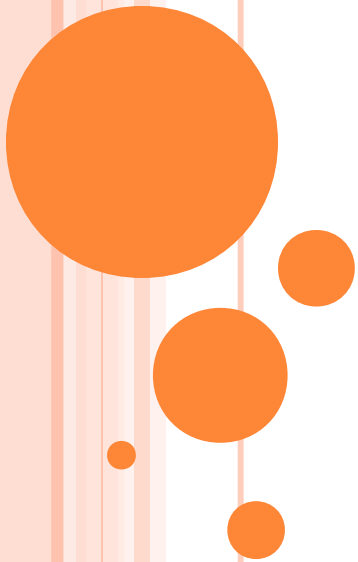


ROOFS



INTRODUCTION

- It may be defined as the uppermost part of the building, provided as a structural covering, to protect the building from weather.
- Structurally, a roof is constructed in the same way as an upper floor, though the shape of its upper surface may be different.
- Roof consists of structural elements which support roof is roof covering.
- The roof coverings may be A.C. sheets, G.I. sheets, wooden shingles, tiles, slab itself.



REQUIREMENTS OF A ROOF

- It should be durable against the adverse effects of various agencies such as wind, rain, sun etc.
- It should grant the desirable insulation against sound and heat.
- It should be structurally stable and sound, it should be capable of taking the loads likely to come over it.
- It should be well-drained.
- It should have efficient water-proofing arrangement.



TYPES OF ROOF

- Pitched or Sloping Roofs
- Flat Roofs or terraced Roofs
- Curved Roof



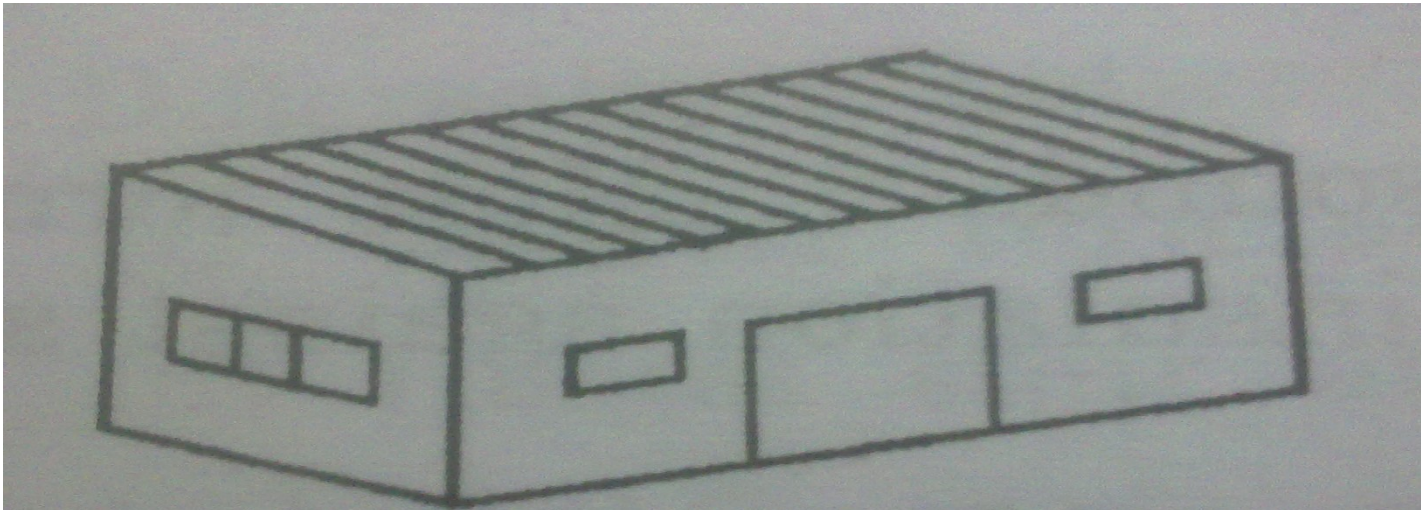
PITCHED ROOF

- A sloping roof is known as pitched roof.
- These are suitable in those areas where rainfall/snowfall is very heavy.



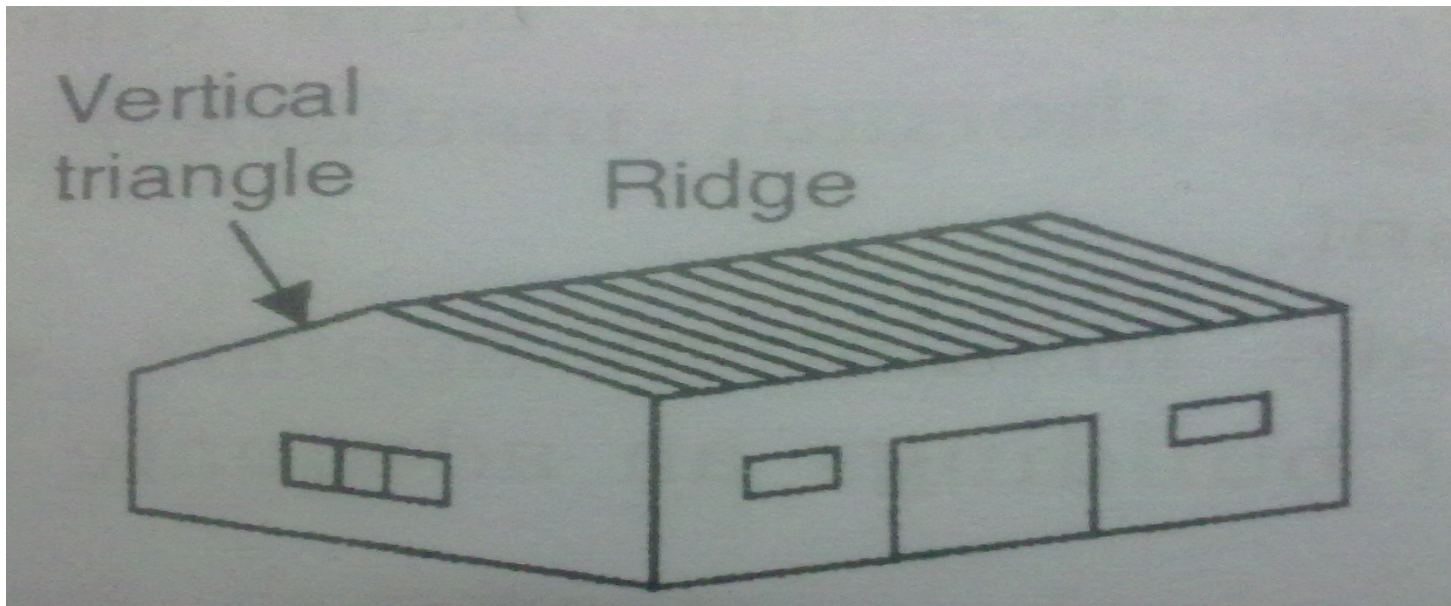
FORMS OF PITCHED ROOF

- **LEAN-TO-ROOF:**-It is the simplest form of a pitched roof and it is known as pent roof. In this type of roof, one wall is carried up sufficiently higher than the other to give necessary slope to the roof.



