TABLE OF CONTENTS

13. ROOFING

13.1 GENERAL

The covering or the upper part of a building constructed to preserve it from exposure to weather is known as roof. Roofs are designed to suit the needs of different climates keeping in view the available materials. For instance, in plains where rainfall is meagre and heat intense, a thick, flat roof is more suitable to ensure greater protection from the sun. In coastal areas, however, where temperature is more or less even almost all the year round, but rainfall heavy, a pitched or sloping roof is desirable.

The Work shall include complete performance and construction of roofs shown on drawings as specified hereof.

13.2 REINFORCED CEMENT CONCRETE ROOFING

13.2.1 ROOFING

The reinforced concrete roofing shall be as shown on Drawings and shall be constructed in accordance with the provisions of Section 5 – Plain and Reinforced Concrete.

13.2.2 ROOFING PROTECTION

The roof protection consisting of water proofing, insulation, earth layer and clay tiles shall be made as shown on drawings and complying with the applicable provisions of Section 8 – Damp Proofing & Water Proofing, Section 11 Brick work, Sub-clause 13.8 for Insulation and as approved by the Engineer-in-Charge.

13.3 FIRST CLASS TILE ROOFING

13.3.1 DESCRIPTION OF WORK

It is made up of different material viz, clay tiles, R.C.C. or wooden battens and mud. The following operation is involved in its construction.

1. Laying of first layer of tiles on batten in 1:6 cement sand mortar.
2. Laying of second layer of tiles in 1:6 cement sand mortar over a bed of half an inch thickness 1:6 cement sand mortar.
3. Half an inch thick 1:6 cement sand plaster over second layer of tiles.
4. Application of a coat of 1.7 kg. hot bitumen per square meter which is blinded with sand.
5. Four-inch earth filling finished with one-inch mud plaster with gobri leaping.

The work shall be performed as shown on drawings and approved by the Engineer-in-Charge. The second layer of tiles is laid by breaking joints in both directions with the first layer of tiles laid underneath. The size of tiles is as mentioned in Clause 13.2.2. Bitumen coating at the rate of 34 Ibs per 100 square feet of surface area or 1/16 of an Inch thick is given for making the roofs waterproof. In order to safeguard against attaching bitumen, sand is generally sprinkled over the bituminous coating at the rate of one cubic foot per 100 square feet of surface area. Battens are placed at 12 inches apart centre to centre.

13.3.2 MATERIALS

1. TILES:

Unless otherwise specified, tiles used in both the layers shall be of size specifications mentioned in Section 11 – Brickwork.

2. CLAY:

Clay used in mud mortar or earth filling should be obtained from good earth containing 20% to 30% fine sand, the clay should not contain more than 0.5 % soluble slats, more than 0.2 % sulphate and more than 4% organic contents. It shall not contain any gravel, coarse sand, kanker, roots of grass and plant. The clay shall comply with the specifications for Clay – Mud Mortar, Section 11 - Brickwork.

3. BITUMEN:

Bitumen shall be refined cut – back bitumen having viscosity (standard Tar Viscometer) of 110 to 150 seconds at 40 degrees C.

4 Battens

The battens shall be of specified type and size and shall have proper finished surface on top so as to give a good bearing to the tile.

The following types of battens could be used.

a. Timber battens
   The battens shall be of timber complying with the provisions of Clause 16.3.

   The battens shall be prepared for sizes and lengths as specified.

b. Pre-cast RCC Battens

   Pre-cast RCC Battens shall be manufactured for sizes and length complying with the provisions of Section 5 - Plain and Reinforced Concrete.

c. Mild Steel Battens

   Mild steel battens shall be of angle or tee sections complying with AST M-36.

   The battens shall be correctly placed and fixed as specified.

13.3.3 CONSTRUCTION OF ROOF

1. Laying of Battens

The battens shall be spaced 12 inches apart centre to centre in accordance with the size of the tile as shown on drawings and shall be placed in straight and parallel lines.

2. Slope To Roof

The necessary main slope in the roof shall be formed by sloping the beam or battens.

3. Laying Of First Layer Of Tiles

Over the battens the first layer of tiles shall be laid in specified mortar with the joints coming over the centre of the battens. Tiles shall be laid straight and square. All vertical joints shall be as fine as possible as specified on drawings and approved by the Engineer-in-Charge.

4. Laying Of Second Layer of Tiles

The second layer of tiles shall then be laid on half an Inch thick bed of specified mortar spread over the first layer of tiles. The Joints shall be broken in both directions with the first layer of tiles laid underneath. The vertical joints shall be as fine as in the case of first layer of tiles and shall be flushed with mortar at top.

5. Bonding Of Tiles With Parapet Wall

Tiles resting on wall shall have bearing of preferably 4 1/2 inches, and in no case less than 3 Inches. These tiles shall butt closely against the brickwork of the parapet wall leaving no voids wherever possible, the ends of the tiles shall be bonded into the Brickwork with specified mortar.

6. Cement Plaster To Parapet

   The portion of the parapet wall between the tiles and drip course shall be plastered with half an inch thick cement sand plaster of 1:3 ratio, unless otherwise specified.

7. Bed For Bitumen Coating

   Half an inch thick cement sand plaster of specified ratio shall then be laid over the surface of the second layer of tiles to serve as a bed for bitumen.

8. Curing of Bed

   The bed shall be cured for seven days, and the surface shall then be allowed to dry thoroughly before bitumen is laid.

9. Application Of Bitumen - Thickness

   Bitumen shall be heated to a temperature specified by the manufacturer and poured on the surface to be treated and pulled out so that the minimum thickness is 1/16 of an inch. The coat of bitumen shall be continued along with the parapet wall up to a drip course.

9. Blinding Of Bituminous Coating

   The bitumen coat 1.70 kg / square meter shall be blinded with sand at the rate of 0.30 cubic meter per 9.5 square meter of the surface area.

10. Earth filling and Mud Plaster

    Four inches thick of good earth (clay) conforming to Specifications as mentioned above, shall then be put and shall be thoroughly rammed and watered. The roof shall be finished with one Inch thick mud plaster with gobri leaping in accordance with provision of Clause 15.1.12, Mud Plaster, and Finishing. This shall be done before laying the drip to ensure a close Joint with the wall.

11. Khurras

    Khurras shall be made before the earth is laid as specified in Clause 13.9.

12. Pointing Of Tiles Underneath

    Unless otherwise specified, on the completion of the work the underside of the tiles shall be washed and neatly pointed with 1:2 cement sand mortar.

