

**TECHNICAL SPECIFICATION FOR CIVIL
WORKS**

1.0 GENERAL

The intent of this specification covers “Design, Engineering, and Construction of all civil works. All civil works shall also satisfy the general technical requirements specified in other Sections of this Specification and as detailed below. They shall be designed to the required service conditions/loads as specified elsewhere in this Specification or implied as per the latest National/ International Standards.

All civil works shall be carried out as per applicable Standards and Codes. All materials shall be of a best quality conforming to relevant Indian Standards and Codes. In case of any conflict between Standards/ Code and Technical Specification, the more stringent provision will govern.

The Contractor shall furnish design, drawings, labor, tools, equipment, materials, temporary works, constructional plant and machinery, fuel supply, transportation, and all other incidental items not shown or specified but as may be required for the complete performance of the Works in accordance with approved drawings, specifications and direction of Purchaser.

The work shall be carried out according to the design/drawings to be developed by the Contractor and approved by the purchaser based on Tender Drawings Supplied to the Contractor by the Purchaser. For all buildings, structures, foundations, etc. necessary layout and details shall be developed by the Contractor keeping in view the functional requirement of the hatchery facilities and providing enough space and access for operation, use and maintenance based on the input provided by the Purchaser. Certain minimum requirements are indicated in this specification for guidance purposes only. However, the Contractor shall quote according to the complete requirements.

The Contractor shall perform the works to comply with the requirements of this specification and relevant enclosed drawings, and shall assume full responsibility for their satisfactory performance.

1.1 Scope of work

The scope of works for all civil, architectural and structural works shall include preparation of designs, the supply of all materials to the site including insurance and storage, drawings for approval, provision of all labour, qualified supervisory personnel, instruments, tools, erection plant and equipment, fixtures, fittings and all temporary and permanent works necessary, whether or not such items are specifically stated herein for satisfactory completion of the job in all respects in accordance with the specification requirements. It shall be noted that the Contractor will have to complete all these works so that the hatchery is handed over to the client ‘ready to use’. Specific items of work involved are excavation, site-grading and back-filling, construction of foundations and erections of structural steel supports of hatchery area, site development including drains, roads, fencing and gates, and miscellaneous items like water tanks, revetment walls, etc.

2.0 GEOTECHNICAL INVESTIGATION

2.1 The detailed geotechnical investigation will be carried out by the employer.

3.0 SITE PREPARATION:

The contractor shall be responsible for proper grading and leveling of the hatchery area site as per layout and levels of the hatchery area finalized during the detailed engineering stage. The layout and levels of all structures etc. shall be made by the Contractor at his own cost from the general grids of the plot and benchmarks set by the Contractor and approved by the Purchaser. The Contractor shall give all help in instruments, materials and personnel to the Purchaser for checking the detailed layout and shall be solely responsible for the correctness of the layout and levels. Site leveling including all operations like clearing of the site, removal of vegetation, trees, tree stubs, etc., slope protection by stone pitching/retaining walls with filter depending on the site location/condition shall be in the scope of the contractor.

3.1 SCOPE

This clause covers the design and execution of the work for site preparation, such as clearing of the site, grading and leveling, the supply and compaction of fill material, slope protection by stone pitching/retaining walls with filter depending on the site location/condition, excavation and compaction of backfill for foundation, road construction, drainage, trenches and final topping by stone (broken hard stone).

3.2 GENERAL

- (1) The Contractor shall develop the site area to meet the requirement of the intended purpose. The site preparation shall conform to the requirements of relevant sections of this specification or as per stipulations of standard specifications. Necessary protection of slope of hatchery area and approach road shall also be carried out by the contractor.
- (2) If the fill material is required, the fill material shall be suitable for the above requirement. The fill shall be such material and the site so designed as to prevent the erosion by wind and water of material from its final compacted position or the in-situ position of undisturbed soil.
- (3) Material unsuitable for the founding of foundations shall be removed and replaced by suitable fill material and to be approved by the Purchaser.
- (4) Backfill material around foundations or other works shall be suitable for the purpose for which it is used and compacted to the density described under Compaction. Excavated material not suitable or not required for backfill, shall be disposed off in areas as directed by purchaser and as per price schedule.

3.3 EXCAVATION AND BACKFILL

- (1) Excavation and backfill for foundations shall be in accordance with the relevant code.
- (2) Whenever a water table is met during the excavation, it shall be dewatered and the water table shall be maintained below the bottom of the excavation level during excavation, concreting and backfilling.
- (3) When embankments are to be constructed on slopes of 15% or greater, benches or steps with horizontal and vertical faces shall be cut in the original slope prior to placement of embankment material. Vertical faces shall measure not more than 1 m in height.
- (4) Embankments adjacent to abutments, culverts, retaining walls and similar structures shall be constructed by compacting the material in successive uniform horizontal layers not exceeding 15 cm in thickness. (Of loose material before compaction). Each layer shall be compacted as required by means of mechanical tampers approved by the Purchaser. Rocks larger than 10 cm in any direction shall not be placed in embankment adjacent to structures.
- (5) Earth embankments of roadways and site areas adjacent to buildings shall be placed in successive uniform horizontal layers not exceeding 20 cm in thickness in loose stage measurement and compacted to the full width specified. The upper surface of the embankment shall be shaped so as to provide complete drainage of surface water at all times.
- (6) The pitching/retaining walls with filters shall be designed and provided for slope protection as per approved drawings. The stone used shall be sound, hard, durable and fairly regular in shape. Stones subjected to marked deterioration by water or weather shall not be used. Suitable measures shall be provided to prevent erosion by seepage of water. The largest stone procurable shall be used as approved by the owner for the work. Random rubble masonry (1:5) /RCC retaining walls shall be provided wherever required as per site condition.

3.4 COMPACTION

- (1) The density to which fill materials shall be compacted shall be as per relevant IS and as per the direction of Purchaser. All compacted sand filling shall be confined as far as practicable. Backfilled earth shall be compacted to a minimum of 95% of the Standard Proctor's density at OMC. The subgrade for the roads and embankment filling shall be compacted to a minimum of 95% of the Standard Proctor's density at OMC. Cohesionless material subgrade shall be compacted to 70% relative density (minimum).
- (2) At all times unfinished construction shall have an adequate drainage system. Upon completion of the road's surface course, adjacent shoulders shall be given a final shaping, true alignment and grade.
- (3) Each layer of earth embankment when compacted shall be as close to optimum moisture content as practicable. Embankment material which does

not contain sufficient moisture to obtain proper compaction shall be wetted. If the material contains any excess moisture, then it shall be allowed to dry before rolling. The rolling shall begin at the edges overlapping half the width of the roller each time and progress to the center of the road or towards the building as applicable. Rolling will also be required on rockfills. No compaction shall be carried out in rainy weather.

3.5 **REQUIREMENT FOR FILL MATERIAL UNDER FOUNDATION**

For expansive soils, the fill materials and other protections, etc to be used under the foundation are to be approved by the Purchaser. The thickness of fill material under the foundations shall be such that the maximum pressure from the footing, transferred through the fill material and distributed onto the original undisturbed soil will not exceed the allowable soil bearing pressure of the original undisturbed soil.

4.0 **ANTI WEED TREATMENT & STONE SPREADING**

4.1 **SCOPE OF WORK**

The Contractor shall furnish all labour, equipment and materials required for the complete performance of the work in accordance with the drawings, specification and direction of the Purchaser.

Stone spreading/asphalt concrete layer shall be done in the areas of the hatchery area under the present scope of work within the fenced area.

4.2 **GENERAL REQUIREMENT**

The material required for site surfacing/stone filling shall be free from all types of organic materials and shall be of standard quality, and as approved by the Purchaser.

4.2.1 The material to be used for stone filling/site surfacing shall be crushed/broken/ river shingles stone of 40mm nominal size (ungraded single size) conforming to Table 2 of IS:383 – 1970. Hardness, flakiness shall be as required for wearing courses are given below:

(a) Sieve Analysis limits (Gradation)
(IS: 383 – Table – 2)

Sieve Size	% passing by weight
63mm	100
40mm	85-100
20mm	0-20
10mm	0-5

“One Test” shall be conducted for every 500 cu.m.

(b) Hardness

Abrasion Value (IS:2386 Part-IV) – not more than 40%

Impact value (IS:2386 Part-IV) – not more than 30% and frequency shall be one test per 500 cu.m. with a minimum of one test per source.

(c) Flakiness Index

One test shall be conducted per 500 cu.m. of aggregate as per IS:2386 Part – I and the maximum value is 25%.

- 4.2.2 After all the structures/equipment are erected, anti-weed treatment of cement concrete shall be applied in the hatchery area wherever stone spreading is done and the area shall be thoroughly de-weeded including removal of roots.
- 4.2.3 Engineer-In-Charge shall decide the final formation level to ensure that the site appears uniform devoid of undulations. The final formation level shall, however, be very close to the formation level indicated in the approved drawing.
- 4.2.4 In areas that are considered by the Engineer-in-Charge to be too congested with foundations and structures for proper rolling of the site surfacing material by normal rolling equipment, the material shall be compacted by hand, if necessary. Due care shall be exercised so as not to damage any foundation structures or equipment during rolling compaction.
- 4.2.5 The subgrade shall be in moist condition at the time the cement concrete is placed. If necessary, it should be saturated with water for not less than 6 hours but not exceeding 20 hours before placing cement concrete. If it becomes dry prior to the actual placing of cement concrete, it shall be sprinkled with water and it shall be ensured that no pools of water or soft patches are formed on the surface.
- 4.2.6 Over the prepared subgrade, 75mm thick base layer of cement concrete in 1:4:8 (1 cement: 4 fine sand: 8 stone aggregate) shall be provided in the area with expansion/construction joints of suitable materials at every 5m interval excluding roads, drains as per detailed engineering drawing. For easy drainage of water, the slope of 1:1000 is to be provided from the ridge to the nearest drain. The ridge shall be suitably located at the center of the area between the nearest drains. The above slope shall be provided at the top of the base layer of cement concrete in 1:4:8. A layer of cement slurry of mix 1:6 (1 cement: 6 fine sand) shall be laid uniformly over the cement concrete layer. The cement consumption for cement slurry shall not be less than 150 kg. Per 100 sq. m.
- 4.2.7 A final layer of 150mm thickness of crushed/broken stones/ river shingles of 40mm nominal size (ungraded size) shall be spread uniformly over the cement concrete layer after curing is complete.

5. SITE DRAINAGE

Providing rainwater drainage systems within the hatchery area fencing under the present scope including the connection at one or more points to the outfall point

located outside the hatchery boundary wall is in the scope of the contractor. The invert level of the drainage system at the outfall point shall be decided in such a way that the water can easily be discharged outside the hatchery boundary wall. In case the outfall point is more than 50M away from the boundary wall, only a 50-meter drain outside the boundary wall is in the scope of the contractor. Outfall point shall be approved by the Engineer-in-charge before the commencement of construction. While designing the drainage system following points shall be taken care of:

- (a) The surface of the hatchery area shall be sloped to prevent the accumulation of water.
- (b) Drain shall be constructed on both sides of the roads. In the hatchery area maximum spacing between two drains shall not be more than 100 meters. It will be ensured that no area is left un-drained.
- (c) Open surface drains having 600mm bottom width and sides having a vertical with 450mm depth at the starting point of drain shall be provided. Any special treatment recommended as per the soil investigation report shall also be taken care of.
- (d) Longitudinal slope shall not be less than 1 in 1000.
- (e) Open surface drains shall be constructed with 100mm thick plain cement concrete 1:3:6 (1cement: 3 coarse sand: 6 stone aggregate 20mm nominal size). PCC 1:3:6 shall be laid over a 40mm thick layer of PCC 1:4:8 (1 cement: 5coarse sand: 10 stone aggregate 20mm nominal size.)
- (f) The sidewall of the drains shall be 25 mm above the gravel level to prevent the falling of gravel into the drain. Groove of 125 mm width shall be provided at 2000 mm spacing with suitable mild steel grating.
- (g) The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8m/sec respectively. However, the minimum non-silting velocity of 0.6m/sec shall be ensured.
- (h) Pipe drains shall be provided in areas of the hatchery area where the movement of crane will be necessary for the operating phase of the hatchery.
- (i) For pipe drains, concrete pipe of class NP2 shall be used. However, for road crossings, etc. higher strength pipe of class NP3 shall be provided. For the design of RCC pipes for drains and culverts, IS:456 and IS:783 shall be followed.
- (j) Pipe drains shall be connected through manholes at an interval of max. 30 m.
- (k) If the invert level of the outfall point is above the last drain point in the hatchery boundary, the sump of suitable size has to be constructed within the hatchery boundary.
- (l) The drainage scheme and associated drawings shall be approved by the employer before the commencement of construction.
- (m) The base and slopes of the existing natural gully (drain) at the boundary of the site shall be protected with the concrete lining as per the design requirement at the site.

6.0 ROADS AND CULVERTS

- (a) The main approach road including modification of existing road to meet the site conditions, roads for access to equipment and building within hatchery are in the scope of the bidder. The layout of the roads shall be based on General detail & Arrangement drawing for the hatchery. Parking areas shall be provided for Site personnel and visitors at convenient locations. Adequate turning space

for vehicles shall be provided and bend radii shall be set accordingly.

- (b) The road outside the hatchery area shall have 3.0m blacktopping/ concrete with 1.0 m wide earthen shoulder on either side of the road. Protection of cut and embankment slopes of roads as per slope stability requirement shall be made. All roads within the hatchery area shall be RCC.
- (c) All roads shall be designed for 1msa (Cumulative traffic) of traffic as per IRC- 37 (Guidelines for the design of flexible pavements).
- (d) IRC specification shall be followed for the construction of Roads.

10.0 FOUNDATION /RCC CONSTRUCTION

10.1 GENERAL

- (1) Work covered under this Clause of the Specification comprises the design and construction of foundations and other RCC constructions for hatchery area structures. This clause is as well applicable to the other RCC constructions.
- (2) Concrete shall conform to the requirements mentioned in IS:456 and all the tests shall be conducted as per relevant Indian Standard Codes as mentioned in the approved field quality plan. A minimum grade of M20 concrete (1: 1.5: 3 mix) shall be used for all structural/load-bearing members as per the latest IS 456.
- (3) If the site is inclined, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate for such slopes.
- (4) The hatchery building plinths shall be a minimum of 450 mm above finished ground level respectively.
- (5) Minimum 75mm thick lean concrete (1:3:6) shall be provided below all underground structures, foundations, trenches, etc. to provide a base for construction.
- (6) Concrete made with Portland slag cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering.
- (7) The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof. The Spread footings foundation or pile foundation as may be required based on soil/sub-soil conditions and superimposed loads shall be provided.

If pile foundations are adopted, the same shall be cast-in-situ driven/bored or pre-cast or under-reamed type as per relevant parts of IS Code 2911. Only RCC piles shall be provided. The suitability of the adopted pile foundations shall be justified by way of full design calculations. Detailed design calculations shall be submitted by the

bidder showing complete details of piles/pile groups proposed to be used. Necessary initial load test shall also be carried out by the bidder at their cost to establish the piles design capacity. Only after the design capacity of piles has been established, the Contractor shall take up the job of piling. Routine tests for the piles shall also be conducted. All the work (design & testing) shall be planned in such a way that these shall not cause any delay in project completion.

- (8) For all soils other than Hard Rock, the total depth of foundations below the natural ground level shall not be less than 1.5 m. The corresponding minimum depths for Hard Rock foundations shall be 0.6m.