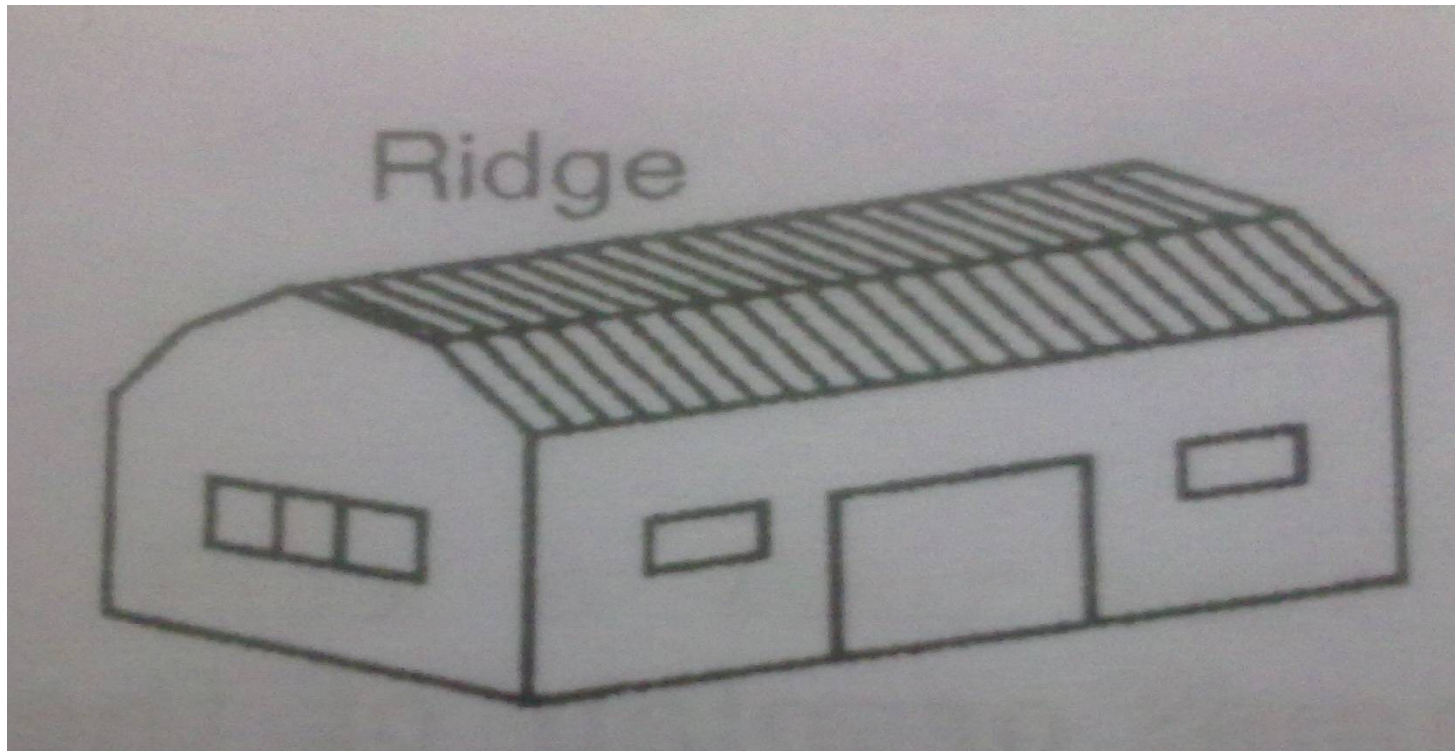
FORMS OF PITCHED ROOF

- **GABLE ROOF:-** This is the common type of sloping roof which slopes in two direction. The two slopes meet at the ridge.



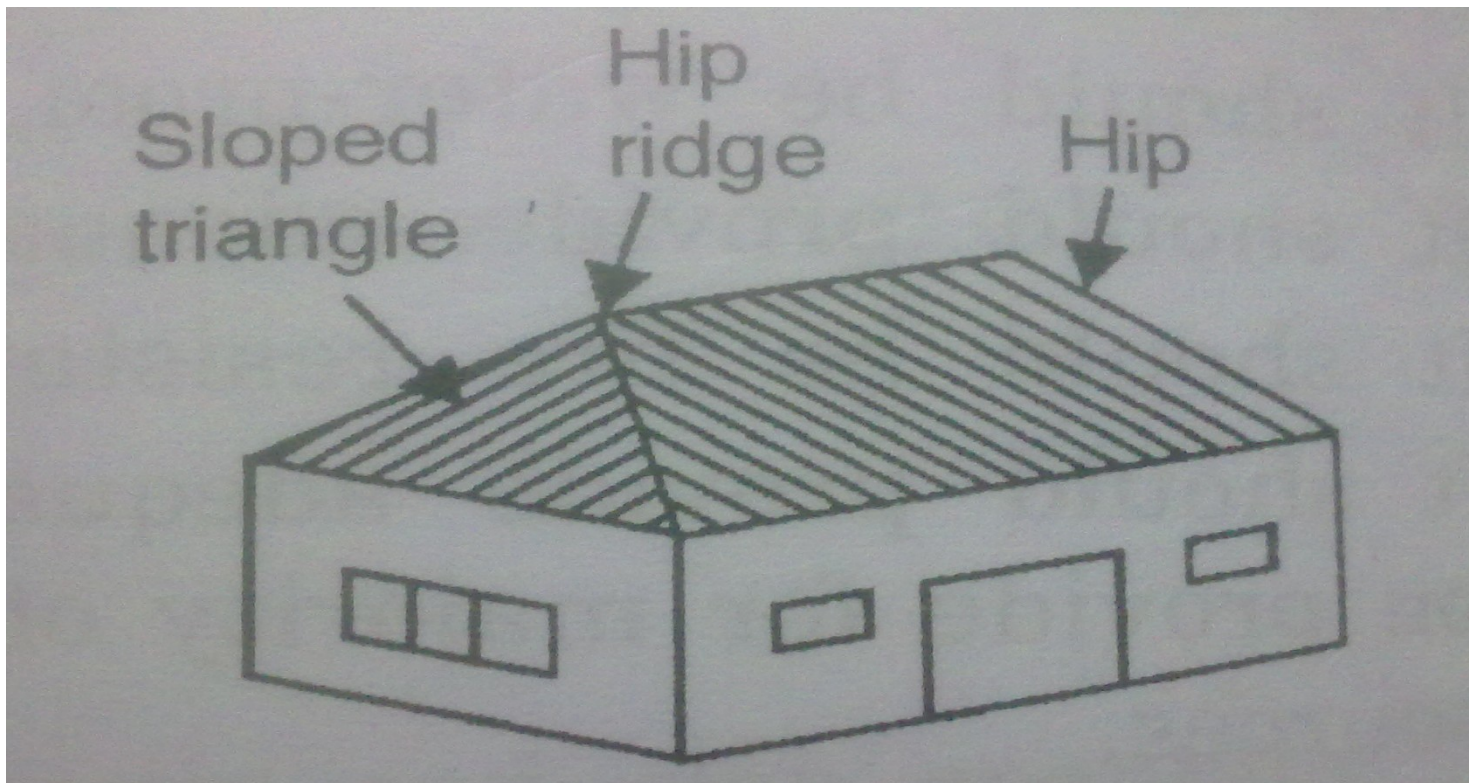
FORMS OF PITCHED ROOF

- **GAMBREL ROOF:-** This roof like gable roof, slopes in two directions but there is break in each slope.



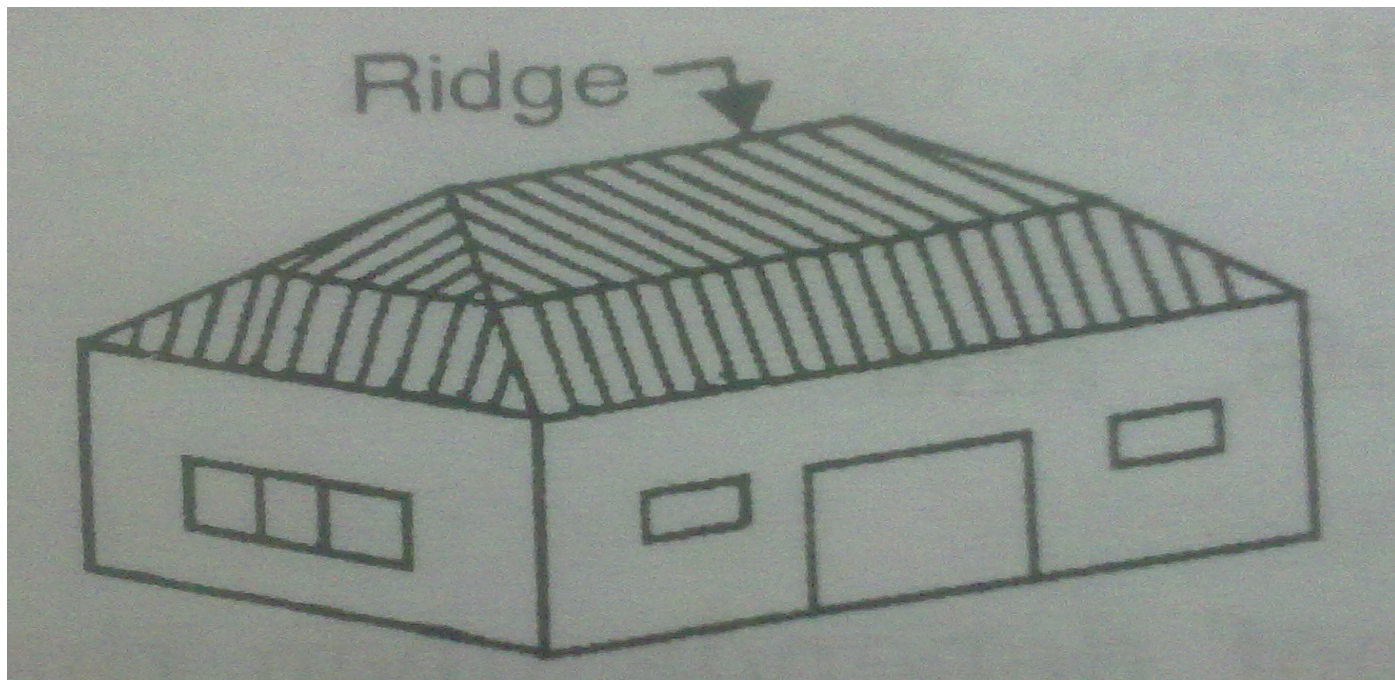
FORMS OF PITCHED ROOF

- **HIP ROOF:-** This roof is formed by four sloping surfaces in four directions.



