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8. DAMP PROOF COURSE AND WATER PROOFING

8.1 DAMP PROOF COURSE

8.1.1 SCOPE

The work shall include furnishing all labour, material and equipment and performing all services to provide the damp-proofing in foundations and over plinths of Structures as shown on the drawings and/or as directed by the Engineer-in-Charge.

8.1.2 RELATED WORKS

- Section 5 - Plain and Reinforced Concrete
- Section 9 - Cement Concrete Block Masonry
- Section 11 - Brick Masonry
- Section 13 – Roofing

8.1.3 INSTRUCTIONS

Damp proofing shall not be applied when the ambient temperature is below 4 degree Centigrade. The work shall be done by workmen experienced in the application of damp proofing, and the Contractor shall co-ordinate damp proofing operations with other phases of the work to prevent staining or damaging finished work. The Contractor shall repair or replace damaged finished work to the satisfaction of the Engineer-in-Charge. Damp proofing shall be applied as shown on the Drawings.

8.1.4 DAMP PROOFING MATERIALS

(a) Damp Proof Course

Damp Proof Course unless otherwise specified shall be one inch thick 1:2:4 Plain Cement Concrete placed at the specified plinth level in accordance with the provisions of Section 5 – Plain & Reinforced Concrete.

(b) Damp Proof Plaster

Damp Proof Plaster is generally for vertical faces and unless otherwise specified is applied with 1:3 Cement Sand Plaster complying with the provisions of Clause 15.1 – Plaster, Finishes.

(c) Polythene Sheet

Polythene Sheet shall be used over bitumen painted surface where specified and shall consist of 0.13mm thick polythene sheet (500 gauge) complying with ASTM D 2103, as approved by the Engineer-in-Charge.

(d) Water Proofing Agent

The specified water proofing agent or asphaltic materials shall be delivered in sealed containers bearing the Manufacturer's original labels. Bituminized Kraft paper shall be delivered in rolls as per Manufacturer's original packing. All materials shall conform to the Specifications designated and shall be approved by the Engineer-in-Charge. Damp proofing materials shall conform to the requirements shown on the Drawings and given hereafter.

(e) Bitumen

Bitumen for damp proofing shall meet the requirements of Clause 13.3.2 under Section 13 – Roofing and as approved by the Engineer-in-Charge.

(f) Hessian Cloth

Hessian Cloth impregnated with bitumen shall be as specified for use on plain plinth surfaces.

8.1.5 EXECUTION

8.1.5.1 PREPARATION OF SURFACES

Surfaces to receive damp proofing shall be smooth, clean and dry. Holes, joints and cracks shall be painted flush with mortar. Before damp proofing, surface shall be swept clean of all foreign matter and shall be inspected and approved by the Engineer-in-Charge. The surface shall be prepared complying with the provision of Clause 13.15.2.

8.1.5.2 PLACEMENT

(a) General

The selection and combination of various water proofing and damp-proofing materials for different locations shall be as shown on the Drawings or as directed by the Engineer-in-Charge. Unless otherwise directed or approved by the Engineer-in-Charge, the procedures given in this sub-section shall be adopted.

(b) Damp Proofing under Floors and Foundations

A priming coat of the suitable thinned bitumen mixed with kerosene oil shall be applied to all parts of the surfaces to be damp proofed before the application of bitumen coating.

The bitumen coat shall be applied uniformly in such a manner as to cover pores completely and to thoroughly bond with the surface, using not less than 1.71 Kg per square meter for each coat and laying single layer of polythene sheet 0.13mm thick (500 gauge) on damp proof course or as specified. The bitumen coat shall be applied after it is heated upto 350°F – 375°F.

The polythene Sheet shall be placed in such a way as to ensure proper bond with the asphalt layer.

(c) Damp Proofing under Masonry Walls

- (i) A layer of 1:2:4 plain cement concrete or as specified of thickness as shown on the drawings will be placed over the area to be damp-proofed under brick masonry, cement concrete block masonry or stone masonry walls.

A priming coat of suitable thinned bitumen shall be applied before the application of bitumen coating.

The bitumen coat, using not less than 1.71 Kg per square metre, shall be applied and laying single layer of polythene sheet 0.13mm thick (500 gauge) on damp proof course.

