IS 2858 (1984): Code of practice for roofing with mangalore tiles [CED 13: Building Construction Practices including Painting, Varnishing and Allied Finishing]

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Indian Standard

CODE OF PRACTICE FOR ROOFING WITH MANGALORE TILES

(First Revision)

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

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Indian Standard

CODE OF PRACTICE FOR ROOFING WITH MANGALORE TILES

(First Revision)

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Indian Standard

CODE OF PRACTICE FOR ROOFING WITH MANGALORE TILES

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 28 September 1984, after the draft finalized by the Building Construction Practices Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Mangalore tiles are machine made burnt-clay tiles widely used for roofing work in this country. Its design incorporates corrugation for drainage and also an efficient interlocking system between the tiles enabling them when laid to form a leak-proof layer. Depending upon the degree of protection needed from the roof, Mangalore tiles may be laid as such or with an under-layer of flat tiles or ceiling tiles, etc. A specific advantage of a tiled roof is the case of maintenance since any broken tiles can be easily replaced without much disturbance to the roofing as a whole. The design of the Mangalore tile takes into account this aspect and the tile as laid on the roof will be able to carry the weight of a man it is called upon to support during such repair. Though originally produced in areas near Mangalore, this tile is now manufactured and used in many parts of this country. For efficient performance of Mangalore tiled roof there are several design and constructional details one should take care of during laying the roof. This code is intended to provide guidance with regard to all these details.

0.3 This standard was published in 1964. The revision has been undertaken to incorporate the necessary modifications as a result of experience gained during the use of this standard. The modifications include additional requirements for ventilating tiles and in requirements for fixing of valley gutter.

0.4 The Sectional Committee responsible for the preparation of this standard has taken into consideration the views of producers, consumers and technologists and has related the standard to the manufacturing and trade practices followed in the country in this field. Due weightage has also been given to the need for international co-ordination among standards prevailing in different countries of the world.

0.5 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 the standard.

1. SCOPE

1.1 This standard covers roofing with Mangalore pattern tiles which may include the following types of work:

a) Mangalore tiles laid directly over reepers (*see* Fig. 1);

b) Mangalore tiles laid with or without mortar on flat tiles, which are laid over reepers (*see* Fig. 2); and

c) Mangalore tiles laid on ceiling tiles which are laid over reepers (*see* Fig. 3).

2. TERMINOLOGY

2.1 For the purpose of this standard, the following definitions shall apply.

2.1.1 *Barge Board* — In the case of a gable roof where there is no gable parapet and the roof projects beyond the gable, the barge boards are planks running down from the ridge to the eaves covering the outer most rafters.

2.1.2 *Ceiling Tile* — A machine pressed tile used under the Mangalore tile so as to provide a surface flush with the underside of the reepers (*see* IS : 1464-1973†).

2.1.3 *Collars* — The structural members fixed horizontally on either side of the ridge so as to serve as connecting ties for the common rafters.

2.1.4 *Dormer* — A vertical window or opening framed in a sloping roof.

2.1.5 *Downpipe* — Pipe which collects rain water from the roof, from the roof gutters, or from both and conveys it to a drain, sump or other point of discharge.

2.1.6 *Eaves* — The lower edge of an inclined roof (*see* Fig. 4).

*Rules for rounding off numerical values (*revised*).
†Specification for clay ridge and ceiling tiles (*first revision*).