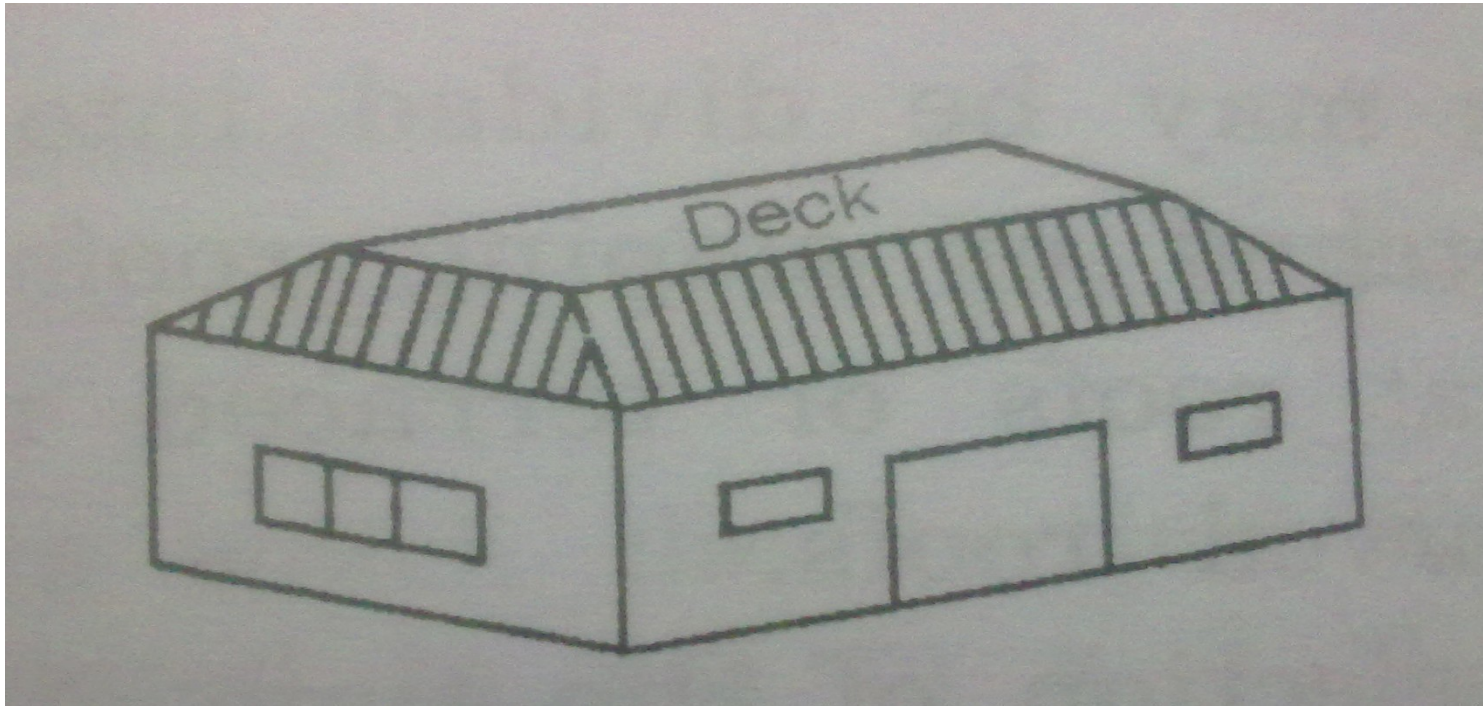
FORMS OF PITCHED ROOF

- **MANSARD ROOF:-** This roof like a hip roof, slopes in four directions but each slope has a break.



FORMS OF PITCHED ROOF

- **DECK ROOF:-** A deck roof has slopes in all the four directions, like a hip roof but a plane surface is formed at the top.



PITCHED ROOF: BASIC ELEMENTS

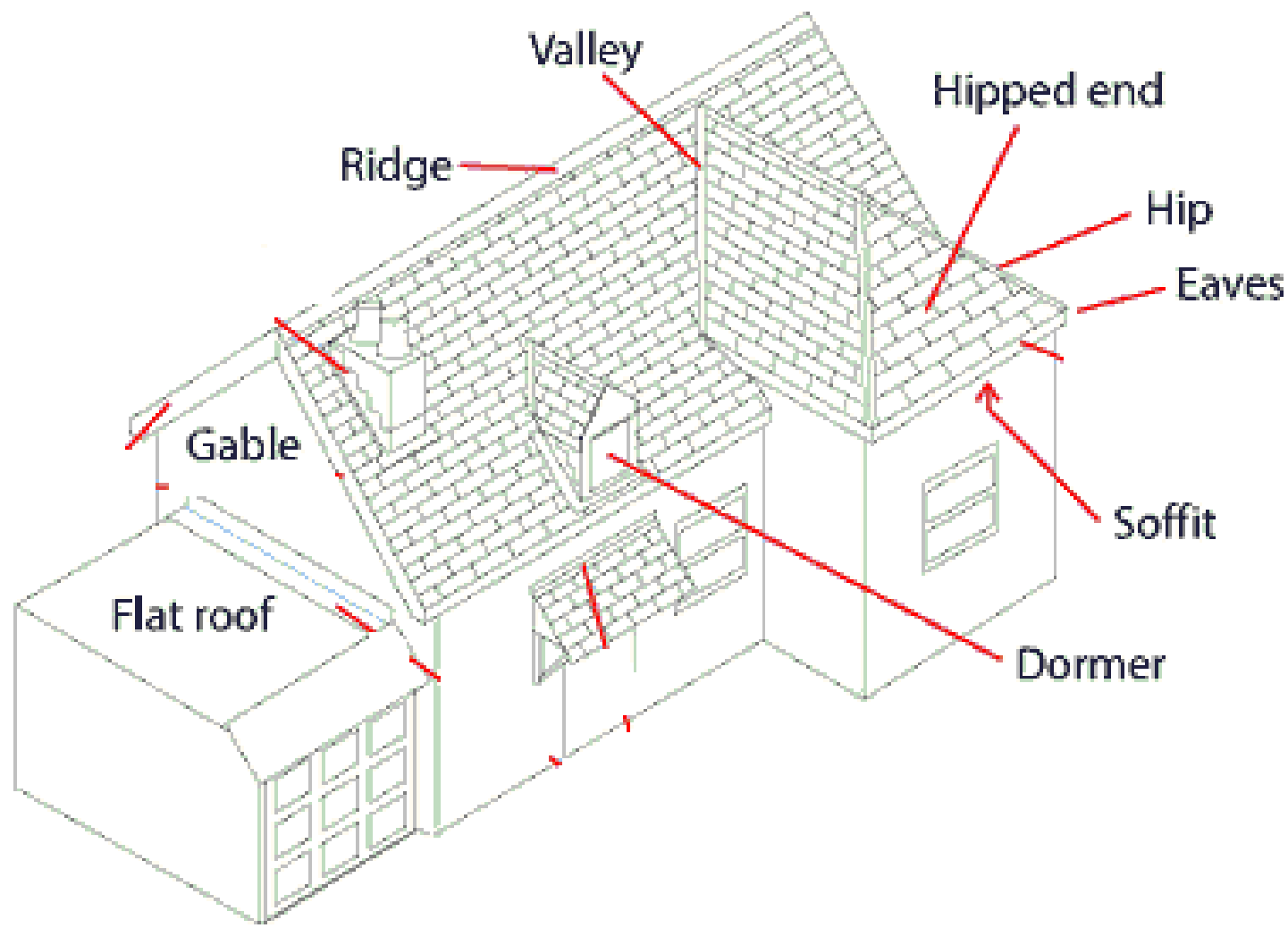
- **SPAN:-** The horizontal distance between the internal faces of walls or supports is known as span or clear span.
- **RISE:-** It is the vertical distance between the top of the ridge and wall plate.
- **PITCH:-** It is the inclination of the sides of a roof to the horizontal plane. It is expressed in degrees or as a ratio of rise to span.
- **RIDGE:-**It is defined as the apex line of the sloping roof.
- **EAVES:-**The lower edge of a roof which are resting upon or projecting beyond the supporting walls are known as eave.



PITCHED ROOF: BASIC ELEMENTS

- **HIP:**-The angle formed at the intersection of two roof slopes is known as hip.
- **VALLEY:**-When two roof surfaces meet together and form an internal angle, a valley is formed.
- **VERGE:**- The edge of a gable, running between the eaves and ridge is known as a verge.
- **COMMON RAFTER:**-These are the intermediate rafters, which give support to the roof coverings.
- **PRINCIPAL RAFTER:**- These are the inclined members of a truss.