Where specified 1:2:4 concrete mixed with an approved Water Proofing Agent shall be placed as Damp Proof Course under walls.

- (ii) Alternatively Damp Proofing with Hessian Cloth Impregnated with bitumen where specified at 1.25 kgs of bitumen per square metre shall be applied on smooth DPC or plastered surface. The coating of bitumen and sand blending shall be carried out as specified.

(d) Damp Proofing Vertical Surfaces

For brick masonry surfaces, a cement plaster of ¾ inches (19mm) thickness shall be applied to the surface. A priming coat of thinned bitumen shall then be applied to the cement coating or concrete surface before the application of bitumen coating.

The bitumen coat, using not less than 1.71 Kg per square metre as specified shall be applied.

8.2 WATER PROOFING ROOFS

8.2.1 SCOPE

The work of insulation, water proofing and roofing of the flat or sloped roofs shall consist of provision of all labour, material and equipment for installing the insulation, water proofing and roofing whichever required in accordance with the Drawings, specified or as directed by the Engineer-in-Charge.

8.2.2 CODES AND STANDARDS

The work shall conform to the requirements of the following Codes and Standards, unless otherwise specified:

ASTM D41-78	Primer for use with asphalt in damp proofing and water proofing.
ASTM D2103-81	Polyethylene film and sheeting.
BS 747-77	Specifications for roofing felt.
BS 1521-72	Water proof building papers.
BS 4016-72	Building paper (breather type).

8.2.3 WATER PROOFING MATERIALS

8.2.3.1 ASPHALT/BITUMEN

Special industrial asphalt shall be of 10/20 penetration, or any other type approved by the Engineer-in-Charge conforming to the following minimum and maximum limits:

Specific gravity	1.02/1.04 at 25°C
Penetration, 100 gm	10/20 at 25°C
Ductility (Cms)	417 at 25°C
Softening Point	77°C / 93°C
Working temperature	150°C /175°C

Asphalt/bitumen primer shall be bitumen of 10/20 penetration grade 1420 from an approved manufacturer or any other type approved by the Engineer-in-Charge conforming to ASTM D 41.

8.2.3.2 FELT

The felt shall be an asphalt impregnated type 1C fibre base. The number of plys thickness shall be as specified in the Drawings. The felt shall be smooth and stout building paper having safe water proofing qualities. Weight of 3 ply standard roll of 20 x 1 metre should not be less than 54 Kilograms. The brand/make of felt shall be as specified and approved by the Engineer-in-Charge.

8.2.3.3 ISOLATION MEMBRANE/POLYETHYLENE SHEET

Isolation membrane shall be polyethylene sheet 0.13mm thick (500 guage). The contractor shall provide sample of the sheet for approval by the Engineer-in-Charge.

8.2.3.4 JUTOID WATER PROOF MATTING

The jutoid matting shall be asphalt impregnated jute base matting as approved by the Engineer-in-Charge. The matting shall be stout jute matting having safe water proofing qualities. The thickness of the matting shall be as specified.

8.2.3.5 RUBEROID WATER PROOFING MEMBRANE

Ruberoid water proofing membrane shall be applied alongwith asphalt felt where specified. The thickness of the membrane shall be 4mm weighing 4 kgs per square meter. The physical properties of membrane when tested according to ASTM D5147 shall be as follows:

Property	Test Method	Values
Tensile Strength @ (nom.), lbf/in	ASTM D5147	90
Elongation @ (nom.), %	ASTM D5147	45
Low Temperature Flexibility (max.), F	ASTM D5147	7
Tear Strength (nom.), lbf	ASTM D5147	98
Dimensional Stability, %	ASTM D5147	<1

8.2.3.6 BLANCO FELT FOR WATER PROOFING

Blanco felt for water proofing shall be of standard manufacturer approved by the Engineer-in-Charge.

8.2.4 EXECUTION

8.2.4.1 ROOFING

(i) GRADING ROOF WITH CEMENT CONCRETE 1:2:4

(a) Materials

Cement, coarse sand and graded stone aggregate 20 mm nominal size, shall be used as specified in the item.

