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IS : 2441 - 1984

*Indian Standard*  
CODE OF PRACTICE FOR  
FIXING CEILING COVERINGS  
( *First Revision* )

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

# Indian Standard

## CODE OF PRACTICE FOR FIXING CEILING COVERINGS

### ( First Revision )

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*Indian Standard*  
**CODE OF PRACTICE FOR  
FIXING CEILING COVERINGS**  
*( First Revision )*

**0. FOREWORD**

**0.1** This Indian Standard ( First Revision ) was adopted by the Indian Standards Institution on 31 May 1984, after the draft finalized by the Building Construction Practices Sectional Committee had been approved by the Building Division Council.

**0.2** Coverings are fixed on to the ceiling to give a decorative appearance, to conceal projections, such as beams occurring underneath the floor slab, to provide a false ceiling, and sometimes to obtain special acoustic effects and insulation against heat and cold. The ceiling being a prominently exposed building feature, even a slight fault in the joints or in the alignment of the ceiling coverings will be perceptible and lead to unsightly appearance; therefore, care is called for in the installation of the supporting frame and fixing of coverings. This standard is intended to provide guidance with regard to the various aspects of the work of fixing ceiling coverings.

**0.2.1** This standard was first published in 1963. This is being revised to incorporate the modifications found necessary as a result of experience gained during the use of this standard. In this revision fixing details for additional types of ceiling coverings have been included and details for existing types modified.

**0.3** This standard is intended chiefly to cover the technical provisions relating to fixing ceiling coverings; it does not cover all the necessary provisions of a contract.

**0.4** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960\*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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\*Rules for rounding off numerical values ( revised ).

## **1. SCOPE**

**1.1** This code covers the details of fixing the following types of ceiling coverings:

- a) Insulating building board ceiling,
- b) Hardboard ceiling,
- c) Plaster of paris ceiling,
- d) Plaster of paris tiles,
- e) Gypsum plaster board ceiling,
- f) Plywood and blockboard ceiling,
- g) Asbestos cement building board ceiling,
- h) Wooden cover fillets beading for ceiling,
- j) Cloth ceiling,
- k) Aluminium sheet ceiling,
- m) Expanded polystyrene ceiling, and
- n) Mineral wool board ceiling.

**NOTE** — The fabrication and fixing of timber ceilings are covered in IS : 5390-1984\*.

## **2. TERMINOLOGY**

**2.1 Framework** — Wooden or metal framework consists of longitudinal bearers and cross bearers by means of which the ceiling boards or coverings are supported ( *see* Fig. 1 ).

## **3. NECESSARY INFORMATION**

**3.1** For efficient planning and execution of the work, detailed data and information with regard to the following shall be furnished:

- a) The situation and purpose of providing the ceilings and any special requirements for the ceiling along with detailed drawings of the building;
- b) Area of ceiling to be covered;
- c) Location of lights, fans and apertures for air-conditioning and ventilation, location of skylights, rooflights, etc, in the case of ceilings to sloped or pitched roofs;
- d) Type of framework for supporting the ceiling covering;
- e) Type and size of ceiling boards to be used for covering;

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\*Code of practice for construction of timber ceiling ( *first revision* ).



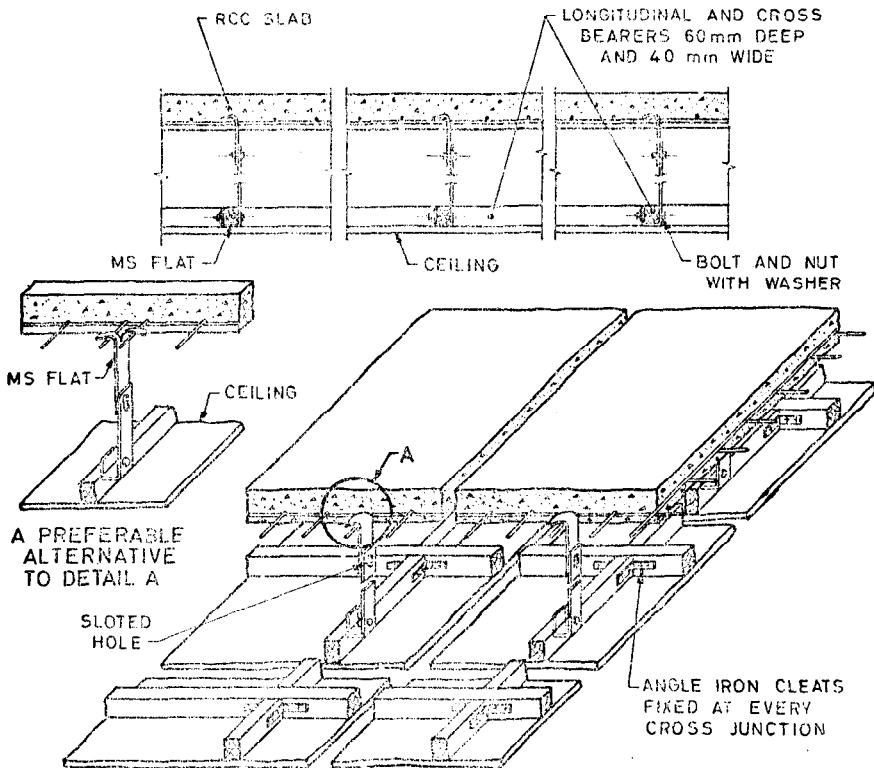


FIG. 1 DETAILS OF CEILING FRAME SUSPENDED FROM RCC SLAB

- f) Matching treatment at the junction of the ceiling with the wall or wall covering and at corners of ceiling and wall, matching treatment at the points of fixing of ceiling lights, fans, etc;
- g) Type of finishing treatment to be applied on the ceiling covering, if any; and
- h) Type of joints in the ceiling covering and type of beading, if any, to be used.

**3.2** All information as in 3.1 shall be made available to those who are responsible for fixing the ceiling coverings. Necessary drawings and instructions for preparatory work shall be made available.

**3.3** The work shall be properly planned and co-ordinated with those who are responsible for electrification, air-conditioning, fitting and fixing of telephone lines, etc. The entire ceiling covering work shall be

executed simultaneously in proper sequence and in order to avoid any dismantling subsequently after fixing of ceiling covering and finishing.

**3.4** The sequence of work shall be planned and properly organized, so that after commencement the ceiling work progresses in a smooth manner without any hindrance, delay or bottleneck at any stage till finishing is given.