13. Filling Spaces Between Battens

    In case of wooden battens the spaces over the beam and between the battens shall be closed by one-inch planks nailed to distance pieces which in turn are nailed to the battens. Where concrete battens have been used the spaces shall be filled with I:3:6 cement concrete block of exact size and laid in spaces with 1:3 cement sand mortar. The filling shall be equal to the battens in height and the outer faces shall be exactly in line with the edge of the beam. For Tee iron/girder beams the filling shall be with mild steel flat pieces of the same thickness as of Tee/Girder tack welded at the faces.

14. Painting With Preservations

    The top surface of wooden battens in contact with the tiles and the end shall be painted with an approved preservative.

13.4 SECOND CLASS TILE ROOFING /PLAIN CEMENT CONCRETE TILESSPECIFICATIONS

13.4.1 SECOND CLASS TILE ROOFING

Second class tile roofing shall conform to Specifications No. 13.2.2. &13.2.3 in all respects except that only one layer of tiles shall be laid instead of two and their size shall be l2”x6”x2”.

13.4.2 PLAIN CONCRETE TILE ROOFING

It is exactly the same as first class tile roofing except that cement concrete tiles are used. Cement concrete tiles shall be of the size as specified and shall be procured from an approved source. The tiles shall be of 1:2:4 concrete mix unless otherwise shall be fully cured.

13.5 GALVANIZED CORRUGATED STEEL(C.G.S) SHEET ROOFING SPECIFICATION

13.5.1 SCOPE

Unless otherwise specified, galvanized steel sheet roofing (corrugated) shall be constructed in accordance with the following specifications.

13.5.2 MATERIALS

13.5.2.1 Galvanized Corrugated Steel Sheets

i. General

Corrugated steel sheets shall be made of ASTMA-36 mild steel, well annealed, even in temper and thickness free from holes, cracks, blisters and other defects. Corrugated steel sheets shall be perfectly rectangular, the corrugations parallel with the sides and regular in curve pitch and depth, and the weight of any ten sheets to be within 7 ½” per cent margin of the weights given below:

ii. Weight

The weight and thickness of corrugated steel sheets before galvanizing shall be as follows:

- No. 24 B.-G. to be 0.02476 inch thick and to weigh 1.01lbs per square foot of girthed surface.
- No. 22 B.-G. to be 0.03125 inch thick and to weigh 1.27 Ibs. per square foot of girthed surface.
- No. 20 B.-G. to be 0.0392 inch thick and to weigh 1.59 Ibs. per square foot of girthed surface.

The allowance for increase in weight by galvanizing shall be 2 ozs, per square foot of girthed surface which weight includes both sides.

iii. Galvanizing

Galvanized corrugated steel sheets shall be thoroughly and evenly coated with zinc, and to be free from stains bare spots and other defects.

iv. Dimensions

The sheets shall be of standard dimensions. The diagonal distance between opposite corner of sheets shall not differ by more than ¾ inch.

iv. Paint

When not galvanized, all corrugated steel sheets shall be coated immediately after manufacture with one coat of oil paint applied by dipping or brushing over the whole of the surface of each sheet.

v. Corrugations

Unless otherwise specifically ordered the corrugations shall be of standard pattern-3 inches pitch and 3/4 inch deep. The widths shall be as under;

8/3 Corrugations	2 ft. 2 ins. measured straight and 2 ft. 6 ins. measured along the girth
10/3 Corrugations	2 ft. 8 ins. measured straight and 3 ft. measured along the girth.

vi. Tolerance

The diagonal distances between opposite corners of any sheet shall not differ by more than 3/4 inch.

vii. Fixing accessories

Hook bolts, screws, bolts, nuts, rivets, washers shall be galvanized or shall be of any other approved quality.

Sealing material shall be bituminous mastic or of any other approved quality.

viii. Flashing Gutters

Flashing gutters shall conform to Specifications No.13.10.3for Flashing Gutters.

13.5.3 LAP

a. End lap shall be minimum of 6 inches for slope and 4 inches for vertical falls which shall be sealed with specified sealing material. Complying with ASTM D-1850.

b. Side lap shall be formed on the sides of the sheet, away from the prevailing direction of wind. The side lap shall vary from one to two corrugations as specified.

13.5.4 INSULATING MATERIAL

Wherever specified, insulating material of approved quality shall be laid either between the purlins and the sheet or under purlins incorporating air gap. Insulation material shall conform with provisions of Sub-Section 13.8.

13.5.5 C.G.S SHEET INSTALLATIONS

i. **Purlin Spacing**

Purlins shall be of the steel or timber of requisite size as specified and shall be fixed over principal rafters for installation of CGS Sheets.

Purlin spacing for roof covering with G.C.S. sheets shall be arranged with a view to using standard sheets of uniform length throughout, and the trusses shall be designed for purlin spacing to suit the standard length of these sheets to avoid unnecessary cuttings. Ridge purlins shall be as near to the ridge as possible having regard to the type of ridge capping to be used and the manner in which it is to be fixed.

ii. **Holes**

The holes for fixing bolts shall be made through crown of the corrugations and shall be either punched or drilled and shall be 1/16 of an inch larger in diameter than the bolts or fixing screws to be used.

Holes shall be in the exact position to suit the purlins and no holes for fixing bolts shall be nearer than 1-1/2 inches to the end of the sheet. These holes shall be made in a manner

that the arises of the punched hole shall come on top when the sheets are laid. Where 4 sheets overlap, holes shall be drilled and not punched.

iii. **Laying of Sheet**.

Before the laying of sheet begins it shall be seen that all purlins are in true plane correctly spaced and securely fixed. The purlin spacing and the length of sheet shall first be checked to see that the arrangement will provide the specified overhanging at the eaves and the laps. The eave course shall be laid first and work shall start atthe leeward end of the building so that side laps have better protections from rain driven by the prevailing wind. The top edges of eave sheet shall extend at least 1 ½" inches beyond the back of steel purlin or 3 inches beyond the centre line of a timber purlin.

iv. **Fixing Sheets**

Sheets shall be fixed to steel purlin by hook bolts and to timber purlin by mushroom-headed galvanized drive screws. Hook bolts and drive screws shall be from 1/4 of an inch to 3/8 of an inch in diameter as specified and shall be spaced at an interval of not more than 15 inches. Sheets shall be secured at every purlin by at least 2 bolts. Nuts or heads of drive screws shall have specially made washers to render the holes waterproof. Washers shall be "Limpet" patent doom and shall be bedded on bituminous felt. Screws or bolts shall be tightened sufficiently to seat washers over the corrugation.

