation for the damaged material or its removal until it is either repaired to the satisfaction of the Engineer-in- Charge.

## **C. Pipe Works and Mechanical Installations**

### **1. Laying and Jointing**

All laying and jointing of pipes shall be in conformity with IS codes or equivalent BS codes. Excavation, backfilling and preparation of bedding are to be carried out as per typical pipe laying details/as mentioned in the BOQ.

Laying and jointing of pipes is to be in accordance with the manufacturer's instructions/relevant IS codes.

The contractor shall provide necessary jointing and cutting materials such as cutting oil, hemp and jointing compound as needed.

### **2. Preparation of Trench**

The bottom of the trench shall be finished to a smooth even surface at the correct level to permit the barrel of the pipe to rest on the surface throughout its whole length between joints.

The bottom of the trench and pipe bed shall be inspected by the Engineer-in-Charge or his representative, and only when passed as satisfactory, shall pipe laying commence.

### **3. Pipe Laying**

Each pipe shall be laid accurately to line and gradient so that, except where otherwise directed, the finished pipeline shall be in a straight line. The deflection at joints and pipes shall not exceed the manufacturer's specification.

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#### **4. Backfilling of Pipe Trench**

Subject to the permission by the Engineer-in-Charge or his representative, pipes shall be covered with approved fill material upon successful completion of laying and jointing. Joints shall remain exposed until completion of the pressure test.

#### **5. Installation of Valves and Specials**

Unless otherwise directed, all valves, fittings and specials shall be individually supported and their weight shall not be borne by the pipeline, joints or couplings, etc.

All valves, fittings and specials shall be fixed with proper sealing tape, gaskets, washers, etc. as necessary to the satisfaction of the Engineer-in-Charge.

#### **6. Valve Chamber**

Unless otherwise directed or detailed, all valves shall be housed in chambers with lockable covers.

Chambers are measured in numbers and shall be priced as Lump Sum Items covering all composite works as specified on the drawing inclusive of excavation in excess of trench excavation, concrete supports for valves and backfilling around the chambers. The depths stated on the drawings are normal depths. Actual depths depend on depth of pipes.

#### **7. Testing of Pipeline System**

The trench must be filled on the pipe barrels, leaving the joints uncovered so as to prevent the pipeline from moving whilst leaving the joints accessible. Thrust blocks must also be constructed before testing. In heavily trafficked roads the backfilling at joints may take place before testing after instruction by the engineer's representative.

At least two days' notice must be given in writing to the Engineer-in-Charge before pressure testing is commenced.

The water test pressure to be applied will be 1.5 times the actual maximum working pressure.

The engineer, however, reserves the right to alter this figure.

Mains shall be filled and tested in sections of convenient lengths, which must not exceed 500 metres. Where pipes are laid with steep gradients the lengths of pipes tested at any one time shall be as directed by the engineer-in-Charge.

The period from start of excavation or breaking of surfaces for pipelines till notice is given to the engineer for pressure testing shall not exceed 2 weeks in trafficked road areas and 3 weeks outside trafficked road areas. If these time limits are not adhered to, the employer shall have the right to withhold payment for an amount equal to the cost of pressure testing for the whole pipe length

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(measure to the nearest value either side of the affected area) until the pressure testing is completed to the satisfaction of the engineer.

The ends of pipes under test shall be closed by means of caps or blank flanges provided by the contractor. Valves must not be used for this purpose. All scour valves and air valves shall be replaced by blank flanges before commencement of the test.

After laying, jointing and anchoring, the main should be slowly and carefully charged with water so that all air is expelled, allowed to stand full for a minimum of three days and then tested under pressure. The test pressure shall be applied by means of a manually operated test pump connected to the main and to two parallel installed pressure gauges calibrated at an approved testing laboratory. The test pressure shall be maintained for one hour, and if there is any leakage, it shall be measured by the quantity of water pumped into the main in order to maintain the test pressure.

The permissible leakage of water which is given in imperial units in 1 gallon per inch of diameter per mile per 24 hours per 100 ft. head is, in metric units 0.0375 litres per mm diameter per 1000m lengths per 24 hours per 10 m head of water.

The above maximum permissible leakage approximately corresponds to the following quantities of water per 100 m length of pipe and 100 m head (1 N/mm<sup>2</sup>).

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Nominal Diameter of pipe	Maximum amount of water pumped per hour at 100 m head per 100 m length of pipe
Dia. 50 mm	0.08 litres
Dia. 80 mm	0.12 litres
Dia. 100 mm	0.16 litres
Dia. 150 mm to 350mm	0.24 litres

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Should leakage of water occur at the joints, the joints shall be reassembled to eliminate such leakage or, should this not prove possible, the contractor shall assemble new joints. Should any pipe or joint burst or should water leak or weep through the body of a pipe or joint the contractor shall forthwith remove the faulty pipe or joint and replace it an un-faulty pipe or joint. In all the above cases the length under test shall be re-tested as above described and the process repeated. If necessary, until the pipeline satisfactorily withstands the pressure test.

The contractor shall provide labour, install and work the test pump, pressure gauges and all other equipment required for the test and he shall fill the pipes with water and subsequently empty them after the test, all to the approval of the engineer-in-Charge. Water drained from the pipes shall be discharged in a way that does not affect the stability of the Works or adjacent structure.

The contractor shall allow for all expenses in connection with testing in his rates for pressure testing and disinfections of pipelines.

#### **8. Cleaning and Sterilization of Water Supply Pipes**

The contractor shall prior to completion and during the maintenance period clean pipelines, chambers and manholes for all dirt and rubbish. All pipes shall be thoroughly cleaned and washed out to remove all contamination, and all water from these operations shall be removed and drained away.

Following the satisfactory cleaning the contractor shall with the use of a portable dosage, system or by some other approved method introduce a solution of a sterilizing chemical containing chlorine into the pipeline. The solution shall be introduced at a very slow rate and shall be of such strength as to give a chlorine concentration of not less than 50 parts per million throughout the length of the pipelines.

All fire hydrants (or tees where appropriate) on the distribution pipes shall be opened successively, working progressively away from the place where the solution is introduced. Each hydrant shall be closed when the water discharged begins to smell of chlorine. The whole system shall then remain charged for 24 hours, after which a test shall be made for residual chlorine. If no residual chlorine is found, the sterilization process will have to be carried out again, until a satisfactory result is obtained. Finally, the pipes shall be thoroughly flushed out and recharged with supply water. On completion of the sterilization process the pipes shall be left full of water. The sterilization process shall be carried out for the pipes laid immediately before handing over to the employer.

**The contractor shall in his rates for pressure testing and disinfections of pipelines include for the satisfactory completion of the cleansing and sterilization operations.**