The specifications for the materials and method of preparation of concrete shall conform in general to the specification described in Section 5 – Plain & Reinforced Concrete. The grading of aggregates shall be limited between 3/4 inches maximum and 3/16 inches minimum.

(b) Laying

Before laying cement concrete for grading, the level markings to the required slope/gradient shall be made only with cement concrete on the surface of the slab at suitable spacing with the help of string and steel tape (Measuring tape) so that the mason can lay the concrete to the required thickness, slope / gradient easily in between the two level markings.

On getting the level marking approved by the Site Engineer the surface should be sprinkled with thick cement slurry and the concrete should be laid carefully, without throwing from height, in predetermined strips.

The concrete should be consolidated by specially made wooden tamping. After the tamping is done the surface should be finished to required slope/gradient with wooden trowels without leaving any spots of loose aggregates etc.

The mixed cement concrete must be laid in position, within half an hour of its mixing. In case any quantity of concrete remains unused for more than half an hour the same should be rejected and removed from the site.

(c) Finishing

The slope of finished terrace shall not be more than 1 in 120 unless a steeper slope is ordered by the Engineer-in-Charge. The minimum thickness of the concrete at its junction with Khurra or parapets shall be 5 cm. The concrete shall be rounded at the junction of roof slab and parapet. It is desirable to provide a haunch/gola/filler at the junction of the parapet wall and the roof slab.

The finished concrete surface shall present a smooth surface with correct slopes and uniform rounding. The concrete should be free from cracks. Excess trowelling shall be avoided.

(d) Thickness

Average thickness shall be 1-1/2 inches to 3 inches and as specified.

(e) Curing

Curing shall be done either by spreading straw/Hessian cloth over the graded surface, keeping the same wet for full 10 days or flooding the graded area with water by making kiaries with weak cement mortar, for 10 days. Occasional curing by simply spraying water now and then shall not be permitted.

(ii) GRADING ROOF WITH CEMENT MORTAR

(a) Materials

Cement and coarse sand shall be as specified in Section 5 – Plain & Reinforced Concrete.

(b) **Cement mortar**

Cement mortar 1:3 (1 cement: 3 coarse sand) /1:4(1 cement: 4 coarse sand) specified in the item of work shall conform to the specification described in Section 11 - Brickwork.

(c) **Preparation of the surface**

The surface shall be cleaned properly with brooms brush and cloth to remove all dirt, dust, mortar droppings.

(d) **Laying**

Same as described under Clause 8.2.4.1(i) (b) above for concrete, except that cement mortar shall be tamped with wooden and steel trowels and surface finished with steel trowel.

(e) **Finishing**

1. The slope of finished surface shall not be more than 1 in 120 unless a steeper slope is specified.
2. The finished surface of the grading shall present a smooth surface with correct slopes and uniform roundings wherever they are provided. The mortar surface shall be free of cracks. Excess trowel-ling shall be avoided.

(f) **Thickness**

The minimum thickness of cement mortar grading at the junction with khurra or parapet wall shall be 20 mm. The cement mortar shall be rounded at the junction of roof slab and parapet. It is desirable to provide a haunch/gola/filler at the junction of parapet wall and the roof slab. The maximum thickness that shall be adopted for grading with cement mortar shall be 50 mm. It is not at all desirable to lay the cement mortar grading for greater thickness and in that case it is advised to go in for grading with Cement Concrete.

(g) **Curing**

Curing for the grading with cement mortar shall be done exactly as described under Clause 8.2.4.1(i) above for concrete.

(iii) **PREPARATION OF SURFACE**

(a) **Flat Roofs**

All surfaces to receive roofing and water proofing treatment shall be sound, clean, smooth, dry and free of debris, loose material or defects which would have an adverse effect on the water proofing application or performance. The work shall not start until the preparatory work has been inspected and approved by the Engineer-in-Charge.

(b) **Sloped Roofs**

Treated wood nailing strips 254 x 50 mm size shall be embedded in the roof with top of strip flush with the deck at 900 mm on centres or as shown on the drawings and/or directed by the Engineer-in-Charge.

Metal gravel strips, scuppers and roof drains shall be placed and metal flashing, flanges etc., shall be provided and installed in time. Cant strips shall be installed at the angle formed by the roof deck and the vertical surfaces.

