

भारतीय मानक

छत के लिए बिटूमैन नमदों वाले जल  
सहकारक की रीति संहिता

( तीसरा पुनरीक्षण )

*Indian Standard*

CODE OF PRACTICE FOR WATERPROOFING OF  
ROOFS WITH BITUMEN FELTS

( *Third Revision* )

---

Second Reprint JULY 1996

UDC 692.415.691.165 : 69982 : 006.76

© BIS 1991

**BUREAU OF INDIAN STANDARDS**  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

## FOREWORD

This Indian Standard ( Third Revision ) was adopted by the Bureau of Indian Standards, after the draft finalized by the Waterproofing and Damp-proofing Sectional Committee had been approved by the Civil Engineering Division Council.

Bitumen felt is one of the materials used for waterproofing of roofs. Waterproofing treatment with bitumen felt is adopted not only in the case of buildings and structures, but also in the case of railway coaches, bus bodies, etc. This standard is one of a series of Indian Standards dealing with damp-proofing and waterproofing using bitumen felts and covers the laying operation. The general features relating to damp-proofing and water-proofing with regard to design detail, surface preparation, drainage, etc, are covered in IS 3067 : 1988 and this standard is intended to cover only the execution part of the work relating to application of bitumen felt in waterproofing of roofs.

This is the third revision of the standard which was first published in 1959. In this revision relevant clauses of the standard have been modified and new clauses added wherever required to take care of the slope of the roof, drainage, roof garden and external fire and in all the treatments other than floating, a layer of primer has been included.

Waterproofing treatment to be efficient and lasting, has to be carefully carried out from the time the surface is prepared to receive the felt to the finishing of the treated surface. Special attention and strict supervision has necessarily to be paid to proper overlapping of joints in felts, treatment around drainage opening in the roof and treatment of the parapet walls. The sticking of the felt to the roof by means of hot bitumen also requires skill, if the job is to be done economically and to give good results.

In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country.

## *Indian Standard*

# CODE OF PRACTICE FOR WATERPROOFING OF ROOFS WITH BITUMEN FELTS

*( Third Revision )*

### 1 SCOPE

1.1 This standard deals with the methods of application of bitumen felts of roofs of buildings designed to render them waterproof.

### 2 REFERENCES

2.1 The Indian Standards listed in Annex A are necessary adjuncts to this standard.

### 3 TERMINOLOGY

3.0 For the purpose of this standard, the definitions given in IS 4911 : 1986 shall apply, in addition to the following.

#### 3.1 Bonding Material

Bitumen adhesive employed to stick the first layer of roofing felt to the roof surface ( or to the underlay when used ) or one layer of roofing felt to another and as a top dressing.

#### 3.2 Multiple Layer

Two or more layers of bitumen felt laid with overlapping joints and bonded together with bitumen.

#### 3.3 Floating Treatment

A waterproofing treatment which is isolated from the base of the structure to be treated.

#### 3.4 Underlay

A layer of bitumen saturated felt sometimes used additionally between the roof surface and the first layer of self-finished bitumen felt when the waterproofing treatment is to be isolated from the roof structure.

### 4 NECESSARY INFORMATION

4.1 The designer of the building shall make sure that he has sufficient information as specified in IS 3067 : 1988. Consideration shall include details of the general design of the roof, its felt coverings and finish in relation to such requirements as may affect them.

### 5 MATERIALS

#### 5.1 Materials for Regrading of Roof Surface

Regrading shall be carried out with a suitable cement mortar incorporating a clean, medium coarse sand or with a lime-SURKHI mortar or any other suitable material.

#### 5.2 Bitumen Primer

Primer shall conform to the requirements laid down in IS 3384 : 1986.

#### 5.3 Bitumen Felts

These shall comply with the requirements laid down in IS 1322 : 1982 and IS 7193 : 1974.