#### **4. DESIGN CONSIDERATIONS**

**4.1 General** — The function of ceiling may be manifold, as for example concealing roof framework, beams, air-conditioning ducts, and electrical wiring, providing sound insulation and aesthetic requirements. For design of the ceiling the following considerations shall be generally necessary:

- a) Strength, stiffness and dimensional stability, choice of nails and screws, battening, beading, method of fixing, etc;
- b) Durability and vermin protection ( *see* IS : 401-1982\* );
- c) Moisture resistance;
- d) Acoustic properties ( *see* IS : 1950-1962† );
- e) Heat insulation ( for thermal insulation properties of different types of boards for ceiling coverings, reference may be made to IS : 1414-1962‡ );
- f) Fire protection ( *see* IS : 1642-1960§ );
- g) Vapour permeability; and
- h) Illumination considerations.

**4.1.1** The fixing of the ceiling coverings shall reasonably permit adjustments for thermal expansion and moisture movements of the coverings. The coverings shall be free from cracks, bending or distortion. From practical considerations it is advisable to provide easily removable ceiling covering at suitable locations for periodical inspection to assess the condition of wooden frames, strap hangers, screws, etc.

**4.1.2** When using special types of sound insulation boards, the manufacturer's instructions regarding selection and fixing shall be followed.

**4.1.3** The screws and nails shall be rustless. These shall conform to relevant Indian Standards and in addition shall be coated wherever specified in relevant clauses.

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\*Code of practice for preservation of timber ( *third revision* ).

†Code of practice for sound insulation of non-industrial buildings.

‡Code of practice for fixing wall coverings.

§Code of practice for fire safety of buildings ( *general* ); Materials and details of construction.

## 4.2 Frame Strength and Stability

**4.2.1** The frame to support the ceiling shall be designed for structural strength and stability taking into consideration the spacing of truss members and the sizes, weight and strength of ceiling coverings to be fixed. Structural design of timber members of frame shall be in accordance with IS : 883-1970\*.

**4.2.2** Generally false ceiling to RCC slabs may be provided to cover projecting beams, frames and slabs at different levels, and also service lines and installations.

NOTE — In public halls where RCC slabs are not provided in one level, use of false ceiling shall achieve better finish, acoustic and thermal insulation, concealed lighting, etc.

**4.2.3** The suspenders used for supporting framework for false ceiling to RCC slabs shall be of length sufficient to reach the ceiling frame; it shall be anchored adequately to structural concrete above so as to obtain the required support for the ceiling ( see Fig. 2 ).

**4.2.4** Where the members of ceiling framework span more than 900 mm centre-to-centre additional cross battens shall be provided to stiffen them.

**4.2.5** Ceiling boards whose mass is not more than 5 kg/m<sup>2</sup>, may be fixed directly to RCC slabs by means of fixing plugs, bolts or other suitable devices.

**4.2.6** Where double ceiling boards are provided, such as in air-conditioning installations and in cold storage rooms, the first layer of ceiling board may be fixed to the ceiling with plugs or other fixing devices ( see IS : 1946-1961† ) in the concrete slabs at required spacings.

**4.3 Mass** — For different types of ceiling the mass shall be as given in IS : 1911-1967‡.

## 5. FIXING OF COVERINGS

### 5.1 Insulating Building Board

#### 5.1.1 Materials

**5.1.1.1 Timber** — Timber for making ceiling framework and beading shall be from any of the species of timber given in IS : 3629-1966§.

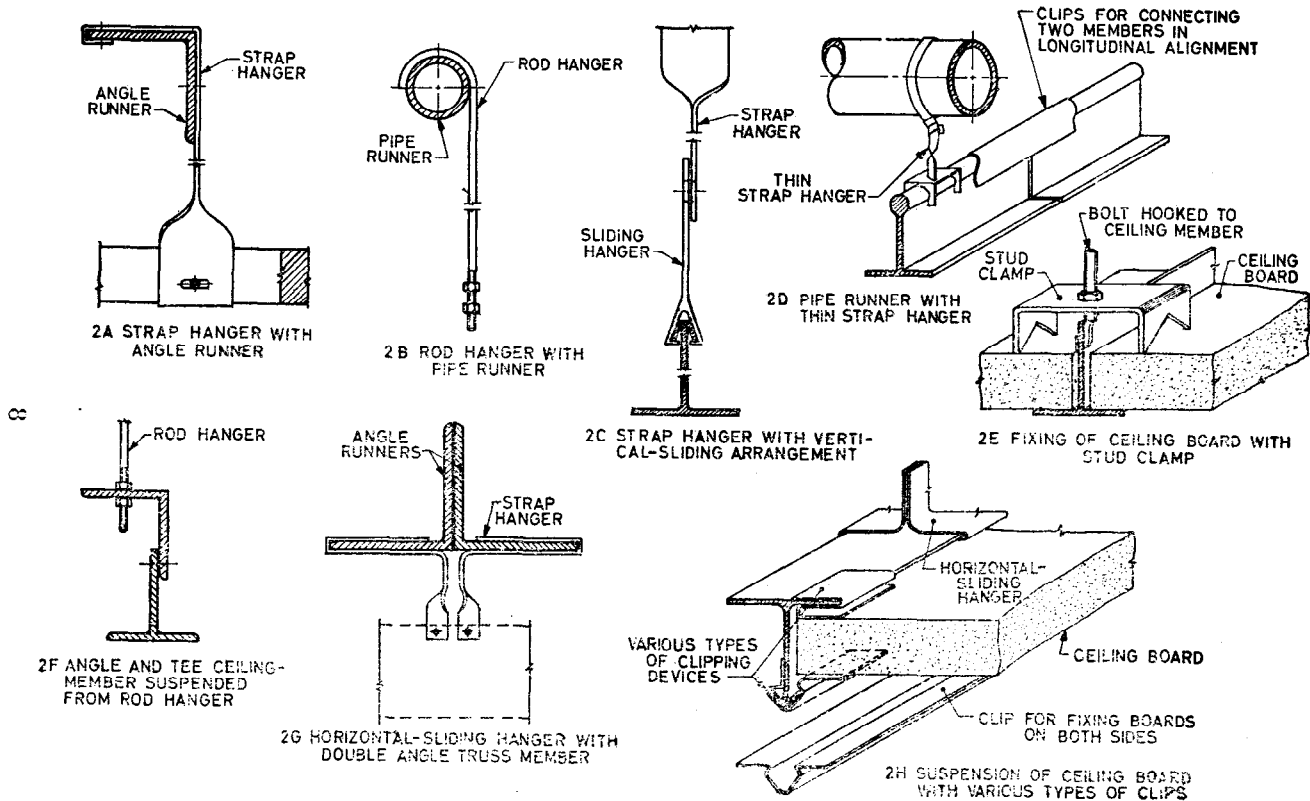
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\*Code of practice for design of structural timber in buildings ( *third revision* ).