10.2

DESIGN

- (1) All foundations shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS:456 and the minimum grade of concrete shall be M20. Higher grade of concrete than specified above may be used at the discretion of the Contractor without any additional financial implication to the Purchaser.
- (2) Limit state method of design shall be adopted unless specified otherwise in the specification.
- (3) For detailing of reinforcement IS:2502 and SP:34, IS 13920 shall be followed. Cold twisted deformed bars ($F_y=500 \text{ N/mm}^2$) conforming to IS:1786 or 'TMT' bars as per specifications shall be used as reinforcement. However, in specific areas, mild steel (Grade I) conforming to IS:432 can also be used. Two layers of reinforcement (on inner and outer face) shall be provided for wall & slab sections having a thickness of 150 mm and above. Clear cover to reinforcement shall be as per IS:456 (latest).
- (4) RCC water retaining structures like storage tanks, etc. shall be designed as un-cracked section in accordance with IS:3370 (Part I to IV) by working stress method. However, water channels shall be designed as a cracked section with limited steel stresses as per IS:3370 (Part I to IV) by working stress method.
- (5) The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and/or superstructure and other conditions which produces the maximum stresses in the foundation or the foundation component and as per the relevant IS Codes of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.
- (6) Design shall consider any sub-soil water pressure that may be encountered following relevant standards strictly.

- (7) Necessary protection to the foundation work, if required shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental/harmful to the concrete foundations.
- (8) RCC columns shall be provided with a rigid connection at the base.
- (9) All sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factors of safety for these cases shall be taken as mentioned in relevant IS Codes or as stipulated elsewhere in the Specifications. For checking against overturning, the weight of soil vertically above footing shall be taken and inverted frustum of the pyramid of the earth on the foundation should not be considered.
- (10) Earth pressure for all underground structures shall be calculated using the co-efficient of earth pressure at rest, co-efficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.
- (11) In addition to earth pressure and groundwater pressure etc., a surcharge load of $2T/Sq.m$ shall also be considered for the design of all retaining walls, underground structures including channels, sumps, tanks, trenches, the substructure of any underground hollow enclosure, etc., for the vehicular traffic in the vicinity of the structure.
- (12) Following conditions shall be considered for the design of water channels, sumps, trenches, and other underground structures:
 - (a) Full water pressure from inside and no earth pressure & groundwater pressure & surcharge pressure from outside (application only to structures which are liable to be filled up with water or any other liquid).
 - (b) Full earth pressure, surcharge pressure and groundwater pressure from outside and no water pressure from inside.
 - (c) The design shall also be checked against buoyancy due to the groundwater during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.
- (13) Base slab of any underground enclosure shall also be designed for the empty condition during construction and maintenance stages with a maximum groundwater table (GWT). Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.
- (14) Base slab of any underground enclosure like water storage tank shall also be designed for the condition of a different combination of pump sumps being empty during maintenance stages with maximum GWT.

Intermediate dividing piers of such enclosures shall be designed considering water in one pump sump only and the other pumps sump being empty for maintenance.

- (15) The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.

10.3 ADMIXTURES & ADDITIVES

- (1) Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labelled containers to enable identification.
- (2) Admixtures in concrete shall conform to IS:9103. The waterproofing cement additives shall conform to IS:2645. Concrete Admixtures/Additives shall be approved by Purchaser.
- (3) The Contractor may propose and the Purchaser may approve the use of a plaster-reducing set-retarding admixture in some of the concrete. The use of such an admixture will not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid to overcoming unusual circumstances and placing conditions.
- (4) The water-reducing set-retarding admixture shall be an approved brand of Ligno-sulphonate type admixture.

The waterproofing cement additives shall be used as required/advised by the Purchaser.

11.0 CHAINLINK FENCING, GATE AND BOUNDARY WALL

11.1 General

Boundary wall shall be designed for the most critical loading combination taking care of earthquake/wind force, stability, the tension on wires, minimum requirements as per this clause and relevant IS recommendations. Areas requiring boundary walls shall be determined jointly by the contractor and the owner. Fencing and gate shall be provided as per details given below:

11.2 Areas requiring Fencing, Boundary wall

Fencing shall be provided for a complete hatchery area as per drawing. Separate gate shall be provided for men and equipment.

Internal fencing, if required, shall also be provided surrounding the various equipment (if) mounted on the ground or a height lower than 2.5m. Necessary gates shall be provided for each area so surrounded.

The minimum requirements for Product materials are as follows:

Chain link fence fabric (without galvanization) in accordance to IS:2721.

- | | | | |
|-----|---------------------|---|--|
| (1) | Size of mesh | : | 50 mm |
| (2) | Nominal wire size | : | 3.15mm diameter |
| (3) | Width of chain link | : | 2000mm |
| (4) | Painting | : | Two or more coats of approved standard make synthetic enamel paint over a coat of standard steel primer. |

GATE

The gate (height 2m x width 4m) shall be made of square hollow section framework (Internal & External) including double bearing 100mm MS wheel (provided every 1m c/c) with channel for running track, locking arrangement including applying one coat of red oxide paint and two coats of synthetic enamel paint to all exposed surfaces of steel. Contractor shall arrange for all the materials, tools, labour, etc. required to complete the job as per drawing. The gates shall be provided with a suitable locking arrangement.

BOUNDARY WALL

The contractor shall construct a boundary wall around the hatchery area as per requirements. The boundary wall shall be of height 2.5M and shall be made of RCC column at an interval of 2.5 m. The panels shall be filled with RRM wall in cement sand mortar 1:5. The boundary wall shall have flush pointing on both internal and external faces. An additional barbed Y-shaped arm of MS angle 50x50x6 with 4-rows (8 nos) barbed wire A-4IS:278 shall be provided above 300 mm high. Three rows of barbed wire shall be provided below the Y-junction of the MS angle. Ribbed wire (concertina) of 700 mm dia with a 100 mm pitch shall be provided on top of the Y junction as shown in the drawings. Expansion joints shall be provided as per codal requirements. MS grating shall be provided at the required locations for drainage purposes. The steelwork shall be given two coats of synthetic enamel paint of approved makeover one coat of primer.

12.0 BUILDINGS - GENERAL REQUIREMENTS

The detail specifications for Hatchery PEB is attached as Annexure-II. Only relevant specifications applicable for sub-structure of PEB shall be adopted.

12.1 GENERAL

The scope includes the design, engineering and construction including anti-termite treatment, plinth protection, DPC of buildings including sanitary, water supply, electrification, false ceiling, false flooring etc.

12.2 HATCHERY BUILDING

The specification regarding finishes and material provided along with the Price schedule and the general specification will govern. However, all the relevant portions of this chapter would be applicable to ensure that, the material, workmanship and other issues under the scope of work are not compromised.

12.2.1 GENERAL SPECIFICATION FOR HATCHERY BUILDING

Refer Annexure - II

12.2.2 DESIGN

- (a) The buildings shall be designed:
- (1) to the requirements of the Building Code of Bhutan, and the standards quoted therein.
 - (2) for the specified climatic & loading conditions.
 - (3) to adequately suit the requirements of the equipment and apparatus contained in the buildings and in all respects to be compatible with the intended use and occupancy.
 - (4) with a functional and economical space arrangement.
 - (5) for a life expectancy of structure, systems and components not less than that of the equipment which is contained in the building provided regular maintenance is carried out.
 - (6) to allow for easy access to equipment and maintenance of the equipment.
 - (7) With, wherever required, fire retarding materials for walls, ceilings, and doors, which would prevent supporting or spreading of fire.
 - (8) with materials preventing dust accumulation.
- (b) Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with the provision of twin columns.
- (c) Individual members of the buildings frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc.
- (d) Permissible stresses for different load combinations shall be taken as per relevant IS Codes.
- (f) The building lighting shall be designed in accordance with the

requirements of the relevant section.

The building auxiliary services like air conditioning and ventilation systems and all other miscellaneous services shall be designed in accordance with the requirements specified in the relevant section or elsewhere in this Specification.

12.2.3 DESIGN LOADS

The building structures shall be designed for the most critical combinations of dead loads, superimposed loads, equipment loads, crane load, wind loads, seismic loads, and temperature loads.

Dead loads shall include the weight of structures complete with finishes, fixtures and partitions and should be taken as per IS:875.

The wind loads shall be computed for the zone of wind velocity 47 m/s as per IS 875, Seismic analysis as per IS 1893, with seismic zone V and importance factor 1.0.

Wind and Seismic forces shall not be considered to act simultaneously.

Floors/slabs shall be designed to carry loads imposed by equipment and other loads associated with building. Floors shall be designed for live loads as per relevant IS. Piping loads shall also be considered additionally for floors / trusses where these loads are expected.

In addition, beams shall be designed for any incidental point loads to be applied at any point along the beams. The floor loads shall be subject to Purchaser's approval.

For consideration of loads on structures, IS:875, the following minimum superimposed live loads shall, however, be considered for the design.

(a)	Roof	1.5 kN/m ² 0.75 kN/m ²	for accessible roofs for in-accessible roofs
(b)	RCC-Floor (i)	5 kN/m ²	for offices
(c)	Stairs & balconies	5 kN/m ²	
(d)	Toilet Rooms	2 kN/m ²	

Any additional load coming in the structure shall be calculated as per IS: 875.

12.2.4 SUBMISSION

The following information shall be submitted for review and approval to the Purchaser:

- (1) Design criteria shall comprise the codes and standards used, applicable climatic data including wind loads, earthquake factors maximum and minimum temperatures applicable to the building locations, assumptions of dead and live loads, including equipment loads, impact factors, safety factors and other relevant information.
- (2) Structural design calculations and drawings (including construction/fabrication) for all reinforced concrete and structural steel structures. Fully, dimensioned concept plan including floor plans, cross-sections, longitudinal sections, elevations and perspective view of each building. These drawings shall be drawn at a scale not smaller than 1:50 and shall identify the major building components.
- (3) Fully dimensioned drawings showing details and sections drawn to scales of sufficient size to clearly show sizes and configuration of the building components and the relationship between them.
- (4) Product information of building components and materials, including walls partitions flooring ceiling, roofing, door and windows and building finishes.
- (5) A detailed schedule of building finishes including color schemes.
- (6) A door & window schedules showing door types and locations, door locksets and latch sets and other door hardware.

Approval of the above information shall be obtained before ordering materials or starting fabrication or construction as applicable.

12.2.5 **GLAZING**

Sun film shall be provided for all windows/doors of AC rooms. Thickness of glazing shall be as specified in the internal finish schedule elsewhere.

12.2.6 **FALSE CEILING**

Providing and fixing of Gypsum Armstrong False ceiling system comprising of support system. Panels shall be fixed on to rolled formed carriers at maximum 0.6 m center to center. Carried to be suspended from roof/truss by 4 mm galvanized steel wire rod hangers or 19 SWG industrial GI wire, with special height adjustment suspension clips at regular intervals. Hangers to be fixed by 'J' hooks and nylon inserts. Panels shall be factory cut-to-length up to maximum of 5 m to suit site dimensions. Edge profiles / wall angels to be 19 mm x 19 mm, 0.5 mm thick of Aluminium matching the colour of the panels.

The rate includes all necessary cutting of ceiling for the fixing of complete fixtures as per drawing finalized during detailed engineering.

12.2.7 **DOORS AND WINDOWS**

The details of doors and windows of the hatchery shall be as per drawing

finalized during detailed engineering and with the relevant IS code. Rolling aluminium shutters and rolling grills shall be provided as per the drawing and requirement of buildings. Paints used in the work shall be of best quality specified in specification.

12.2.8 **PARTITION**

Partition made of UPVC frame provided with 5.5 mm thick clear glass shall be supplied and installed at locations shown in tender drawings or as required after detailed Engineering.

12.2.9 **PLUMBING & SANITATION**

- (i) All plumbing and sanitation shall be executed to comply with the requirements of the appropriate bye-laws, rules and regulations of the Local Authority having jurisdiction over such matters. The Contractor shall arrange for all necessary formalities to be met in regard to inspection, testing, obtaining approval and giving notices, etc.
- (ii) Poly-ethylene Sintex or equivalent make Roof water tank of adequate capacity depending on the number of users for 24 hours storage shall be provided. Minimum 2 Nos 1000 litres capacity shall be provided.
- (iii) Galvanised MS pipe of medium-class conforming to IS:1239 shall be used for internal & external piping work for potable water supply.
- (iv) UPVC pipes with lead joints conforming to IS:1729 shall be used for sanitary works above ground level.
- (v) Each toilet shall have the following minimum fittings.
 - (a) WC (Western type) 390 mm high with toilet paper roll holder and all fittings
 - (b) Urinal (430 x 260 x 350 mm size) with all fittings.
 - (c) Wash basin (550 x 400 mm) with all fittings.
 - (d) Bathroom mirror (600 x 450 x 6 mm thick) hardboard backing
 - (e) CP brass towel rail (600 x 20 mm) with C.P. brass brackets
 - (f) Soap holder and liquid soap dispenser.

Water cooler for drinking water with adequate water storage facility shall be provided and located near the office instead of near toilet block.

- (vi) An Eye & face fountain conforming to IS:1052 shall be provided in the battery room.

- (vii) 1 no. stainless steel kitchen sink with Drainboard (510 x 1040 x 178 mm bowl depth) for pantry shall be provided.
- (viii) All fittings, fastener, grating shall be chromium plated.
- (ix) All sanitary fixtures and fittings shall be of approved quality and type manufactured by well-known manufacturers, such as Jaguar make. All items brought to the site must bear identification marks of the type of the Manufacturer.
- (x) Soil, waste and drain pipes, for underground works, shall be UPVC for areas not subject to the traffic load. Heavy-duty cast iron pipes shall be used otherwise.

12.2.10 Bidder should include all such items in the BPS which are not specifically mentioned but are essential for the execution of the work. Items which explicitly may not appear in various schedules and are required for successful completion of the building work shall be included in the bid price and shall be provided at no extra cost to the owner.

15.0 MISCELLANEOUS GENERAL REQUIREMENTS

- 15.1 Dense concrete with controlled water-cement ratio as per IS-code shall be used for all underground concrete structures such as tanks, water retaining structures, pipe trenches, etc. for achieving water-tightness.
- 15.2 All joints including construction and expansion joints for the water retaining structures shall be made watertight by using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 5 mm and the minimum width shall be 230 mm.
- 15.3 All steel sections and fabricated structures which are required to be transported on sea shall be provided with anti-corrosive paint to take care of sea worthiness.
- 15.4 All mild steel parts used in the water retaining structures shall be hot-double dip galvanized. The minimum coating of the zinc shall be 750 gm/sq. m. for galvanized structures and shall comply with IS:2629 and IS:2633. Galvanizing shall be checked and tested in accordance with IS:2633. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen.
- 15.5 A screed concrete layer not less than 100 mm thick and of grade not weaker than M10 conforming to IS:456-1978 shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the

- base slab concrete of the water retaining structures.
- 15.6 Bricks having minimum 50 kg/cm² compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 50 kg/cm² compressive strength before submitting his offer.
- 15.7 Doors and windows on external walls of the buildings (other than areas provided, with insulated metal claddings) shall be provided with all requisite Bhutanese Architecture components.
- 15.8 All stairs shall have a maximum riser height of 150 mm and a minimum tread width of 300 mm. Minimum width of stairs shall be 1500 mm. Service ladder shall be provided for access to all roofs.
- 15.9 Angles 50x50x6 mm (minimum) with lugs shall be provided for edge protection all-round cut-outs/openings in floor slab, edges of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes supporting covers, supporting edges of manhole precast cover and any other place where breakage of corners of concrete is expected.
- 15.10 Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors, etc. as per IS:6313 and other relevant Indian Standards.
- 15.11 Hand-railing minimum 900mm high shall be provided around all floor/roof openings, projections/balconies, walkways, platforms, steel stairs etc. All handrails and ladder pipes shall be 32 mm nominal bore MS pipes (medium class) and shall be galvanized (medium-class as per IS:277). All rungs for ladder shall also be galvanized as per IS:277 medium class.
- For RCC stairs, hand railing with 20 mm square MS bars, balustrades with suitable MS flats & aluminium handrails shall be provided.
- 15.12 For all civil works covered under this specification, nominal mix by volume batching as per specification is intended. The relationship of the grade of concrete and ratio of ingredients shall be as below:

Sl.No.	Mix	Cement	Sand	Coarse aggregate of 20 mm down grade as per IS 383
1.	M 10	1	3	6
2.	M 15	1	2	4
3.	M 20	1	1.5	3
4.	M25	1	1	2

The material specification, workmanship and acceptance criteria shall be as per relevant clauses of specification and approved Field Quality Plan.