#### 5.4 Bonding Materials

The bonding material between the felt and the roof surface and between the successive felts should be industrial blown type bitumen of Grade 85/25 or 90/15 conforming to IS 702 : 1988. For top dressing bitumen used shall be industrial blown type of allowable penetration not more than 40 when tested in accordance with IS 1203 : 1978.

For vertical surfaces up to 1 metre height blown type bitumen of grade 85/25 or 90/15 and above 1 metre height 115/15 grade are recommended.

### 6 WATERPROOFING TREATMENT

6.1 In selecting the combinations of layers and grades of felt to be used, consideration shall be given to the type and construction of buildings, climatic and atmospheric conditions and the degree of permanence required.

#### 6.2 Concrete and Masonry Roofs, Flat or Sloping

The following treatments are recommended:

a) *Normal Treatment* — Five courses for moderate conditions:

- 1) Primer conforming to IS 3384 : 1986 at the rate of 0.27 l/m<sup>2</sup>, *Min*;
- 2) Hot applied bitumen at the rate of 1.2 kg/m<sup>2</sup>, *Min*;
- 3) Hessian-base self-finished felt, Type 3 Grade 1 or glass fibre base Type 2, Grade 1;
- 4) Hot applied bitumen at the rate of 1.2 kg/m<sup>2</sup>, *Min*; and
- 5) Pea-sized gravel or grit devoid of fine sand at the rate of 0.006 m<sup>3</sup>/m<sup>2</sup>.

OR

*Floating Treatment*

- 1) Fibre base bitumen saturated underlay, Type 1;

- 2) Hot applied bitumen at the rate of  $1.2 \text{ kg/m}^2$ , *Min*;
  - 3) Fibre-base self-finished felt, Type 2, Grade 1 or Grade 2;
  - 4) Hot applied bitumen at the rate of  $1.2 \text{ kg/m}^2$ ; and
  - 5) Pea-sized gravel or grit devoid of fine sand at the rate of  $0.008 \text{ m}^3/\text{m}^2$ .
- b) *Heavy Treatment* — Seven courses for severe conditions:
- 1) Primer conforming to IS 3384 : 1986 at the rate of  $0.27 \text{ l/m}^2$ , *Min*;
  - 2) Hot applied bitumen at the rate of  $1.2 \text{ kg/m}^2$ , *Min*;
  - 3) Hessian-base self-finished felt, Type 3, Grade 1 or glass fibre base felt Type 2, Grade 1;
  - 4) Hot applied bitumen at the rate of  $1.2 \text{ kg/m}^2$ , *Min*;
  - 5) Hessian-base self-finished felt, Type 3, Grade 1 or glass fibre base felt Type 2, Grade 1;
  - 6) Hot applied bitumen at the rate of  $1.2 \text{ kg/m}^2$ , *Min*; and
  - 7) Pea-sized gravel or grit devoid of fine sand at the rate of  $0.006 \text{ m}^3/\text{m}^2$ .

OR

- 1) Primer conforming to IS 3384 : 1986 at the rate of  $0.27 \text{ l/m}^2$ , *Min*;
- 2) Hot applied bitumen at the rate of  $1.2 \text{ kg/m}^2$ , *Min*;
- 3) Fibre-base self-finished felt, Type 2, Grade 1 or Grade 2;
- 4) Hot applied bitumen at the rate of  $1.2 \text{ kg/m}^2$ , *Min*;
- 5) Fibre-base self-finished felt, Type 2, Grade 1 or Grade 2;
- 6) Hot applied bitumen at the rate of  $2.5 \text{ kg/m}^2$ , *Min*; and
- 7) Pea-sized gravel or grit devoid of fine sand at the rate of  $0.008 \text{ m}^3/\text{m}^2$