Ridges and hips shall be laid starting from directions as laying of sheets. Final pieces shall also be provided for closing the end of ridge line at gable end.

v. **Ridges and Hips**

a) General accessories: Ridge or hip capping, wherever possible shall be secured to the purlin by the same bolts or screws which secured the sheeting.

b) Ridge cap shall be made up of galvanized flat steel conforming to Clause 13.5.2.1(i) or Flat Steel Sheet ASTMA-36 or otherwise specified:

In case (a) above is not possible as the purlin is not sufficiently near the ridge, the capping shall be secured to the sheet by 1/4 of an inch to 3/8 of an inch diameter bolts: two roofing bolts to each wing capping at centre not further apart than the bolts used for sheets. The lap of the capping along the ridge shall not be less than 6 inches and shall be so arranged as to protect the joints from the prevailing wind.

c) Hip cap shall be cut to the required mitre and shall be close butted. The slope joints shall be covered with plain ridge cap which shall be secured through the roof sheet or the slope runner by one bolt on each side at the same spacing as for the roof sheets. Hip caps shall have a minimum lap of 6 inches.

vi. **Special Fastening Against Cables**

For any situation exposed to strong winds, sheets shall be fastened down above the eaves by continuous length of 1 ½" x ½" flat iron bars bolted down every 5 feet by ½" bolt built a foot into the wall and secured at the lower end by a 3" square washer. The fixing shall be with J-bolts.

vii. **Painting Sheet**

Wherever desired, sheets shall be painted with ICI, BERGER, NIPPON or equivalent as approved by the Engineer-in-Charge.

13.6 CORRUGATED ASBESTOS CEMENT SHEET ROOFING

APPLICABLE STANDARDS

- BS 691-1963
- BS 430-1964

13.6.1 GENERAL

Corrugated asbestos cement sheets shall conform to the approved Drawings and shall be procured from standard manufacturer. Unless otherwise specified, corrugated asbestos cement sheet roofing shall be constructed in accordance with the following specifications.

13.6.2 MATERIALS

a. AC Corrugated Sheets

i. **Classification**

Corrugated sheets shall be classified according to the sizes and form of the corrugations as follows:

Type of Sheet	Depth of Corrugation	Centres of Corrugations
Small	Under 2”	2-7/8” and 3”
Large Section	2” and Over	5-3/4” and 6”
Alternate Flat and Corrugated section	2” and over	13-1/3“ usually

ii. **Tolerance**

The sheets shall be corrugated in a true and regular manner. The corrugated sheets shall not vary from the standard dimension of length and width by more than 0.25%.

iii. **Breaking Strength**

When tested wet the average breaking load of 3 specimens shall not be less than the vales given in the following table:-

Class of Sheet	Span at which tested		Minimum width of sheet tested		Minimum average breaking load per inch width of specimens tested
	ft	in	ft	in	Lbs
Small Section	2	6	2	0	12
Large Section	3	6	3	0	26
Alternate flat and corrugated section	3	6	3	6	26

If breaking strength of a specimen is less than 70% of the average breaking strength of the 3 specimens tested, a further 3 specimens shall be tested and the results combined with the results of the previous two tests, the lowest results having been eliminated. The lowest breaking strength of any one of the 3 specimens shall not be less than 70 % of the average breaking strength of the specimen.

(iv) **Colour**

Pigments that are embodied in the asbestos cement for colouring purposes shall be of permanent colour. They shall not contain substances deleteriously affecting cement, such as lead oxide. The proportions of water soluble chloride and of water soluble sulphates together shall not exceed 2.5 per cent by weight of pigment.

The finish product shall be free from visible defects and shall have been manufactured for at least four weeks before use.

a) **Fixing accessories**

Hook bolts, nuts, and screws shall be galvanized or of any other approved quality. Washers shall be bituminous and galvanized iron or of any other approved type and quality.

b) **Sealing Material**

When specially required, sealing material shall consist of mastic of approved quality.

c) **Flashing Gutters**

Flashing gutters shall conform to provisions of Sub-Section 13.10.2.

13.6.3 LAP

a) End lap shall be of a minimum size of 6 inches.

b) Side lap shall be formed on the sides of the sheet away from the prevailing wind. It shall be half the corrugation of sheets.

13.6.4 OVERHANGING

The minimum end overhanging in case of eave verges and cable ends shall be12 inches. Overhanging verges shall be supported by purlins over the full width ofthe sheet.

13.6.5 SHEET INSTALLATIONS

i. **Purlin Spacing**

The purlins shall be as specified in Clause 13.5.5.

Purlin spacing for roof covering with ACC sheets shall be arranged with a view to using standard sheets of uniform length throughout, and the trusses shall be designed for Purlin spacing to suit the standard length of these sheets to avoid unnecessary cuttings. Ridge purlins shall be as near to the ridge as possible having regard to the type of ridge capping to be used and the manner in which it is to be fixed.

ii. **Holes**

Holes in sheets shall always be drilled and shall on no account be punched. They shall be 1/16 of an inch larger in diameter than that of bolt or fixing screw, and shall be drilled through the crown of the corrugations. Holes shall be drilled in exact position to suit the purlins. No hole shall be made in valleys of corrugations and closer than 1-1/2 inches from the edge.

iii. **Laying of Sheet**

Before sheeting begins the structure shall be inspected to see that all purlins are in true plane correctly spaced and securely fixed. Purlin spacing and the length of sheet shall be checked to see that the arrangement provides the specified laps and overhanging. The eave course shall be laid first, and work shall start at the leeward end of the building, so that the side laps shall have better protection from rain driven by the prevailing winds. The top edge of eave sheets shall extend 3 inches beyond the central line of purlins. Close fittings of sheets at the junction of side and end lap shall be ensured.

iv. **Fixing Sheets**

G. I. bolts and screws required for fixing sheets shall be 1/4 to 5/16 of an inch in diameter. Nuts or heads of screws shall bear evenly on washers. Bolts or screws shall be fixed with G. I. washers over bituminous washers to fit tightly on the outer face of the sheet. Bolts or screws shall in the first operation be tightened lightly. They shall be tightened fully when about a dozen of sheets have been laid in position.

For metal angle purlins the sheet shall be secured by bolts of 'J' or 'L' shape. For wooden purlins the sheet shall be fixed with gimlet pointed roofing screws which shall not be hammer-driven.

Ridges and hips shall be laid starting from directions as laying of sheets. Final pieces shall also be provided for closing the end of ridge line at gable ends.

v. **Ridge Cap**

Capping shall be secured to the ridge purlins by the same bolts or screws which secured the sheeting: if ridge purlin is not sufficiently near the ridge to permit this each wing of the ridge, capping shall be secured to the sheeting by 1-1/2" x5/16" roofing bolts.

Other asbestos cement accessories such as flashing etc. shall be secured either to the structure or by the roofing bolt of the sheeting.

vi. **Painting**

When specially required, the paint used for painting of sheets shall be of ICI, Berger or Nippon or as approved by the Engineer-in-Charge.