†Code of practice for use of fixing devices in walls, ceilings and floors of solid construction.

‡Schedule of unit weights of building materials ( *first revision* ).

§Specification for structural timber in buildings.



Different methods of attachment of hangers to Top Members are illustrated in 2A, 2B, 2D and 2G, and to Ceiling Frames are illustrated in 2A, 2C, 2D, 2F and 2G.

Use of clips, studs and hooks for fixing boards are illustrated in 2H and 2E.

FIG. 2 DETAILS SHOWING SOME TYPICAL METHODS OF SUSPENSION OF CEILING FRAME FROM STRUCTURAL MEMBERS

**5.1.1.2 Insulating building boards** — This may be particle boards conforming to IS : 3129-1965\* or fibre insulating boards conforming to IS : 3348-1965†.

**5.1.1.3 Nails** — Nails shall conform to IS : 723-1972‡. The length of nails shall generally be equal to the thickness of the board plus 25 mm so that their grip on the frame scantling will not be less than 25 mm.

Galvanized lost head nails of diameter 2.80 mm conforming to IS : 6738-1972§ may be used when joints are left exposed. Where joints are to be covered with beading, galvanized felt nails of 2.50 mm diameter conforming to IS : 6730-1972|| may be used.

**5.1.1.4 Screws** — If screws are used, they shall conform to IS : 6760-1972¶ wood screws.

## 5.1.2 Handling

**5.1.2.1** Boards shall be carefully handled, stored and conditioned before use. The following precautions shall be taken:

- a) When transporting or stacking at site, the boards should be laid flat on an even foundation of battens and covered with tarpaulins to prevent damage by changing weather conditions, soiling by earth, mortar, concrete or other rubbish and damage to edges and cracking.
- b) When handling boards shall be carried on edge and not flat, to prevent buckling and cracking.
- c) Before use, the boards shall be conditioned to the humidity of the atmosphere by stacking them loosely on edge for a period of 24 to 48 h so that air can have free access to both sides of each sheet during that period.

## 5.1.3 Fixing

**5.1.3.1 Cutting boards to required size** — The boards shall be cut to the required size to conform to the pattern of panelling as shown in the detailed drawings and each panel shall be in one whole piece. The cutting shall be done with a carpenter's panel saw with fine teeth. The boards should be sawn with the face side up. By placing a strip of waste under the sheet and sawing through both the layers simultaneously a fine and even edge can be obtained. Unless specially mentioned joints

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\*Specification for particle board for insulation purposes.

†Specification for fibre insulating boards.

‡Specification for steel countersunk head wire nails (*first revision*).

§Specification for panel pins and lost head nails.

||Specification for felt nails.

¶Specification for slotted countersunk wood screws.

in the boards shall be with square or slightly bullnosed edges. The edge shall then be lightly sandpapered to make them smooth.

**5.1.3.2 Timber frame** — Timber frame shall be fixed by the method described in 5.2.3. Aluminium frame may also be used in place of timber frame work.

**5.1.3.3 Fixing of insulating building boards ceiling framework** — Building boards shall be fixed with lengths parallel to all joints centred over the the framing members. Where joints are to be covered, the boards shall be spaced 3 to 6 mm apart. 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 grounds with timber pieces the latter being moved outwards as the nailing proceeds. The boards are first nailed to intermediate framing member proceeding from the centre of the board outwards, the edges being nailed last.

**5.1.3.4** Where joints are to be left exposed, the outer rows of nails shall be placed at 100 mm centres and about 12 mm from edge of the sheet. The rows in the middle of the sheet shall be placed 200 mm apart. Nails in the outer rows on either side of joint shall be paired and not staggered. Nails shall be countersunk in the underside of the board with a suitable punch. Care shall be taken in driving the nails so that the sheets are not marked by hammer blows.

**5.1.3.5** Where joints are to be covered with beadings, felt nails shall be used instead of lost head nails. The spacing of the nails in the interior rows in boards shall be the same as in 5.1.3.4. In the outer rows at edges to be covered by beadings, the nails shall be spaced at 200 mm centres in each row but with the nails staggered. The beadings shall then be fixed over the sheets with screws at 200 mm centres in each row with screws in two rows staggered and passing through beading, sheet and framing, so that ultimately the facing of the fixing ( nails and screws taken together ) in each row shall be 100 mm centres so far as the sheets and frames are concerned.

#### **5.1.4 Finishing**

**5.1.4.1** The exposed side of the board 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 the colour of the boards is not spoilt during the fixing operations.

Where the joints are required to be covered, beading shall be fixed as in 5.8. The ceiling shall be treated as required with suitable finishing materials.



## 5.2 Hard Board

### 5.2.1 Materials

**5.2.1.1 Timber** — The timber for making ceiling framework and beading shall be from any of the species of timber given in IS : 5390-1984\*.

**5.2.1.2 Hard Board** — Medium type hard board conforming to IS : 1658-1966† shall be used for ceiling purposes.

**5.2.1.3 Nails** — The nails shall conform to IS : 723-1972‡.

**5.2.1.4 Screws** — The screws shall conform to IS : 6760-1972§.

### 5.2.2 Handling

**5.2.2.1** Hard board shall be handled in the same manner as for the insulating building boards described in 5.1.2. The conditioning of the hard board sheets before use shall be done in the manner described in 5.2.2.2.

**5.2.2.2** The sheets shall be damped with water on the textured face before they are fixed. This shall be done by brushing the textured face evenly and carefully with a sponge or swab soaked in water. After this the sheets shall be stacked with the damped sides against each other in pairs and left to remain for a period of 24 to 48 hours. During this conditioning, the sheets should be sheltered from sun and strong heat.

### 5.2.3 Fixing

**5.2.3.1 Framework** — The longitudinal battens and cross battens supporting the ceiling shall be spaced according to the size of the boards to be fixed.

**5.2.3.2** The size of battens may range from 60 to 75 mm × 50 mm and the spacing may range from 450 to 600 mm for longitudinal battens and 600 to 1 200 mm for cross-battens depending on the size of the boards. The battens shall be treated with two coats of preservative paint preferably odourless before the ceiling is fixed. The preservative shall be allowed to dry up before fixing sheets.

NOTE — Treatment with two coats of preservatives is a temporary measure reference shall be made to IS : 401-1982|| for details.

\*Code of practice for construction of timber ceilings ( *first revision* ).

†Specification for fibre hard board ( *revised* ).

‡Specification for steel countersunk head wire nails ( *first revision* ).

§Specification for slotted countersunk head screws.

||Code of practice for preservation of timber ( *second revision* ).