OR

*Floating Treatment*

- 1) Fibre-base bitumen saturated underlay, Type 1;
- 2) Hot applied bitumen at the rate of  $1.2 \text{ kg/m}^2$ , *Min*;
- 3) Fibre-base self-finished felt, Type 2, Grade 1 or Grade 2;
- 4) Hot applied bitumen at the rate of  $1.2 \text{ kg/m}^2$ , *Min*;
- 5) Fibre-base self-finished felt, Type 2, Grade 1 or Grade 2;
- 6) Hot applied bitumen at the rate of  $2.5 \text{ kg/m}^2$ , *Min*; and

- 7) Pea-sized gravel or grit devoid of fine sand at the rate of  $0.008 \text{ m}^3/\text{m}^2$ .
- c) *Extra Heavy Treatment* — Nine courses for very severe conditions:
- 1) Primer conforming to IS 3384 : 1986 at the rate of  $0.27 \text{ l/m}^2$ , *Min*;
  - 2) Hot applied bitumen, at the rate of  $1.2 \text{ kg/m}^2$ , *Min*;
  - 3) Hessian-base self-finished felt, Type 3, Grade 1 or glass fibre base bitumen felt Type 2, Grade 1;
  - 4) Hot applied bitumen at the rate of  $1.2 \text{ kg/m}^2$ , *Min*;
  - 5) Hessian-base self-finished felt, Type 3, Grade 1 or glass fibre base bitumen felt Type 2, Grade 1,
  - 6) Hot applied bitumen at the rate of  $1.2 \text{ kg/m}^2$ , *Min*;
  - 7) Hessian-base self-finished felt, Type 3, Grade 1 or glass fibre base bitumen felt Type 2, Grade 1;
  - 8) Hot applied bitumen at the rate of  $1.2 \text{ kg/m}^2$ , *Min*; and
  - 9) Pea-sized gravel or grit devoid of fine sand at the rate of  $0.006 \text{ m}^3/\text{m}^2$

OR

- 1) Primer conforming to IS 3384 : 1986 at the rate of  $0.27 \text{ l/m}^2$ , *Min*;
- 2) Hot applied bitumen at the rate of  $1.2 \text{ kg/m}^2$ , *Min*;
- 3) Fibre-base self-finished felt, Type 2 Grade 1 or Grade 2;
- 4) Hot applied bitumen at the rate of  $1.2 \text{ kg/m}^2$ , *Min*;
- 5) Fibre-base self-finished felt, Type 2, Grade 1 or Grade 2;
- 6) Hot applied bitumen at the rate of  $1.2 \text{ kg/m}^2$ , *Min*;
- 7) Fibre-base self-finished felt, Type 2, Grade 1 or Grade 2;
- 8) Hot applied bitumen at the rate of  $2.5 \text{ kg/m}^2$ , *Min*; and
- 9) Pea-sized gravel or grit devoid of fine sand at the rate of  $0.008 \text{ m}^3/\text{m}^2$ .

NOTE — Where pea-sized gravel or grit are not available, coarse sand may be used.

### 6.3 Surface Finish

In all the above treatments (see 6.2) a surface finish of pea-sized gravel or grit shall be provided. This affords a measure of protection to the treatment and increases its durability. On the flashings and at the drain mouths, the gravel or grit may be omitted and instead two coats of bituminous paint at the minimum rate of  $0.1 \text{ l/m}^2$  per coat or a single coat of bituminous emulsion at the rate of  $0.5 \text{ l/m}^2$  may be applied.

**6.3.1** In order to prolong the life of the waterproofing treatment or when the roof surface is subjected to foot traffic the following surface treatment is recommended:

- 1) Cement concrete flooring tiles conforming to IS 1237 : 1980;
- 2) Burnt clay flat terracing tiles conforming to IS 2690 ( Part 1 ) : 1975 or IS 2690 ( Part 2 ) : 1975.

Alternatively, a screeding of proportion of 1 : 4 of cement and sand 45 mm thick can be laid over the roofing treatment and marked off into squares of 600 mm made with expansion joints provided at a distance of 3 m which shall be properly caulked with bituminous sealing compound conforming to Grade A of IS 1834 : 1984.