13.7 PLAIN ASBESTOS CEMENT SHEETING

Where specified the plain Asbestos Cement Sheeting shall be used for roofing. The procurement and installation shall comply with the applicable provisions of the Clause 13.6.

13.8 INSULATION MATERIAL

The thermo pore where specified for insulation of the roofing shall be extruded polystyrene complying with the provisions of ASTMC-578 – Standard Specification for Rigid Cellular Polystyrene Thermal Insulation and as approved by the Engineer-in-Charge. The contractor shall submit samples of the material for approval before use.

13.9 KHURRAS, PARNALAS AND SPOUTS

13.9.1 TOP KHURRAS

Unless otherwise specified, top Khurras shall be 24 inch x 24 inches x 2 inches and shall be made of 1:2:4 cement concrete 1-1/2" inch thick, laid on 1:4:8 cement concrete. The outside edge of the Khurras shall be flush with the level of the mud plaster or leepai and the surface shall slope uniformly from that place to the outlet, which shall be 2 inches lower than the edges. Concrete shall have a slope 1:1 at the sides so as to be overlapped by earth and mud plaster. Cement concrete shall be continued into the outlet so as to ensure a watertight joint.

13.9.2 BOTTOM KHURRAS ON ROOF

Unless otherwise specified bottom khurras on top of verandah or similar roofs shall be 24X24 inches and will consist of a 1-1/2 inch layer of I:2:4 cement concrete laid on 1:4:8 cement concrete. The surface shall be shaped like a saucer drain, the depth of the saucer being 2 inches, and joining up with the roof drain, described in paragraph13.9.7.

13.9.3 BOTTOM KHURRAS ON GROUND

Unless otherwise specified, bottom khurras when used on the ground, in conjunction with spouts, shall be 4 feet x 2 feet x 7-1/2 inches and shall consist of bricks on edge laid in cement, laid on 3 inches of 1:4:8 cement concrete.

13.9.4 REVEALED PARNALAS

Unless otherwise specified, revealed parnala's shall be made by leaving a channel 7 inches wide and 2-1/4inches deep in the wall during construction, and afterwards plastering the channel with 1:3 cement plaster. The corner of the channels shall be rounded to a radius of one Inch in plastering. If revealed parnala's are left in a wall made of brickwork in mud, the bricks shall be laid in cement mortar (I:3) for a depth of 4-1/2 inches from the back and sides of the parnala's, this work being included in the rate.

13.9.5 KHASSI PARNALA'S

Unless otherwise specified, khassi parnala's shall consist of two fillets of cement plaster. (1:3) raised 1-1/2 inches and spaced 9 inches apart, the space in between being plastered with 1:3 cement plaster. The fillets shall be prismatic in section (but with all corners and angles rounded), the Inner sides being at right angle to the wall and the outer sides sloping.

Unless otherwise specified, khassi parnala's shall in no case be made on top of the cement or other plaster on the wall, but made In contact with the brickwork or masonry after raking out the Joints.

13.9.6 SPOUT

Unless otherwise specified, spouts shall be made of PVC, cast iron, AC and reinforced cement concrete and shall have an open Channel 3-1/4 inches x 3-1/2 inches with a semi-circular bottom. They shall project at least 15 inches from the face of the wall and shall be built into the wall for a depth of at least 13-1/2 inches. The part built into the wall shall be sufficiently thickened to provide adequate support for the overhanging portion. Spouts shall be fixed at a slope not flatter than 1 in 6 and shall have a lip at the lower edge to allow water to drip clear.

13.9.7 ROOF DRAIN

Roof drains shall be provided on verandah and similar roofs to conduct water, discharged by the parnala's of a higher roof, to the outlet. They shall run in a straight line from the bottom khurra of one to the (top) khurra for the outlet concerned. Unless otherwise specified, the drain shall be saucer-shaped in section, the depth being 2 inches. Drains shall be made of 2 inches thick 1:2:4 cement concrete laid on cement concrete 1:4:8 of a section to give the necessary shape, with edges flush with the roof plaster.

13.10 GUTTERS AND FLASHINGS

13.10.1 SCOPE

Unless otherwise specified, gutters and flashings shall be constructed with plain galvanised iron/steel & plain AC sheets of the following specifications.

Galvanized steel sheets shall be:-

For gutters No. 18 S.W.G. to No. 22 S.W.G

For flashings No. 20 S.W:G. to No. 24 S.W.G.

The galvanised steel sheets shall conform with the provisions of Clause 13.5.

The ACC valley gutters shall be 1/4" to 3/8” thick and the sizes as specified. The AC sheets shall conform to the provisions of Clause 13.6.

13.10.2 GUTTERS

13.10.2.1 General

(i) Unless otherwise specified, gutters shall be semi-circular in shape, made of the material specified above and shall be properly finished and laid in specified shape. Gutters shall be supported with brackets fixed to wall or roofing at a specified distance apart.

(ii) The overall width of the sheet as specified shall mean the peripheral width of the gutter including the rounded edges. The longitudinal edges shall be turned back to the extent of 12mm and beaten to form a rounded edge. The ends of the sheets at junctions of pieces shall be hooked into each other and beaten flush to avoid leakage.

13.10.2.2 Slope

Gutter shall be laid with a minimum slope of 1 in 120.

13.10.2.3 Laying and fixing

(i) Gutter shall be supported on and fixed to M.S. flat iron brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1.20 metres.

(ii) Where these brackets are to be fixed to the sides of rafters, they shall be of 40x3mm section bend to shape and fixed rigidly to the sides of rafters with 3 Nos. 10mm dia bolts, nuts and washers. The brackets shall overlap the rafter not less than 30 cm and the connecting bolts shall be at 12 cm centre to centre.

(iii) Where the brackets are to be fixed to the purlins, the brackets shall consist of 50x3mm M.S. flat iron bent to shape with one end turned at right angle and fixed to the purlin face with 2 Nos. of 10mm dia bolts nuts and washers. The bracket will be stiffened by provision of 50x3mm. M.S. flat whose over hung portion bent to right angle shape with its longer leg connected to the bracket with 2 Nos. 6mm dia M.S. bolts, nuts and washers and its shorter leg fixed to face of purlin with 1 No. 10mm dia, bolt, nut and washer. The overhang of the vertical portion of the bracket from the face of the purlin shall not exceed 22.5 cm with this arrangement. The spacing of the brackets shall not exceed 1.20 metres.

(iv) The gutter shall be fixed to the brackets with 2 Nos. G.I. bolts and nuts 6mm dia, each fitted with a pair of G.I. and bitumen washers. The connecting bolts shall be above the water line of the gutters.

(v) For connection to down take pipes, a proper drop end or funnel shaped connecting piece shall be made out of G.S. sheet of the same thickness as the gutter and riveted to the gutter, the other end tailing into the socket of the rain-water pipe. Where over necessary stop ends, angles etc., should be provided.