(iv) **INSTALLATION OF ROOF FELT / MATTING**

- (a) Bitumen for built-up roofing shall not be applied when it is above 205°C, (400°F) nor shall it be heated above 245°C (475°F).

- (b) The terms Felt/Matting used are synonymous

Felt shall be stacked in properly protected piles and maintained at temperature of at least 10°C (50°F) for a period of not less than 24 hours prior to laying. Felt surfacing material shall always be dry and the several layers of felt shall be laid free from wrinkles.

- (c) Roofing shall not be applied during rain or while surfaces are damp; it shall be applied only to surfaces that are clean and dry.
- (d) Method of laying the different layers of built-up roofing shall be strictly in accordance with the recommendations of the manufacturer and the method proposed by the Contractor and approved by the Engineer-in-Charge.
- (e) Built-up roofing shall not be laid when the temperature at the location of the work is below 5°C (40°F).
- (f) Heating of asphalt/bitumen shall be strictly regulated by means of an accurate thermometer of approved type, kept constantly suspended in the heating kettle while the work is in progress.
- (g) Entire deck surface and parapet walls shall be painted with asphalt primer or as specified and allowed to dry thoroughly. Primer shall be kept several centimetres back from joints of pre-cast panels.
- (h) Mopping of surface with asphalt/bitumen shall be performed so that the surface shall be completely covered. Bond coats of asphalt shall be at the rate of 1.25 Kg per square metre or as specified. At no point shall felt touch the underlying concrete and the rate of application shall be such that the asphalt mopping shall not be more than one metre ahead of the roll of felt. All asphalt shall be applied with mops except that the hot surfacing application shall be poured from a dipper.
- (i) Felt shall be laid with each sheet lapping the preceding one. Each sheet shall be lapped with an exposed lap of 300 mm. All end laps shall be 100 mm minimum. The laying of felt shall, in general, be started at low points working upwards to high points of the surface. The roofing felt shall be rolled while mopping, rubbing and pressing the felt sheets as it spreads on to the surface, so as to ensure thorough sticking and a smooth firm surface, free from wrinkles or bubbles. Roofing felt shall be extended to points and position as shown on the drawings.
- (v) **DAMP PROOFING OF THE ROOF WITHOUT FELT / MATTING**
 - (a) The damp proofing of the roof with bitumen coating without Felt/matting shall be carried out in accordance with the applicable items of preparation under Clause 8.2.4.1(iii) (a) above.
 - (b) The bitumen at the specified rate and the layers shall be applied by mopping of surface in accordance with the procedure according to the items (a), (c),(e),(f), & (h) of Clause 8.2.4.1(iv) above.
 - (c) Blinding with Coarse, Sand/Washed Shingle as specified shall be sprinkled and penetrated into bitumen coat to seal the surface properly.
 - (d) Where specified, 0.13mm thick (500 gauge) polyethylene sheet shall be spread over final coat of bitumen and rammed with minimum 75mm side laps and 100mm end laps staggered with layers bonded to gather with asphalt. The surface shall be broomed to ensure that it is free of wrinkles.
 - (e) The Contractor shall take care to maintain the slopes, levels and protect the work from any damage during the construction and maintenance period. The Contractor shall have to remove, replace and rectify such damaged work.
- (vi) **RUBEROID WATER PROOFING**

The following shall be sequence of operation for laying Ruberoid water proofing:

 - o Asphalt Saturated Felt
 - o Ruberoid Compound
 - o Ruberoid Reelia Roofing (of the specified ply)
 - o Ruberoid Compound
 - o Washed Gravel

The roof surface shall be prepared as per (iii) above. The work shall be performed according to the instructions of the manufacturer.

Two or three underlay sheets will be unrolled and placed in position on the roof. Each sheet overlapping the adjoining one by 2 inches. Where the sheets meet the parapet or other roof obstructions they should be turned up 6 inches and bonded with Ruberoid Compound to the concrete for a width of about 15 inches.