**5.2.3.3** All edges of the hard board shall be fixed to the frame battens by means of screws. Along the edge line of the board the screws shall be at a spacing of 75 mm centre to centre and shall have a clearance of at least 10 mm from the edge line. Along the lines of intermediate supports, the screws may be spaced at 150 to 200 mm centre to centre. All the screws shall be countersunk.

**5.2.3.4** Screws shall be rustless. The steel screws if used, shall be coated with either brass, nickel or cadmium. The length of the screws shall be 25 mm for 3 to 6 mm thick board and 30 or 35 mm for 8 to 12 mm thick board.

**5.2.3.5** The cutting and chamfering of the sheets shall be done in the same manner as for insulating building boards described in **5.1.3**.

**5.2.3.6** *Jointing* — Joints shall not be normally filled with plaster, but where the hard boards are to be cement plastered the joints shall be left with gap of about 6 mm which shall be covered with scrim and bedded in cement plaster before the finishing coat of plaster is applied.

**5.2.3.7** If the hard board specially moulded on the edges are used, the manufacturer's instructions for cutting at site shall be followed.

**5.2.3.8** In the case of rebated edges, screwing shall not be done through the rebates.

**5.2.3.9** Open joints may be covered with strips of various materials such as the following:

- a) Wooden beading as described in **5.8**;
- b) Plain strips cut from sheets of the same material as the boards or mouldings of hard boards separately procured for use as cover strips, or special types of moulded cover strips supplied by the manufacturer;
- c) Metal cover strips such as aluminium or chromium plated metal;
- d) Shaped plastic strip; and
- e) Linen backed adhesive strip.

Cover strips shall be screwed along the centre line of the joints, so that the fixing of screws pass through the open joints. The spacing of screws shall be at least 150 to 200 mm centre to centre. Special type of cover strip of hard board, metal, plastic, etc, may be fixed in accordance with the manufacturer's instructions.

Linen-backed adhesive may be fixed by wetting the linen and pressing over the edges of the boards.

**5.2.4** *Finishing* — Details of work shall be same as given in **5.1.4**.

### 5.3 Plaster of Paris

#### 5.3.1 Material

**5.3.1.1 Timber** — Timber for making ceiling framework, wooden strips of laths shall be from any of the species of timber given in IS : 5390-1984\*.

**5.3.1.2 Plaster of paris** — Plaster of paris shall conform to IS : 2547-1976†.

#### 5.3.2 Fixing

**5.3.2.1 Frame** — In case of sloping roofs, wooden battens of suitable section ( at least 50 mm × 60 mm ) shall be firmly fixed as main supports, to the underside of the beams of the trusses at required centres by means of bolts and nuts of proper size.

In case of flat roofs, battens shall be securely fixed to the walls and pillars by holding down bolts and shall be fastened to the slabs above with iron straps or mild steel bars of suitable sections anchored therein. Cross battens of 50 mm × 40 mm section at about 400 mm centres shall then be fixed at right angles to the main battens. The framework shall be treated with suitable wood preservatives before it is covered with ceiling. The underside of the framework shall be true to planes and slopes.

Aluminium frame may also be used if specified in the item of work.

**5.3.2.2 Wooden strips or laths** — Wooden strips or laths 25 mm × 6 mm of first class kail wood ( unless otherwise stipulated specifically in the description of the item ), shall be fixed to the cross battens, in parallel rows with gaps of 10 mm in between adjacent rows, by means of felt nails as per IS : 6730-1972‡. The strips shall be fixed butt jointed and not overlapped. The joints shall be staggered. The minimum length of strips to be used shall be 1.5 m depending upon the length of strips required.

**5.3.2.3 Rabbit wire mesh** — The mesh shall be fixed with nails at pitch of 150 to 200 mm to the underside of wooden strips at their junction with the battens. The wire mesh shall be straight, tight and perfectly true to planes and slopes and without any sagging, and shall be slightly below the underside of the laths to allow the plaster to encase the mesh around.

**5.3.2.4 Application of plaster of paris** — The plaster of paris shall be mixed with water to a workable consistency. The plaster of paris shall be applied to the underside of the laths over the rabbit wire mesh in

\*Code of practice for construction of timber ceilings ( first revision ).

†Specification for gypsum building plaster.

‡Specification for felt nails.

suitable sized panels and finished to a smooth surface by steel trowels. The plaster shall be applied in such a manner that it fully fills the gaps between the laths. The thickness over the laths is as specified in the description of the item. Joints shall be finished flush to make ceiling in one piece. Finished surface shall be smooth and true to plane, slopes or curves as required.

**5.3.2.5 Thickness** — The thickness of the plaster of paris ceiling shall not be less than 12 mm.

## **5.4 Plaster of Paris Tiles**

### **5.4.1 Materials**

**5.4.1.1 Timber** — Timber for making ceiling framework, shall be from any of the species of timber given in IS : 5390-1984\*.

**5.4.1.2 Plaster of paris** — This shall conform to IS : 2547-1976†. The thickness of the plaster of paris tiles shall not be less than 12 mm.

**5.4.1.3 Hessian cloth** — This shall conform to IS : 2818 ( Part 1 )-1971‡. The hessian cloth shall be of an open webbed texture.

### **5.4.2 Preparation**

**5.4.2.1 Tiles of plaster of paris reinforced with hessian cloth** shall be prepared to the required size. The maximum sizes of tiles shall be limited to 750 mm in each direction and thickness shall be 12 mm. Wooden forms of height equal to the thickness of tiles ( 12 mm ) shall be placed on a truly level and smooth surface such as a glass sheet.

The section of form sides shall be such that the edges of the tiles shall be provided with a neatly formed chamfer around of 5 mm width and 8 mm depth, unless the tiles are to be provided with cover fillets over joints in which case the edges of the tiles shall be truly square. The glass sheet or surface on which the form is kept and the forms sides shall be given a thin coat of non-staining oil to facilitate easy removal of the tile. Plaster of paris shall be evenly spread into the form up to about half of the depth and hessian cloth shall be pressed over the plaster of paris layer. The ends of the hessian shall be turned over at all edges to form a double layer to a width of 50 mm. The plaster below and above the hessian cloth shall intermix with each other and form an integral mass. The form shall then be filled with plaster of paris which shall be uniformly pressed and then wired out to an even and smooth surface. Tiles so moulded shall be allowed to set initially for an hour and then removed from the form and allowed to dry and harden for about a

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\*Code of practice for construction of timber ceilings ( *first revision* ).

†Specification for gypsum building plaster.

‡Specification for Indian hessian: Part 1 General ( *first revision* ).

week. A good tile after drying and hardening shall give a ringing sound when struck. The tiles shall be true and exact to shape and size and with clean and regular chamfers. The exposed faces shall be truly plane and smooth.