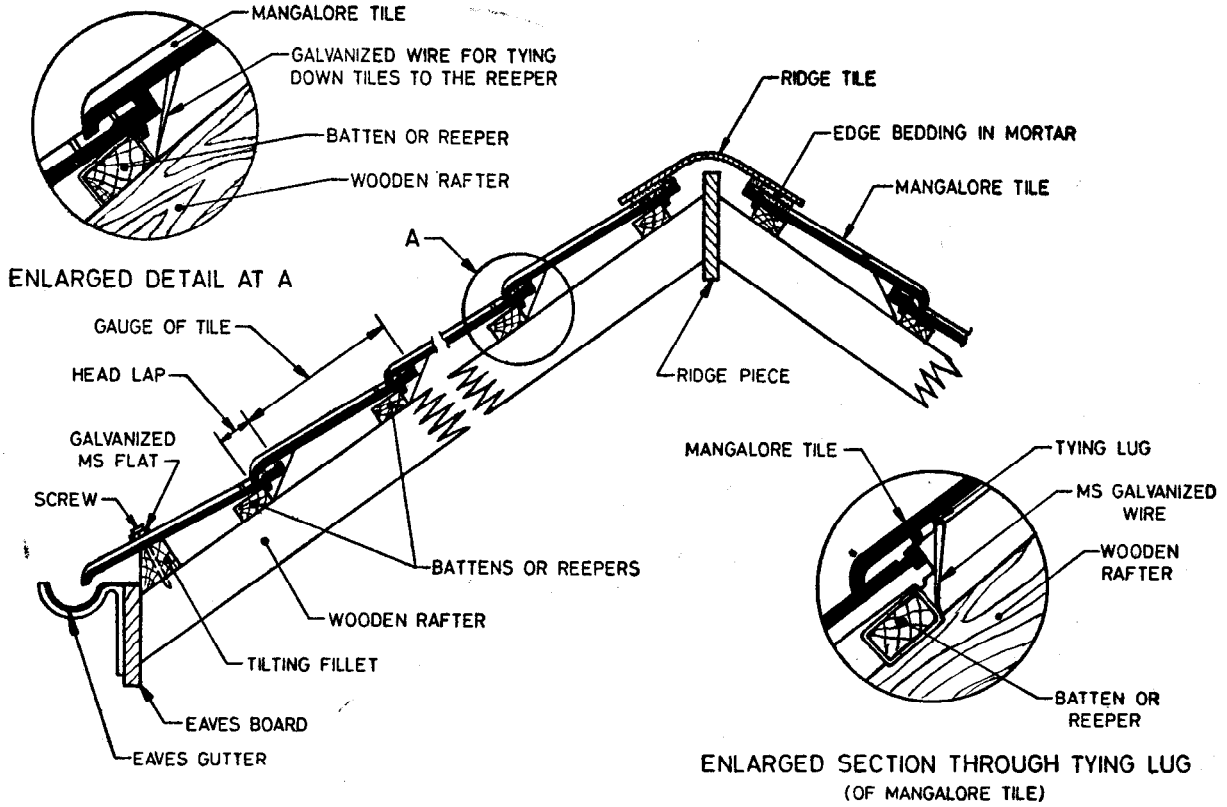

FIG. 1 DETAIL OF MANGALORE TILES LAID ON REEPERS

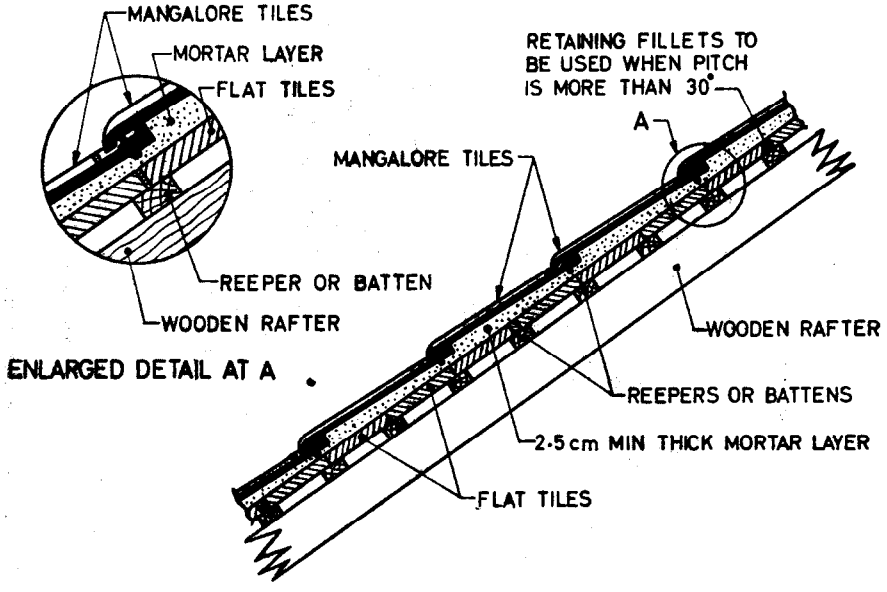

FIG. 2 DETAIL OF MANGALORE TILES EMBEALDED IN MORTAR OVER FLAT TILES

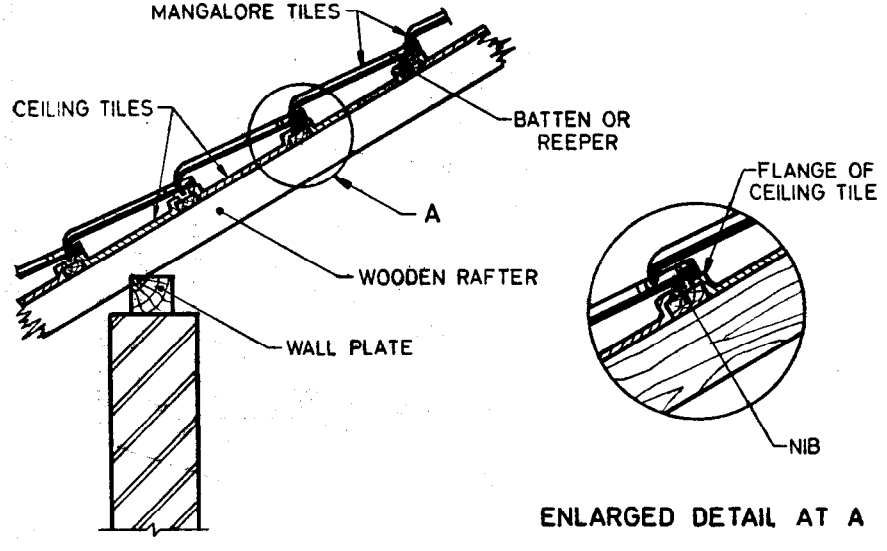

FIG. 3 MANGALORE TILE LAID OVER CEILING TILES

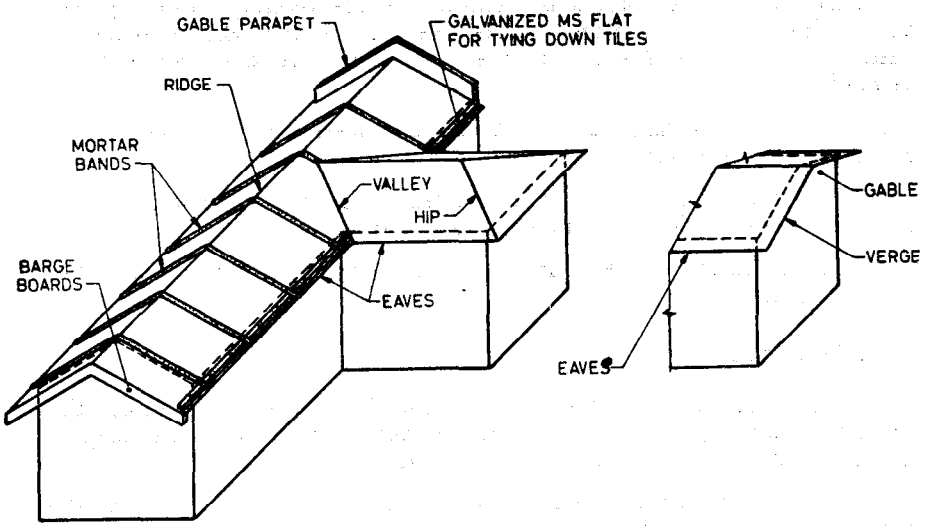

FIG. 4 NOMENCLATURE OF A PITCHED ROOF

2.1.7 *Eaves Board* — A thin plank at the eaves covering the lower ends of common rafters.

2.1.8 *Edge Bedding* — The bedding of the ridge tile at its two longitudinal edges over mortar layers supported on the two courses of roofing tiles occuring on either side.

2.1.9 *Flashing* — A strip of impervious material, usually metal, used to exclude water from the junction between a roof covering and another part of the structure.

2.1.10 *Flat Tile* — A hand made or machine pressed burnt clay tile laid in one or more courses as an underlayer for roofing.

2.1.11 *Gable* — The tringular upper part of a wall at the end of a ridge roof (*see* Fig. 4).

2.1.12 *Gauge of Tile* — The effective distance along the roof slope which is covered by the tile.

2.1.13 *Gutter* — Any form of roof water channel.

2.1.14 *Hip* — A salient angle formed by the intersection of two inclined roof surfaces (*see* Fig. 4).

2.1.15 *Lap* — The distance by which one tile overlaps and adjacent tile. When measured from course over course, this will be termed as 'head lap', and when measured edge over edge of the tile, this will be termed as 'side lap'.

2.1.16 *Mangalore Pattern Tile* — A machine pressed roofing tile conforming to IS : 654-1972*.

2.1.17 *Pitch* — The angle of inclination with the horizontal of the rafters or other surface on which tiles are laid.

2.1.18 *Pitched Roof* — A roof the pitch of which is greater than 10° to the horizontal.