13.10.3 FLASHING

When the edge of a roof sheeting, or of a valley gutter is turned up against a wall, the edge shall be weather-proofed with a flashing. The flashing shall be inserted into the brickwork or masonry joints to a depth of 2 inches, the joints being filled up with 1:3 cement mortar unless otherwise specified. It shall be further secured in the joint by means of galvanized iron clip, in at least 4 Inches into the masonry. The lower edge of the flashing shall overlap the sheeting below it by at least 4 inches, the edges of the sheeting and flashing being left free to expand and contract. Wherever flashing has to be laid at a slope, it shall be stepped at each course of the masonry, the steps being cut back at an angle of not less than 30 degrees to the vertical.

Fixing accessories and holes are to be the same as used for the adjoining sheets. Each sheet should be fixed at every purlin or rail by at least two bolts situated at the side laps and three intermediate fastenings for use with galvanized or aluminium corrugated profiles.

In addition to purlin or rail fixings, side laps are to be secured by means of seam bolts at maximum 300 mm centres. The use of self-tapping screws or blind rivets are not permitted. Provide neoprene washers under bolt heads.

13.11 FLAT STEEL SHEET ROOF (G.I. SHEETS)

13.11.1 SCOPE

Unless otherwise specified, plain flat steel sheet roofing shall be constructed.In accordance with the following specifications.

13.11.2 MATERIAL

Unless otherwise specified, material shall conform to the following specifications:

(a) **Flat Steel Sheets**

i) **Sheets**

Flat steel sheets shall be made of ASTMA-36 mild steel, well annealed, even in temper and thickness, free from hales, cracks, blisters and other defects.

The sheets shall be perfectly rectangular and the weight of any ten sheets to be within 7 1/2 per cent margin of the, weights given in below.

The weight and thickness of sheets before galvanizing shall be as follows:

a) No. 24 B.-G.to be 0.02476 inch thick and to weigh 1.01 Ibs/Square foot.

b) No. 22 B.-G.to be 0.03125 inch thick and to weigh 1.27 Ibs/ Square foot.

c) No. 20 B-G.to be 0.039 inch thick and weigh 1. 59 lbs/Square foot.

The allowance for increase in weight by galvanising shall be 2 oz./ square foot.

ii) **Galvanizing**

Galvanized steel sheets shall be thoroughly and evenly coated with zinc and shall be free from stains, bare spots and other defects.

iii) **Painting**

When not galvanized all sheets shall be coated immediately after manufacture with one coated oil-paint applied by dipping or brushing over the whole of the surface of each sheet.

iv) **Dimensions**

The sheets shall be of standard dimensions. The diagonal distance between opposite corner of sheets shall not differ by more than 3/4 inch.

The galvanised flat steel sheets shall be in the form of rolls in accordance with the above specifications.

a) Fixing Accessories

Fixing accessories shall be screws and clips and shall be of approved quality and shall be invariably galvanized.

b) Timber

The timber for Roll Battens/Boarding shall be wooden conforming to the provisions of Clause 16.3 – Woodwork.

13.11.3 ROOFING CONSTRUCTION

a. **Roofing Boarding**

The sheeting shall be laid on boarding of wood of thickness specified. The boarding shall be butt jointed unless specified otherwise with two screws (3") holding each board to each rafter. Only that side of the boarding shall be wrought which is not covered by sheets.

b. **Roll Battens**

The roll battens shall be of specified wood, 2" by 1-1/2" in section, with the top rounded to the curve of the ridge. They shall be fixed at the correct spacing, in parallel rows and secured to the boarding from underneath with 3" screws spaced not more than 2-1/2 feet apart.

c. **Preparing Sheets**

The longitudinal edges of the sheets shall be curvd to a radius of half an inch to that the rolled edge stands ¾ of an inch above the sheet. The top end of the upper most sheet shall be bent up 1-1/2".

d. **Laying Sheets**

The sheet shall be laid between the battens from the lower edge of the roof upwards. The lower edge of the first sheet shall be held to the planking by galvanized iron clips 6"x3/4"x1/8" at the two edges and then middle. The upper edge shall be kept under the lower edge of the next sheet which shall be held by an equal number of similar clips but 8" long. The 8" clips shall be fixed to the boarding by two screws at one end leaving the other end free for at least 6" to allow the lower sheet to be tucked underneath. The top most sheet, the upper edge of which has already been turned up, will butt against a batten 1-1/2"x1" running between the roll battens and parallel to the ridge plate and the turned up portion shall be screwed to this batten. The turned up longitudinal edges shall be kept down by 2"x1"x1/4" galvanized iron pieces recessed into and screwed to the battens with 2" screws. Two such clips shall be used at the ends and two spaced equally in between.

e. **Preparing and Fixing Rolls**

Rolls shall be made from 5" wide strips bent to a radius of 1" and leaving 1-1/2" gap between the edges. They shall then be slipped down the roll battens so as to enclose the turned edges of the roofing sheets. Rolls shall be held at the lower end, in each case by a clip, 6"x3/4"x1/8" countersunk into the batten and screwed to it.

f. **Ridge Sheeting**

Unless otherwise specified, the ridge shall be made from 2 feet strips, one longitudinal edge of which shall be turned up 1-1/2" to a radius of ½". The ridge sheet shall be laid on longitudinal planking which shall be of wood and thickness specified, butt jointed and unwrought both sides. The ridge boarding shall be fixed on top of roll battens after the rolls have been fixed in place and shall be secured with 2" screws per board to each roll batten.

The lower longitudinal edge of the ridge shall be secured by clips 6"x3/4"x1/8" screwed to the battens through the boarding, with 2" screws.

g. **Ridge Roll (Wooden)**

The ridge roll shall be made to a radius equal to the thickness of the ridge plate and with the edges separated by thickness of the beam and slipped over the ridge sheets so as to enclose the turned-up edges.

h. **Laps**

Roof sheets and rolls shall not overlap to a length of less than 6". Ridges, sheets and ridge roll shall not overlap to a length of less than 9".

i. **Wood Preservative**

Unless otherwise specified, all boarding, battens and fillets shall be given two coats of hot creosote or other approved wood preservative.

j. **Bending by Machine**

A machine of approved type shall be used for turning the edges of sheets and making all rolls. No hammering shall be allowed.

k. **Hips, Valleys, Gutters and Flashings**

Valleys, gutters and flashings shall be made in accordance with the approved drawings. Hips shall conform to the above paras (f) and (g) of the specifications for ridges except that the end is stopped with a piece of galvanized iron sheet cut to fit. The junction between the ridges and hips shall be capped with milled lead sheeting weigh 5 lbs per square foot. The lead sheet cap shall be carefully moulded to fit and shall have less than 9" overlap.