#### 5.4.3 Fixing

**5.4.3.1 Frame** — The timber frame shall be provided as described in 5.2.3. The width of the scantlings shall be sufficient to provide a minimum nailing surface of 60 mm. The longitudinal and header scantlings shall be so arranged that the tiles can be fixed to form the desired panel arrangement and there is supporting scantling under each and every edge of the tiles. Aluminium frame may also be used in this type of ceilings.

**5.4.3.2 Fixing** — The tiles shall be fixed to the cross battens of the ceiling frame with 40 mm long brass screws as in IS : 6760-1972\* at spacings not exceeding 200 mm centre to centre on all edges. The tiles shall be laid with their edges in just close position to the adjoining tiles without any gap in between. The line of screws shall be not less than 15 mm away from the edge of the tiles. The screws shall be slightly countersunk in holes of tiles. Holes for screws shall be drilled. The countersunk heads of screws shall be covered with plaster of paris and smoothly finished.

Where a surface unbroken by visible joints is required, the joints shall be filled with plaster of paris and trowelled smooth so that the whole surface appears as one without any joints.

### 5.5 Gypsum Plaster Board

#### 5.5.1 Materials

**5.5.1.1 Gypsum plaster boards** — Gypsum plaster boards shall conform to IS : 2095-1964†.

**5.5.1.2 Nails** — Nails shall conform to IS : 723-1972‡. The nails used for taking gypsum boards shall be 2·00 mm size. The length of nails shall be as follows:

- |                                    |       |
|------------------------------------|-------|
| a) for 10 mm thick boards          | 30 mm |
| b) for 12·5 and 16 mm thick boards | 40 mm |

**5.5.1.3 Screws** — Screws used for fixing gypsum boards shall conform to IS : 6760-1972§. Steel screws without brass or nickel coating shall not be used.

\*Specification for slotted countersunk head wood screws.

†Specification for gypsum plaster boards.

‡Specification for steel countersunk head wire nails ( *first revision* ).

§Specification for slotted countersunk head wood screws.

The size of the screws shall be 3.10 or 3.45 mm diameter and the length as follows:

- |                                    |             |
|------------------------------------|-------------|
| a) for 10 mm thick boards          | 30 mm       |
| b) for 12.5 and 16 mm thick boards | 35 or 40 mm |

### 5.5.2 Fixing

**5.5.2.1 Fixing of gypsum plaster boards to framework** — The gypsum plaster boards shall be fixed as given in 5.2.3.

**5.5.2.2 Jointing** — The boards shall be fixed with a joint with clearance of about 6 mm. The joints shall always be in perfect line and plane. Jointing may also be provided in a decorative pattern.

**5.5.2.3 Finishing of joints** — The joints shall be filled with gypsum plaster or other finishing materials recommended by the manufacturers of the board. After filling the joints, a thick skin of the finishing material shall be spread about 50 mm wide on either side of the joint and shall be trowelled dry with a reinforcing scrim cloth about, 100 mm wide. When metal scrim is used, a stiffer plaster may be necessary to enable the trowelling of the scrim down to the board. The joints may also be left open if desired ( see Fig. 3 ).

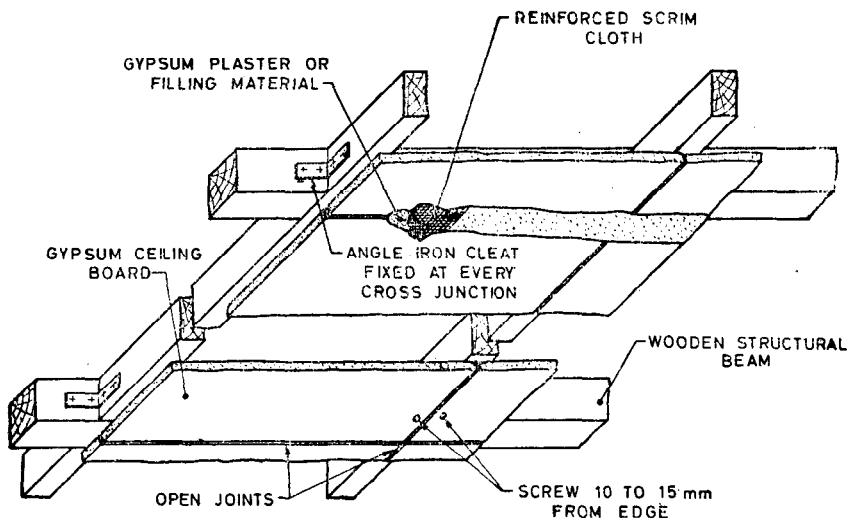


FIG. 3 FINISHING TREATMENT FOR JOINTS IN GYPSUM BOARD CEILING



## 5.6 Plywood and Blockboard

### 5.6.1 Materials

**5.6.1.1 Timber** — Timber for making ceiling framework shall be from any of the species of timber given in IS : 5390-1984\*.

**5.6.1.2 Plywood** — Plywood shall conform to IS : 303-1975†.

**5.6.1.3 Blockboard** — Blockboard shall conform to IS : 1659-1969‡.

**5.6.1.4 Screws** — The screws shall conform to IS : 6760-1972§.

### 5.6.2 Fixing

**5.6.2.1 Framework** — Longitudinal battens and cross battens supporting the ceiling shall be spaced in section as detailed, taking into consideration the size and shape of the board, thickness of the board, including its strength and weight, the pattern of the figure and grain matching in the case of decorative boards. The sizes of battens may range from 60 to 75 mm × 40 to 50 mm.

**5.6.2.2** For boards in thickness 4 mm to 10 mm, spacings vary from 450 to 600 mm for longitudinal battens and 600 to 1 200 mm for cross battens. For boards above 10 mm thickness, the above spacings may vary from 600 to 900 mm for longitudinal battens from 900 to 1 300 mm for cross battens.

**5.6.2.3** After fixing, the framework shall be checked with regard to the level position of its outside and for proper fixture and joints.

### 5.6.2.4 Fixing

**5.6.2.5** The plywood or blockboard shall be checked for correct size, squareness of adjacent sides and laying patterns. In the case of decorative boards, the patterns and figure matching should be as per details and put on paper at site and the boards preferably numbered for their positions. Any board so required shall be cut to the required plan.

**5.6.2.6** Where necessary, particularly, when it is not sufficient thick to be self-supporting from edge to edge, plywood may be stiffened along the edges and also in intermediate positions by stiles or narrow strips of wood, metal, plastic or other materials.

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\*Code of practice for construction of timber ceilings ( *first revision* ).

†Specification for plywood for general purposes ( *second revision* ).