The first spread of the underlay should be 18 inches wide so that the laps of the Ruberoid Reelia Roofing break joints with those of the underlay. Each length of the Ruberoid Reelia Roofing is in turn fitted in position and rolled back half way so that when unrolled it will resume its former position. The Ruberoid compound heated to the fusing point will then be poured from a suitable container such as watering can without a rose or a bucket and dipper at the rate of 30 lbs per hundred sft. on the underlay. As Ruberoid Reelia Roofing is rolled out pressure is applied so as to ensure adhesion while the compound is still hot. The other half of the length is then rolled up and the process repeated. The joints of the Ruberoid roofing should overlap 2 inches and care should be taken to see that ample compound is applied so that it flows out along-with edges. The length of the Ruberoid roofing should not exceed 15 feet. It is advisable that the laying operation for underlay and Ruberoid roofing should follow each other in such a way that a minimum of incomplete work is exposed to weather.

The Ruberoid roofing should be inserted for a depth of about 2 inches in the parapet wall by cutting chases in the first convenient course of parapet and covering these with cement plaster. It should be clearly understood that the underlay is not bonded with compound to the concrete substructure except at vertical abutments etc.

Over this surface of the Ruberoid roofing a bitumen compound will be spread at the rate of 30 lbs per hundred sft. in the same manner as described above washed gravel graded from 3/8 inch downward will be spread at the rate of 3 Cu.ft. per hundred Sq.ft. over the bitumen compound and pressed to the surface by means of wooden thappies so that it adheres well to the bitumen compound.

vii) **PROVIDING BLANCO ROOFING FELT**

The following will be the sequence of operation for laying Blanco roofing felt:

1. Sticking layer of bitumen
2. Layer of 2 ply Blanco felt
3. Flood coat of bitumen
4. Washed gravel

The roof surface shall be prepared as per (iii) above shall be filled in with 1:3 cement mortar. The work shall be carried out according to the instructions of the manufacturer.

Over the surface thus prepared a layer of bitumen heated to the fusing point will be spread from a suitable container such as watering cans without a rose or a bucket and dipper at the rate of 30 lbs per hundred Sq.ft.

Over this the Blanco felt roofing will be laid and the same will be pressed hard on the surface so that it may adequately adhere to it. Where the felt meets the parapet or other roofing obstruction they should be turned up 6 inches and bonded with bitumen to the concrete for a width of about 15 inches. The length of the roofing felt should not exceed 15 feet. The joints of the felt should overlap 2 inches.

Over this surface of roofing felt bitumen will be spread at the rate of 30 lbs. per hundred sft. in the same manner as described above. Washed gravel graded from 3/8 inch downward will be spread at the rate of 3 Cu.ft. per hundred Sq.ft. over bitumen compound and pressed to the surface by means of wooden thappies so that it stick well to the bitumen.

viii) **JUTOID WATER PROOF MATTING**

Jutoid can be nailed into position over a wooden surface or can be fixed on a concrete base. If the area to be covered is more than 40 inches in width or 28 yards in length then another roll of similar dimension can be joined together by allowing an overlapping of about 4 inches in such a manner that the overlapping piece is on the higher level in case of a slope and the piece inserted below as the joint comes from the lower level of the slope. This allows the water to smoothly flow over the joint without striking it or penetrating inside to effect the water proofing. The overlap would have to be fixed with a special adhesive. This adhesive is heated, mixed with kerosene oil in specified quantities and applied hot at the joints and at the outer edges of the structure.

ix) **FLASHINGS**

Roofing joints and parapets shall be provided base flashings as shown on the Drawings or directed by the Engineer-in-Charge. The base flashings can be either of the following types:

Where built-up base flashings are required, they shall be made by continuing the built-up roofing upon the cant and over the tip and securing the edge with galvanized roofing nail used with metal discs. The nails shall be spaced not over 100 mm apart.

Where metal base flashings are required, 3 layers of felt shall be applied extending up 150 mm on the vertical surface and out on the roof surfaces 100 to 150 mm respectively cementing the same in place with asphalt plastic, troweled on. These flashing strips shall be applied over the top ply of roofing and under the metal base flashing. The portion of metal flashing extending out over roof surfaces shall be covered with two additional plies of felt, 400 mm and 450 mm wide respectively and both cemented in place with bitumen.

8.3 MEASUREMENT AND PAYMENT

8.3.1 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.

8.3.2 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.

8.3.2 QUANTIFICATION

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

1. 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 items of CSR are measured according to this criteria;

Item No.:8-1 to 8-20