2.1.19 *Rafters*

2.1.19.1 *Common rafters* — The structural members which form the principal framework for the slopes of the roof, and support the reepers or boarding which carry the roof covering.

2.1.19.2 *Hip rafters* — The structural members of the roof at the intersection of two roof surfaces forming a hip.

2.1.19.3 *Jack rafter* — The rafters that are shorter than the common rafters running from a hip to the eaves or from a ridge to the valley, and cut against the hip and ridge.

2.1.19.4 *Valley rafters* — The structural members of the roof at the intersection of the two roof surfaces forming a valley.

2.1.20 *Reepers or Battens* — Horizontal timber members of small section on which tiles are supported.

2.1.21 *Ridge* — The horizontal intersection of two rising roof surfaces inclined in opposite directions.

2.1.22 *Ridge Piece* — The timber member underneath the ridge, to which the ends of common rafters are jointed (*see* Fig. 1).

2.1.23 *Ridge Tile* — A machine pressed clay roofing tile usually angular shaped used at the ridges and hips of roofs, and with its size corresponding to the size of the roofing tile (*see also* **5.3** and IS : 1464-1973†).

2.1.24 *Roof Parapet* — The part of the structure of the side walls of the building rising above the eave level of the roof.

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*Specification for clay roofing tiles, Mangalore pattern (*second revision*).
†Specification for clay ridge and ceiling tiles (*first revision*).

2.1.25 *Tilting Fillet* — A fillet or reeper fixed over the rafter on shorter side so as to provide an extra rise to the lower most course of the tile and bring its slope in conformity with the general pitch of the roof. Sometimes the top edge of the eaves board may itself be made to serve the function of the tilting fillet.

2.1.26 *Undercover* — A layer of flat tiles, ceiling tiles, bituminus felt, wooden boards, or corrugated sheets provided between the rafters and the Mangalore tile layer so as to improve functional performance of the roof.

2.1.27 *Valley* — The re-entrant angle formed by the intersection of two inclined roof surfaces (*see* Fig. 4).

2.1.28 *Verge* — The edge of a roof surface finished at a gable, or the edge of vertical tiling at window reveals, ends of walls and dormer cheeks (*see* Fig. 4).

2.1.29 *Wall Plate* — A structural member resting on the wall and supporting the rafters with the specific object of distributing the load evenly over the wall.

3. NECESSARY INFORMATION

3.1 For efficient design and construction of the work, detailed information with regard to the following is necessary:

a) Surface area to be covered;

b) Type of supporting elements and restrictions, if any, to their arrangement;

c) Treatment of junctions with walls;

d) Provision for slope and other requirements for drainage; and

e) Provision for fixing ridge tiles.

3.2 All information shall be made available to those who are responsible for laying the roof. Necessary drawings and instructions for preparatory work shall be given.

3.3 Arrangement shall be made for proper exchange of information between those engaged in laying and all others whose work will affect or will be affected.

4. DESIGN CONSIDERATIONS

4.1 Weather Resistance — In addition to other normal functions, the essential function of a tiled roof covering will be to drain away rain

water and effectively prevent its ingress into the structure below. The interlocking of the tiles as well as the laying technique shall ensure that the joints are leak-proof; furthermore the roof shall also have an effective roof drainage system which will quickly drain off the rain water. For this purpose, in addition to the drainage channels formed by the corrugations of the Mangalore tiles, a proper layout of roof gutters and downpipes for the roof surface as a whole will be necessary.

Provision of an undercover for the roof will not only add insulation and waterproofing but will also prevent debris and insects falling from the roof.

4.1.1 *Protection of Verges Against Wind* — The verges of roof shall be protected against lifting by wind by provision of either bargeboard and filletting arrangements or a bending wall over the gable wall. Other constructional features regarding laying of tiles for protection at eaves shall be as in **9.1.1**.

4.2 Lap and Pitch — Generally the pitch of the common rafter or surface on which Mangalore tiles are laid shall not be less than 24° and not greater than 45°. Where abnormal conditions may be expected, such as in elevated sites or in areas of heavy rainfall, this minimum pitch may not ensure full protection to weather and pitch shall be suitably increased in which case each tile shall be screwed or tied down to the roofwork below. If necessary, additional protective measures such as the provision of an undercover of a layer of roofing felt, or a course of flat tiles with a mortar layer for bedding of Mangalore tiles or a ceiling boarding nailed to rafters shall be adopted under the roof. In the design of roofs with low pitches, it shall be borne in mind that each tile is tilted up at its lower edge by the tile below and that the pitch of the tile is less than that of the common rafter.