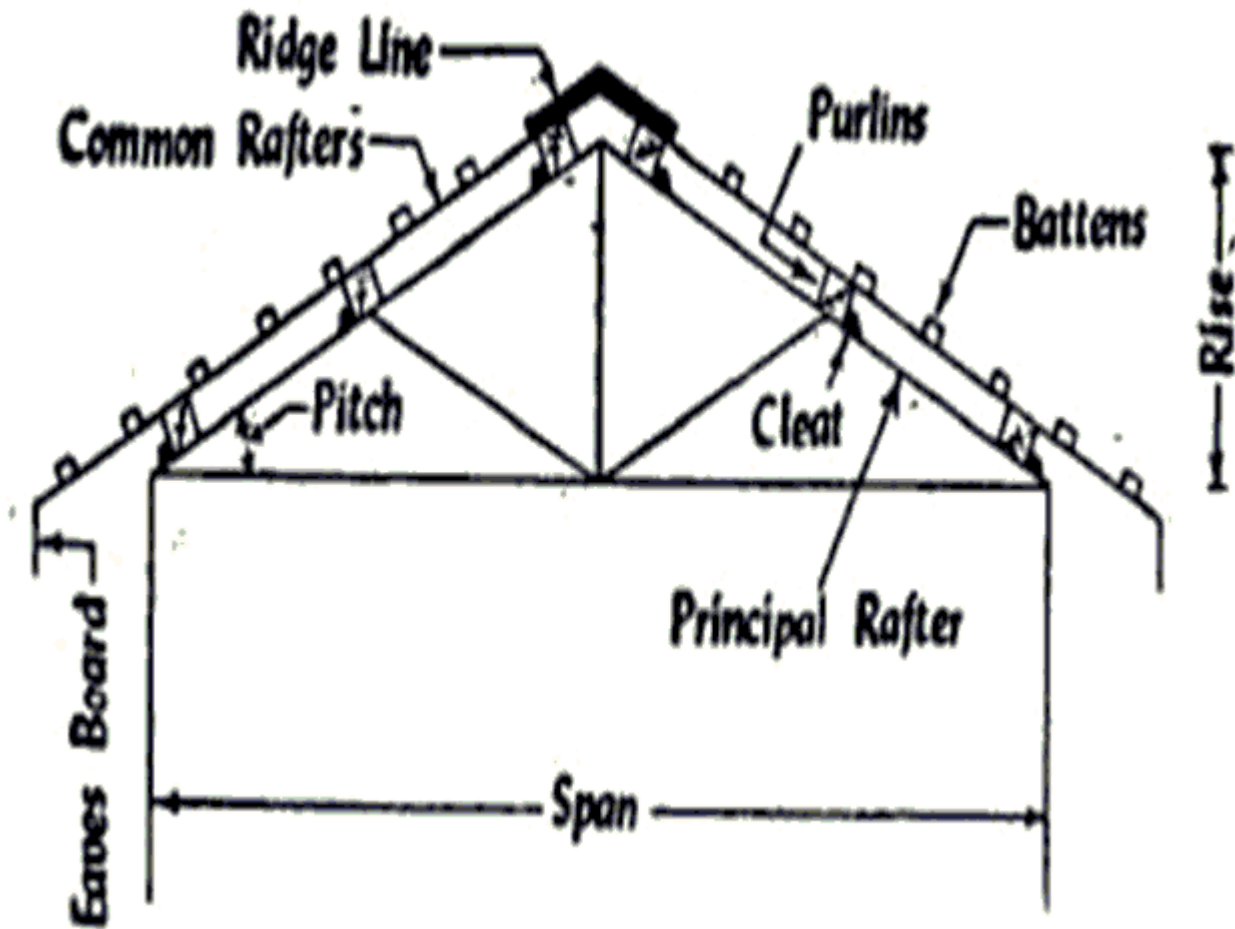




PITCHED ROOF: BASIC ELEMENTS

- **HIP RAFTER:-** Which provided at the junction of two roof slopes.
- **PURLINS:-** The wooden pieces which are placed horizontally on principal rafters to carry the common rafters are known as purlins.
- **BATTENS:-** Thin strips of wood which are fixed on rafters or ceiling to support the roof ceiling.
- **CLEATS:-** Small blocks of wood which are fixed on truss to prevent the sliding of purlins.
- **GABLE:-**The triangular upper part of a wall formed at the end of a pitched roof is known as gable.





TYPES OF PITCHED ROOF

A) Single Roofs:-

- Lean-to-Roof
- Couple Roof
- Couple-close Roof
- Collar beam Roof or Collar tie Roof

B) Double or Purlin Roof

C) Framed or Trussed Roof

- King Post Roof Truss
- Queen Post Roof Truss
- Combination of king-post & queen-post truss
- Mansard roof Truss



TYPES OF PITCHED ROOF

- Truncated roof Truss
- Bel-fast roof Truss or latticed roof Truss
- Composite roof Truss
- Steel sloping roof Truss



SINGLE ROOFS

- In this type of roofs common rafters are provided to each slope without any intermediate support.
- Such roof is used only when the span is limited to 5m.
- It is of following types:-
 - Lean-to-Roof
 - Couple Roof
 - Couple-close Roof
 - Collar beam Roof or Collar tie Roof

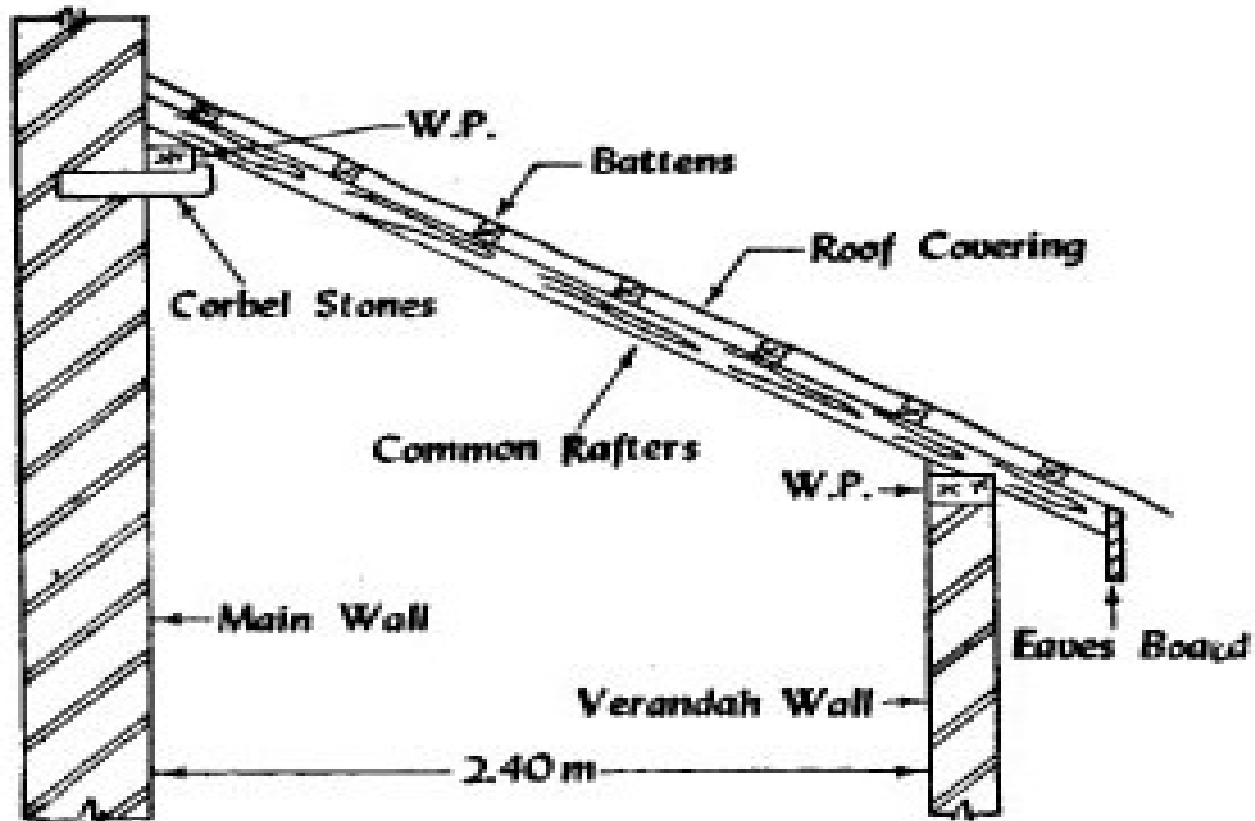


LEAN-TO-ROOF

- It is the simplest form of a pitched roof and it is known as pent roof or Aisle roof.
- In this type of roof, one wall is carried up sufficiently higher than the other to give necessary slope to the roof.
- A lean-to roof is generally used for sheds, out-houses attached to main buildings verandah etc.
- This is suitable for a maximum span of 2.4m..