For heat reflecting surface or for aesthetic reasons bitumen based aluminium paints or coloured bituminous emulsions may be used.

**6.3.2** Where it is required to provide fire protection to the roof surface the waterproofing treatment shall be covered by a layer of cement concrete flooring tiles ( see IS 1237 : 1980 ). The surface covering shall be built into the walls at the edges or taken up along the parapet as required.

#### 6.4 Timber Roofs, Sloping

##### a) Normal Treatment

- 1) Fibre-base bitumen saturated underlay Type 1, or hessian based felt Type 3, Grade 1 or glass fibre base felt Type 2, Grade 1;
- 2) Hot applied bitumen at the rate of 1.2 kg/m<sup>2</sup>, *Min*; and
- 3) Fibre-base self-finished felt Type 2, Grade 1 or Grade 2, or hessian based felt Type 3, Grade 1 or glass fibre base felt Type 2, Grade 1.

##### b) Heavy Treatment

- 1) Fibre-base self-finished felt Type 2, Grade 1, or hessian based felt Type 3, Grade 2 or glass fibre base felt Type 2, Grade 2;
- 2) Hot applied bitumen at the rate of 1.2 kg/m<sup>2</sup>, *Min*; and
- 3) Fibre-base self-finished felt Type 2, Grade 1 or Grade 2 or hessian based felt Type 3, Grade 2 or glass fibre base felt Type 2, Grade 2.

#### 6.4.1 Surface Finish

For timber roofs the treatment shall be finished with hot applied bitumen at the rate of 1.2 kg/m<sup>2</sup>, *Min*, with two coats of bituminous paint at the minimum rate of 0.1 l/m<sup>2</sup> per coat or a single coat of bituminous emulsion at the rate of 0.5 l/m<sup>2</sup> over it.

## 7 METHOD OF LAYING WATERPROOFING TREATMENT

### 7.1 Sequence of Operation for All Types of Roofs

- a) Preparatory work ( see IS 3067 : 1988 );
- b) Collecting and storing of materials and tools;
- c) Cleaning roof surface of foreign matter;
- d) Treatment of gutters and drain mouths;
- e) Treatment of the main roof, flat or sloping;
- f) Treatment of flashings and projecting pipes;
- g) Top dressing, that is gravel or grit, fixing or laying of tile or concrete protection or putting paints or emulsion; and
- h) Cleaning and removal of surplus materials.

### 7.2 Concrete and Masonry Roofs, Flat

In order to avoid stagnation of water a slope should be provided to the roofs to allow the water to flow away and thus avoid ponding. A minimum slope of 1 in 100 should be provided.

Prior to applying the waterproofing system, the preparatory works as described in IS 3067 : 1988 shall be completed and the cement or lime work allowed to set and allowed to dry completely. The surface of roof and that part of the parapet and gutters, drain mouths, etc, cover which the waterproofing treatment is to be applied, shall be cleaned of all foreign matter, namely fungus, moss, dust, etc, by wire brushing and dusting.

**7.2.1** The felt is normally laid in lengths at right angles to the direction of the run-off gradient, commencing at the lowest level and working up to the crest. In this way, the overlaps of the adjacent layers of felt offers the minimum obstruction to the flow-off of water.

**7.2.1.1** For applying bitumen primer, roof surface shall be thoroughly cleaned and primer shall be brushed over it and left till the time it is dry.

**7.2.1.2** The bitumen bonding material shall be prepared by heating to the correct working temperature and conveyed to the point of work in the bucket or pouring can.

**7.2.1.3** The felt shall be first cut to required lengths, brushed clean of dusting materials and laid out flat on the roof and allowed to soften. This serves to eliminate curls and subsequent stretching. Each length of felt prepared for laying as described above shall be laid in position and rolled up for a distance of half its length. The hot bonding material shall be poured on to the roof across the full width of the rolled felt as the latter is steadily rolled out and pressed down. The excess bonding material is squeezed out at the ends and is removed as the laying proceeds.