13.12 PLASTIC ROOFING (FIBRE GLASS)

13.12.1 SCOPE

The scope of work includes of supply of all materials and construction of plastic (Fibre Glass)roofing complete as shown on drawings in accordance with the specifications and as approved by the Engineer-in-Charge.

13.12.2 MATERIALS

a) The preformed plastic panels or corrugated translucent sheets made from thermosetting polyester resins to comply with BS 4154 and are to match with the profile of the roofing as specified and shown on drawings.

The thickness and colour of plastic panels shall be as designated in drawings. The sheets shall be procured from an approved source.

b) The fixing accessories shall consist of G.I. bolts nut, limpets and washers for installation and jointing of sheets.

c) Roll battens/boards shall be wooden, aluminium and mild steel sections as shown on drawings. The wooden battens and section shall conform with the provisions of Clause 16.3 - Woodwork.

The steel sections shall be made of galvanised steel sections conforming ASTM A-36. The aluminium sections shall be conforming BS 1474.

13.12.3 ROOF CONSTRUCTION

The fibre glass sheets shall be laid on the previously installed boarding frame and firmly secured with the holding accessories following the procedure for flat steel sheets Clause 13.11.3. The over laps and ridges shall be provided in accordance with the provisions of Clause 13.11.3(f) and (g).

13.13 WOODEN CEILING

13.13.1 BOARDS

i) Boards shall be of the class of timber and of finished thickness as specified in the description of the item and shall be in accordance with the general specifications for wood work. Only selected boards of uniform width shall be used. Unless otherwise specified in the

description of the item or shown in the drawings, the width of boards selected for use shall not be less than 100 mm nor more than 150 mm.

ii) The specific width of boards once selected within these two limits shall be maintained throughout and shall not be varied except in the first and last lines of boards adjustment to the two walls, where remaining odd width shall be adjacent equally on both sides. The maximum length of the board in the finished work shall be 180 cm. The minimum length of board in the finished work shall be such that it will span at least two spacing of the supporting frame work except where shorter lengths are unavoidable, depending on the arrangements of the lines of heading joints which shall be carried out to the pattern ordered by the Engineer-in-Charge.

The boards shall be plained true on the exposed side.

(iii) Unless stipulated otherwise in the description of the item, the longitudinal joints of the boards shall be tongued and grooved, while the heading joints shall be of the square butt type and shall occur under the centre line of the supporting joint. Heading joints in adjacent boards shall not be placed over the same joists, those in alternate boards being arranged in the same line, except where the joints are to be concealed by headings.

13.13.2 FRAME

Generally timber for frame shall conform with the provisions of Clause 16.3 – Woodwork.

Timber frame of the class of timber and section specified in the description of the item or as ordered by the Engineer-in-Charge shall be provided. The width of the frame scantling shall not be less than 50 mm. The arrangements and spacing of the frame scantling shall be as per design furnished. The frame shall be given two coats of approved preservative paint before the boarding is screwed. The frame and paints thereof shall be paid for separately unless specifically included in the description of the item. M.S. angles shall be used for suspending the frame and paid for separately.

The bottom surface of the frame shall be checked and corrected to true plans and slopes as specified and shown on drawings

13.13.3 MILD STEEL SCREWS

Screws shall be got approved from the Engineer-in-Charge before fixing. They shall be of the slotted counter sunk head type of length not less than the thickness of the board plus 20 mm. The designation number shall not be less than 9 for screws of length 40 to 50 mm and shall not be less than 6 for screws of length 25 to 35 mm.

13.13.4 FIXING

The outer lines of boards shall be accurately fixed, parallel and close to the wall. Each subsequent plank shall be carefully jointed up. The boards shall be fixed to the frame scantling above with two screws at each of frame and one at every intermediate joist. The screws shall be counter sunk and the screw holes filled with putty or sloping out wax.

The unexposed faces of planks shall be painted with wood preservative before fixing.

13.13.5 FINISHING

The exposed side of the boards shall be truely level and plane. The joints shall be truely parallel and/or perpendicular to the walls.

Beadings shall then be fixed to the ceiling, to the size and pattern required. These shall be measured and paid for separately unless specifically included in the description of the ceiling item.

13.14 CEILING WITH THERMOPORE

13.14.1 THERMOPORE SHEETS

Thermopore Sheets shall be procured from on approved source and shall be of thickness as specified. The thermopore shall comply with ASTM-C578-04sheets. The thermopore sheets shall be fixed on wooden frame for installation as ceiling.

13.14.2 FRAME

Frame of the class of timber and section specified in the description of the relevant item or as ordered by the Engineer-in-Charge shall be provided. The width of the scantlings provided shall be sufficient to provide a minimum nailing surface of 50 mm. The longitudinal and header scantlings shall be so arranged that (a) the sheets can be fixed to form the panel arrangements required as per drawings or as ordered by the Engineer-in-Charge (b) the longitudinal scantling to which the boards are mainly fixed are spaced at 30 to 45 cm centres, the actual spacing selected depending on the width of the cut board in the panel arrangement, (c) all edges of the cut board units are supported either on the longitudinal scantlings or on the header scantlings or on both.

The frame shall be given two coats of approved preservative paint (to be paid for separately) before the thermopore sheets are fixed on wooden frame and will be paid for separately. The frame and painting thereof shall be paid for separately unless specifically included in the description of the ceiling item. bottom surface of the frame shall be checked and corrected to true planes and slopes.

13.14.3 NAILS

The sheets shall be fixed to the frame scantling with G.I. headless nails 2.24 mm dia when the joints are to be left exposed. Where the joints will be covered with beadings, the sheets are to be fixed to the frames scantlings with G.I. felt headed (clout) nails 2.5 mm dia. The length of the nails shall generally be equal to thickness of sheet plus 25 mm so that their grip on the framing holding members will not be less than 25 mm.

13.14.4 FIXING

The boards shall be laid with lengths parallel to all joints centered over the framing members. Where joints are to be covered, the boards may be spaced 3 to 6 mm apart as described in the respective manufacturers' specifications. Where joints are to be left exposed the sheets shall be butt laid with their edges abutting in moderate contact, but without having to force them into place. The boards shall be supported and held tight to the frame with timber pieces the later being moved outwards as the nailing proceeds. The boards are first nailed to the intermediate framing member proceeding from the centre of the board outwards, the edges being nailed last.

13.14.5 FINISHING

The exposed side of the thermopore sheet frame shall be truly level and plane without any local bulges or sags. The joints shall be truly parallel and/or perpendicular to the walls. The width of joints shall be uniform. Care shall be taken to see that the uniformity of colour of the sheets is not spoilt during the fixing operations.