The tiles shall be laid with both head lap and side lap as fixed by the design of the tile. If the head lap is not fixed by the design of the tile, it shall not be less than 75 mm (*see* Fig. 1).

4.3 Reepers — The spacing of rafters shall not normally exceed 600 mm unless the reepers are otherwise designed against sagging taking into consideration the species of timber used and the load covering over them. The size of reepers, unless otherwise designed, shall normally be 50 × 25 mm for Mangalore tiles laid over flat tiles over reepers and 50 × 15 mm for Mangalore tiles over reepers or over ceiling tiles laid on reepers.

4.3.1 Where ceiling boarding is adopted, the boarding shall not be less than 12 mm thick, and shall be tongued and grooved, and it shall be nailed to the rafters first so as to form a continuous surface from ridge to eave, and the reepers nailed over them. Alternatively, the ceiling boarding may be fixed direct to purlins. The size of the reepers shall

not be less than 25 × 25 mm fixed at suitable distances apart to suit the tile spacing. The maximum spacing of the rafters shall not exceed 750 mm.

4.4 Aspects of Dimensional Coordination — In the design of pitched roof coverings the span of the roof and other details shall facilitate the minimum cutting of tiles during laying. Knowing the 'gauge' of the tile, and the play that is permitted by the interlock between tiles and allowing suitable extra distances required near the eave and the ridge or hip, it is possible to adjust the length of the common rafter and other relevant dimensions of the roof to correspond to exact multiples of the gauge length of tile, and this will avoid use of cut tiles near the ridge. Generally a ridge tile corresponding to a pattern of roofing tile will have a length which covers exactly twice the effective width of the roofing tile.

4.5 Strength and Stability — While considering the strength and stability of the roof framework supporting Mangalore tiled roof, the following dead loads shall be taken into account:

Description of Roof	*Rise/Span*	*Dead Mass of Roof Covering* kg/m^2
Mangalore tiles embedded in mortar over flat tiles	$\frac{1}{4}$ to $\frac{1}{2}$	110
Mangalore tiles with flat tiles without mortar for embedment	$\frac{1}{4}$ to $\frac{1}{3}$	80
Mangalore tiles alone	$\frac{1}{4}$ to $\frac{1}{3}$	90

4.6 Roof Drainage — No gutter or rainwater pipe shall discharge water from one roof to another unless the discharge is from a small area such as a 'dormer'. For detailed information relating to the disposal of rain water from roofs, reference shall be made to IS : 2527-1984*. If a valley gutter is formed by means of sheet metal, the sheet shall be taken at least a distance of 300 mm under the roof on either side of the gutter. Near a wall the sheet metal constituting the valley gutter shall be taken at least 75 mm into the wall and set with cement mortar.

4.7 Use of Glass Tiles — Glass tiles, usually of the same shape as the Mangalore tiles may be fixed in the same manner as other tiles at suitable spacing according to the requirements of roof lighting. Glass tiles of special types shall be laid in accordance with the instructions of the manufacrurers of these tiles.

*Code of practice for fixing rain-water gutters and downpipes for roof drainage (*revised*).

5. MATERIALS

5.0 The materials used in roofing with Mangalore tiles shall conform to **5.1** to **5.5.**

5.1 Mortar — The mortar for use in bedding ridge tiles as well as Mangalore tiles shall be:

Either composite mortar 1 : 2 : 9 (one part cement conforming to IS : 269-1976* or IS : 1489-1976† or IS : 455-1976‡, two parts lime conforming to IS : 712-1973§ and 9 parts sand) or lime mortar 1 : 3 (one part lime conforming to IS : 712-1973§ and three parts sand). Water used for making mortar shall conform to **4.3** of IS : 456-1978‖.

Water used for making mortar shall be clean and free from deleterious materials.

5.2 Mangalore Tiles — These shall conform to IS : 654-1972¶.

5.3 Ridge Tiles — These shall conform to IS : 1464-1973**.

5.4 Ceiling Tiles — Ceiling tiles for use with Mangalore tiles shall conform to IS : 1464-1973**.

5.5 Flat Tiles — Flat tiles for use with Mangalore tiles shall have one of the dimensions equal to the gauge of the Mangalore tile.