**7.2.1.4** When the first half of the strip of felt has been bonded to the roof, the other half shall be rolled up and then unrolled on to the hot bonding material in the same way.

**7.2.1.5** Minimum overlaps of 100 and 75 mm shall be allowed at the end and the sides of strips of felt. All overlaps shall be firmly bonded with hot bitumen.

**7.2.1.6** The laying of the second layer of felt shall be so arranged that the joints are staggered with those of the layer beneath it.

**7.2.1.7** In case of pent roofs where the type of treatment consists of one layer of felt only, as in normal treatment ( *see* 6.2 ), an additional layer of felt shall be provided at the ridge which shall cover a minimum length of the slope of 250 mm on both sides of the ridge.

### **7.2.2 Junctions of Parapet Wall and Roof**

Felt shall be laid as flashing with minimum overlaps of 100 mm. The lower edge of the flashing shall overlap the felt laid on the flat portion of the roof and the upper edge of the flashing shall be tucked into the groove made in the parapet on the vertical face of the wall. Each layer shall be so arranged that the joints are staggered with those of the layer beneath it.

**7.2.2.1** After all the layers specified have been laid and the flashings properly bonded, the groove shall be filled up with cement mortar ( normally 1 : 4 ), or lime mortar ( 1 : 3 ), or cement concrete ( 1 : 3 : 6 ) which when set, will satisfactorily secure the treatment to the wall. The groove filling shall be properly cured by watering for at least 4 days after filling to ensure satisfactory strength and to avoid shrinkage cracks.

**7.2.2.2** It is essential to apply a cement mortar fillet of 1 : 4 along the wall and floor juncture.

### **7.2.3 Drain Mouths**

Drain mouths with a bell mouth entry shall be fixed and properly set to allow the water to flow into it. Felt shall generally be laid as on the other portion of the roof and the treatment shall be carried inside the drain pipes overlapping at least 100 mm. If possible a grating cap should be provided over the drain mouth to protect checking caused by leaves, stones etc.

### **7.2.4 Gutters**

The treatment to be laid in the gutters shall provide for one layer of roofing felt more than is provided on the roof proper. Hence at least two layers of felt shall be laid in the gutters even when only one layer of felt has been specified for the roof as in normal treatment ( *see* 6.2 ). A priming coat shall first be applied. Over this, the first layer of felt shall be bonded with hot bitumen followed by successive layers of felt securely bonded together

and finally painted with a coat of hot bitumen at not less than 1.5 kg/m<sup>2</sup>.

**7.2.4.1** The felt layers laid separately in the gutters shall be overlapped with the corresponding layer on the roof proper.

**7.2.4.2** The felt layers laid separately in the gutters shall be carried down into the outlet pipes to a minimum depth of 100 mm. Where there are walls, grooves shall be cut out at a reasonable height and the felt tucked in the grooves which shall than be filled in with cement mortar.

**7.2.4.3** For gutters in pent roofs, the flashing shall be laid separately at the sides and carried well under the eaves of the pent roofs.

### **7.2.4.4 Surface finish**

Two coats of bituminous paint at the rate of 0.1 l/m<sup>2</sup> per coat or a single coat of bituminous emulsion at the rate of 0.5 l/m<sup>2</sup> shall be applied.

## **7.3 Timber Roofs, Sloping ( *see* Fig. 1 )**

The underlay or first layer of coated felt shall be secured by nails spaced at 100 to 150 mm centres along overlaps and at 20 mm from the exposed edges. In case of struck on treatment, the felt shall be bonded with the timber roof in the same manner as in the case of masonry roof but with nailing strips and back nailing.

**7.3.1** Where required additional nailing may be provided midway between overlaps at 150 mm centres.

**7.3.2** The second and subsequent layers of felt shall than be applied with hot bonding materials in the manner described for concrete and masonry roofs.