LEAN-TO-ROOF



Lean-to roof

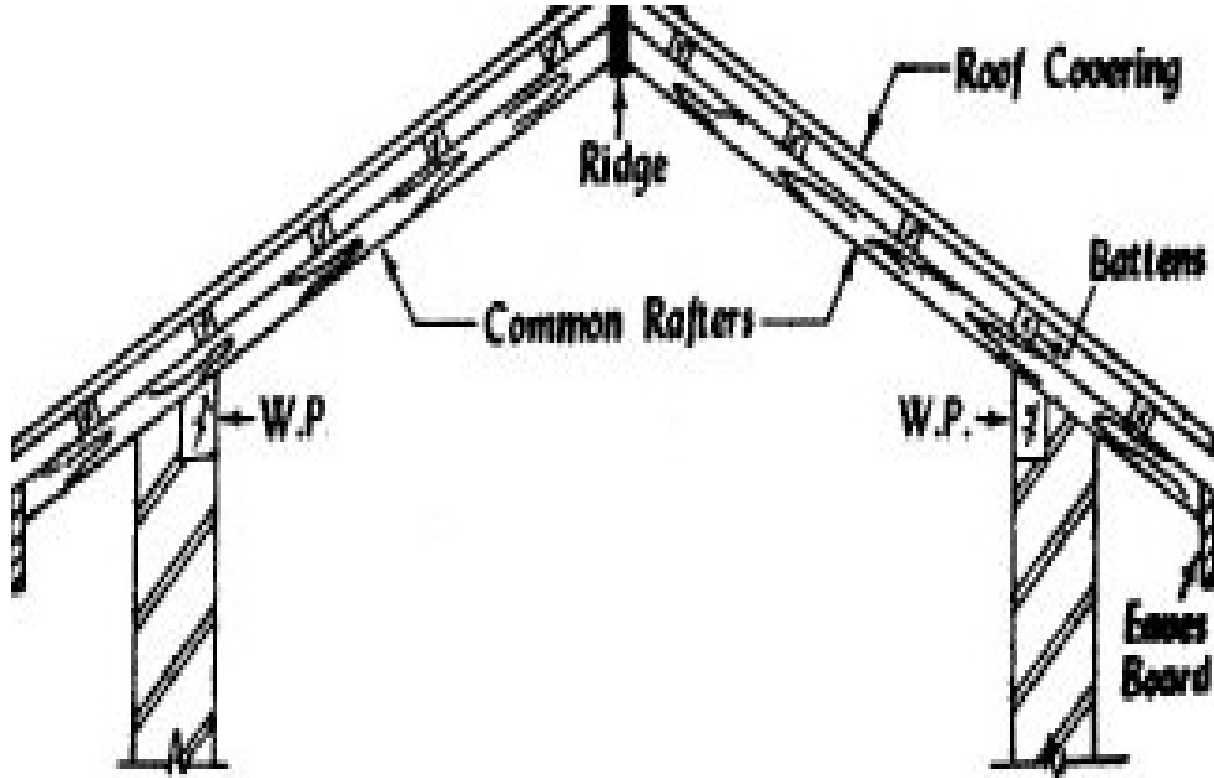


COUPLE ROOF

- This type of roof is formed by couple or pair of rafters which slope to both the sides of the ridge of the roof.
- In this type of roof the common rafters slope upwards from the opposite walls and they meet on a ridge piece in the middle as shown in the fig.
- A couple roof is suitable for spans up to about 3.6m.



COUPLE ROOF

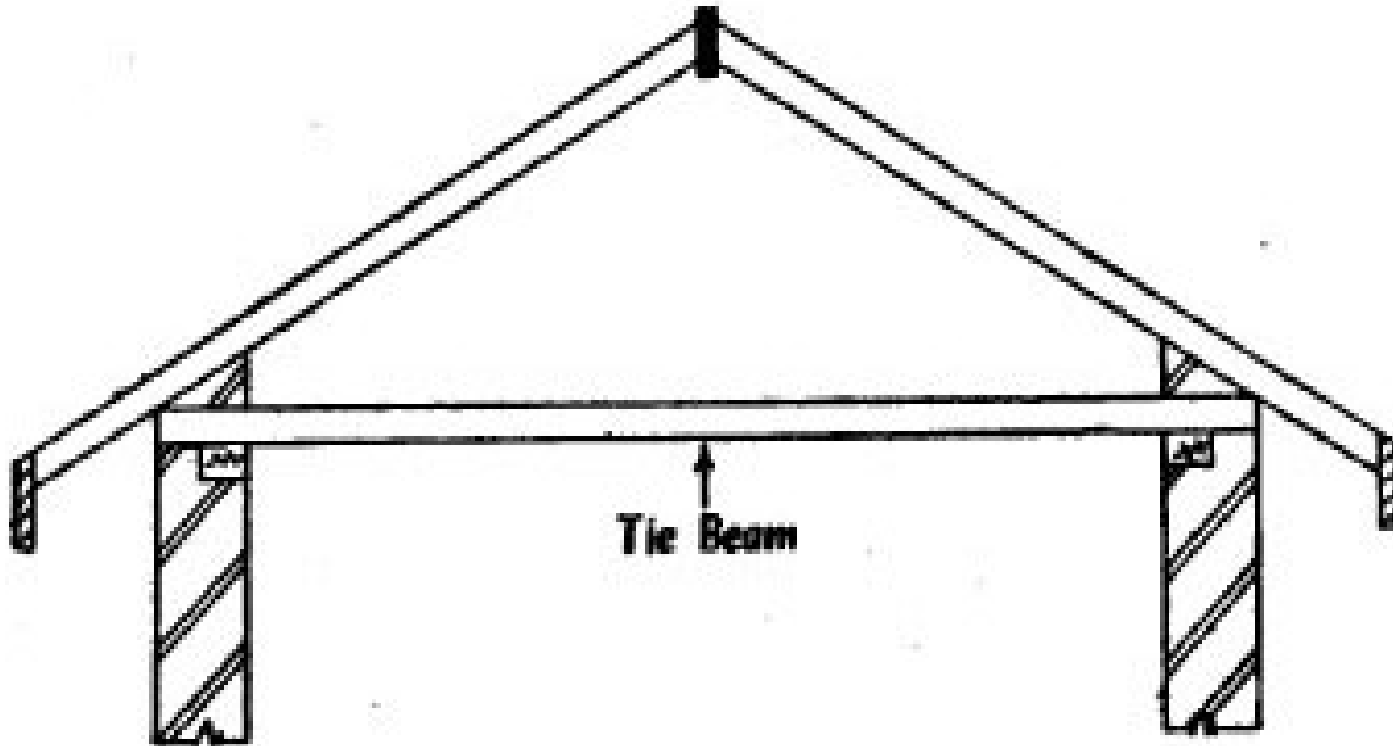


COUPLE CLOSE ROOF

- This roof is just similar to couple roof except that the ends of the couple of the common rafters is connected by horizontal member, called tie beam.
- The tie beam prevents the tendency of rafters to spread out and thus danger of overturning of the walls is avoided.
- The tie beam may be a wooden member or a steel rod.
- This roof can be adopted economically up to the span of 4.2m.