‡Specification for blockboards ( *first revision* ).

§Specification for slotted countersunk head wood screws.

**5.6.2.7** The boards shall be carefully lifted in a predetermined manner and fixed on to the frame by use of wood screws. All the edges shall be fixed to the frame members by screws spaced 75 mm centre to centre for 4 to 6 mm thick plywood; for thicker boards the centre to centre spacing of these screws may be at about 15 times the thickness. The screws shall have a clearance of 10 mm from the edge line. At the lines of intermediate support, the screws shall be fixed at centre to centre spacing not exceeding 25 times the thickness. All the screws shall be countersunk.

**5.6.2.8** The screws shall be rustless. The screws shall be fixed starting from one corner and extending to both sides to fix the board flat and level. The length of the screws shall be as follows:

- |                                      |                   |
|--------------------------------------|-------------------|
| a) for boards up to 7 mm             | 25 mm             |
| b) for boards above 7 mm up to 12 mm | 35 mm             |
| c) for boards above 12 mm            | Thickness + 20 mm |

**5.6.2.9** *Jointing*

**5.6.2.10** The boards may be butt jointed with a minimum clearance of 2 mm.

**5.6.2.11** The joints, if left open, shall be filled with painter's putty and brought to level or may be cut to 'V' shape. These may also be left open levelled or parallel grooved using plane and a chisel or grooving cutter. The boards may also be pre-cut and edges rounded before fixing. In the case of decorative boards, the joints may be coloured to match the general colour and pattern of the ceiling boards.

**5.6.2.12** The joints may also be rebate-jointed or jointed with tongue and groove. Screws shall in that case not be fixed through the rebate.

**5.6.2.13** Alternatively, the open joints may be covered by a moulding or strips.

**5.6.2.14** When fixing moulding in case of decorative boards, care shall be taken that their colour, shape and size are selected appropriate to the decorative pattern of the ceiling.

**5.6.3** *Finish*

**5.6.3.1** The ceiling after fixing shall be finished by hand-sanding, where necessary, and given finishes of waxing, polishing, clear varnishing or painting as required. Finishing of wooden surfaces shall be done in accordance with IS : 2338 ( Part 1 )-1967\*.

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\*Code of practice for finishing of wood and wood based material: Part 1 Operations and workmanship.

## 5.7 Asbestos Cement Building Board

### 5.7.1 Materials

**5.7.1.1 Timber** — Timber for making ceiling framework shall be from any of the species of timber given in IS : 5390-1984\*.

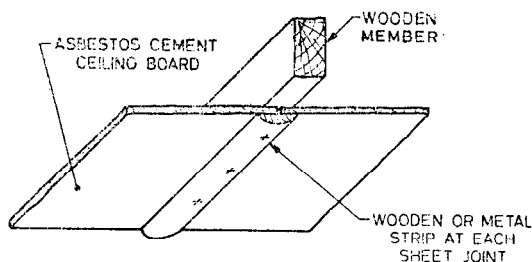
**5.7.1.2 Asbestos cement building board** — This shall conform to IS : 2098-1964†.

**5.7.1.3 Screws** — The screws shall conform to IS : 6760-1972‡.

### 5.7.2 Fixing

**5.7.2.1 Framework** — This shall be as per details given in 5.2.3.

**5.7.2.2 Fixing** — The asbestos cement building boards shall be laid truly parallel or perpendicular to the walls and shall be fixed to the battens with screws. In fixing the A.C. boards care shall be taken to avoid rigid fixing as this may cause cracking if the supporting structure expands or shrinks. The boards shall be fixed with screws to the wooden frame by means of metal channels and clips as shown in Fig. 4. Holes in the boards shall be drilled as on no account be punched. No hole shall be nearer than 12 mm to the edge of the sheet. The board shall be butt jointed with screws at 150 mm intervals at edges and 300 mm intervals in the middle. Screws shall be countersunk and covered by plaster of paris. A gap of 3 to 6 mm shall be kept between the adjoining edges of the sheets. The joints where required may be covered with wooden beading as described in 5.8.1.3 or with plain strips out from the sheets of the same material.



NOTE — For fixing with metal section and clips, reference may be made to Fig. 2G.

FIG. 4 FIXING ASBESTOS CEMENT CEILING BOARDS TO WOODEN MEMBERS

\*Code of practice for construction of timber ceilings (first revision).

†Specification for asbestos cement building boards.

‡Specification for slotted countersunk head wood screws.

### **5.7.3 Finish**

**5.7.3.1** The ceiling, when completed, shall present a neat and uniform appearance. Care shall be taken to see that the asbestos cement boards are not dirted during construction. Usually no finishing treatment of asbestos cement building board ceiling is needed. Ceiling may, if required, be painted to the desired shade.

## **5.8 Wooden Cover Fillets Beading**

### **5.8.1 Materials**

**5.8.1.1 Timber** — Timber used for making beading shall be from any one of the species listed in IS : 5390-1984\*.

**5.8.1.2 Screws** — These shall conform to IS : 6760-1972†.

**5.8.1.3 Beading** — The beading shall be planed, smooth over all exposed faces and true on the rear face. The beading shall be of size 12 mm × 40 mm or of any other size as given in the description of the item.

### **5.8.2 Fixing**

**5.8.2.1** The beadings shall be fixed centrally over the butt joints between the two timber planks or boards with screws in two rows on either side of the joint. The spacing of the screws in each row shall be 200 mm centres. The screws shall pass through the beading, timber plank or ceiling board and into the ceiling rafters, with a minimum grip of 25 mm in the latter and where the beading is to be fixed to the board above for ornamental purposes there being no framework scantling above, then the beading shall be fixed with screws which shall be driven through the full depth of the board and their spacing shall be the same as before. The screws shall be oiled before insertion and shall be screwed in by means of a screw driver and in no case the use of a hammer for fixing the screws is permissible. The screws shall be driven slightly countersunk below the surface of the beading.

**5.8.2.2** The junction of the beading shall be of the fully mitred or of partly mitred kind as required by the authority. Where joints are to be fully mitred both the longitudinal as well as cross beadings shall be to the exact length as required by the panel arrangements. Where the joints are partly mitred variety and the length of the beading in one direction can run continuously over more than one panel then the minimum lengths of these beadings shall be 1'80 m and the joints shall come at a corner of the panel and not in the middle of the panel side.

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\*Code of practice for construction of timber ceilings (*first revision*).

†Specification for slotted countersunk head wood screws.

### 5.8.3 *Finish*

**5.8.3.1** The beading shall be finished smooth and fixed with such a workmanship that there is absolutely no gap left between the beading and the ceiling board or in the joint faces. The beading lines shall be absolutely straight and parallel. The plane of the underside of the beading shall be uniform.