15.13 The details given in tender drawings shall be considered along with details available in this section of the specification while deciding various components of the building.

15.14 Items/components of civil works/buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.

16.0 INTERFACING

The proper coordination & execution of all interfacing civil works activities like fixing of conduits in roofs/walls/floors, fixing of foundation bolts, fixing of lighting fixtures, fixing of supports/embedments, provision of cut-outs, etc. shall be the sole responsibility of the Contractor. The contractor shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and dismantling, breakage, etc. is reduced to a minimum.

17.0 WATER SUPPLY

- (i) Tapping of water from the source to the hatchery area is in the scope of the contractor. The water treatment system including intake structure, sedimentation tank, flocculation tank, storage tank, etc is also in the scope of the contractor and shall submit the detailed design for approval of the owner before implementation. Water supply system including all plumbing/erection works, testing and commissioning, all complete, is in the scope of the contractor. Contractor shall estimate the total water requirement both in terms of quantity and head and furnish to the purchaser. The contractor shall carry out the detail survey for the water supply and submit the longitudinal profile of the line. The details of water pressure envisaged along the pipe shall be shown and the requirement of pressure break tank shall be indicated supported by appropriate calculations.
- (ii) The contractor shall carry out all the plumbing/erection works required for the supply of water in the hatchery building beyond the single point as at (i) above.
- (iv) The details of tanks, pipes, fittings, fixtures, etc for water supply are given elsewhere in the specification under respective sections.
- (v) Borewells and pumps for water supply are in the scope of the contractor.
- (vi) A scheme shall be prepared by the contractor indicating the layout and details of water supply which shall be approved by the Purchaser before the actual start of work including all other incidental items not shown or specified but as may be required for the complete performance of the works.

- (vii) The system shall be designed as per relevant IS Codes.

18.0 SEWERAGE SYSTEM

- (i) Sewerage system shall be provided for hatchery building as per the project requirement.
- (ii) The Contractor shall construct a septic tank and soak pit suitable for 50 users or as per project requirement.
- (iii) The system shall be designed as per relevant IS Codes.

19.0 STATUTORY RULES

- 19.1 Contractor shall comply with all the applicable statutory rules pertaining to factories act (as applicable for the Country), Bhutan Electricity Authority, Water Act for pollution control, etc.
- 19.2 Provisions for fireproof doors, no. of staircases, fire separation wall, plastering on structural members (in fire-prone areas), etc. shall be made according to the recommendations of the Bhutan Electricity Authority.
- 19.3 Statutory clearance and norms of the National Environment Commission of Bhutan shall be followed as per relevant acts.
- 19.4 Requirement of sulphate resistant cement (SRC) for substructural works shall be decided in accordance with the Indian Standards based on the findings of the detailed soil investigation to be carried out by the Bidder.
- 19.5 Foundation system adopted by Bidder shall ensure that relative settlement and other criteria shall be as per provision in IS:1904 and other Indian Standards.
- 19.6 All water retaining structures designed as uncracked section shall also be tested for water tightness at full water level in accordance with clause no. 10 of IS:3370 (Part-I).
- 19.7 Construction joints shall be as per IS: 456.
- 19.8 All underground concrete structures like basements, water retaining structures etc. shall have plasticizer cum waterproofing cement additive conforming to IS:9103. In addition, the limit on permeability as given in IS:2645 shall also be met with. The concrete surface of these structures in contact with earth shall also be provided with two coats of bituminous painting for water/damp proofing.
- In case of water leakage in the above structures, Injection Method shall be applied for repairing the leakage.
- 19.9 All building/construction materials shall conform to the best quality if not otherwise mentioned in this specification.

19.10 All tests as required in the standard field quality plans have to be carried out.

SUPPLEMENTARY SPECIFICATION FOR CIVIL WORKS

1.0 This part covers the supplementary requirements for the civil works of the hatchery and growout.

2.0 ROADS

All roads within the hatchery area shall be bituminous/concrete road. Road shall be designed based on the relevant standards/codes and considering the vehicular traffic and the hatchery equipment to be brought in during the execution of work and also during maintenance/replacement of the hatchery equipment.

Roads will include the construction of sub-base, Dense bituminous macadam course and Asphalt, provision of kerb-stone as per the drawings attached.

The construction shall be such as to satisfy provisions of all applicable IS and IRC codes, the more important ones of which are mentioned below. Additional specifications for items such as Rubble Sub-base, concreting for slab, reinforcement, etc. shall be as given elsewhere in this document.

IS:73	:	Specification for Paving Bitumen
IS:215	:	Specification for Road Tar
IS: 217	:	Specification for Cutback Bitumen
IS:454	:	Specification for Digboi type Cutback Bitumen
IS:460 (Parts 1 to 3)	:	Specification for Test Sieves
IS: 1077	:	Specification for common burnt clay building bricks
IS:1124	:	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.
IS:1195	:	Specification for Bitumen Mastic Flooring.
IS:1196	:	Code of Practice for Laying Bitumen Mastic Flooring
IS: 1834	:	Specification for Hot Applied Sealing Compounds for Joints in Concrete.
IS:2386 (Parts 1 to 8)	:	Methods of tests for aggregates for concrete.

IS:2720 (Part 5)	:	Methods of Test for Soils: Part 5 Determination of Liquid and Plastic Limit
IS: 6241	:	Method of test for determination of stripping value of road aggregates
IRC: 15	:	Standard specifications and code of practice for construction of Concrete Roads (Second Revision)
IRC: 16	:	Specification for priming of base course with bituminous primers
IRC: 17	:	Tentative specification for single coat bituminous surface dressing.
IRC: 19	:	Standard specification and code of practice for water bound macadam
IRC: 29	:	Specification for bituminous concrete (Asphalt concrete) for road pavement.
Ministry of Surface Transport (Roads Wing)	:	Specifications for road and bridge works

2.1 Construction Sequence

It is the intent of this specification that the water-bound macadam road be constructed first. This shall then be opened to traffic, as directed by Employer/Engineer. After such a period of time as decided by Employer/Engineer, preferably when the major construction and/or erection activities within plant limits are over, the Contractor shall rectify all defects, wear and tear, etc. and surface the road with bituminous wearing course treatment.

2.2 Measurements and Rates

Drawings showing a typical cross-section of roads are attached herein. These are for guidance in bidding and construction. The cross-section, actual width, etc. will be decided during the execution of the work. Payment shall be on item rate as specified in the Price Schedule and quoted rates shall be all-inclusive, satisfying all the specifications as above. The Engineer reserves the right of getting all materials and methods tested as per procedures given in the codes listed above. The quoted Rate shall include the cost of all such testing, preparation of reports etc.

3.0 CONSTRUCTION OF CIVIL WORKS

4.0 EXCAVATION

4.1.1 Drawings

Based on the contour drawings, hatchery layout and sections provided by the employer the Contractor shall furnish drawings for the approval of the Engineer, showing his scheme for the areas to be excavated/ filled, grade level, the sequence of priorities, etc, to achieve the most economic arrangement considering excavation, fill, amount of material used for structures, foundations, drainage systems, etc. The Contractor shall strictly follow such drawings. The Contractor shall submit the most economic scheme, fixing the grade level at his discretion, including stepped gradation at 2 or more levels for the different structures, but the final scheme shall be adopted only after the approval of the Engineer.

4.1.2 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 which shall be disposed off as directed by the Engineer. Where earth fill is intended, the area shall be stripped of all loose/ soft patches, topsoil containing objectionable matter/ materials before fill commences.

It shall be noted and remembered that unauthorized tree cutting being an offence in Bhutan, any tree cutting shall be started only after the requisite permission has been obtained by the Employer from the concerned authorities for each and every tree to be cut.

4.1.3 Precious Objects, Relics, Objects of Antiquity etc.

All gold, silver, oil, minerals, archaeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the Employer and the Contractor shall duly preserve the same to the satisfaction of the Employer and from time to time deliver the same to such person or persons as the Employer may from time to time authorize or appoint to receive the same.

4.1.4 Classification

All materials to be excavated shall be classified by the Engineer, into one of the following classes and shall be paid for at the rate tendered for that particular class of material. No distinction shall be made whether the material is dry, moist or wet. The decision of the Engineer regarding the classification of the material shall be final and binding on the Contractor and not be a subject matter of any appeal or arbitration.

Any earthwork will be classified under any of the following categories:

(a) Ordinary And Hard Soils

These shall include all kinds of soils containing sand, silt, murrum and/or shingle, gravel, clay, loam, peat, ash, shale, etc., which can generally be excavated by spade, pickaxes and shovel, and which is not classified under "Soft and Decomposed Rock" and "Hard Rock" defined below. This shall also include embedded rock boulders not longer than 1 metre in any one direction and not more than 200 mm in any one of the other two directions.

(b) Soft and Decomposed Rock

This shall include rock, boulders, slag, chalk, slate, hard mica schist, laterite and all other materials which in the opinion of Engineer is rock, but does not need blasting and could be removed with picks, hammer, crow bars, wedges, and pneumatic breaking equipment. The mere fact that the Contractor resorts to blasting for reasons of his own shall not qualify for classification under 'Hard Rock'.

This shall also include excavation in macadam and tarred roads and pavements. This shall also include rock boulders not longer than 1 metre in any direction and not more than 500 mm in any one of the other two directions. Masonry to be dismantled will also be measured under this item.

(c) Hard Rock

This shall include all rock occurring in large continuous masses, which cannot be removed except by chiseling, drilling or blasting for loosening it. Harder varieties of rock with or without veins and secondary minerals which, in the opinion of the Engineer require blasting shall be considered as hard rock. Boulders of rock occurring in such sizes and not classified under (a) and (b) above shall also be classified as hard rock. Concrete work both reinforced and unreinforced to be dismantled will be measured under this item, unless a separate provision is made in the Schedule of Quantities.

4.1.5 General

The excavation shall be done 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 to avert an accident.

The rates quoted shall also include for the dumping of excavated materials in regular heaps, bunds, riprap with regular slopes as directed by the Engineer, within the lead specified and leveling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as directed by the Engineer.

All excavation work shall be carried out by mechanical equipment unless, in the opinion of the Engineer, the work involved and time schedule permit manual work.

Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer.

All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor in each individual case, for the method he proposes to adopt for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval, however, 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. Removal of the slipped earth will not be paid for separately, but shall be deemed to be included in the contract rate of excavation

The Contractor shall ensure that excavations are made to the correct depth and width. If excavations are taken too deep, the excess depth shall be back-filled with lean concrete at the Contractor's expense. If excavations are made too wide, such modifications to the design as the Engineer may require shall be made at the Contractor's expense.

4.1.6 Stripping Loose Rock

All loose boulders, semi-detached rocks (along with earthy stuff 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 the Engineer, to fall or otherwise endanger the workmen, equipment, or the work, etc., shall be stripped off and removed away from the area of the excavation. The method used shall be such as not to shatter, or render unstable or unsafe the portion which was originally sound and safe.

4.2 Fill, Back Filling and Site Grading

4.2.1 General

All fill material whether such material is brought from outside borrow areas or from excavation from within the site will be subject to the Engineer's approval. If any material is rejected by the Engineer, the Contractor shall remove the same forthwith from the site at no extra cost to the Employer. Surplus fill material shall be deposited/disposed off as directed by the Engineer after the fill work is completed.

No earthfill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Engineer.

Material

To the extent available, selected surplus soils from excavated materials shall be used as backfill. Fill material shall be free from clods, salts, sulphates, organic or other foreign material. All clods 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 up the voids and the mixture used for filling.

If any selected fill material is required to be borrowed, the Contractor shall make arrangements for bringing such material from outside borrow pits. The material and source shall be subject to prior approval of the Engineer. The approved borrow pit area shall be cleared of all bushes, roots of trees, plants, rubbish, etc. topsoil containing salts/ sulphate and other foreign material shall be removed. The materials so removed shall be disposed off as directed by the Engineer. The

Contractor shall make necessary access roads to borrow areas and maintain the same, if such access road does not exist, at his cost.

It shall be the Contractor's responsibility to locate suitable borrow areas for borrowing fill material. Such an area will be inspected by the Engineer and approved before the Contractor makes arrangements to borrow the fill material. The topsoil which may contain vegetation, rubbish, slush, etc. shall not be used. If demanded by the Engineer, the Contractor shall arrange to have trial pits of specified dimensions and numbers dug at locations specified, for the Engineer to examine the nature and type of material likely to be obtained from the borrow area.

The borrowed soil shall be generally granular, and non-cohesive. It shall consist of sand, silty sand, murrum, ordinary soil, gravel and shingle. Dredged material shall also be free from sulphates, salts, organic, foreign and other harmful or objectionable materials. Any material rejected by the Engineer shall be removed from the site immediately.

4.2.2 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 the Engineer. The earth shall be rammed with approved mechanical compaction machines. Usually, no manual compaction shall be allowed unless the Engineer is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and leveled to proper profile as directed by the Engineer or indicated on the drawings.

4.2.3 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 Engineer may, however, permit manual compaction by hand tampers in case he is satisfied that mechanical compaction is not possible. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours allowed to dry and then the surface again compacted as specified above to avoid settlements at a later stage. The finished level of the filling shall be trimmed to the level/slope specified.

Where found necessary by the Engineer, compaction of the plinth fill shall be carried out by means of 12-tonne rollers smooth wheeled, sheep-foot or wobbly wheeled rollers. In the case of compaction of granular material such as sands and gravel, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by the Engineer. As rolling proceeds, water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fill.

The thickness of each unconsolidated fill layer can, in this case, be up to a maximum of 300 mm. The Engineer will determine the thickness of the layers in

which fill has to be consolidated depending on the fill material and equipment used.

Rolling shall commence from the outer edge and progress towards the center and continue until the compaction is to the satisfaction of the Engineer, but in no case, less than 10 passes of the roller will be accepted for each layer.

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated and filled and consolidated.

At some locations/ areas, it may not be possible to use rollers because of space restrictions etc. The Contractor shall then be permitted to use pneumatic tampers, rammers, etc. and he shall ensure proper compaction. Alternatively, the Contractor shall ensure necessary compaction by the passage of trucks, carrying the fill material over the deposited fill in such a way that the entire fill area is covered. This will reasonably compact the sand fill and will be accepted by the Engineer. However, the Contractor shall ensure that every layer is thus compacted before the succeeding layers are deposited. Each layer shall not exceed 200 mm in thickness.

4.2.4 Sand filling in the plinth and other places

At places backfilling shall be carried out with local sand if directed by the Engineer. The sand used 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. Any temporary work required to contain sand under flooded conditions shall be to the Contractor's account. The surface of the consolidated sand shall be dressed to the required level or slope. Construction of floors or other structures on sand fill shall not be started until the Engineer has inspected and approved the fill.

4.2.5 Filling in trenches

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care 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 centreline 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 centreline of the pipe 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 of the level of the centreline of the pipe shall be done by hand compaction in layers not exceeding 8 cm. Whereas the filling above the centreline 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 simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

4.2.6 Soil fill

Approved soil fill consisting of ordinary soil, moraine, soil containing gravel, shingle, etc. shall be deposited in layers not exceeding 200 mm. The Contractor should ensure that all clods of earth are broken down to a size not larger than 100 mm.