COUPLE CLOSE ROOF

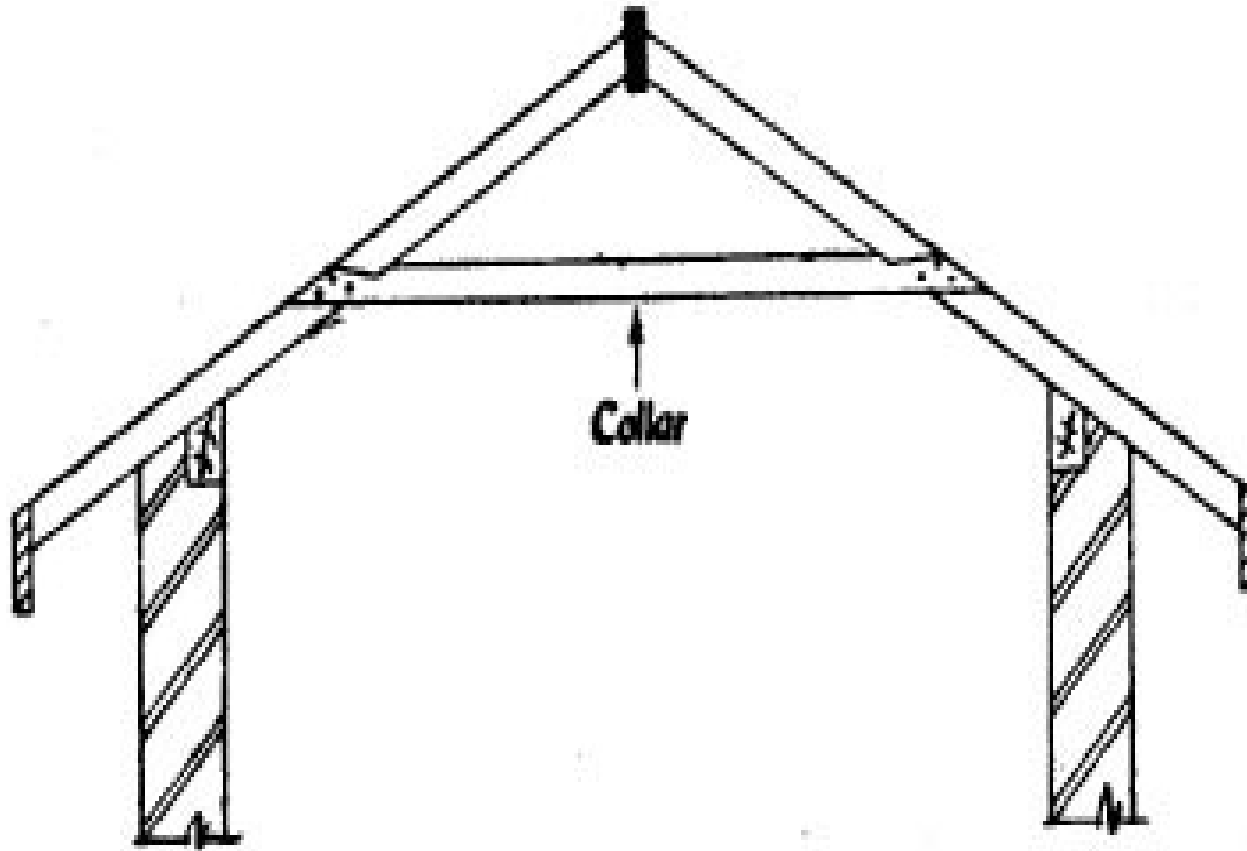


COLLAR BEAM ROOF

- When the span increases or when the load is more the rafters of the couple close roof have the tendency to bend.
- This is avoided by raising the tie beam and fixing it at one-third to one-half of the vertical height from the wall plate to the ridge. This raised beam is known as collar beam.
- This beam roof is adopted to economise the space and to increase the height of a room.
- This roof can be adopted up to a maximum span of 4.8m.



COLLAR BEAM ROOF

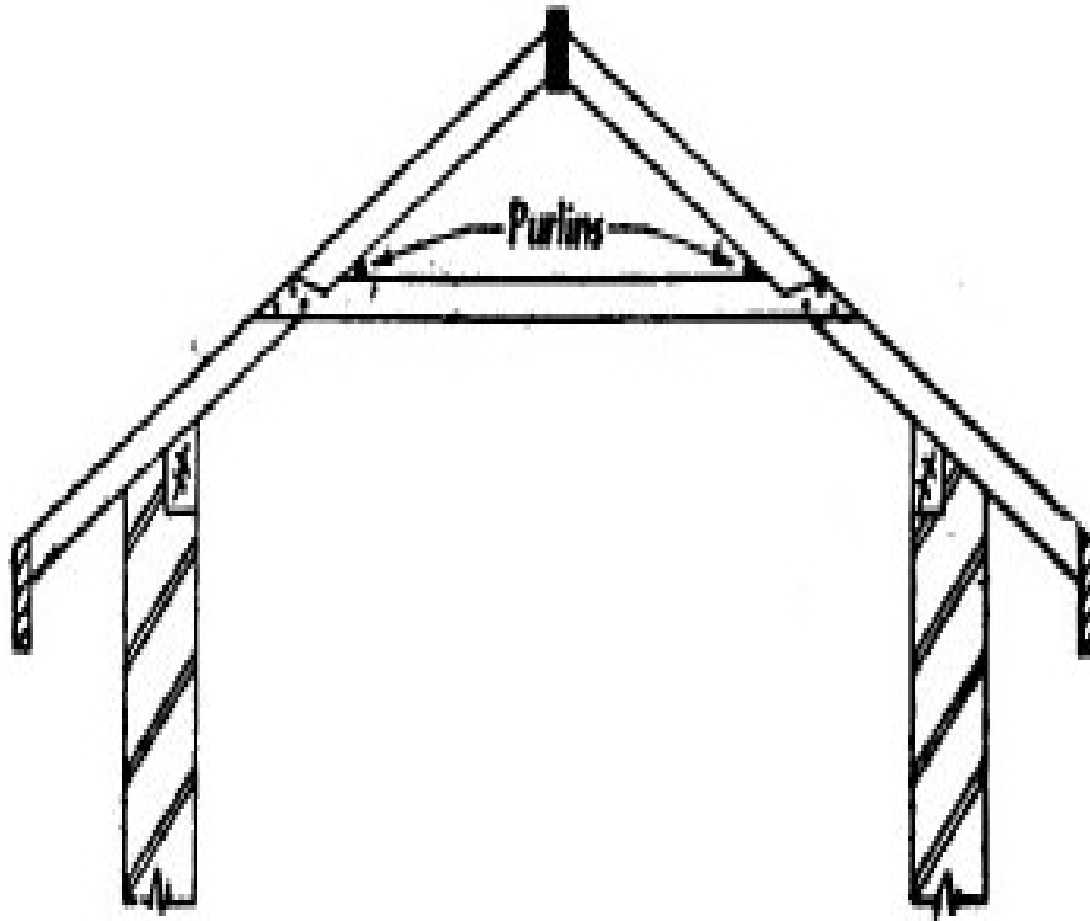


DOUBLE OR PURLIN ROOFS

- When the span exceeds 2.4m, the necessary size for the rafters becomes uneconomical.
- Hence in order to reduce the size of rafters, intermediate supports called purlins are introduced under the rafters as shown in fig.
- This roof can be adopted economically up to 4.8m.



DOUBLE OR PURLIN ROOFS



FRAMED OR TRUSSED ROOF

- When the span exceeds 5 m and when there are no inside supporting walls or partitions for purlins, framed structure known as trusses are on the roof, position of cross walls, span and material of the truss.
- The spacing is 3m for wooden trusses.
- Trusses carry the ridge piece and purlins on which the common rafters rest.

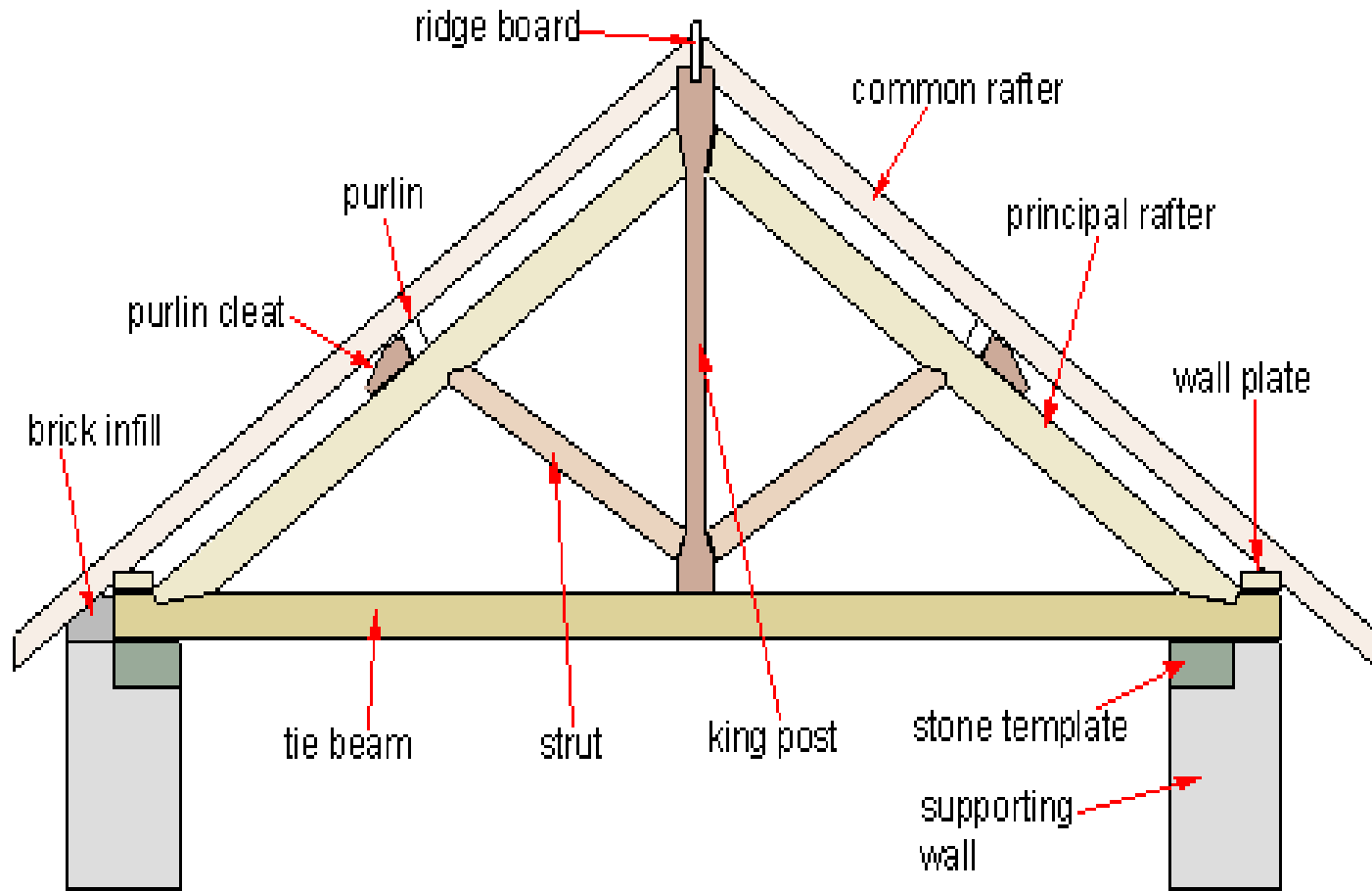


KING POST TRUSS

- In this type of truss, the central post known as king-post forms support for the tie beam.
- The inclined members, known as struts, prevents the principal rafters from bending in the middle.
- A king-post truss suitable for roofs of span varying from 5 to 8 m as shown in fig.