## 5.9 *Cloth*

### 5.9.1 *Material*

**5.9.1.1 *Timber*** — Timber for making ceiling framework and beading shall be from any of the species given in IS : 5390-1984\*.

**5.9.1.2 *Bamboo*** — Good quality bamboo shall be used for framework. The quality of bamboo to be used for the framework shall be approved before using for the work.

### 5.9.1.3 *Cloth*

**5.9.1.4** The selection of cloth for the ceiling depends on the following factors:

- a) External characteristics,
- b) Colour,
- c) Acoustics properties,
- d) Fire resistance and moisture resistance,
- e) Method of construction, and
- f) Cost.

In general, any type of cloth (thicker cloth) can be used as a ceiling material, depending upon the function and appearance desired in the room. The cloth for ceiling can be manufactured from either natural fibres or synthetic fibres. For knowing the exact properties of the cloth to be used as ceiling material, textile expert shall be consulted.

**5.9.1.5 *Cloth*** — Dungry cloth conforming to IS : 749-1978† shall be used. If canvas or any mill made white drill is used in place of dungry cloth, it shall be specified. The cloth shall be thoroughly washed before use to free it from chemicals, otherwise after being whitened it may turn black.

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\*Code of practice for construction of timber ceilings (*first revision*).

†Specification for handloom cotton dungry cloth (*first revision*).

**5.9.1.6 *Type of fibres:***

**a) Natural fibres**

- 1) Cotton
- 2) Linen
- 3) Silk and wool

**b) Man-made fibres or synthetic fibres**

- 1) Rayon or artificial silk,
- 2) Glass fibres,
- 3) Nylon,
- 4) Decron,
- 5) Orlon or the fibres approved by competent authority.

**5.9.1.7 *Scantlings or framework*** — The scantlings for the framework shall be of 75 mm × 65 mm size, unless otherwise specified. They shall have a perfectly straight edge and face to which the cloth will be attached. Other sides may be left rough.

**5.9.1.8 *Beading*** — Wooden beadings shall be of size 12 mm × 40 mm or of any other size as given in description of the item and shall be plained round-edged.

**5.9.1.9 *Nails*** — Nails shall conform to IS : 723-1972\*.

**5.9.1.10 *Screws*** — Screws shall conform to IS : 6760-1972†.

**5.9.2 *Fixing***

**5.9.2.1 *Framework*** — The framework of wood bamboo battens shall be securely spiked to the wall plaster or fixed to wooden blocks let into the walls and firmly screwed to the underside of the beams or to ceiling joists where joists are used. The battens shall form square or oblong panels not more than 1.5 m in length on any side.

**5.9.2.2** When the framework is bamboo neat, even width and sand prepare, split bamboo battens shall be securely nailed to the joists, to make the same size panels.

**5.9.2.3 *Fixing*** — The cloth shall be damped, stretched and nailed to the upper side of the framework which shall be planned and varnished. In the case of bamboo framework, cloth shall be tied up to the under-side neatly by strong string without tearing the cloth.

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\*Specification for steel countersunk head wire nails (*first revision*).

†Specification for slotted countersunk head wood screws.



**5.9.2.4 Beading** — To prevent the cloth from blowing and flapping about, wooden beadings, planed and moulded shall be fixed under the cloth ceiling to form panels. The beadings shall be screwed over the cloth to the framework above to panels and all round the wall with screw not further apart than 150 mm. The wooden beadings shall be varnished.

**5.9.2.5 Finish** — The cloth shall be white-washed or distempered.

## **5.10 Aluminium Sheet**

### **5.10.1 Materials**

**5.10.1.1 Aluminium trays** — The ceiling may be made up of aluminium 'T' grid and aluminium trays made of aluminium alloy sheets of 19 000 or 31 000 of IS : 737-1974\*. For insulation and acoustic control, the trays perforated or plain are filled with either glass wool or mineral wool blanket of 20 to 40 mm thickness depending on the job requirement.

**5.10.1.2 Grid** — The aluminium grid, concealed or exposed shall be made of specifically extruded aluminium 'T' section of 63 400 Wp of IS : 733-1975†. The fittings will be made out of aluminium or rust proofed steel.

### **5.10.2 Fixing**

**5.10.2.1 Exposed grid system** — In this case, the panels shall be placed on the aluminium false ceiling grid of inverted 'T'.

**5.10.2.2 Concealed grid system** — The panels shall be clipped by means of fine plated spring clips on aluminium 'T' grid.

### **5.10.3 Finish**

**5.10.3.1 Aluminium false ceiling trays** supplied in painted or anodised or mill finish with 'T' grid shall match the back ground.

**5.10.3.2 Painted finish** — The trays and 'T' are chemically treated and painted with acrylic resin paint which does not attract fungus and does not discolour.

**5.10.3.3 Natural satin anodised finish** — The trays and Ts shall be chemically cleaned, treated and anodised in controlled conditions to the required specifications. The specific grade suitable for this purpose is AC 10 of IS : 1868-1982‡. The anodised surface shall finally be sealed for life-long finish.

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\*Specification for wrought aluminium and aluminium alloys, plate ( for general engineering purposes ) ( *second revision* ).

†Specification for wrought aluminium and aluminium alloy, bars, rods and sections ( for general engineering purposes ) ( *second revision* ).

‡Specification for anodic coatings on aluminium ( *second revision* ).

**5.10.3.4 Mill finish** — This finish is suitable for industrial application.

**5.10.4 Erection** — The aluminium false ceiling trays may be placed in the exposed grid frame or clipped in the concealed grid system. The handing of the main Ts shall be done with sliding hangers and 5 to 6 mm painted mild steel rods or galvanized wires. The grid shall be truly levelled and the joints of the trays made straight and parallel.

## **5.11 Expanded Polystyrene**

### **5.11.1 Material**

**5.11.1.1 Expanded polystyrene** — This shall be in accordance with IS : 4671-1961\*.

**5.11.1.2 Screws** — Screws shall be of brass and shall conform to IS : 6760-1972†.

**5.11.1.3 Framework** — The framework may be wood or metal and in either case it has only its own load to support, the load of expanded polystyrene being negligible. Very light sections, therefore, are sufficient. However, members should be of sufficient depth to ensure that the frame does not sag under its self weight across the given span and width for easy gluing/screwing of tiles.