5.6 Glass Tiles — These shall preferably be of the same shape as Mangalore tiles.

5.7 Ventilating Tiles — Tiles equal in size to one plain Mangalore tile or two tiles laid side by side after allowing for overlapping. These may be used to provide top ventilation in a room. Ventilating tiles shall be provided wherever required at the rate of two ventilating tiles for every 10 m^2 area of finished roof surface. A typical view of ventilating tiles has been shown in Fig. 5.

5.8 Nails for Fixing Reepers — Nails used for fixing reepers or rafters shall be plain head nails of size 2·50 mm or 2·24 mm conforming to IS : 723-1972††. The nails shall be galvanized.

5.9 Sheet Metal for Valley Gutters — This shall be of galvanized metal and of thickness not less than 1·25 mm.

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*Specification for ordinary and low heat Portland cement (*third revision*).
†Specification for Portland pozzolana cement (*second revision*).
‡Specification for Portland slag cement (*third revision*).
§Specification for building limes (*second revision*).
‖Code of practice for plain and reinforced concrete (*third revision*).
¶Specification for clay roofing tiles, Mangalore pattern (*second revision*).
**Specification for clay ridge and ceiling tiles (*first revision*).
††Specification for mild steel wire nails (*second revision*).

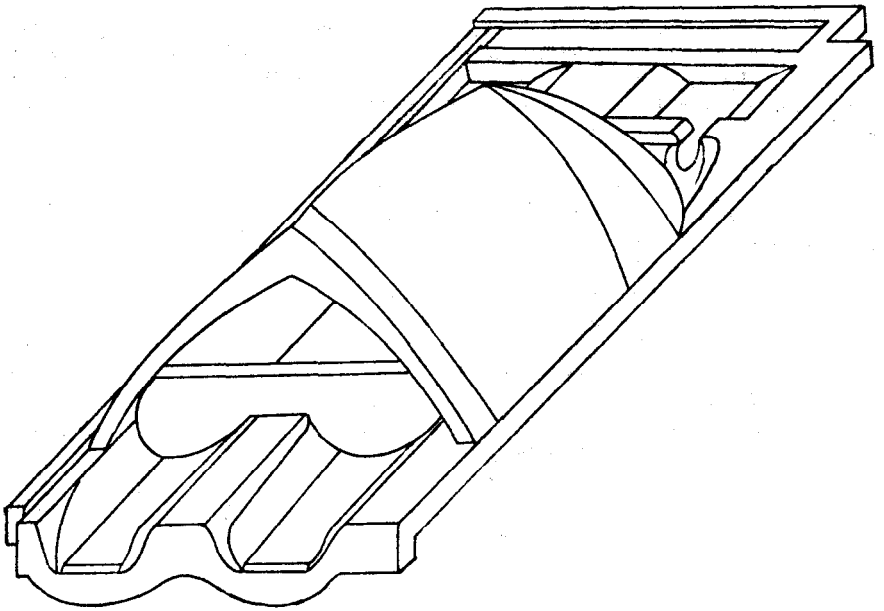

FIG. 5 TYPICAL VIEW OF VENTILATING TILE

5.10 Reepers — Reepers shall be of any species of structural timber given in IS : 883-1970* and the size shall be in accordance with the design but shall in no case be less than the size as specified in **4.3.** Reepers shall be treated for protection against decay and termites in accordance with IS : 401-1982†.

5.11 Wire for Tying Down the Tile — The wire shall be galvanized and shall conform to IS : 280-1978‡.

6. PROGRAMMING THE WORK

6.1 Before taking up the work of roof covering, the roof framework shall have been completed and the reepers nailed into position ready for supporting the roof covering.

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*Code of practice for use of structural timber in building (material, grading and design) (*third revision*).

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

‡Specification for mild steel wire for general purposes (*third revision*).

7. PREPARATORY WORK

7.1 For Flat Tiles — Before use in the roofing, the flat tiles shall first be prepared by immersing in water for two hours and air-dying before laying. The underside of the flat tiles, may also, if so specified, be dipped in whitewash mixed to a creamy consistency and the tiles then dried.

7.2 For Mangalore Tiles — Wherever Mangalore tiles are to be embedded in a mortar layer over flat tiles, the Mangalore tiles shall first be soaked in water for at least two hours before laying.

8. FIXING OF REEPERS

8.1 The reepers shall be fixed over the rafters at the specified or designed spacing and nailed. The nails shall penetrate at least 2 cm into the rafters. They shall extend at least over a length of three spans between the rafters. The reepers shall be nailed to the rafters by means of plain headed nails (*see* **5.8**). Their length shall be extended only by means of butt joint. The joint shall occur only over the rafters. The joints of no two adjacent rows of reepers shall come over the same rafter. At the eaves a tilting fillet shall be fixed, if necessary (*see* Fig. 1).