KING POST TRUSS



King Post Roof Truss

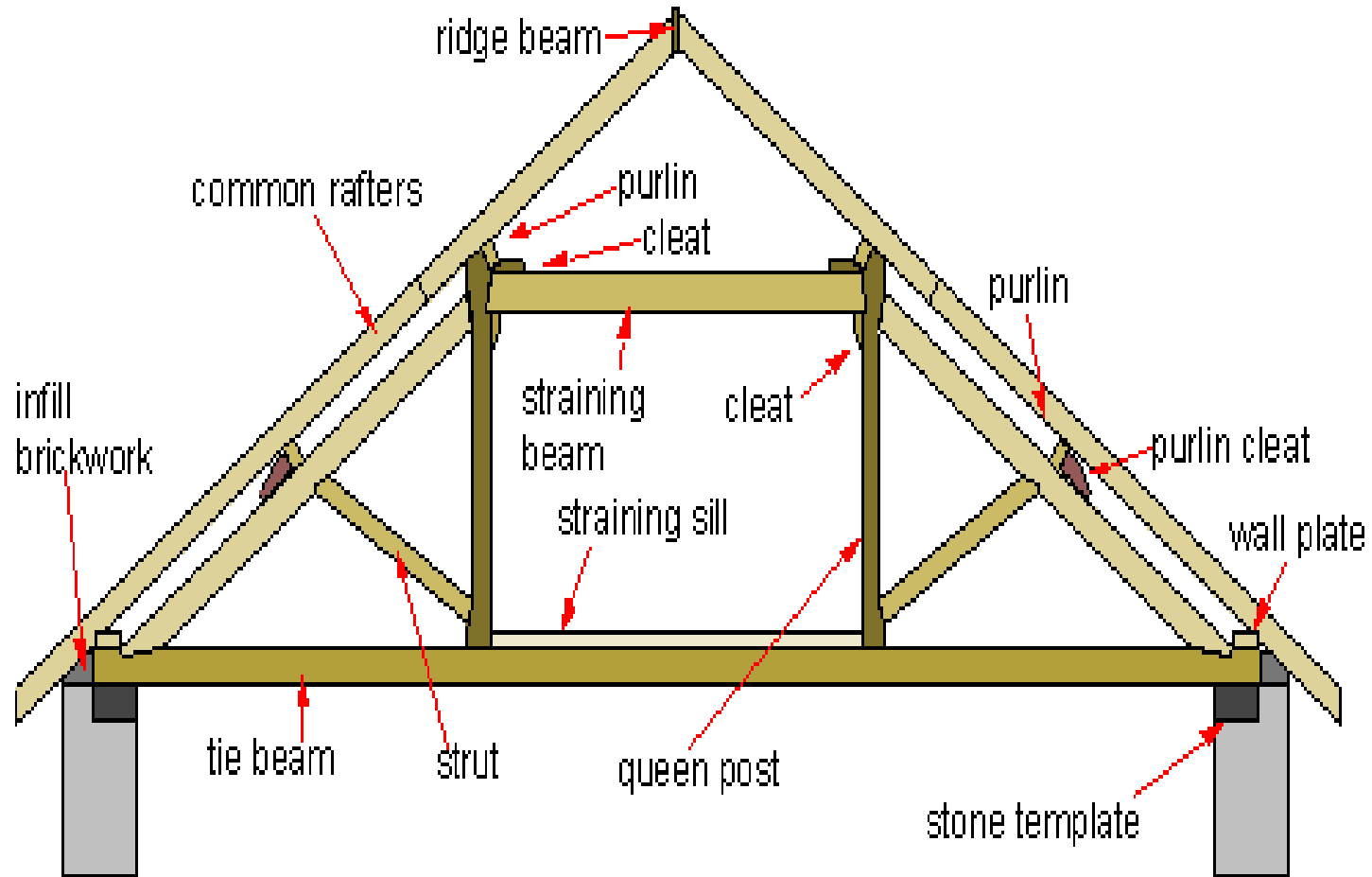


QUEEN POST TRUSS

- This truss is different from a king-post truss in having two vertical members known as queen posts.
- The upper ends of the queen posts are kept in position by means of a horizontal member known as straining beam.
- Additional purlins are supported on the queen posts.
- A queen post truss is suitable for roof spans varying 8 to 12 m as shown in the fig below



QUEEN POST TRUSS



Queen Post Roof Truss

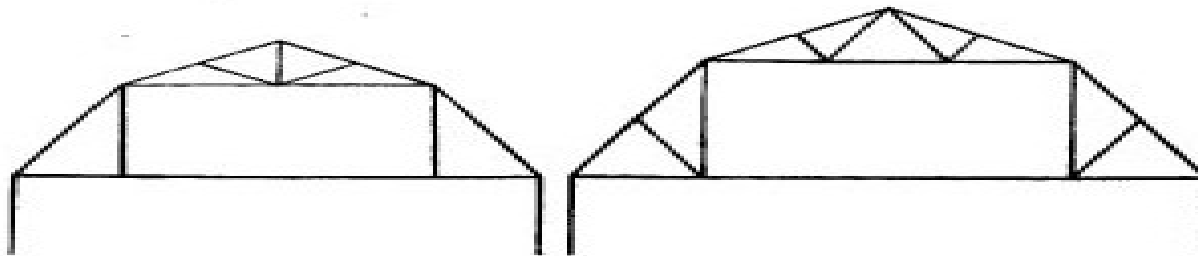
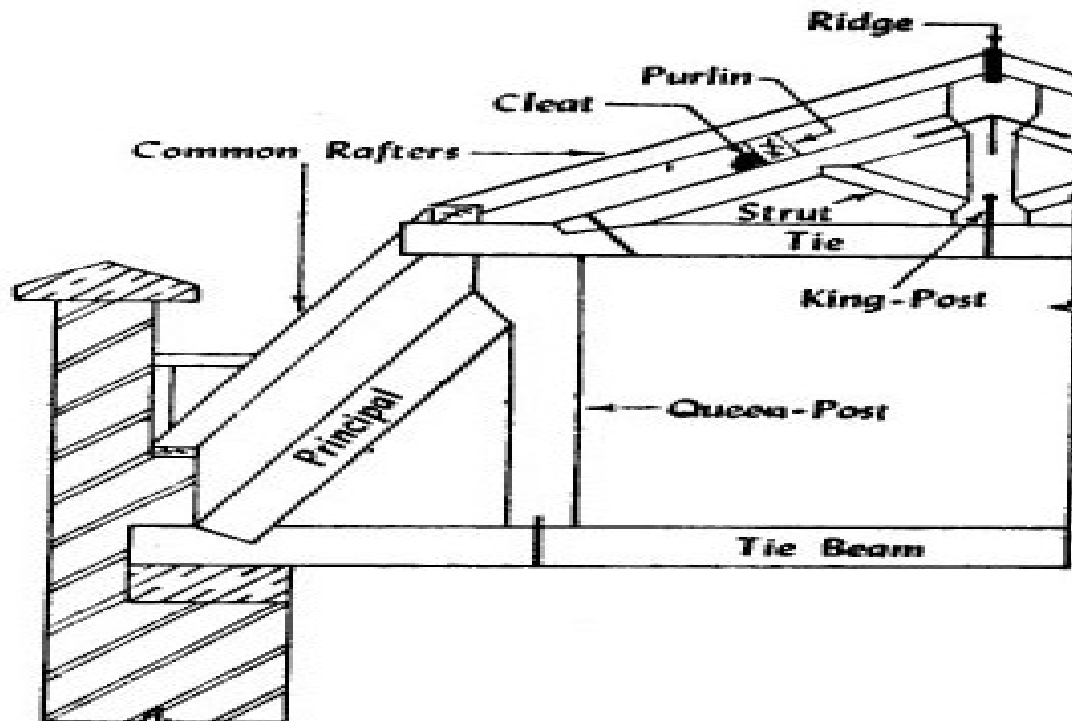


MANSARD TRUSS

- This is a combination of king post and queen post trusses.
- Lower queen post & upper king post trusses.
- Use of mansard trusses results in the economy of space and room may be provided in the room as shown in the figure.