Where the density of fill or use of rollers is not specified the fill shall be carried out as specified in Clause 3.2.5.

Where specified, the required density of fill shall be obtained by proper compaction.

4.2.7 General Site Grading

Site grading shall be carried out as indicated in the approved drawings and as directed by the Engineer. Excavation shall be carried out as specified in the specification. Filling and compaction shall be carried out as specified herein unless otherwise indicated below.

If no compaction is called for, the fill may be deposited to the full height in one operation and levelled. If the fill has to be compacted, it shall be placed in layers not exceeding 225 mm and levelled uniformly and compacted as indicated in Clause 4.2 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 at his cost.

Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed. This shall hold good for embankments as well.

The Contractor shall protect the earthfill from being washed away by rain or damaged in any other way. Should any slip occur, the Contractor shall remove the affected material and make good the slip at his cost.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

If specifically permitted by the Engineer, compaction can be obtained by allowing loaded trucks conveying fill or other material to ply over the fill area. Even if such a method is permitted, it will be for the Contractor to demonstrate that the desired/ specified compaction has been obtained. In order that the fill may be reasonably uniform throughout, the material should be dumped in place in approximately uniform layers. Traffic over the fill shall then be so routed to compact the area uniformly throughout.

If so directed by the Engineer, the rock as obtained from excavation may be used for filling and levelling to indicated grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above, has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonne roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

4.2.8 Fill Density

The compaction, only where so called for, in the schedule of quantities/ items shall comply with the specified (Standard Proctor/ Modified Proctor) density at moisture content differing not more than 4 percent from the optimum moisture content. The Contractor shall demonstrate adequately at his cost, by field and laboratory tests that the specified density has been obtained.

4.2.9 Lead

Lead for deposition/ disposal of excavated material, shall be as specified in the respective item of work. For the purpose of measurement of lead, the area to be excavated or filled or area on which excavated material is to be deposited/ disposed off shall be divided into suitable blocks and for each of the blocks, the distance between centrelines shall be taken as the lead which shall be measured by the shortest straight line route on the plan and not the actual route taken by the Contractor.

4.2.10 Measurement and Payment

All excavation shall be measured net. Dimensions for purpose of payment shall be reckoned on the horizontal area of the excavation at the base for foundations of the walls, columns, footings, tanks, rafts or other foundations/ structures to be built, multiplied by the mean depth from the surface of the ground in accordance with the drawings. Extra excavation for working space requirements and excavation in side slopes will not be paid for. The Contractor may make such allowance in his rates to provide for working space and for excavation in side slopes keeping in mind the nature of the soil and safety of excavation. Excavation paid for will be of the exact size of the foundation, undercut being paid for extra as per its volume.

Unless otherwise specified, the unit rates quoted for excavation in different types of material shall also account for a basic lead of 100 metres for disposal as specified or directed. Only leads beyond the basic lead of 100 metres will be considered as extra lead and paid for at the rates quoted in the schedules.

Backfilling as per specification the sides of foundations of columns, footings, structures, walls, tanks, rafts, trenches etc. with excavated material will not be paid for separately. It shall be clearly understood that the rate quoted for excavation

including backfilling shall include stacking of excavated material as directed, excavation/ packing of selected stacked material, conveying it to the place of final backfill, compaction etc. as specified. As a rule, material to be backfilled shall be stacked temporarily within the basic lead of 100 metres unless otherwise directed by the Engineer. If the Engineer directs/ permits a lead of over 100 metres for such material, the conveyance of the material for the extra distance over the basic lead of 100 metres for backfilling will be paid for.

Payment for fill inside trenches, plinth or similar filling with selected excavated material will be made for only compaction as specified / directed. Cost of all other operations shall be deemed to have been covered in the rate quoted for excavation. Payment for this work will be made based on measurement of plinth/ trench dimensions filled. The plinth ground levels shall be surveyed before hand for this purpose. If no compaction is specified/ desired such filling will not be separately paid for. In such an event the fill shall be levelled/ finished to the profile as directed at no extra cost.

Backfilling, plinth filling etc. with borrowed earth will be paid for at rates quoted. The quoted rate shall include all operations such as clearing, excavation, lead and transport, fill, compaction etc. as specified. Actual quantity of consolidated filling or actual quantity of excavation in the borrow pits (less such top soil which has been excavated and not used for filling) whichever is less shall be measured and paid for in cubic metres. The lead, lift etc. shall be as indicated in the schedule of quantities. Actual quantity of consolidated sand filling shall be measured and paid in cubic metres.

4.3 Close timbering

It 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 directed by Engineer. 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 walings of strong wood at maximum 1.2 metres spacings, strutted with ballies or as directed by Engineer. The length of the ballies 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 wallings, 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 Engineer. It shall be the responsibility of Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc., from collapsing.

Timber shoring may 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 Engineer.

The withdrawal of the timber shall be done very 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. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

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 Engineer. In all other respects, specification 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 for sides of excavations/pits cannot be strutted against, suitably inclined struts supported on the excavated bed shall be provided. Load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut.

4.4 Dewatering

All excavations shall be kept free of water. Grading in the vicinity of excavation shall be properly closed to prevent surface water from running into excavated areas. The contractor shall remove by pumping or other means approved by the Engineer any water inclusive of rainwater and subsoil water accumulated in excavation and keep all excavations dewatered until the foundation work is completed and backfilled. Sumps made for dewatering must be kept clear of the excavations/trenches required for further work. Method of pumping shall be approved by Engineer; 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.

Unless separately provided for in the Schedule of quantities, dewatering is deemed to have been included in the unit rates quoted for excavation. If separately provided for, the unit of measurement shall be as indicated in the schedule of quantities.

5.0 **BLASTING IN HARD ROCK**

5.1 General Requirements

Unless otherwise stated herein, I.S. specification "IS-4081: Safety code for Blasting and related Drilling Operations" shall be followed. After removal of overburden, if any, the excavation shall be continued in rock to such widths, lengths, depths, and profiles as are shown on the drawings or such other lines and grades as may be specified by Engineer. 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 the Engineer, 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, the Contractor shall repair the same to the satisfaction of the Engineer at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and the amount of explosives used shall be progressively and suitably reduced.

Specific permission of Engineer will have to be taken by Contractor for blasting rock and he shall also obtain a valid Blasting License from the authorities concerned. If permission for blasting is refused by the Engineer, the rock shall be removed by wedging, pick, barring, heating and quenching, or other approved means. All loose or loosened rock in the sides shall be removed by barring, wedging, etc. The unit rates for excavation in hard rock shall include the cost of all these operations.

The contractor shall obtain the necessary license for storage of explosives, fuses, and detonators issued to him from Employer's stores or supplier arranged by him, from the authorities dealing with explosives. The fees, if any, required for obtaining such license, shall be borne by the Contractor. The contractor shall have to make necessary storage facilities for the explosives etc. as per rules of local, State, and Central Government authorities and Statutory bodies/regulations. Explosives shall be kept dry and shall not be exposed to direct rays of the sun or be stored in the vicinity of fire, stoves, steam pipes or heated metal, etc. No explosives shall be brought near the work over the 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 as possible from the area to be blasted; Engineer's prior approval shall be taken for the location proposed for the magazine.

In no case shall blasting be allowed closer than 30 metres 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. As far as is possible, all blasting shall be completed prior to laying concrete for any foundations or any other purposes. Permission for blasting may be refused, at the discretion of the Engineer, after casting of foundations is started, in which case excavation in hard rock shall be done by other methods.

5.2 Specific Requirements

For blasting operations, the following points shall be observed.

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.

Before any blasting is carried out, Contractor shall intimate Engineer 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.

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 5 minutes before firing time by sounding warning whistle. The area shall also be given a warning by sounding a distinguishing whistle.

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 with small charges only and where directed by Engineer, a trench shall have to be cut by chiselling prior to the blasting operation, separating the area under blasting from the existing structures.

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.

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.

Contractor shall preferably detonate the explosives electrically.

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. In dry weather and normal dry excavation, ordinary low explosive gunpowder may be used. In damp rock, high explosive like gelatine with detonator and fuse wire may be used. Underwater or for excavation in rock with substantial accumulated seepage electric detonation shall be used.

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.

When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an overbreak limit of 75 mm shall be filled up as instructed by Engineer, with concrete of strength not less than M10. The cost of filling such excess depth shall be borne by Contractor and the excavation carried out beyond the limit specified above will not be paid for. Stopping in rock excavation shall be done by hand trimming.

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 Government of Bhutan Rules.

5.3 Measurement

Volume of rock excavated shall be calculated on the basis of length, breadth and depth of excavation indicated on the drawings. No payment will be made for excavations/overbreak beyond payment line specified. Where such measurement is not possible as in the case of strata intermixed with soil, excavated rock shall be properly stacked as directed by Engineer and the volume of rock calculated on the basis of stack measurements after making appropriate allowance for voids. The allowance to be made for voids shall be decided by Engineer and this will not be a subject matter of dispute or appeal.

6.0 LINE DRILLING AND PRE-SHEARING

6.1 Procedure

Line drilling and Pre-shearing in rock shall be resorted when so specified or directed by the Engineer. This technique shall be used when the excavation in rock (hard and stratified) has to be carried out to exact lines and levels and when absolutely no over excavation is permissible. It shall also be used where rock blasting is required to be carried out in the close proximity of existing structures, equipment etc.

This technique consists of drilling holes, as close as warranted by the rock conditions and to such depth as may be necessary, along the periphery (or line) of the area within which excavation has to be carried out. This will ensure that when rock inside the area is blasted, over excavation/ over break damage to adjoining property is avoided as the rock shears off along the line of drilled holes.

The diameter, depth and spacing of holes, shall be decided by the Engineer or as specified in the drawings/ schedules. The holes shall be generally be 48 mm in diameter. The Engineer may direct a second line or subsequent lines of holes to be drilled in addition at suitable location/s to facilitate safe excavation.

The layout of the interior blasting holes shall be carefully planned. Only light blasting is permitted in the interior holes which are close to the line drilled holes.

The Contractor shall have to carry out tests to determine the amount of explosives required to ensure an even break at the line drilled holes, so that damage to structure outside line drilled holes as also over breaks are avoided.

After the interior holes are blasted any irregularities in the vertical line drilled face which was line drilled shall be removed and trimmed by wedging, splitting, chiselling and barring.

Excavation shall generally be carried from the centre to the outside.

The Engineer may direct a trench to be cut between adjacent line drilled holes. In such a case, rock between line drilled holes shall be blasted with such pattern of holes as will not cause any damage to any structure close by and also not shatter or render unsuitable any good rock outside the line drilled holes.

Line drilling and preshearing will only be permitted in hard rock.

8.0 CONCRETE

All cement to be used shall be Portland cement meeting the requirements of the relevant Indian Standards (mainly IS 269), from an approved manufacturer. Cement shall be adequately protected from moisture or contamination during transportation and storage at site. Cement in bags shall be limited within a heap of 13 bags in store and 7 bags at site. No cement containing lumps or deleterious matter shall be used.

The reinforced cement concrete used for the foundation shall be of M20 grade (i.e., of 20N/mm² cube compression strength at the end of 28 days), with 20mm down graded stone metal for walls and other members less than 600 mm thickness and 40mm down graded stone metal for thicker members of the works including pyramid portions. Aggregates shall conform to specifications for coarse and fine aggregates from natural sources for concrete as per IS: 383. The methods used for the preparation of concrete, and all its properties regarding its strength under compression, tension, shears, punching and bending etc., as well as workmanship shall conform to the relevant Indian Standard codes of practice.

The sand used for the concrete shall be composed of hard siliceous materials. It shall be clean and of a sharp angular grit type and free from earthy or organic matter and deleterious salts and screened through a mesh not more than 5mm in the clear.

The aggregates shall be of clean broken hard granite or other stone specified or approved by the Engineer. It shall be of hard, closed-grained quality. It shall also be as far as possible cube like, preferably angular, but not flaky, perfectly clean and free from earth, organic or other deleterious matters. 40mm aggregate shall be of size as will pass through a mesh of 40mm measured in the clear and 20mm aggregate through 20mm square mesh measured in clear. All fine and coarse aggregates shall be obtained from sources approved by the Engineer.

The water used for mixing concrete shall be fresh clean and free from oil, acid and alkali organic materials or other deleterious substances. Salty or brackish water should not be used. Potable water is generally satisfactory.

Though not generally expected, sulphate-resisting cement may be necessary if so indicated during soil investigation. Sulphate resisting Portland cement shall be in accordance with IS standards and shall be obtained from a source approved by the Engineer. The Engineer shall decide the locations where it shall be mandatory for the Contractor to use sulphate-resisting cement. The Contractor shall certify that the proposed cement is of the required quality regarding resistance to corrosion due to sulphates. Methods of testing this quality shall be deemed to have been included in the rates quoted. The use of aluminous cements will not be permitted. For payment purposes, the bidder shall quote for ordinary M20 Concrete and PCC, as listed in the BOQ. If sulphate resistant cement is used, the bidder shall quote an extra per tone of Concrete and PCC; over an above the rates quoted for the corresponding items with ordinary cement

8.1 Batching and Mixing of Concrete

It shall be Contractor's responsibility to carry out tests on samples for concrete that the Contractor proposes to employ in foundation concrete. The procedure for testing is outlined in the appropriate clauses under "Inspection and Testing".

The test result of the proposed mixture together with data for water cement ratio and slump shall be submitted to the Engineer for approval at least four (4) weeks before the commencement of concreting operation. The trial mix proportions shall be approved if the average compressive strength of a set of 9 specimen tested at 28 days exceeds 21N/mm², with not more than 3 specimen being less than 20N/mm², and no single specimen being less than 17 N/mm².

The Contractor shall be responsible for maintaining the mixture, control and testing of concrete throughout the working period. Neither the mix proportions nor the source of the supply of materials shall be altered without the prior approval of the Engineer. The minimum cement content, the water cement ratio, the slump and all other characteristics of concrete shall be demonstrated to conform to the relevant Indian Standards.

The concrete shall be mixed with an approved concrete mixer. In no case shall hand mixing be allowed. The Contractor shall provide the measuring equipment and shall maintain and operate the equipment as required to accurately determine and control the amount of each separate ingredient entering the concrete. The equipment shall be constantly maintained in first-class workable condition during the working period. The concrete mixing shall be cleaned and inspected at suitable intervals in the presence of the Engineer.

Each time 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.

The cost of all concrete testing shall be deemed to be included in the price of the concrete works. In addition, the Engineer shall retain the right to undertake slump tests at any time prior to the placement of concrete and reject any batch of concrete that fails such tests, all at the cost of the contractor.

Mixing shall be continued until there is uniform distribution of material and the mix is uniform in color and consistency but in no case the mixing is done for less than 2 minutes. Normally mixing shall be done close to the foundation. The concrete shall be placed and compacted before setting commences.

The concrete should be mixed as stiff as the requirement of placing the concrete in the forms or moulds with ease and the degree to which the concrete resists segregation. Hence the quantity of water used should not be too much.

Concrete shall not be directly poured from a height more than 1.5m to avoid mix segregation.

Form work shall conform to the provisions of Clause 10 "Form-Work" IS: 456. Proper forms or moulds adequately braced to retain proper shape while concreting should be used for chimney and pyramid or slab portions. The mould should be water tight so that cement cream should not come out leaving only sand and jelly consequently forming of honeycombing in the concrete. The form boxes shall be cleaned and oiled before these are used for concreting.

The stub shall be free of rust and cleaned thoroughly and painted with cement paste, made of 1 part of cement and ¾ part of water (cement slurry) to a thickness

of 1.6mm before the concrete is laid against the stub. The painting with cement slurry shall be done each time to such a height before the cement wash becomes dry.