**7.3.3** In the case of a gabled roof, one single strip of felt shall cover from gutter to gutter, over the ridge. If the treatment consists of one layer of felt only, as in normal treatment ( *see* 6.2 ), an additional layer of felt shall be provided at the ridge which shall cover a length of slope of 250 mm on both sides of the ridge.

### **7.3.4 Flashings**

If the parapet is of masonry construction, the flashing shall be treated in the same way as in 7.2.2. In case the roof butts against a vertical timber wall, the flashings shall be continuously bonded down over the felt turn up and angle fillet. Joints in the felt flashings shall be lapped 100 mm and sealed. The upper end of the flashing shall be firmly secured to the timber wall by screwing down with a timber batten.

## **7.4 Shell Roofs**

**7.4.1** In the case of shell roofs, an additional layer of felts shall be provided for the valley gutter for normal treatment and for other types of treatment,

the number of felts in the valley gutters shall be one layer extra. The treatment on the valley gutter shall be laid first and the height to which the felt is to be taken shall be at least 150 mm above the anticipated standing water in the gutter. For normal treatment on pent roofs or shell roofs; the felt shall be laid parallel to the direction of the run off gradient. The felts in case of shell roofs shall be laid from one edge of the valley gutter to the other, that is, round the curvature. In the case of northlight cylindrical shells, it can either start from the valley gutter or from the upper edge. The upper edge shall be securely anchored at the edge of the shell.

NOTE — Where insulation has been specified, the insulating material shall be applied on the top of the shell surface and plastered, if necessary, with cement mortar to provide adequate base for application of waterproofing treatment.

**7.4.1.1** When felt is laid parallel to the direction of runoff gradient that is, round the curvature in case of shell roof, side of overlap should be 100 mm and overlap at the end should be 75 mm (Min) that is side overlap and overlap at end should interchange with those as in the case when felt is laid across the runoff gradient.

**7.4.2 Surface Finishing**

Instead of the normal bituminous gravel finish the surface may be finished as follows:

- a) With two coats of bituminous aluminium paint at the rate of 0.1 litre/m<sup>2</sup> per coat; or
- b) One coat of colour bituminous emulsion at the rate of 0.5 litre per m<sup>2</sup>/coat; or

- c) One coat of acrylic based coating at the rate of 0.3 litre/m<sup>2</sup> per coat.

**7.5 Expansion Joints**

Expansion joints shall be designed to suit the requirements of each roof. Expansion joint coverings may be of zinc or of lead sheet or of bitumen felt. In case of the latter, a minimum of two layers of bitumen felt, Type 2, Grade 2 as specified in IS 1322 : 1982 or Type 2, Grade 1 as per IS 7193 : 1974 shall be used with a top dressing gravel or other suitable finish. The typical cases are illustrated in Fig. 2.

**7.6 Treatment of Bubble Formation**

If ballooning occurs, the defect may be rectified as given in 7.6.1.

**7.6.1** Remove the gravel on the ballooned surface. Then cut open and squeeze out the trapped vapour by firm pressure applied by hand. Seal the bitumen felt so lifted, back on the surface by applying additional bitumen. Finally seal the cut with a piece of bitumen felt with bitumen application and reapply the gravel finish over it to make the surface look uniform with the rest.

**7.6.2 Roof Gardens**

Where it is required to create roof gardens the waterproofing treatment shall be carried out as per IS 1609 : 1976. As far as possible, plants should be planted in containers to avoid root penetration into the roof below.