8.2 Where ceiling boards are used reapers shall be fixed in accordance with **4.3.1.**

9. LAYING OF MANGALORE TILES

9.1 The tiles shall be laid from the eaves towards the ridge properly interlocked according to the design of the tile. The tile shall be laid either directly over the reepers or over an undercover (*see* **9.1.1** and **9.1.2**). The tiles shall be laid breaking joint, that is, the left channel of the upper tile shall lie in the right channel of that below and shall fit properly one to another, the catches resting fully against battens. The hips and ridges of the roof shall be covered with ridge tiles which shall be edge-bedded in mortar (*see* **5.1**) as illustrated in Fig. 1. The mortar in edge bedding may be further finished with plaster or paint to match with the colour of the tiles. If the courses of roof tiles adjacent to the hip or to the ridge do not finish exactly underneath the ridge tiles, either purpose-made tiles or tiles cut to suitable shapes may be used. While finishing joints gaps in the troughs of the roof tiles giving ridge or hip, if large enough, shall be neatly packed watertight using small pieces of chips of broken tiles and mortar. At eaves the lower most course of the tiles shall overhang the tilting fillet by a distance sufficient to ensure that the water drained off from the roof discharges clear off the eaves into the gutter.

9.1.1 *Protective Measures Against Wind* — A suitable arrangement shall be made to secure the ends of lower most course of tiles to the roof structure for preventing the tiles from being blown up by wind. Al teast the bottom most layer of tiles, and preferably more number of layers above it, shall be tied to the reepers or other roof elements by means of galvanized wire. The tiles at the eaves shall also be protected against lifting by means of a galvanized steel flat of size 40 × 3 mm fixed to the roof as in Fig. 4. Mortar bands 200 to 250 mm wide 60 to 65 mm deep may also be provided over the tiled roof at a spacing of 2·5 to 3 m for additional protection against wind. The mortar bends shall run along the roof slope.

9.1.2 *Laying Mangalore Tiles Over a Flat Tile Undercover* — The flat tiles shall first be prepared by immersing in water for two hours and dried before laying. The underside of flat tiles shall also be dipped in white-wash mixed to creamy consistency and dried. The flat tile shall then be laid over the reeper. The mortar layer shall be spread over the flat tile to a thickness of not less than 25 mm. The Mangalore tile shall also be soaked for two hours before laying in the roof. When the mortar layer is spread, the soaked Mangalore tiles shall be laid so as to be fully embedded in the mortar over the flat tiles (*see* Fig. 2). Where the pitch of the roof is more than 30°, additional fillets shall be fixed to the reepers at a spacing of about one metre centres, so that the flat tiles laid between them are retained in position (*see* Fig. 2). The Mangalore tiles may also be fixed over flat tiles without mortar bedding if the work is so specified.

9.1.3 *Laying Mangalore Tiles Over Ceiling Tiles* — Where a layer of ceiling tiles is to be laid as under cover the ceiling tiles shall be laid over the reepers and the Mangalore tiles shall be laid over them with appropriate interlocking between the tiles in the two layers (*see* Fig. 3).

9.2 Alignment — The finished slope of the roof shall be uniform ridge eaves. The eaves-line and the ridge-line shall, be perfectly straight, horizontal and parallel to each other.

9.3 Junction Between Ridges and Hips — The joints between hip and ridge tiles shall be grouted so as to be leak-proof. A metal saddle not less than 45 cm^2 area may preferably be used underneath such junctions as additional protection against leakage.

9.4 Work at Valleys — Since valley is a particularly vulnerable part of the roof as its pitch is several degrees less than that of the general roof surface and it has to provide a channel for the water running down into it from two slopes on either side, special care shall be taken that a clear and an unobstructed channel is formed. Undercover (*see* **9.1.1** and **9.1.2**) shall be provided for the courses of tiles adjacent to the valley. The valley gutters shall be of galvanized steel sheet of minimum 1·25 mm

thickness and 1·2 m wide. A 300 mm overlap shall be given at joints, if any, down the slope. The valley gutters shall be laid over the reepers and not nailed on to them from underneath. Two additional reepers of section 50 × 25 mm shall be fixed over the metal sheets, 150 mm away from the central line of the valley on either side, so as to retain the tiles and mortar against falling into the gutter of the valley. On either side of the valley, the roof shall be plastered with mortar to a thickness of 12 mm so that rain water from the gutter is prevented from percolating through the tiles or the undercover to the underside of the roof (*see* Fig. 6).