Concrete shall, in all cases be placed in the presence of the Engineer. No concrete shall be placed until the Engineer has approved the excavated surface, stub setting, and inspection of formwork and completion of all preparation work. Adequate chutes or other approved method shall be employed to place concrete. All concrete shall be consolidated to the maximum practicable density with a concrete vibrator and surface made smooth and free from pockets and honeycomb.

The concrete shall be laid in 150mm layers and consolidated well so that the cement cream works up to the top and no honeycombing are left in the concrete. Concreting is to be done continuously so that the subsequent layers are laid before the final setting of the bottom layer begins.

If fresh concrete is to be laid on old concrete less than a week old, the surface of the old set concrete should be chipped and cleaned thoroughly with wire brush and washed with a layer of thick cement slurry before the new concrete is laid. If, however, the concrete is more than 10 days old, the top layer of the set concrete should be chipped and cleaned thoroughly with wire brush and water and layer of cement mortar (1:2) 12 mm thick shall be laid evenly after giving a coat of cement slurry, as specified above to ensure proper bonding between old and new concrete. If a foundation / chimney or any other concrete member is damaged during the course of the works, it shall be brought to the notice of the Engineer, and rectified as directed by him.

After concreting the chimney portion to the required height, the top surface should be finished smooth, with slight slope towards the outer edge to drain off the rainwater falling on the coping.

In wet locations, the site must be kept completely de-watered both during the placing of the concrete and for 24 hours after completion. There should be no disturbance of concrete by water during this period.

The forms or mould shall not be removed before a lapse of about 24 hours after the completion of concreting. After removal of the forms, the concrete surface, where required shall be repaired with a rich cement and sand mortar in the shortest possible time. For concreting during hot weather adequate provision shall be made to lower concrete temperature which shall not increase beyond 40°C at the time of placement of fresh concrete. All exposed concrete and structure steel within one meter of the ground or high water level, whichever is higher, shall be painted with a black bituminous paint, Flintcote or approved type, before handing over to the Employer.

8.2 Concreting in Cold Weather.

When there is danger of freezing, certain minimum temperatures of concrete, as placed, are specified because much of the heat generated during hydration of cement is not immediately available. The temperature of the concrete shall not be less than 4.5°C in moderate weather or 10°C when the mean daily temperature drops below 4.5°C. To obtain the required temperature for freshly mixed concrete

in cold weather, it is necessary to heat mixing water or aggregates, or both, depending on severity of the weather. Heating of the mixing water is the most practicable and efficient procedure. The minimum temperature at which water and the aggregates should enter the mixer, to produce 15⁰ C temperature of concrete shall be 6⁰C and 3.5⁰C respectively. Fluctuations in temperature from batch to batch shall be avoided. Very hot water should not be allowed to touch the cement because of the danger of causing quick or “flash” set. If hot water and the coldest portion of the aggregate can be brought together in the mixer first so that the temperature of this mixtures does not exceed about 38⁰ C the possibility of flash set will be minimized. The aggregates should be heated uniformly and carefully eliminating all frozen lumps, ice and snow, and avoiding overheating or excessive drying. Average temperatures should not exceed 62⁰ C and maximum temperatures should not exceed 100⁰ C. Heating of aggregates is preferably accomplished by hot water.

Concrete shall be protected against freezing temperatures for at least 48 hours after being placed when the mean daily temperature is 4.5⁰ C or above. When the mean daily temperature is below 4.5⁰ C, concrete as placed should have a temperature of not less than 10⁰ C and should be maintained at the same temperature for at least 72 hours. Heat of hydration can be gainfully conserved by having insulating formwork covers of timber, clean straw blanket sacking, tarpaulins, plastic sheets etc. in conjunction with air gap upto first 3 days even when ambient temperatures are lower.

For moderately cold weather timber formwork alone are sufficient & preferable to steel formwork. When the concrete is cured by membrane curing no additional protection against freezing is required if the protection at 10⁰ C for 72 hours is obtained by means of adequate insulation in contact with the forms or concrete surfaces. If membrane cured concrete is not protected by insulation, the concrete should be protected against freezing temperatures for an additional 72 hours immediately following the 72 hours of protection at 10⁰ C. Water cured concrete must be protected against freezing temperatures for 3 days immediately following the 72 hours protection at 10⁰ C.

Protection required in cold weather is only as much necessary as to keep the temperature of the concrete from falling below specified temperature during certain initial periods. The most common method of protection is to enclose the structure and surround it with atmosphere warm enough to maintain the required temperatures.

Enclosures should be tight and windproof. Stoves of various types may be used for heating. These are easy to handle, inexpensive and are convenient for small jobs but they have the disadvantages of producing dry heat. Dry heat for protection of concrete in cold weather tends to produce rapid drying because warm air will hold much more moisture than cold air. It is important, therefore, that the concrete be supplied with adequate moisture when dry heat is used.

Because of slower rate of gain of strength during cold weather, the formwork & props have to be kept in place for longer than in usual concreting practice. The appropriate time of removal of formwork may be 5 days for chimney.

8.3 Curing

The concrete after it is 24 hours old shall be cured by keeping concrete wet continuously for a period of 14 days after laying. The pit may be backfilled with selected earth sprinkled with necessary amount of water and well consolidated in layers not exceeding 150mm of consolidated thickness after a minimum period of 24 hours and thereafter both the back-filled earth and chimney top shall be kept wet for the remainder of the prescribed period of 14 days. The uncovered concrete member above the back-filled earth shall be kept wet by providing empty cloth or hessian bags dipped in water fully wrapped around the concrete member for curing and ensuring that the bags are kept wet by frequent pouring of water on them.

8.4 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-holes, etc shall be brought to the notice of the Engineer who may permit the patching of the defective areas or reject the concrete work. Rejected concrete shall be removed and replaced by the Contractor without any additional expense to the Employer. After removing loose materials, the surface shall be prepared and saturated with water for 24 hours before patching is done with 1:1 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as directed by the Engineer.

9.0 REINFORCEMENT

All materials, activities and methods regarding reinforcing steel shall conform to the relevant I.S. Codes, particularly to IS 432 for mild steel bars and wires, IS 1786 for High Strength bars/TMT bars and wires, and IS 1566 for steel wire fabric. The Contractor shall provide certificates stating origin and process of manufacture of reinforcing steel, and submit test certificates from supplier to the Engineer. At the discretion of the Engineer, samples of reinforcing steel selected by the Engineer shall be tested by the contractor at a local laboratory of the Engineer's choice, to demonstrate the tensile strength of the steel. The cost of such testing shall be deemed to be included in the Scheduled Rates of Items for supply of reinforcement.

The wire shall be 1.25mm in diameter or heavier black annealed iron wire. Preformed clips or attachments shall be of proper design and strength so that reinforcing bars are rigidly supported/held in position, and are not capable of movement during concrete pouring.

Reinforcing steel shall be protected from damage during transportation and during storage. It shall be stacked horizontally with adequate supports to prevent distortion. Bars of different lengths and diameters shall be stacked separately and marked for easy identification.

Reinforcing steel shall be cold bent without any application of heat, by a slow and regular movement. Bending shall be done accurately to dimensions given in the bar bending schedule or foundation drawings in accordance with IS 2502.

Bars having cracks or splits on the bends shall be rejected.

Immediately before placing concrete, it shall be ensured that reinforcing steel is free from dirt, detrimental scale, paint, mortar, oil, or other foreign substances.

Reinforcing steel embedded or partially embedded in the concrete shall remain completely undisturbed for a minimum period of 24 hours, or longer if the Engineer so directs, after a unit of concrete placement has been completed.

Steel shall be placed accurately in accordance with the Drawings. It shall be tied securely at each intersection. Metal or concrete chairs and metal spreaders of approved types shall be used where necessary for support or spacing of steel bars.

Wood supports or spreaders shall not be used.

Splicing of bars except where shown on the Drawings shall not be permitted without the prior written consent of the Engineer. Bar splicing shall be by overlapping, as indicated on the Drawings, and the lap lengths shall not be less than 52 times the diameter of the smaller bar. The price for splicing length shall be paid as verified. However, spacers and wastage etc. shall not be considered for payment.

12.0 RETAINING WALLS

Retaining walls are expected to be erected along the boundary of the hatchery building, or at locations, for instance on slopes, where there are chances of soil erosion due to rainwater, etc. The wall shall consist of broken stone pieces cemented with the help of 1: 5 cement mortar and weep holes and filters (300mmX300mmX300mm gradation from 75mm to 120mm). The weep shall be HDPE medium duty pipe minimum of 110mm diameter placed at least 1.5m apart staggered horizontally and vertically with slope of 1 in 100. The revetment walls shall be finally pointed with 1:3 cement mortar. The empty space between revetment and foundation shall be filled by earth. Alternatively, RCC retaining wall shall also be permitted. The design of the revetment and foundation shall be developed by the Contractor and approved by the Engineer.

If RCC or Masonry works are found necessary at the time of execution of the Contract, the same shall be decided upon by the Engineer. In that case, the unit rates quoted by the Contractor for items required for such works (e.g., the rates for excavation, concrete, reinforcing steel etc.) shall remain binding upon the Contractor. For dry stone and stone masonry revetment, separate rates shall be quoted per cum. of the wall. These rates shall be inclusive of supply of all materials, items of work involved (like excavation, laying etc.) and all costs of workmanship, labour, etc. necessary to complete revetment works.

The various Factors of Safety for stability checks of all types of retaining walls shall be as follows:

Overturning – Dead & Live Load and earth pressure with wind or EQ:	1.5
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Overturning - Dead & Live Load and earth pressure without wind or EQ:	2.0
Sliding -- Dead & Live Load and earth pressure with wind or EQ:	1.5
Sliding -- Dead & Live Load and earth pressure without wind or EQ:	1.75

All Retaining walls greater than 5.0 m in height shall be RCC walls, with counterforts. Apart from the provisions given in the relevant I S publications for gravity structures, IS 456 shall be used for the design of RC retaining walls, and IS 1905 shall be used for the design of Masonry Walls. Earth Quake load shall be taken as per IS 1893.

The filter medium for all walls shall consist of hand-packed stones, 50 to 75 mm in size, for a width of 600mm immediately behind the wall, from the top of the wall to a level at least 300mm below the lowest weep hole.

14.0 BREAKING OF CONCRETE, BRICKWORK, BLOCKWORK AND STONE MASONRY

The Contractor shall demolish any brickwork, blockwork, stone masonry or concrete, either plain or reinforced, as may be required. The waste material shall be removed from the location and dumped at suitable location or transported and disposed off as directed by the Engineer. The Contractor shall observe all precautions by way of necessary propping, strutting, etc. to the satisfaction of the Engineer to ensure that adjacent framework is not damaged. Any damage to the adjacent framework, brickwork or blockwork resulting from negligence of the Contractor thereof shall be made good at the Contractor's cost to the satisfaction of the Engineer. Payment for these items shall be done as per specifications and rates quoted for excavation in soft and hard rock, unless a separate item is included in the Schedule of prices.

15.0 INSPECTION AND TESTING

15.1 General

Unless the Approved Make / Manufacturer is specifically spelt out in the Specifications, procurement of all items shall be made only after intimation and approval of the source by the Employer / Engineer.

All material supplied by the Contractor, whether as procured (steel, cement, aggregates, reinforcement etc), or in finished form (concrete, galvanized fabricated steel members etc), shall be subject to testing to approval of Engineer / Employer as per the relevant IS code governing that material, at any stage during the execution of the Contract, from procurement upto commissioning and handing over of the plant to the Employer, the cost of which shall be borne by the Contractor.

Apart from the tests specified in the relevant IS Codes, those specified here in below and others mentioned in the Specifications of individual components of the

works shall also be performed to the satisfaction of the Engineer, and shall be deemed to be included in the Scheduled Rates of the respective items, unless a separate rate is asked for in the BOQ.

All the contractor's establishments, whether for manufacture or for storage of material, will be inspected by the Engineer during the tenure of the contract. Every facility shall be provided by the Contractor to enable the Engineer to carry out the necessary inspection of the establishment and the cost of all tests during manufacture and preparation of test records shall be deemed to be included in the Scheduled Rate of the item, unless separately provided for in the schedule. The dispatch clearance will be issued to the Contractor by the Employer, on receipt of concurrence from the Engineer. The materials shall be inspected and tested during manufacture by an approved inspection firm or laboratory and be accompanied by appropriate compliance certification as part of the extent of works. The Employer / Engineer may also inspect and test raw and finished materials from time to time at any independent laboratory of his own choice, independently of the Contractor. All expenses related to such testing including transport of the material to the laboratory, testing charges, inspection / supervision of the tests by the Employers / Engineer shall be reimbursed by the Contractor.

It is the responsibility of the Contractor to advise the Engineer that the materials shall be available for inspection.

The passing of such inspection or test will not, however, prejudice the right of the Engineer to reject at a later date, the Plant and any or all of material, if it does not comply with the Specifications, or give complete satisfaction in service.

Instruments shall be approved and shall, if required by the Engineer, be calibrated by the National Physical Laboratory or such other body as may be approved, at the expense of the Contractor.

Unless otherwise specified in this Contract, selection of test samples, numbers of specimens and acceptance of results shall be in accordance with the terms of the relevant Indian standard, where applicable. Where no terms exist, the Engineer is to instruct details in advance of the inspection and tests in response to the request of the Contractor.

The following tests, apart from those specified in the relevant IS codes, shall be carried out at the manufacturer's works:

15.2 Structural steel Material Test

Steel material used for supporting steel structures shall be subjected to tensile load or bend test in accordance with the Indian standards. Test shall be performed by the contractor without any additional cost. The test specimens shall consist of members selected randomly by the Engineer from any of the structures selected by him for the purpose of testing, whether erected or not the engineer reserves the right, if the situation so warrants, to get tested at contractor's expenses 5% by weight of the steel used for support structures.

15.3 Concrete Tests

The Contractor shall carry out tests on sample of concrete from the foundation and other concrete works, as required by the Engineer.

The test specimens shall be cubes of 150 mm side and the mould shall be of metal with inner face accurately machined. Each mould shall be provided with a metal base having a smooth machined surface. The interior surfaces of the mould and base shall be lightly oiled before concrete is placed in the mould.

Test Specimens shall be moulded by placing the fresh concrete in the mould in 50 mm layers, each layer being thoroughly compacted with a steel bar 380 mm long and having a ramming face 25 mm square and weighing 2.8 kg. The concrete may be compacted by vibration, each layer being vibrated by means of an electric or pneumatic hammer or by means of a suitable vibrating table.

Concrete for test specimens shall be taken at the point of deposit. To ensure that the specimens are representative of the concrete in the foundations a number of samples shall be taken from different points. Each sample shall be large enough to make one test specimen and shall be taken from one point in the work.

The test specimens shall be stored at the site at a place free from vibration, under damp sacks for 24 hours, plus 1/2 hour, after which time they should be removed from the moulds, marked and stored in water at a temperature between 10° C and 21° C until the test date. Specimens that are to be sent to a laboratory for testing shall be packed for transit in damp sand, or other suitable damp material, and shall reach the laboratory at least 24 hours before test. On arrival at the laboratory, they shall be similarly stored in water until the date of the test.

The test shall be made at the age of the concrete corresponding to that for which the strengths are specified. Compression test shall be made between smooth plane steel plates without end packing and a load shall be applied axially at the rate of approximately 13.8 N/mm² per minute. One compression plate of the testing machine shall be provided above seating in the form of a proportion of a sphere, the center of which coincides with the central point of the face of the plate. Test specimens shall be placed in the machine in such a manner that the load is applied to the sides of the-specimens as cast.

The results shall be handed in triplicate to the Engineer, as soon as possible after testing.