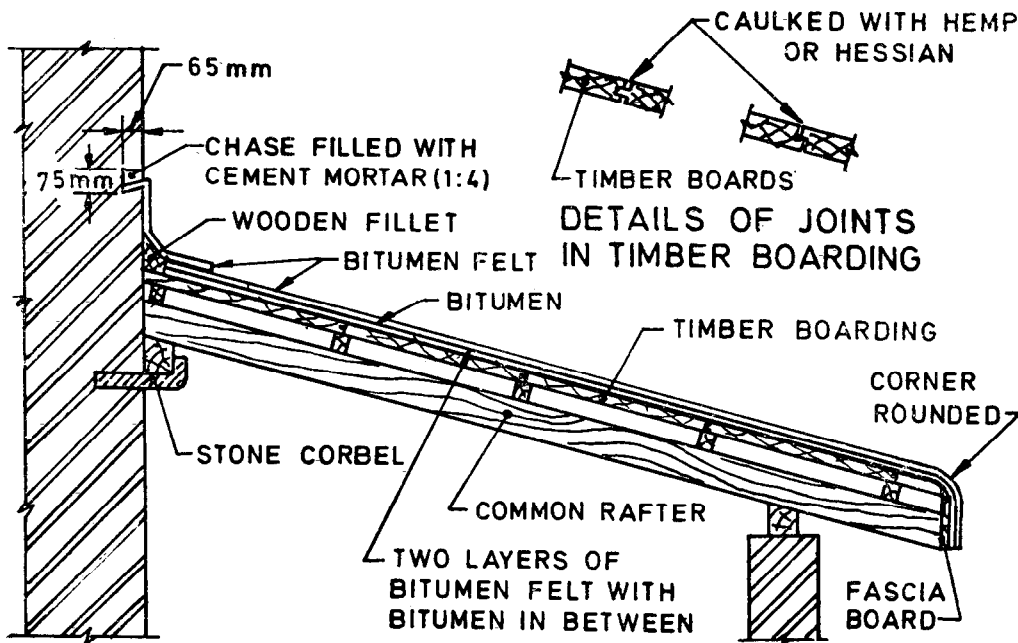
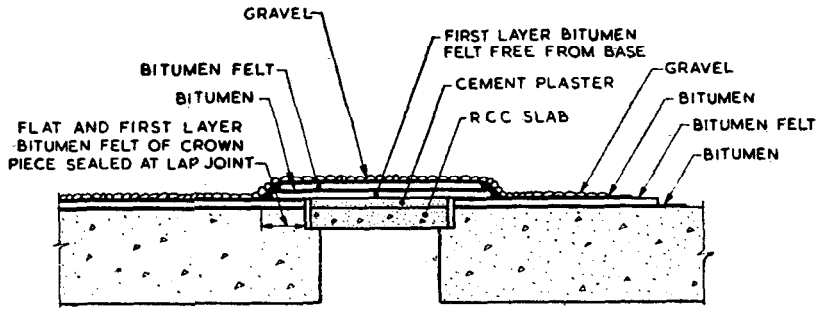