13.15 PAINTING OF ROOF SLAB WITH HOT BITUMEN

13.15.1 SCOPE

Where specified a bitumen coat shall be applied on roof as specified and approved by the Engineer-in-Charge. Unless otherwise approved by the Engineer-in-Charge, the bitumen shall conform to ASTM Designation D-449-89.

13.15.2 PREPARING THE SURFACE

The surface shall be painted only when it is fully dry. The surface to be painted shall be cleaned with wire brushes and cotton or gunny cloth. All loose materials and scales shall be removed and the surface shall be further cleaned with a piece of cloth lightly soaked in kerosene oil.

13.15.3 PAINTING WITH BITUMEN

The contractor shall bring the bitumen to site in its original packing and shall open and use it in the presence of the Engineer-in-Charge or his authorised representative. The containers shall not be removed from the site until the painting job is completed and the Engineer-in-Charge has satisfied himself regarding the quantity of bitumen actually used and has given his permission to remove the empty containers.

The surface prepared and treated shall be painted uniformly with bitumen of approved quality such as residual type petroleum bitumen of penetration 80/100, hot cut back bitumen or equivalent as per specifications of the manufacturer. The coat of bitumen shall be continued 15 cm along the vertical surfaces joining the roof. In case of parapet walls it shall be continued upto the drip courses. Residual type petroleum bitumen of penetration 80/100 shall be heated to a temperature of not less than 180 degree C and not more than 190 degree C and shall be applied on the roof surface at not less than 180 degree C. Similarly, hot cut back bitumen shall be heated to a temperature of not less than165 degree C and not more than 170 degree C and shall be applied on the surface at not less than 165degree C.

Care shall be taken to see that no blank patches are left. The quantity of bitumen to be applied per 10 square metres of roof surface shall be 17 kg, unless otherwise stipulated in the description of the item. It shall be carefully regulated so that the application is uniform at the stipulated rate of 17 Kg. per10 square metres.

13.15.4 SPREADING SAND

Immediately after painting, dry, clean sharp coarse sand at the rate of 60 cubic decimetre per 10 Sq.m. shall be evenly spread and levelled over the surface when the bitumen is still hot.

13.16 CAST IRON RAIN WATER PIPES

13.16.1 CAST IRON PIPES& FILLING

Cast Iron pipes and fillings shall conform to BS 78 for spigot and socket vertically cast pipes and BS 1211 for spigot and spun pipes. The pipes shall be perfectly, smooth and cylindrical, their inner and outer surfaces being as nearly as practicable concentric. These shall be sound and of uniform castings, free from laps, pin holes or other imperfections and shall be neatly finished and carefully fitted both inside and outside. The ends of pipes shall be reasonably square to their axes. The pipes shall be procured from an approved source.

13.16.2 DIMENSIONS

C.I. rain water pipes shall be of the dia. specified in the description of the item and shall be in full length of 1.8 metre including socket ends of the pipes, unless shorter lengths are required at junctions with fittings. The pipe lengths shall be in each case be with socket. The pipes shall be supplied without ears unless otherwise specifically mentioned. The pipes supplied shall be factory painted (with a tar base composition) both inside and outside which shall be smooth and tenacious. Every pipe shall ring clearly when struck all over with a light hand hammer. When shorter pipes are cut from full lengths they shall be cut with a hacksaw. The sizes, weights, sockets and tolerances of pipes shall be as shown in Table 13.16.

TABLE 13.16

Dimensions and Weight of C.I. Rain Water Pipes

	Nominal size of pipes (Internal diameter in mm)	50	75	100	125	150
1	**PIPE**					
a)	External diameter in mm	53	79	104	130	156
	Tolerance in mm	± 3	± 3	± 3.5	± 3.5	± 4
b)	Thickness in mm	3	3	3	3	4
	Tolerance in mm	± 1	± 1	± 1	± 1	± 1
	Nominal size of pipes (Internal dia. in mm)	50	75	100	125	150
c)	Nominal weight of 1800 mm					
	long pipe without ears in kg	7.50	11	14	20	26
	Tolerance in weight	(-) 10%	(-) 10%	(-) 10%	(-) 10%	(-) 10%
	Tolerance in length in mm	± 13	± 13	± 13	± 13	± 13
2	**SOCKET**					
a)	Internal diameter in mm	63	89	114	139	167
	Tolerance in mm	± 3	± 3	± 3	± 3	± 3
b)	Thickness in mm	4	4	4	4	4
	Tolerance in mm	± 1	± 1	± 1	± 1	± 1
c)	Internal depth in mm	60	65	65	75	75
	Tolerance in mm	± 10	± 10	± 10	± 10	± 10

Note:

1. All dimensions are in mm.
2. Pipes weighing more than the nominal weight may be accepted provided they comply in every other respect with the requirements of the standard.
3. The above table applies only to rain water pipes fixed on wall face.
4. For pipes and fittings which are to be embedded in masonry, specifications shall correspond with those of pipes for soil, waste, and vent pipes.

13.16.3 FIXING AND JOINTING

i) Pipes shall be either fixed on face of wall or embedded in masonry, as required in the description of the item.

ii) Plain pipes (without ears) shall be secured to the walls at all joints with M.S. holder bat clamps. The clamps shall be made from 1.6 mm thick galvanised M.S. sheet of 30 mm width, bent to the required shape and size so as to fit tightly on the socket of the pipe, when tightened with screw bolts. It shall be formed out of two semi-circular pieces, hinged with 6 mm dia M.S. bolt on one side and provided with flanged ends on the other side with hole to fit by the screw bolt and nut, 40 mm long. The clamp shall be provided with a hook made out of 27.5 cm long 10 mm diameter M.S. bar, rivetted to the ring at the centre of one semi circular piece. The clamps shall be fixed to the wall by embedding their hooks in cement concrete block 10 x 10 x 10 cm in1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone

aggregate 20 mm nominal size) for which necessary holes shall be made in the wall at proper places. The clamps shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning and painting of pipes.

Note:

Where G.I. sheet clamps are not provided, M.S. sheet clamps of 3 mm thick and 20 mm wide shall be used for making the clamps.

iii) The pipes shall be fixed perfectly vertical or to the lines as directed. The spigot of the upper pipe shall be properly fitted in the socket of the lower pipe such that there is a uniform annular space for filling with the jointing material. The annular space between the socket and the spigot shall be filled with a few turns of cotton spun yarn soaked in neat cement slurry. These shall be pressed home by means of caulking tool. More skins of yarn shall be wrapped if necessary and shall be rammed home. The joint shall then be filled with stiff cement mortar 1:2 (1 cement : 2 fine sand) well pressed with caulking tool and finished smooth at top at an angle of 45 degree sloping up. The joints shall be kept wet for not less than 7 days by tying a piece of gunny bag, four fold, to the pipe and keeping it moist constantly.

iv) Where pipes are to be embedded in masonry, these shall be fixed in masonry work as it proceeds. In such cases care shall be taken to keep the pipes absolutely vertical or to the line as directed by the Engineer-in-Charge. The pipe shall have a surrounding of 12 mm minimum thickness of mortar at every portion of the external surface. The mortar shall be of the same mix as is used in the masonry. The joint shall be caulked with lead as soon as the next length of pipe is placed in position. The open end (socket end) of the pipe shall be kept closed till the next length is fitted and jointed, to prevent any brick bats or concrete or pieces of wood falling in and choking the pipe.