15.4 Testing of Rock Anchors

Where rock anchor foundations are used in hard rock, as provided for by the Specification, the Contractor shall type test individual anchors by tensile test loading to failure. The type test shall be considered satisfactory if the foundation fails at or above the design ultimate strength of steel.

Anchor for type testing shall be installed away from permanent foundation anchors but in the same rock. The frequency of type testing shall depend upon the different types of hard rock encountered and the number of type tests performed shall be such as to give confidence in the employment of rock anchor foundations and experience of the type of rock suitable for their use.

The frequency of type testing shall, in the case of dispute, be reasonably determined by the Engineer.

The cost of rock anchor tests shall be included in the Scheduled Price of Hard rock foundation.

16.0 GENERAL BUILDING WORKS

16.1 Scope

This specification covers the general requirements for building works comprising brick and stone masonry, flooring, doors, windows, ventilators, wood/aluminium work, water- proofing, plastering, painting and such other related works forming a part of this job, which may be required to be carried out though not specifically mentioned above. The work under this specification shall consist of furnishing of all tools, plants, labour, materials, and everything necessary for carrying out the work.

16.2 Applicable Codes and Specifications

The following codes, standards and specifications are made a part of this specification. All standards, 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:110	Ready mixed paint, brushing, grey 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 for timber used for different purposes.
IS:337	Varnish, finishing interior.
IS:348	French polish.
IS:383	Specification for coarse and 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, colour as required.
IS:702	Specification for industrial bitumen.
IS:710	Specification for marine plywood.

IS:712	Specification for building limes.
IS:733	Wrought aluminium and aluminium alloys, bars, rods and sections for general engineering purposes.
IS:777	Specification for glazed earthenware tiles.
IS:1003	Specification for timber panelled and glazed shutters (Part 1)
IS:1003	-DO- (Part 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 & aluminium) 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:1397	Specification for kraft paper.
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 (Part 1).
IS:1477	-DO- (Part 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:1659	Specification for block boards.
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 (non extruding and resilient type): Part 1 Bitumen impregnated fibre.
IS:1948	Specification for aluminium doors, windows and ventilators.
IS:1949	Specification for aluminium windows for industrial buildings.
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 (Part 1).
IS:2185	-DO- Part 2.
IS:2185	-DO- Part 3.
IS:2202	Specification for wooden flush door shutters (Solid core type): Part 1.
IS:2202	-DO- Part 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 (Part 1).
IS:2338	-DO- (Part 2)
IS:2339	Aluminium paint for general purposes, in dual container.
IS:2395	Code of practice for painting of Concrete, masonry and plaster surfaces (Part 1).
IS:2395	-DO- Part 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 water-proofing 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:3036	Code of practice for laying lime concrete for a water-proofed roof finish.
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:3461	Specification for PVC-asbestos floor tiles.
IS:3462	Specification for unbacked 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, wood primer, pink.
IS:3564	Specification for door closers (hydraulically regulated.)
IS:3696	Safety code of scaffolds and ladders (Part 1).
IS:3696	-DO- (Part 2).
IS:4020	Methods of test for wooden flush door (Part 1 to 16).
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 2).
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, colour as required.
IS:5411	Specification for plastic emulsion paint (Part 1).

IS:5411	-DO- (Part 2)
IS:5437	Wired and figured glass.
IS:5491	Code of practice for laying of in-situ granolithic concrete floor topping,
IS:6041	Code of practice for construction of autoclaved cellular concrete block masonry.
IS:6042	Code of practice for construction of light weight concrete block masonry.
IS:6248	Specification for metal rolling shutters and rolling grills.
IS:7193	Specification for glass fibre base coal tar pitch and bitumen felts.
IS:7452	Specification for hot rolled steel sections for doors, windows and ventilators.
IS:8042	Specification for white Portland cement.
IS:8543	Methods of testing plastics (Part 1/Section 1)
IS:8543	Methods of testing plastics (Part 1/Section 2)
IS:8543	Methods of testing plastics (Part 2/Section 1)
IS:8543	Methods of testing plastics (Part 2/Section 2)
IS:8543	Methods of testing plastics (Part 2/Section 3)
IS:8543	Methods of testing plastics (Part 3/Section 1)
IS:8543	Methods of testing plastics (Part 3/Section 2)
IS:8543	Methods of testing plastics (Part 4/Section 1)
IS:8543	Methods of testing plastics (Part 13/Section 1)
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.

16.3 Brickwork

16.3.1 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 200mm x 100mm x 100mm with the permissible tolerances over the actual size of 190mm x 90mm x 90mm 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 230mm x 115mm x 75mm 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, homogenous in texture, well burnt in kiln without being vitrified, hand/machine moulded, deep red, cherry or copper coloured, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 5N/sq.mm unless otherwise specified in the item.

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 ENGINEER for approval and bricks supplied shall conform to approved samples. If demanded by ENGINEER, brick samples shall be got tested as per IS: 3495 by CONTRACTOR at no extra cost to EMPLOYER. Bricks rejected by ENGINEER 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. Sand for masonry mortar shall conform to IS:2116. 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 ENGINEER. If so, directed by the ENGINEER, 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 ENGINEER. 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 forthwith from the site. Droppings of mortar shall not be re-used under any circumstances.

It is also intended to use locally available bricks and contractor shall get prior approval from the engineer before adoption at site

The CONTRACTOR shall arrange for test on mortar samples if so, directed by the ENGINEER.

16.3.2 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. 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 utilised only to make up required wall length or for bonding. Bricks shall be laid with frogs uppermost.

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 levelled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, atleast 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°. But in no case the level difference between adjoining walls shall exceed one metre. Brickwork shall not be raised more than one metre per day.

Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not 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. The arrangement for curing shall be got approved from the ENGINEER.

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 1). 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 ENGINEER. 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/painting.

In the event of usage of traditional bricks of size 230 mmx115mmx75mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/floor or slabs and at the top of the parapet shall be laid with bricks on edge.

All brickwork shall be built tightly against columns, floor slabs or other structural members.

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

RCC/steel beams resting on masonry wall shall be provided with plain or reinforced concrete bed blocks of dimensions as indicated in the drawings 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 as specified elsewhere before taking up plastering work.

The above items shall be measured and paid for separately under the respective items of 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 deshuttered 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 are generally required to be provided in half brick partition walls. Reinforced concrete for transoms and mullions shall be measured and paid for separately under the respective items of work.

Where drawings indicate that structural steel sections are to be encased in brickwork, the brick masonry shall be built closely against the steel section, ensuring a minimum of 20mm thick cement-sand 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.

CONTRACTOR shall note that the unit rates quoted for the masonry work shall be deemed to include for the installation of miscellaneous inserts such as pipe sleeves, bolts, steel sections with anchors etc. and providing pockets, leaving openings, cutting chases etc. in accordance with the construction drawings. Any of the miscellaneous inserts which are required to be fabricated and supplied by the CONTRACTOR and cement concrete to be provided in the pockets for the hold fasts of door/window frames etc. shall however, be measured and paid separately under the respective items of work.

Facing bricks of the type specified conforming to IS:2691 shall be laid in the positions indicated on the drawings and all facing brickwork shall be well bonded to the backing bricks/RCC surfaces. The level of execution of the facing brick work 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 painting to be carried out shall be as specified in the item of work. The pattern of laying the bricks shall be as specifically indicated in the drawings.

For facing brickwork, double scaffolding shall be used.

Faced works shall be kept clean and free from damage, discoloration etc., at all times.

16.3.3 Measurement

Measurement shall be in cu.m correct to two places of decimal for brickwork of thickness one brick i.e., 200mm/230mm and above. Measurement shall be in sq.m correct to two places decimal for facing brickwork and brickwork of thickness half brick i.e., 100mm/115mm and below. Measurement shall be for the quantities as actually executed duly deducting for openings, lintels, transomes/mullions etc. All concrete works shall be measured and paid for separately under the respective items of work.

16.4 Uncoursed Random Rubble Masonry, in Foundation. Plinth and Superstructure

16.4.1 Materials

Stones for the works shall be of the specified variety which are hard, durable, fine grained and uniform in colour (for superstructure work) free from veins, flaws and other defects. Quality and work shall conform to the requirements specified in IS:1597 (Part-1). 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 ENGINEER 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 unless otherwise specified in the respective items of work. Materials and preparation of mortar shall be as specified in clauses 16.3.1.

16.4.2 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 band well with the masonry. The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourths the thickness of wall nor less than 150 mm. The height of stone may be upto 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 & chips shall not be used on the face of the wall and below hearting stones to bring them to the level of face stones.

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

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

All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. All connected walls in a structure shall be normally raised uniformly and regularly. However, if any part of the masonry is required to be left behind, the wall shall be raked back (and not saw toothed) at an angle not exceeding 45°. Masonry work shall not be raised by more than one metre per day.

Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly moist on all the faces for a minimum period of seven days for proper curing of the joints.

Type of scaffolding to be used shall be as specified in Clause 16.3.2

Installation of miscellaneous inserts in the masonry shall be as specified in Clause 16.3.2.

16.4.3 Measurement

Measurement shall be in cu.m correct to two places of decimal. The quantities measured and paid for, shall be those as actually executed after making necessary deductions for openings, lintels etc.

16.5 Coursed Rubble Masonry (First Sort) for Superstructure

16.5.1 Materials

The material specification for the work shall be as per Clause 16.4.1

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

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

The requirement regarding through or bond stones shall be as specified in clause 16.4.2 with the further stipulation that these shall be provided at 1.5 m to 1.8 m 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 drafts of 25mm width at four edges, all the edges being in the same plane.

Type of scaffolding to be used shall be as per Clause 16.3.2.

Requirements of execution of the work and curing shall be as stipulated in clause 16.4.2

Installation of miscellaneous inserts in the masonry shall be as specified in clause 16.3.2.

16.5.3 Measurement

Measurement shall be in cu.m correct to two places of decimal. The quantities measured and paid for, shall be those as actually executed after making necessary deductions for openings, lintels etc.

16.6 Concrete Masonry Block

16.6.1 Materials

Masonry units of hollow and solid concrete blocks shall conform to the requirements of IS: 2185 (Part 1).

Masonry units of hollow and solid light-weight concrete blocks shall conform to the requirements of IS:2185 (Part 2).

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 300 mm to correspond to the full length blocks. Actual dimensions shall be 10 mm short of the nominal dimensions.

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

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 be as specified. 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 i.e. (1:6).

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 ENGINEER.

16.6.2 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 in the respective items of work. The minimum nominal thickness of non-load bearing internal walls shall be 100 mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.

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

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

Concrete blocks shall be embedded with a mortar which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works unless otherwise specified in the respective items of work. Preparation of mortar shall be as specified in clause 0.

The thickness of both horizontal and vertical joints shall be 10 mm. The first course shall be laid with greater care, ensuring that it is properly aligned, levelled 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 10 mm. For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or on the edges of the succeeding unit when it is standing vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joint. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the

mortar will stiffen and lose its plasticity. Mortar while hardening shrinks slightly and thus pulls away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be raked to a depth of 10 mm as each course is laid to ensure good bond for the plaster.

Dimensional stability of hollow concrete blocks 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 surface 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 bond beam/studs, joint reinforcement shall be provided at locations as per details indicated in the construction drawings. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS:280 or welded wire fabric/high strength deformed bass as per the drawings.

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 atleast 50% of the concrete blocks. The sequence for construction of partition walls and treatment at the top of load bearing walls for the RCC slab shall be as detailed under clause 3 for the brick work.

Curing of the mortar joints shall be carried out for atleast 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet.

Double scaffolding as per clause 16.3.2 shall be adopted for execution of block masonry work.

Cutting of the units shall be restricted to a minimum. All horizontal and vertical dimensions shall be in multiples of half length and full height of units respectively, adapting 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.

16.6.3 Measurement

Measurement shall be in cu.m. correct up to two places of decimal for walls of thickness 200 mm and above. Measurement shall be in sq.m correct up to two places of decimal for walls of 100mm/150mm in thickness. Measurement shall be for the quantities as actually executed duly deducting for openings, and concrete works. Concrete and reinforcement will be measured and paid separately. The rate

quoted shall be for the type of masonry blocks specified in the respective items of work which shall include for the specific sequential operations as stipulated in the construction drawings.

16.7 Damp - Proof Course

16.7.1 Materials and Workmanship

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

The surface of brick/stone masonry work shall be levelled 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 atleast seven days after which it shall be allowed to dry for taking up further work.

16.7.2 Measurement

Measurement of damp-proof course shall be in Sq.m. correct to two places of decimal as actually executed. No separate payment will be made for formwork.

16.8 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 locations and levels, all as detailed in the construction drawings. CONTRACTOR shall prepare and use templates for this purpose, if so, directed by the ENGINEER. In the event, any of the inserts are improperly installed, CONTRACTOR shall make necessary arrangements to remove and re-install at the correct locations/levels, all as directed by the ENGINEER without any extra cost to the EMPLOYER.

16.8.1 Measurement

Miscellaneous inserts, supplied by the CONTRACTOR shall be measured and paid for as per the respective items of work.

16.9 Wood Work in Doors, Windows, Ventilators & Partitions

16.9.1 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 planed to the required sizes. The maximum permissible moisture content shall be from 10 to 16 percent for timber 50mm and above in thickness and 9 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 colour 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 of fittings and fixtures shall be of the best quality from approved manufacturers.

16.9.2 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 and/or as directed by the ENGINEER. All members of the door, window, and ventilator shall be straight without any warp or bow and shall have smooth well planed faces. The right angle shall be checked from the inside surfaces of the respective members of the frame. Frames shall have mortice 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. The workmanship shall generally conform to the requirements specified in IS:4021.

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

Three hold fasts using 25 mm x 6 mm mild steel flats 225 long with split ends shall be fixed on each side of door and window frames, one at the centre 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 panelled 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. The stiles and rails shall be joined by mortice 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 indicated in the bid drawings/item of work. 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 lipping etc. shall be as indicated in the respective items of work. Panels of shutter shall be of marine plywood conforming to IS:710, if so, specified in the item of work. Flush door shutters shall be from reputed manufacturers and CONTRACTOR shall submit test results as per IS:4020, if so desired by the ENGINEER.

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 in the item of work.

The material of the fittings and fixtures either of chromium plated steel, cast brass, copper oxidised or anodised aluminium shall be as specified in the item of work. The number, size and type of the fittings and fixtures shall be as indicated in the bid drawings/item of work.

Wood work shall not be provided with the finishes of painting, galvanising etc. unless it has been approved by the ENGINEER. The type of finish and the number of coats shall be as stipulated in the respective items of work. Preparation of the wood surface and application of the finishes shall be in accordance with clause 16.29.

Wooden hand railing and architraves shall be of the size and shape with the fixing arrangement as indicated in the bid drawings/described in the item of work.

The framework of the partitions with mullions and transomes shall be with the sections of dimensions as per the item at work. Panels of double/single glazing/plywood shall be fixed as per details indicated in the drawings. 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.

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 specification requirements, at no extra cost to the EMPLOYER.

16.9.3 Measurement

Measurement for doors, windows, ventilators architraves and partitions shall be in sq.m correct to two places of decimal. Hand railing shall be measured in running metres, correct to two places of decimal. Measurement shall be from out to out of the frames. Rate quoted shall be for all the works including glazing, painting, builder's hardware of fittings and fixtures as specifically described in the respective items of work.

16.10 Aluminium Doors, Windows, Ventilators & Partitions

16.10.1 Materials

Aluminium 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.

16.10.2 Workmanship

All aluminium doors, windows, ventilators and partitions shall be of the type as specified in the respective items of work and of sizes as indicated in the drawings. The doors, windows, ventilators shall conform to the requirements of IS:1948. Aluminium windows, shall conform to IS:1949, if so specified.