FIG. 1 WATERPROOFING TREATMENT OF TIMBER ROOF

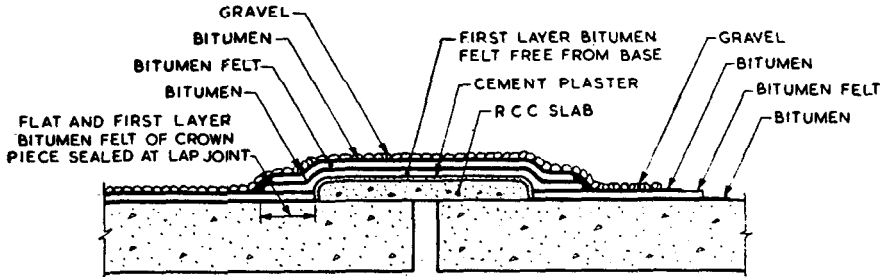
**8 INSPECTION AND MAINTENANCE**

**8.1** It is recommended that arrangements should be made for a detained inspection of the water-

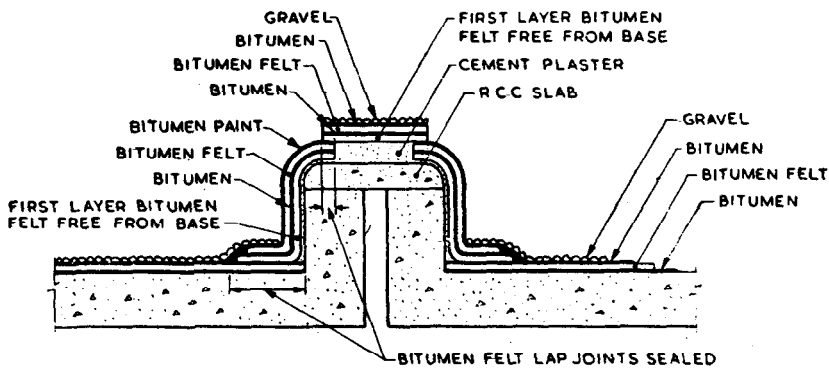
proofing treatment periodically, preferably prior to the advent of the rainy season, with a view to repairing any apparent defect and to ensure complete waterproofing.



**2A** Expansion Joint with Tee Iron Tile and Terrace Construction in Level with Roof Surface



**2B** Expansion Joint with RCC Slab on Roof Surface



**2C** Raised Type Expansion Joint

**FIG. 2 EXPANSION JOINTS**



**ANNEX A**

( Clause 2.1 )

**LIST OF REFERRED INDIAN STANDARDS**

<i>IS No.</i>	<i>Title</i>	<i>IS No.</i>	<i>Title</i>
702 : 1988	Specification for industrial bitumen ( <i>second revision</i> )	2690 ( Part 1 ) : 1975	Specification for burnt clay flat terracing tiles : Part 1 Machine made ( <i>first revision</i> )
1203 : 1978	Method of testing tar and bituminous material: Determination of penetration ( <i>first revision</i> )	2690 ( Part 2 ) : 1975	Specification for burnt clay flat terracing tiles : Part 2 Hand made ( <i>first revision</i> )
1237 : 1980	Specification for cement concrete flooring tiles ( <i>first revision</i> )	3067 : 1988	Code of practice for general design details and preparatory work for damp-proofing and waterproofing of buildings ( <i>first revision</i> )
1322 : 1982	Specification for bitumen felts for waterproofing and damp-proofing ( <i>third revision</i> )	3384 : 1986	Specification for bitumen primer for use in waterproofing and damp-proofing ( <i>first revision</i> )
1609 : 1976	Code of practice for laying damp-proofing treatment using bitumen felts ( <i>second revision</i> )	4911 : 1986	Glossary of terms relating to bituminous waterproofing and damp-proofing of buildings ( <i>first revision</i> )
1834 : 1984	Specification for hot applied sealing compound for joint in concrete ( <i>first revision</i> )	7193 : 1974	Specification for glass fibre base coal tar pitch and bitumen felts

## Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

### Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publication), BIS.

### Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Additions'.

This Indian Standard has been developed from Doc: No. **CED 41 (4706)**.

### Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

## BUREAU OF INDIAN STANDARDS

### Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002  
Telephones: 323 01 31, 323 83 75, 323 94 02

Telegrams: Manaksanstha  
(Common to all offices)

### Regional Offices:

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg  
NEW DELHI 110002

Telephone  
323 76 17, 323 38 41

Eastern : 1/14 C.I.T. Scheme VII M, V.I.P. Road, Maniktola  
CALCUTTA 700054

{ 337 84 99, 337 85 61  
337 86 26, 337 91 20

Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160022

{ 60 38 43  
60 20 25

Southern : C.I.T. Campus, IV Cross Road, MADRAS 600113

{ 235 02 16, 235 04 42  
235 15 19, 235 23 15

Western : Manakalaya, E9 MIDC, Marol, Andheri (East)  
MUMBAI 400093

{ 832 92 95, 832 78 58  
832 78 91, 832 78 92

Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR.  
COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI.  
HYDERABAD. JAIPUR. KANPUR. LUCKNOW. PATNA.  
THIRUVANANTHAPURAM.