### **5.11.2 Fixing**

**5.11.2.1 Ceiling layout** — Work shall be started from the centre outward, pushing the small inevitable erection defects to the fringes of the ceiling. Ceiling dimensions shall be measured and width and length of centre lines shall be marked. If a dimension is a full odd multiple of tile size ( that is  $4\ 500\text{ mm} = 9 \times 500\text{ mm}$  ) the starter tile shall be placed with its centre line falling on the dimensions centre lines. If a dimension is a full even multiple of the tile size ( that is  $4\ 000 = 8 \times 500\text{ mm}$  ) the starter tile edge shall be placed along the dimension centre line.

#### **5.11.2.2 Fixing tile**

**5.11.2.3 With adhesive** — The framework should be clean. The framework shall be wiped to remove dust and loose particles clinging to members. Adhesive shall be applied on the annular area of tiles. Wait till adhesive becomes tacky. Tiles shall be fixed in position pressing adjacent tiles close together along their joint.

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\*Specification for expanded polystyrene for thermal insulation purposes.

†Specification for slotted countersunk head wood screws.

**5.11.2.4 With screws** — 35 mm long, No. 6 brass screws at the rate of 4 per 500 mm × 500 mm tile or 6 per 1 000 mm × 500 mm slab shall be used for fixing. Adjacent slabs should be pressed tightly together along their joint.

#### **5.11.2.5 To metal frame**

**5.11.2.6** Slabs/tiles shall be fixed by specially designed cleats/clips, etc, supplied along with the framework.

**5.11.2.7 Precaution** — Care shall be taken to see that the solvents used to clean adhesive applicable tools shall not be brought in contact with expanded polystyrene surfaces.

### **5.11.3 Finish**

**5.11.3.1** The white expanded polystyrene ceiling may be painted to any desired shade with plastic emulsion paints or water bond distemper. Oil paints may be applied over a protective barrier coat of shellac. A smooth jointless finish can be obtained, if required by applying a 3 mm layer of plaster of paris direct on expanded polystyrene surfaces.

## **5.12 Mineral Wool Board**

### **5.12.1 Material**

**5.12.1.1 Timber** — Timber for making ceiling framework and beading if any shall be from any of the species given in IS : 5390-1984\*.

**5.12.1.2 Metal T** — shall conform to relevant Indian Standard.

**5.12.1.3 Nails** — Nails shall conform to IS : 723-1972†.

**5.12.1.4 Screws** — Screws shall conform to IS : 6760-1972‡.

**5.12.1.5 Mineral wool** — This shall conform to IS : 3677-1973§.

### **5.12.2 Fixing**

**5.12.2.1 Application 1** — A metal 'T' bar grid of required size of either aluminium, mild steel or slotted angles shall be suspended first. Mineral wool of specified thickness to the size of the facing board may be cut and spot stuck to fibreglass with suitable adhesive.

**5.12.2.2 Application 2** — Framework of wooden battens shall be suspended as detailed in 5.8.

\*Code of practice for construction of timber ceilings ( first revision ).

†Specification for steel countersunk head wire nails ( first revision ).

‡Specification for slotted countersunk head wood screws.

§Specification for unbonded rock and slay wool for thermal insulation.

Mineral wool about 12 mm less than the size of the facing board and spot stick fibreglass to the board with adhesive.

Fix the board with the insulation over it to the battens by means of screws. If desired and if space permits, mineral wool may be rolled over the suspended false ceiling. Mineral wool may also be cut slightly oversize and friction fitted between the angles or battens from above. In both these cases, the facing board will have to be fixed first.

**5.12.2.3** *Direct under deck insulation of flat concrete roofs* — Wooden battens shall be fixed to the ceiling.

The fixing of mineral wool with a facing board shall be the same as in Application 2.

**5.12.2.4** *Application 3* — Under deck insulation of ceiling, when the false ceiling is being used as a return airplenum.

Slotted angles of size 30 mm × 30 mm shall be fixed to the ceiling by means of raw plugs at 750 mm centres.

Draw 14 g tie wires from the slots.

Make a mat of mineral wool backed with scrim cloth with a light coating of plaster of paris or polythene faced hessian and 24 g × 25 mm mesh wire netting.

Stretch the mat tightly across the angles, holding it in place by means of wires. The joints of the wire netting should be butted and tightly laced down with G.I. wire.

**5.12.2.5** *Application 4* — Mineral wool insulation in under purlin lining.

Metal clips shall be fixed on the purlins and metal or wooden frame of required dimension shall be attached to the clip.

The fixing of mineral wool and facing board is similar as in application 1 and application 2.

**5.12.2.6** *Application 5 Mineral wool insulation in double sheeted asbestos roof* — Wooden battens as spacers shall be fixed over the existing AC sheets. Mineral wool of specified thickness shall be unrolled between these spaces. New layer of asbestos cement sheets shall be attached and bolted tightly. All openings shall be sealed and made water tight.

( Continued from page 2 )

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# INTERNATIONAL SYSTEM OF UNITS ( SI UNITS )

## Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

## Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

## Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s <sup>2</sup>
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m <sup>2</sup>
Frequency	hertz	Hz	1 Hz = 1 c/s (s <sup>-1</sup> )
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m <sup>2</sup>





# INDIAN STANDARDS INSTITUTION

## Headquarters :

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

Telephones : 26 60 21, 27 01 31

Telegrams : Manaksanstha  
( Common to all Offices )

## Regional Offices :

### Telephone

\*Western : Manakalaya, E9 MIDC, Marol, Andheri ( East ), BOMBAY 400093 6 32 92 95

†Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola 36 24 99  
CALCUTTA 700054

Southern : C. I. T. Campus, MADRAS 600113 41 24 42

Northern : B69 Phase VII, Industrial Focal Point, 8 73 28  
S. A. S. NAGAR 160051 ( Punjab )

## Branch Offices :

\*Pushpak, Nurmohamed Shaikh Marg, Khanpur, AHMADABAD 380001 { 2 63 48  
2 63 49

\*F' Block, Unity Bldg, Narasimharaja Square, BANGALORE 560002 22 48 05

Gangotri Complex, Bhadbhada Road, T. T. Nagar, BHOPAL 462003 6 27 16

22E Kalpana Area, BHUBANESHWAR 751014 5 36 27

5-8-56C L. N. Gupta Marg, HYDERABAD 500001 22 10 83

R14 Yudhister Marg, C Scheme, JAIPUR 302005 6 98 32

117/418 B Sarvodaya Nagar, KANPUR 208005 4 72 92

Patliputra Industrial Estate, PATNA 800013 6 23 05

Hantex Bldg ( 2nd Floor ), Rly Station Road, TRIVANDRUM 695001 32 27

## Inspection Office ( With Sale Point ) :

Institution of Engineers ( India ) Building, 1332 Shlvaji Nagar, PUNE 410005 5 24 35

\*Sales Office in Bombay is at Novelty Chambers, Grant Road, 89 65 28  
Bombay 400007

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