All aluminium units shall be supplied with anodised 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, mitred and welded at the corners to a true right angle conforming to the requirements of IS:1948. Tolerance in overall dimensions shall be within + 1.5mm. 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.

Aluminium swing type doors, aluminium sliding windows, partitions shall be as described in the item of work and/or bid drawings which indicates generally the arrangement along with the overall size of the various components and weight per running metre of the extruded sections to be adopted.

IS:1948 and IS:1949 referred to incorporates the sizes, shapes, thicknesses and weight per running metre 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 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 ENGINEER and will be accepted only if they are equal to or marginally more than that specified in the codes/ drawings.

The framework of the partitions with mullions and transomes shall be with anodised aluminium box sections of dimensions as per the item of work. Anodised Aluminium 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 drawing. 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.

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 all-round 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 item of work. 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 gasket shall be provided for fixing the beads with concealed screws. The type of fixing the glazing shall be as indicated in the item of work and/or in drawings.

The material of the Builders hardware of fittings and fixtures of chromium plated steel, cast brass, brass copper oxidised or anodised aluminium shall be as specified in the item of work. The number, size and type of fittings and fixtures shall be as in the bid drawings/item of work.

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.

Glazing beads shall be of the snap-fit type suitable for the thickness of glazing proposed as indicated in the item of work. A layer of clear transparent lacquer shall be applied on aluminium sections to protect them from damage during installation. This lacquer coating shall be removed after the installation is completed.

16.10.3 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be from out to out of the frames. Rate quoted shall be for the works including glazing, Builder's hardware of fittings and fixtures as specifically described in the respective items of work.

16.12 Rubble Sub-Base

16.12.1 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 + 10mm. 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 ENGINEER.

16.12.2 Workmanship

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

16.12.3 Measurement

Measurement shall be in sq.m correct to two places of decimal for the specified compacted thickness of rubble sub-base.

16.13 Base Concrete

The thickness and grade of concrete and reinforcement shall be as specified in the item of work.

Before placing the blinding concrete of 1:3:6 mix, 50/75mm thick as per the item of work, 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.

16.13.1 Measurement

Measurement shall be in sq.m correct to two places of decimal. This work could be either separate or combined along with the floor finish as indicated in the respective items of work.

16.14 Terrazzo and Plain Cement Tiling Work

16.14.1 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 colour etc, of the tiles for flooring/dado/ skirting shall be as specified in the respective items of work.

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 colouring 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/coloured 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.

16.14.2 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 50mm above the level of proposed skirting/dado.

The base concrete shall be finished to a reasonably plane surface about 40 to 45mm below the level of finished floor. Before the tiling work is taken up, the base concrete or structural slab shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. using steel wire brush and well wetted without allowing any water pools on the surface.

A layer of 25mm average thickness of cement mortar consisting of one part of cement to 6 parts of sand shall be provided as bedding for the tiles over the base concrete. The thickness of bedding mortar shall not be less than 10mm at any place. The quantity of water to be added for the mortar shall be just adequate to obtain the workability for laying. Sand for the mortar shall conform to IS:2116 and shall have minimum fineness modulus of 1.5. The surface shall be left rough to provide a good bond for the tiles. The bedding shall be allowed to harden for a day before laying of the tiles.

Neat cement slurry using 4.4 kg of cement per one sq.m 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 on the colour 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 atleast 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 bevelled edges to obtain a neat and true joint. After the work has set, hand polishing with carborundum 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.

CONTRACTOR shall note that the unit rate quoted for skirting shall also include for any chipping of the brick work required to be carried out for this item.

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 gap 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. Localised deviation of ± 3 mm in any 3m length is acceptable in a nominally flat floor.

16.14.3 Measurement

Measurement for floor tiling and dado shall be in sq.m correct to two places of decimal. Actual quantity of tiling work as laid shall be measured for payment as per the respective items of work after making deductions for openings etc. Measurement for skirting shall be in running metres correct to two places of decimal for the specified height as per the item of work.

16.17 Glazed Tile Finish

16.17.1 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.

16.17.2 Workmanship

The size, thickness, colour, with or without designs etc of the tiles for flooring/dado/skirting shall be as specified in the respective items of work. 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.

Coloured 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 band 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 one sq.m 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 1 mm 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 atleast 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 caves, internal and external angles, cornices, beads and their corner pieces shall be of thickness not less than the tiles with which they are used.

16.17.3 Measurement

Measurement shall be as per Clause 16.14.3.

16.18 In-Situ Cement Concrete Floor Topping

16.18.1 Materials

The mix proportion for the in-situ concrete floor topping shall be 1:2½ :3½ (one part cement: two and half parts sand: three and half parts coarse aggregates) by volume unless otherwise specified in the item of work.

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.

16.18.2 Workmanship

The thickness of the floor topping shall be as specified in the item of work. The minimum thickness of the floor topping shall be 25mm.

Preparation of base concrete/structural slab before laying the topping shall be as per clause 0. The surface shall be rough to provide adequate bond for the topping.

Mixing of concrete shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the ENGINEER. 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/sq.m 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 from that specified in the drawings and these shall be made good immediately.

Finishing of the surface by trowelling shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled 3 times at intervals so as to produce a smooth uniform and hard surface. Immediately after laying, the first trowelling just sufficient to give a level surface shall be carried out avoiding excessive trowelling at this stage. The surface shall be retrowelled 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 tolerance, 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 discoloration to the floor finish which are difficult to repair satisfactorily.

16.18.3 Measurement

Measurement shall be in sq.m correct up to two places of decimal.

16.19 In-Situ Granolithic Concrete Floor Topping

16.19.1 Materials and Workmanship

The requirements of materials and workmanship shall be all as per clause 20 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 thickness of the floor topping shall be as specified in the item of work. The minimum thickness of granolithic floor topping on hardened concrete base shall be 40mm.

16.19.2 Measurement

Measurement shall be in sq.m correct upto two places of decimal.

16.20 Floor Hardener Topping

16.20.1 Materials & Workmanship

Floor hardener topping shall be provided either as integrally finished over the structural slab/grade slab or laid 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.

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 and it is still plastic but stiffened enough for the workmen to tread over it by placing planks. The surface of the concrete layer shall be kept rough for providing adequate bond for the topping. Laitance shall be removed before placing the topping. The topping shall be screeded and thoroughly compacted to the finished level. Trowelling to a smooth finish shall be carried out as per clause 0. After the surface has hardened sufficiently, it shall be kept continuously moist for atleast 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.

16.20.2 Measurement

Measurement shall be in sq.m correct to two places of decimal. This work could be either separate or combined along with the floor finish as indicated in the respective items of work.

16.21 PVC Sheet/Tile Flooring

16.21.1 Materials

PVC floor covering shall be of either unbacked homogeneous flexible type in the form of sheets/tiles conforming to IS:3462 or homogeneous PVC asbestos tiles conforming to IS:3461.

The 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 codes. CONTRACTOR shall submit the test certificates, if so desired by the ENGINEER.

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

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

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

16.21.2 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 under bed 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 atleast 7 days. During this period, the temperature range shall be between 200C and 300C and this shall be maintained during the laying operations and also for 48 hours thereafter.

Layout of the PVC flooring shall be marked with guidelines on the underbed and PVC tiles/sheets shall be first laid for trial, without using the adhesive, according to the layout. The adhesive shall be applied by using a notched trowel to the surface of the underbed and to the backside of PVC sheets/tiles. When the adhesive has set sufficiently for laying, it will be tacky to the touch, which generally takes about 30 minutes. The time period need be carefully monitored since a longer interval will affect the adhesive properties. Adhesive shall be uniformly spread over only as much surface area at one time which can be covered with PVC flooring within the stipulated time.

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

Tiles shall be laid in the same manner as sheets and preferably, commencing from the centre 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 slid 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 in 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, if specified in the item of work, using special equipment as per manufacturer's instructions.

16.21.3 Measurement

Measurement shall be in sq.m correct to two places of decimal. The item could be either separate or as a combined item with the floor finish as specified in the respective items of work.

16.22 Acid Resisting Brick/Tiling Work

16.22.1 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 the 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.

16.22.2 Workmanship

The size and thickness of tiles/size and class of bricks for use in the flooring/skirting/dado shall be as specified in the respective items of work.

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:1530. Tiles or bricks shall be laid directly without the application of bitumen, if epoxy or polyester resin is used for the mortar.

Just adequate quantity of mortar which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for bedding and jointing. Rigid PVC/Stainless steel/chromium plated tools shall be used for mixing and laying.

For laying the floor 6 to 8 mm thick mortar shall be spread on the back of the tile/brick. Two adjacent sides of the tile/brick shall be smeared with 4 to 6 mm thick mortar. Tile/brick shall be pressed into the bed and pushed against the floor and with the adjacent tile/ brick, until the joint in each case is 2 to 3 mm thick. Excess mortar shall then be trimmed off and allowed to harden fully. Similar procedure shall be adopted for the work on walls by pressing the tile/brick against the prepared wall surfaces and only one course shall be laid at a time until the initial setting period. The mortar joints shall be cured for a minimum period of 72 hours with 20 to 25% hydrochloric acid or 30 to 40% sulphuric acid. After acid curing, the joints shall be washed with water and allowed to thoroughly dry. The joints shall then be filled with mortar to make them smooth and plane. Acid curing is not required to be carried out if epoxy or polyester resin is used for the mortar.

Resin mortars are normally self curing. The area tiled shall not be put to use before 48 hours in case epoxy, polyester and furane type of resin is used for the mortar. If phenolic or cashewnut 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.

16.22.3 Measurement

Measurement shall be in sq.m correct to two places of decimal for flooring/dado. Measurement shall be in running metres correct to two places of decimal for skirting of height as specified in the item of work.

16.23 Preformed Fillers and Joint Sealing Compound

16.23.1 Materials

Preformed filler for expansion/isolation joints shall be non-extruding and resilient type of bitumen impregnated fibres 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.

16.23.2 Workmanship

The thickness of the preformed bitumen filler shall be as specified in the respective items of work. 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/sq.m. 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/sq.m. 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.

16.23.3 Measurement

Measurement for the preformed joint filler shall be in sq.m correct to two places of decimal for the specified thickness as per the items of work. Measurement for applying the bitumen coat to concrete/masonry surfaces shall be in sq.m correct to two places of decimal. Measurement for the joint sealing compound shall be in running metres correct to two places of decimal for the specified width and thickness as per the items of work. Measurement for the mild steel corner angle and plate shall be by weight as per the item of work.

16.24 Cement Plastering Work

16.24.1 Materials

The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to four parts of sand) unless otherwise specified under the respective item of work. Cement and sand shall be mixed thoroughly in dry condition and then water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS. 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 ENGINEER. If so desired by the ENGINEER sand shall be screened and washed to meet the specification requirements. 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.

16.24.2 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 15 mm 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 ENGINEER. Rate quoted for plaster work shall be deemed to include for plastering of all these surfaces.

Plain Faced Ceiling plaster - This plaster shall be applied in a single coat of 6mm thickness. Application of mortar shall be as stipulated for interior plain faced plaster.

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 for interior plain faced plaster 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 for exterior plain faced plaster.

Exterior Sand Faced Plaster - This plaster shall be applied in 2 coats. The first coat shall be 14mm thick and the second coat shall be 6mm thick. These coats shall be applied as stipulated for exterior plain faced plaster. 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 ENGINEER duly satisfying the requirements of curing each coat (rendering/floating) for a minimum period of 2 days and curing the finished work for atleast 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 ENGINEER.

Where specified in the drawings, 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.

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 atleast 7 days.

When the specification items of work call for waterproofing plaster, the CONTRACTOR shall provide the waterproofing compound as specified while preparing the cement mortar. Payment for water-proofing compound will be made separately if it is not included as a combined item of work. Where lath plastering is specified, it shall be paid for at the same rate as for plaster work except that separate payment for metal lath will be made.

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

Double scaffolding to be used shall be as specified in clause 16.3.2

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

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

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. This steel item shall be measured and paid for separately.

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.

16.24.3 Measurement

Measurement for plastering work shall be in sq.m correct to two places of decimal. Unless a separate item is provided for grooves, mouldings, etc., these works are deemed to be included in the unit rates quoted for plastering work. The quantity of work to be paid for under these items shall be calculated by taking the projected surface of the areas plastered after making necessary deductions for openings for doors, windows, fan openings etc. The actual plaster work carried out on jambs/sills of windows, openings, etc. shall be measured for payment.

16.25 Cement Pointing

16.25.1 Materials

The cement mortar for pointing shall be in the proportion of 1:3 (one part of cement to three parts of fine sand) unless otherwise specified in the respective items of work. 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 ENGINEER and if so, directed it shall be washed/screened to meet specification requirements.

16.25.2 Workmanship

Where pointing of joints in masonry work is specified on drawings/respective items of work, 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 atleast 7 days after the pointing is completed. Whenever coloured pointing is to be done, the colouring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the ENGINEER.

16.25.3 Measurement

The quantity of work to be paid for under this Item shall be measured in sq.m correct to two places of decimal by taking the projected surface of the area pointed after making necessary deductions for openings, etc.

16.26 Metal Lath & Wire Fabric

16.26.1 Materials

Welded steel wire fabric shall conform to IS:4948

Expanded metal shall conform to IS:412

Galvanised wire mesh shall be of approved quality.

16.26.2 Workmanship

The type and details of the steel material to be used for metal lath plastering work and at the junctions of brick masonry/concrete before wall plastering shall be as specified in the respective items of work.

For metal lath plastering work, the weight of steel material shall be not less than 1.6 kg/sq m.

Steel material for use at the Junction of brick masonry/ concrete shall have the mesh dimensions not greater than 50 mm.

Steel material shall be obtained in maximum lengths as manufactured to restrict joints to the minimum. Overlap at the joints shall be minimum 25 mm which shall be securely tied with wires of diameter not less than 1.25 mm at spacings not more than 100 mm for lath plastering work. Nailing to wall shall be at spacings not exceeding 200 mm. The material shall be straightened, cut and bent to shape if required for fixing as per the details indicated in the drawings.

16.26.3 Measurement

Measurement shall be in sq.m correct to two places of decimal for the type as specified in the respective items of work.

16.27 Water-Proofing Admixture

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 Engineer. Payment shall be made for the actual quantity of such admixture used unless it is already covered in the rate for the relevant item of work.

16.28 Painting of Concrete Masonry & Plastered Surfaces

16.28.1 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.

Acrylic emulsion paint shall be of an approved manufacture.

Plastic emulsion paint shall conform to IS:5411.

Lead free acid, alkali and chlorine resisting paint shall conform to IS:9862.

White wash shall be made from good quality fat lime conforming to IS:712. It shall be slaked at site and mixed with water in the proportion of 5 litres of water to 1 kg of unslaked lime stirred well to make a thin cream. This shall be allowed to stand for a minimum period of one day and strained through a clean coarse cloth. Four kg of gum dissolved in hot water shall be added to each cu.m of cream. 1.30 kg of sodium chloride dissolved in hot water shall then be added per 10 kg of lime used for the white wash to be ready for application.

Colour 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 ENGINEER.

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

16.28.2 Workmanship

CONTRACTOR shall obtain the approval of the ENGINEER regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting.

Painting of new surfaces shall be deferred as much as possible to allow for thorough drying of the sub-strata.

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

Surfaces of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them.

16.28.2.1 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 3 coats shall be applied unless otherwise specified in the item of work. The dry surface shall present a uniform finish without any brush marks.

Colour Wash

Colour wash shall be applied in the same way as for white wash. A minimum of 3 coats shall be applied unless otherwise specified in the item of work. 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/sq.m. A minimum of 3 coats of the same colour shall be applied unless otherwise specified in the item of work. 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 in 16.28.2.1.

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 in the item of work. 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 in.

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 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 colour shall be applied unless otherwise specified in the item of work. 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 in the item of work.