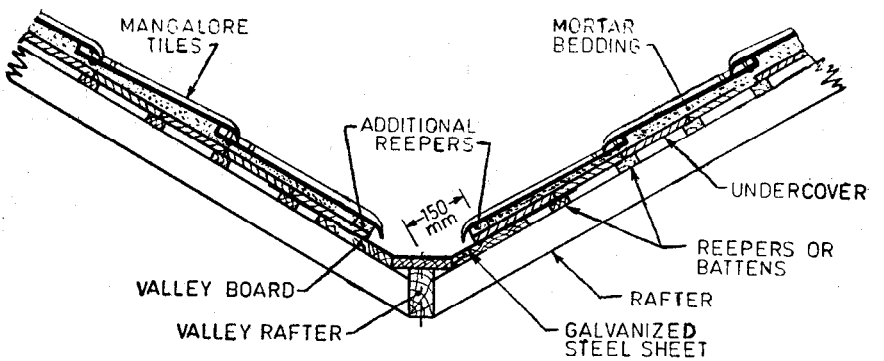

FIG. 6 FIXING OF VALLEY GUTTER

10. FINISHING EDGES AROUND CHIMNEY STACKS AND SKYLIGHTS

10.1 In the case of chimney stacks and other similar features, full tiles shall be used around them and taken into the masonry. In addition, metal or bitumen flashing shall be used to cover the intersection between the top edge of the tiling and any projection through the roof. The flashing shall be turned against the projection and dressed down over the tile. The flashing shall be well tucked into either the joints in masonry or grooves in concrete as the case may be and shall be wedged and pointed.

11. TREATMENT OF JUNCTIONS WITH WALL

11.1 Junctions of the roof with walls shall preferably be treated for waterproofing in accordance with the relevant Indian Standards for waterproofing. Wherever special features like roof gutters and flashings are not provided between the junctions of the roof and wall, the tiles shall be let into the wall to a depth of not less than 50 mm and a drip moulding shall be provided at about 100 mm height above the roof surface, and joints between the roof and the wall shall be grouted with a waterproofing mortar or such other materials (*see* Fig. 7).

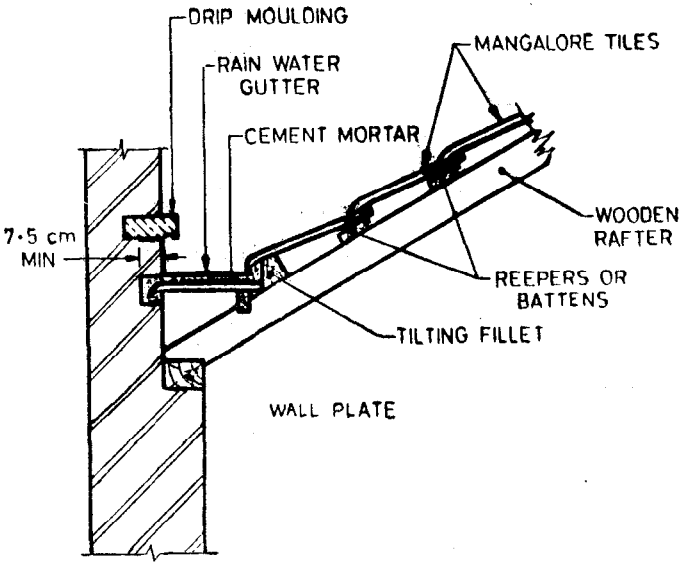

FIG. 7 DETAIL AT THE JUNCTION OF THE ROOF WITH WALL
(WHERE TILES THEMSELVES ARE USED FOR ROOF DRAINAGE)

12. INSPECTION

12.1 Inspection shall be done to avoid unsatisfactory construction which may result in one or more of the following defects:

Stage	*Particulars of Inspection*	*Type of Failure that May Occur if (2) is not Satisfactory*
(1)	(2)	(3)
Laying of reepers	No joint between the reepers shall occur except over the joist. At eaves the tilting fillet shall be fixed to the correct height.	Sagging or cracking
Laying of tiles	Where Mangalore tiles are laid over flat tiles, their joints shall not, as far as possible, occur over the joints of the tiles. Where Mangalore tiles are *laid as such* over reepers, or over ceiling tiles, interlocking of tiles shall be ensured.	Unsightly fall of roof surface near the eaves

(*Continued from page* 2)

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