The depth of lead from the lip of socket shall be 25 mm minimum. In case of 100 mm dia. 75 mm and50 mm pipes, the quantity of lead required per joint shall be 1.00 kg, 0.66 kg and 0.50 kg respectively for purpose of reckoning theoretical Consumption.

In order to ensure that required quantity of lead is poured into the joint and to control wastage of lead, at the beginning, three or four samples shall be made and the quantum of lead per joint approved by the Engineer-in-Charge.

The actual consumption of lead should be within ± 5% of the approved sample job subject to the provision that a variation of ± 20% shall be allowed over the theoretical quantity of lead due to dimensional tolerances. This variation includes allowances of wastage also.

v) The spigot end shall butt the shoulder of the socket and leave no gap in between. The annular space between the socket and the spigot will be first well packed in with spun yarn leaving 25 mm from the lip of the socket for the lead. The joint shall then be fully lead caulked approved by the Engineer-in-Charge.

13.17 CAST IRON ACCESSORIES FOR RAIN WATER PIPES

13.17.1 C.I. FITTINGS

C.I. accessories such as bends of various degrees, heads, offsets of different projections, branches and shoes shall be of approved quality complying with BS-78.Bends shall be of the nearest standard degree as actually required at site. Heads shall be of the flat or corner type as required. Offsets shall be of the projection as stipulated in the description of the item. Branches shall be single or double as described in the item and shall be of the nearest standard degree as actually required. Standard shoes shall be of overall vertical length, 180 mm for 75 mm dia., 205 mm for 100 mm dia and 275 mm for 150 dia sized pipe from top of socket to lowest tip of shoe. Shoes of longer lengths if used shall be in lengths 300 mm, 375

mm, 450 mm, or 600 mm from top of socket to lowest tip of shoe of as actually required at site.

13.17.2 DIMENSIONS

The fittings shall be of the diameter specified in the description of the item. The thickness of the fittings and details of spigots and sockets shall be same as those of the corresponding size of straight pipes. The fittings shall be supplied without ears unless otherwise specifically mentioned in the item. The fittings shall be factory painted with a tar basis composition both inside and outside which shall be smooth and tenacious. Every fitting shall ring clearly when struck all over with a light hard hammer. The fittings shall be of standard size and their individual weights shall conform to the weights given in the Table 13.17.

TABLE 13.17
Weight of C.I. Rain Water Pipe Fittings

Sr. No.	Description	75 mm dia	100 mm dia	150 mm dia	Unit
		Kgs.	Kgs.	Kgs.	
1.	Bends (Plain)	3.20	4.50	9.10	Each
2.	Offsets (Plain)				
a)	55 mm projection	2.70	5.00	8.20	Each
b)	75 mm projection	3.20	5.50	9.10	Each
c)	115 mm projection	4.10	5.90	9.50	Each
d)	150 mm projection	4.50	6.40	10.40	Each
e)	225 mm projection	5.00	7.30	11.80	Each
f)	300 mm projection	6.00	8.60	12.70	Each
Sr. No.	Description	75 mm dia	100 mm dia	150mm dia	Unit
		Kgs.	Kgs.	Kgs.	
3.	Branches (Plain)				
	Single	5.00	7.30	14.50	Each
	Double	6.80	10.00	19.10	Each
4.	Standard shoes (Plain)	3.20	4.10	8.60	Each
5.	Longer shoes (Plain)				
a)	300 mm	3.20	5.00	-	Each
b)	375 mm	4.10	5.50	-	Each
c)	450 mm	5.50	6.40	-	Each
d)	600 mm	7.30	8.60	-	Each
6.	Heads	6.40	6.80	11.30	Each
7.	Extras:				
a)	For ears cast on any fitting and short pipes	0.90	0.90	1.35	Each
b)	For inspection doors fitted on any fitting	1.80	1.80	2.25	Each

Note:

1. The above table applies only to rain water fittings which are part of pipe lines fixed on wall face. Permissible tolerance in weight of fittings shall be 5%.
2. For fittings to be used with pipe lines to be embedded in masonry, specifications shall correspond with BS 437 of pipe fittings for soil, waste and vent pipes.
   Fixing and jointing shall be as specified in 13.16.3(iii).

13.18 MEASUREMENT AND PAYMENT

13.18.1 COMPOSITE RATE

The measurement and payment for the items of the work of Brickwork hereof shall be made corresponding to the applicable CSR items as provided in Contract Agreement and shall constitute full compensation, for procurement, transportation, performance in all respects and completion of work as specified including the site clearance as approved by the Engineer-in-Charge.

13.18.2 LABOUR RATE

The measurement and payment for the items of the work of Brickwork hereof shall be made corresponding to applicable CSR item as provided in Contract Agreement and shall constitute full compensation for procurement transportation, performance in all respects and completion of work as specified including site clearance, as approved by the Engineer-in-Charge except the cost of materials to be provided by Department at designated location as defined in the Contract Agreement.

13.18.3 QUANTIFICATION

The unit of measurement shall be measured as mentioned below in accordance with corresponding CSR items.

1. For Volumetric items, the unit of measurement shall be cubic meter or cubic foot. Following item of CSR is measured in the above mentioned criteria;
   Item No.: 13-36
2. Following item shall be measured as %age increase;
   Item No.: 13-52
3. For surface area items, the quantity of work shall be measured by surface area. The unit of measurement shall be Square meter or Square foot. Following item of CSR are measured according to this criteria;
   Item No.:13-1 to 13-8,13-13,13-18 to13-24,13-32 to 13-35,13-37 to 13-40,13-45and 13-47 to 13-50
4. For linear items, the quantity of work shall be measured linearly along centre line of structure. The unit of measurement shall be running meter or running foot. Following items of CSR are measured according to this criteria;

   Item No.: 13-9,13-12,13-14,13-25 to 13-27,13-27,13-29 to 13-31, 13-42,13-46 and13-51
5. The following items shall be measured as Each;
   Item No.: 13-10 to 13-11,13-15 to 13-17, 13-28,13-41,13-43 and 13-44