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.

16.28.3 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the areas as executed duly deducting for any openings etc. Rate quoted shall take into account the provision of necessary enabling works such as scaffolding, painter's cradle etc.

16.29 Painting & Polishing of Wood Work

16.29.1 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 ENGINEER for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

16.29.2 Workmanship

The type of finish to be provided for woodwork of either painting or polishing, the 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.

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 smoothed 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. 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 application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the ENGINEER. A minimum of 2 finishing coats over one coat of primer shall be provided unless otherwise specified in the item of work.

All the wood surfaces to be provided with clear finishes shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothed with abrasive paper using it in the direction of the grains and dusted off.

Any slight irregularities of the surface shall be made up by applying an optimum coat of transparent liquid filler and rubbed down with an abrasive paper for obtaining a smooth surface. All dust and dirt shall be thoroughly removed. Over this prepared surface, varnish conforming to IS:337 shall be applied by brushing. Varnish should not be retouched once it has begun to set. Staining if required shall be provided as directed by the ENGINEER. When two coats of varnish is 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 per the item of work. 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. A minimum of 2 finishing coats over one coat of primer shall be provided unless otherwise specified in the item of work

16.29.3 Measurement

Measurement shall be in sq.m correct to two place of decimal. Measurement shall be for the projected area between out to out of frames and no multiplying factor is allowed on any account. Rate shall be inclusive of enabling works such as scaffolding, etc. Measurement and payment is applicable only if a separate item is specified and not if it is already made as part of a combined item.

16.30 Painting Of Steel Work

16.30.1 Materials

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

Synthetic enamel paint shall conform to IS:2932.

Aluminium 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 for the brand of manufacture and the colour/shade. All the materials shall be brought to the site in sealed containers.

16.30.2 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-1) 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 application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the ENGINEER.

16.30.3 Measurement

Measurement shall be as per clause 16.29.3.

16.31.0 Flashing

16.31.1 Materials

Anodised aluminium sheets shall be 1.00mm thick with anodic film thickness of 0.025 mm.

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

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

16.31.2 Workmanship

The type of the flashing and method of fixing shall be as specified in the respective items of work.

Flashing shall be of the correct shape and size as indicated in the construction drawings 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. 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 litre/sq.m after the installation.

16.31.3 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the actual area of the flashing material provided and the rate shall include for all the incidental works of bending to shape and fixing details as per the construction drawings.

16.32 G. I. Roof & Side Sheeting and Accessories

16.32.1 Scope

This specification covers the general requirements for supply, delivery and erection of all sheeting for roofing and side cladding including all accessories and fixtures necessary to provide weather exposed surfaces of roof and building walls for industrial, residential and commercial types of buildings, complete with openings for doors, windows, roof lights, ventilators, pipes, etc.

16.32.2 Applicable Codes And Specifications

The following specifications, standards and codes, including all official amendments and revisions and other specifications referred to therein shall be

considered as a part of this specification. In all cases the latest issue/edition/revision shall apply. In case of discrepancy between this specification and those referred to herein, this specification shall govern.

- (a) Specification for galvanised steel sheets (plain and corrugated).
- (b) Specification for hook bolts for corrugated sheet roofing.
- (c) Specification for washers for corrugated sheet roofing.

16.32.3 Materials

Galvanised steel corrugated sheets shall be hot dipped galvanised conforming in all respects to IS: 277 with a coating of grade 750.

The galvanised sheets shall be of the thickness, as specified and shall be of approved quality and manufacture as approved by Engineer.

The sheets shall be free from cracks, pitting, blisters, split edges, twists, laminations, scales and other surface defects. Sheets shall be clearly sheared and be free from twist or buckle and shall have uniform corrugations, true in depth and pitch parallel to the sides of the sheet. The galvanised coating shall be clean, bright, smooth and free from ungalvanised spots and other defects. The sheets supplied shall show no sign of rust or white powdery deposits on the surface.

16.32.4 Storage of Materials

Sheets shall be stacked to a height of not more than one metre on firm and level ground, with timber or other packing beneath them.

Galvanised steel materials of same variety and size shall be stacked together.

All galvanised materials shall be protected from damage while stored on site preferably in sheltered store. If they are to be placed in an exposed position. They shall be protected from damage by wind and rain by providing a suitable cover.

Contractor shall exercise great care in handling the sheets and accessories. Damaged materials shall not be stacked with sound materials. All damaged or rejected materials shall be removed from site immediately.

16.32.5 Laying

The sheets shall be laid on the purlins/other roof members and side girts as indicated on the drawings or as instructed by Engineer.

The maximum spacing of purlins shall be 2.0 m, 1.8 m and 1.6 m for sheets of 1.0 mm, 0.8 mm 0.63 mm thickness respectively.

Before the actual laying of sheets is started, the purlin spacing and the length of the sheets shall be checked to ensure proper laps and the specified overhang at the eaves. The end lap of the sheets shall always fall over a purlin/ side girt.

The bearing surface of all purlins/other roof members and side /girts shall be in one plane so that the sheets being fixed shall not be required to be forced down to rest on the purlins/side girts. The finished roof shall present a uniform slope and lines of corrugations shall be straight and true and the completed work shall present a neat and uniform appearance and be leak proof. For side sheeting, corrugations shall be vertical and in one plane.

The sheets shall be laid with a minimum lap of 150 mm at the ends and 2 ridges of corrugations at each side. In the case of roofs with a pitch flatter than 22 degrees or in the case of very exposed situations. Minimum end laps shall be 200 mm. The side laps shall be laid on the side facing away from the prevailing monsoon winds. The minimum lap of sheets with ridges, hips and valleys shall be 200 mm measured at right angles to the line of ridge, hip or valley respectively. The free overhang of the sheets at the eaves shall not exceed 300 mm.

The sheets shall be cut to suit the dimensions or shape of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge and chiselled to give a smooth and straight finish. The corrugated galvanised sheets shall not generally be built into gables and parapets. They shall be bent up along their side edges close to the wall and the junction shall be protected by suitable flashing or by a projecting drip course covering the junction by at least 75 mm.

Where slopes of roofs are less than 22 degrees, sheets shall be joined together at the side laps by galvanised iron seam bolts and nuts of size 25 mm x 6 mm, each bolt with a bitumen and G.I. limpet washer or with a G.I limpet washer filled with white lead. The seam bolts shall be placed zig- zag over the two overlapping corrugations at a spacing not exceeding 600mm along each of the staggered rows.

All laps in G.I sheets shall be painted with one coat of zinc rich primer and two coats of approved paint before fixing in place.

16.32.6 Fixing

Sheets shall be secured to the purlins and other roof members by means of 8mm diameter galvanised iron J or L hook bolts and nuts. with bitumen and G.I. limpet washer or with a G.I. Limpet washer filled with white lead, as directed by Engineer. The grip of the hook bolt on the side of the purlin shall not be less than 25 mm. Each hook bolt shall have a bitumen washer and a galvanised iron washer placed over the sheet before the nut is screwed down from above. There shall be a minimum of three hook bolts placed at the ridges of corrugations in each sheet on every purlin and spacing shall not exceed 300mm. Bitumen washer 35 mm in dia. and 1.5 mm thick shall be of approved manufacture. Each nut shall be screwed lightly at first. After 10 or more sheets are laid. The nuts shall be tightened to ensure a leak proof roof. The bolts shall be sufficiently long so that after fixing they project at least 12 mm above the top of their nuts.

Where sheets are laid on tubular purlins, the fixing bolt shall be designed to encompass at least half the tube circumference and precautions should be taken to prevent its rotation.

Holes for hook bolts etc. shall be drilled and not punched in the ridges of the corrugations in the exact positions to suit the purlins while the sheets are on the ground. The diameter of holes shall be 1.5 mm more than the diameter of the fixing bolts, while the holes in the washers shall be of the exact diameter of the hole bolts or the seam bolts. No hole shall be nearer than 40 mm to any edge of a sheet or an accessory. Sheets with holes drilled wrongly shall be rejected.

Direct fixing of sheets to drilled steel frame work or by stud welding or fixing by coach screws shall not be permitted.

16.32.7 General

All work shall proceed in a diligent and systematic manner.

Contractor shall not allow access to any person other than workmen employed for laying and fixing sheeting while the above work is in progress. If, however, it is not possible to keep the area clear, suitable safety measures shall be taken by Contractor during the progress of the work.

Contractor shall use roof ladders or planks while laying and fixing the sheets, to avoid damage to sheets and to provide security to the workmen.

Contractor shall arrange any staging or other temporary structures required for the purpose of installing the roof and side sheeting at his own cost.

At no time shall the sheets or accessories be laid and left unfixd. Temporary fixing/supporting shall not be acceptable. In case of any loss or damage due to infringement of these conditions by contractor, the same shall be made good by contractor at no extra cost to Employer.

16.32.8 Galvanised Iron Accessories

16.32.8.1 Ridges and hips.

Ridges and hips of corrugated galvanised roofs shall be covered with ridge and hip sections of plain G.I sheets with a minimum 200 mm lap on either side over the C.G.I sheets. The end laps at the ridges and hips and between ridges and hips shall also be not less than 200 mm. The ridges and hips shall be of 600 mm overall width made from plain G.I sheets, 0.6 mm or 0.8 mm thick, bent to shape and fixed as shown on the drawings.

Ridges and hips shall be fixed to the purlins below with the same 8 mm dia. G.I. hook bolts and nuts and bitumen and G.I limpet washers which fix the sheets to the purlins. At least one of the fixing bolts shall pass through the end laps of ridges and hips, on either side. If this is not possible extra hook bolts shall be provided.

The end laps of ridges and hips shall be joined together by G.I seam bolts 25 x 6 mm size each with a bitumen and G.I limpet washer. There shall be at least two such bolts in each end lap.

The edges of the ridges and hips shall be straight from end to end and their surfaces shall be plane and parallel to the general plane of the roof. The ridges and hips shall fit in squarely on the sheets and shall be leak proof.

16.32.8.2 Valleys and Flashings

Valleys shall be 900 mm wide overall made from plain G.I. sheet 1.6 mm thick bent to shape and fixed as shown on the drawings or as directed by engineer. Laps with C.G.I. sheets shall not be less than 250mm on either side. The end laps of valleys shall also not be less than 250 mm.

Flashing shall be of 1.25 mm thick or 1.00 mm thick plain G.I sheet having 400 mm overall width, bent to shape and fixed as shown on the drawings. They shall lap not less than 150 mm over the roofing sheets. The end laps between flashing pieces shall not be less than 250 mm.

Laying and fixing shall be as for Ridges and Hips.

16.32.8.3 Eaves and Valley Gutters.

Gutters shall be fabricated from PVC as specified.

Eaves or valley gutters shall be of the shapes and section as shown on the drawings or as directed by the Engineer. The overall width of the sheets referred to therein shall mean the peripheral width of the gutter including the rounded edges. The longitudinal edges shall be turned back to the extent of 12 mm. And beaten to from a rounded edge. The ends of the sheets at junctions of pieces shall be hooked into each other and beaten flush to avoid leakage.

Gutters shall be laid with a minimum fall of 1 in 120. Gutters shall be true to line and slope and shall be supported on and fixed to M.S. flat iron / PVC brackets bent to shape. Where the brackets are to be fixed to the purlins, the brackets shall consist of 50 mm x 3 mm flats bent to shape with one end turned at right angle and fixed to face of purlin with 10 mm dia. bolt, nut & washer. The requisite slope in the gutters shall be given in the line of brackets. The brackets shall be placed at a spacing of not more than 1.2 m. The gutters shall be fixed to the brackets with 2 No. 6 mm dia G.I. bolts and nuts, each fitted with a pair of G.I and bitumen washers. The connecting bolts shall be above the water line of the gutters.

For connections to downtake pipes, Contractor shall fabricate a proper drop end or funnel- shaped connecting piece, stop ends, etc., and flat iron brackets and bolts and nuts required for fixing the later to the roof members.

16.32.9 Measurement & Payment

The measurement shall be taken for the finished work in superficial area on the flat in the plane of the roof/side measured in sq.m. without allowance for laps and corrugations and payment shall be affected based on the rates quoted by contractor after making necessary deductions for openings.

The laps between the sheets both at the ends and at the sides, shall not be measured. However, the overlaps of the sheets over valley gutters, ridge, hip and flashing pieces shall be included in the measurement.

No deduction shall be made for opening less than 0.4 sq.m in area and nothing extra shall be paid for forming such openings. For openings exceeding 0.4 sq.m in area deductions shall be made in measurements for the full opening payment shall

be made separately for labour involved for making these openings, with the cutting required being measured in meters. Cutting across corrugations shall be measured flat and not girthed. No additions shall be made for laps cut through.

Roofs with curved sheets shall be measured and paid for separately. Measurement shall be taken on the flat and not girthed. The breadth of the roof shall be measured along the trough of the curved sheets.

If separate rates are called for accessories in the schedule of Quantities these shall be measured and paid for separately or else the rate quoted for roof / side sheeting shall be deemed to include for all accessories. Where called for separately the accessories shall be measured for the finished work taken along the centre line. The measured length of the finished work shall include the length over accessories and the rate for the same shall include the cost of accessories. Laps shall not be measured.

The rate shall include the cost of all materials and labour involved in all the operations described in these specifications and as may be necessary for the work, including one coat of approved primer and two coats of paint on overlappings of C.G.I. sheets and accessories. The materials shall include sheets, accessories, galvanised iron J or L hook bolts, and nuts, G.I seam bolts and nuts, bituminous and G.I limpet washers, brackets etc.

The rate quoted shall also include providing any staging or any temporary structure required for the purpose of installing the roof and side sheeting.

17. POND LINER

17.1 Installation

The pond liner can be a single piece or made up of multiple sheets to line the ponds. The pond liner should be made from HDPE. HDPE material can be fusion welded together, which can streamline installation time and help reduce the potential for leaks. The ability to weld HDPE pond liners with a double wedge weld also allows installers to form seals in the field, simplifying transportation logistics and overall installation complexity. The double wedge weld is significant because it allows the installer to test the seam and ensure its integrity.

Large ponds come with several unique challenges. First, the large surface area will necessitate a protracted preparation phase, requiring careful planning to avoid weather delays. Second, to keep installation time within reason, the installation contractor should utilize a pond liner manufactured in large rolls and stationed to support the site's logistics. Using larger rolls will reduce the number of welds needed and, therefore, drastically decrease installation time.

Sandbags are especially helpful with larger sheets of liner and can help keep the pieces in place prior to welding. After all the sheets are in their correct positions, welding can take place. The weld settings themselves should match the properties of the chosen geomembrane, taking into consideration the melt index, thickness, and resin type. A higher melt index, for example, allows the seaming process to

take place at lower temperatures and at higher speeds. Specifying a higher melt index can improve installation time and liner integrity.

Lastly, construction quality control is essential for all pond installations, especially large ponds. This step involves bringing in site test equipment, conducting non-destructive and destructive testing of the field seams, and conducting inspections. Certain non-destructive tests, like spark testing, require the use of a conductive geomembrane liner.

During the final inspection, the entire HDPE pond liner surface should be examined by the engineer in charge to confirm that the liner does not have any defects, holes, blisters, or contamination. If necessary, the surface should be cleaned to facilitate the inspection process. Any areas that do not pass the criteria will be marked for additional testing. If the pond liner passes the inspection process, then the installation is considered complete upon site cleanup and the submission of required certifications.

17.2 Measurement & Payment

The measurement shall be taken for the finished work in superficial area on the flat in the plane of the pond/side measured in sq.m. without allowance for laps and payment shall be affected based on the rates quoted by contractor.

The laps between the sheets both at the ends and at the sides, shall not be measured. The rate shall include the cost of all materials and labour involved in all the operations described in these specifications and as may be necessary for the work.