MANSARD TRUSS

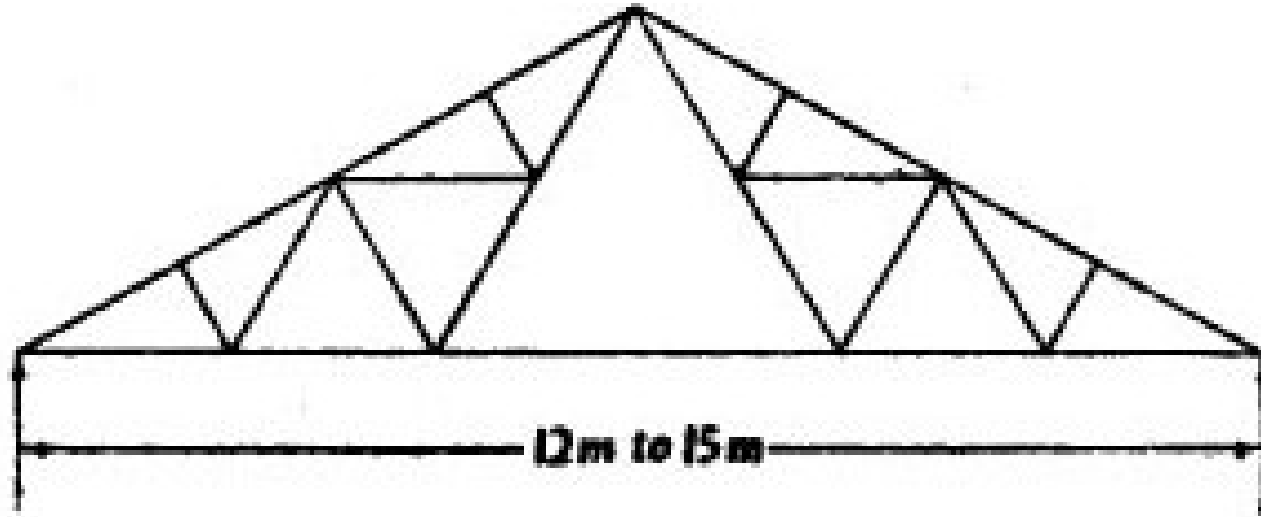


STEEL TRUSS

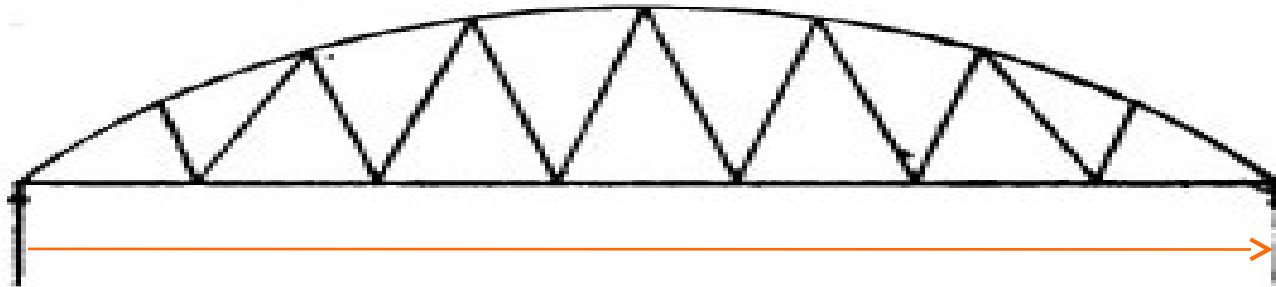
- For spans greater 12m, it becomes economical to use steel trusses.
- For smaller spans, steel trusses consists of angles riveted or welded together through plates known as gusset plates.
- As steel resists both compression and tension stresses, the design of steel truss is simplified various types of steel trusses are shown in Fig.



STEEL TRUSS



Compound Fink Truss

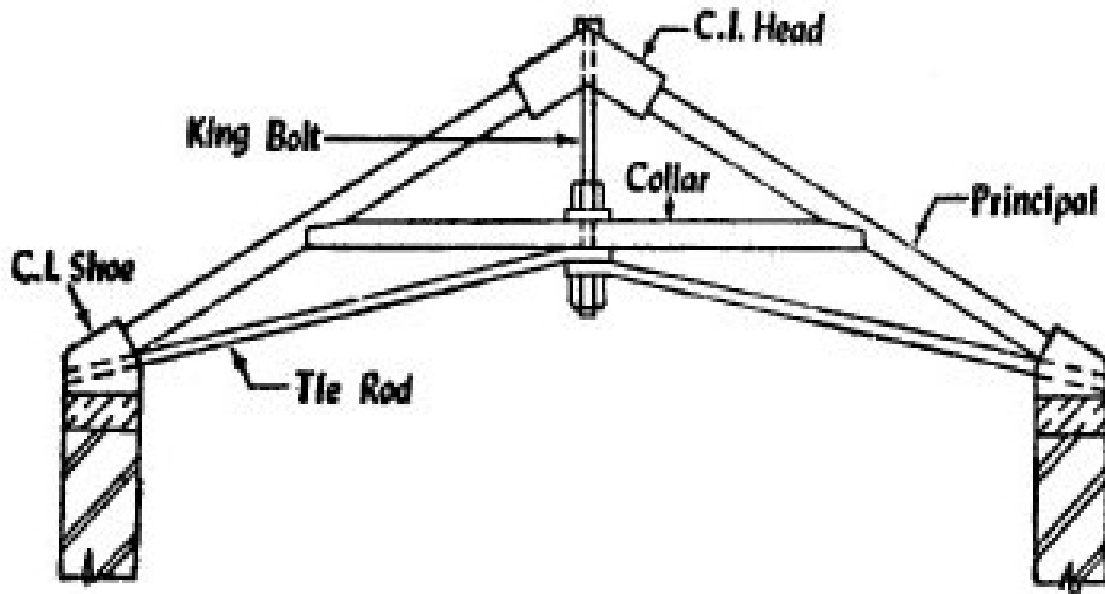


Bow-string truss (20 to 30 m)



COMPOSITE TRUSS

- This truss composed of wooden members and steel. Steel members resist tension. A composite truss is light and economical as shown below.



ROOF COVERING FOR PITCHED ROOF

- Roof covering is an essential part of pitched roof , to be placed over the roof frame work.
- It protect from rain, snow, sun, wind & other atmospheric agencies.
- Selection of roofing materials depends upon:-
 - a) Type of framework
 - b) Initial cost
 - c) Maintenance requirement
 - d) Appearance
 - e) Durability
 - f) Availability
 - g) Climate



ROOF COVERING MATERIALS

- Following are the roof covering materials
 - a) Thatch Covering
 - b) Wood Shingles
 - c) Tiles
 - d) Asbestos cement sheets
 - e) Galvanized corrugated iron sheets
 - f) Light weight roofing



THATCH COVERING

- This is the cheapest roof covering, commonly used in villages.
- It is very light, but is highly combustible.
- It is unstable against high winds. It absorbs moisture & liable to decay.
- The framework to support thatch consists of round bamboo rafters spaced 20 to 30 cm apart & tied with split bamboos laid at right angles to the rafters.
- In order to drain roof effectively a minimum slope of 45° is kept.
- The thickness of thatch covering should at least be 15cm, normal thickness varies from 20 to 30 cm.



THATCH COVERING



THATCH COVERING



WOOD SHINGLES

- It's use is restricted to hilly areas where local timber is easily available at low cost.
- Though it is light weight, it is not fire & termite resistant.
- It is obtained from well seasoned timber.
- They are obtained in lengths varying from 30 to 40 cm & widths varying 6 to 25 cm.
- They are approximately 10mm thick at the tail or butt end and taper to 3mm.



WOOD SHINGLES



TILES

- It is the oldest type of roof covering materials & is still preferred for residential building and country houses.
- This is because country tiles are manufactured from locally available earth.
- Following are the various types of tiles generally used:-
 - A) Plain tiles
 - B) Curved tiles
 - C) Italian or Allahabad tiles
 - D) Interlocking tiles
 - E) Spanish tiles



PLAIN TILES

- Plain tiles are made of clay or concrete, though clay are more common.
- Plain or flat tiles are manufactured in rectangular shapes, of sizes varying from 25cm X 15 cm to 28 cm X 18 cm, with thickness from 9 mm to 15 mm.
- The tiles are not perfectly flat, but have slight camber of 5 to 10 mm in their length.
- Before laying the tiles, common rafters are laid at 20 to 30 cm spacing.
- Battens are then fixed across the rafters at a spacing 4 to 6cm.



PLAIN TILES



PLAIN TILES



CURVED OR PAN TILES

- Pan tiles are 33 to 36 cm long, 22.5 to 25 cm wide and 12 to 19 mm thick.
- They are flat longitudinally, but are curved transversely to a flat wave or S-curve.



CURVED OR PAN TILES



SPANISH TILES

- This tiles are commonly used in villages.
- These tiles are laid in pairs of under-tiles and over-tiles.
- The under-tiles are laid with concave surface upwards while the over-tiles are laid with convex surface upwards.



SPANISH TILES

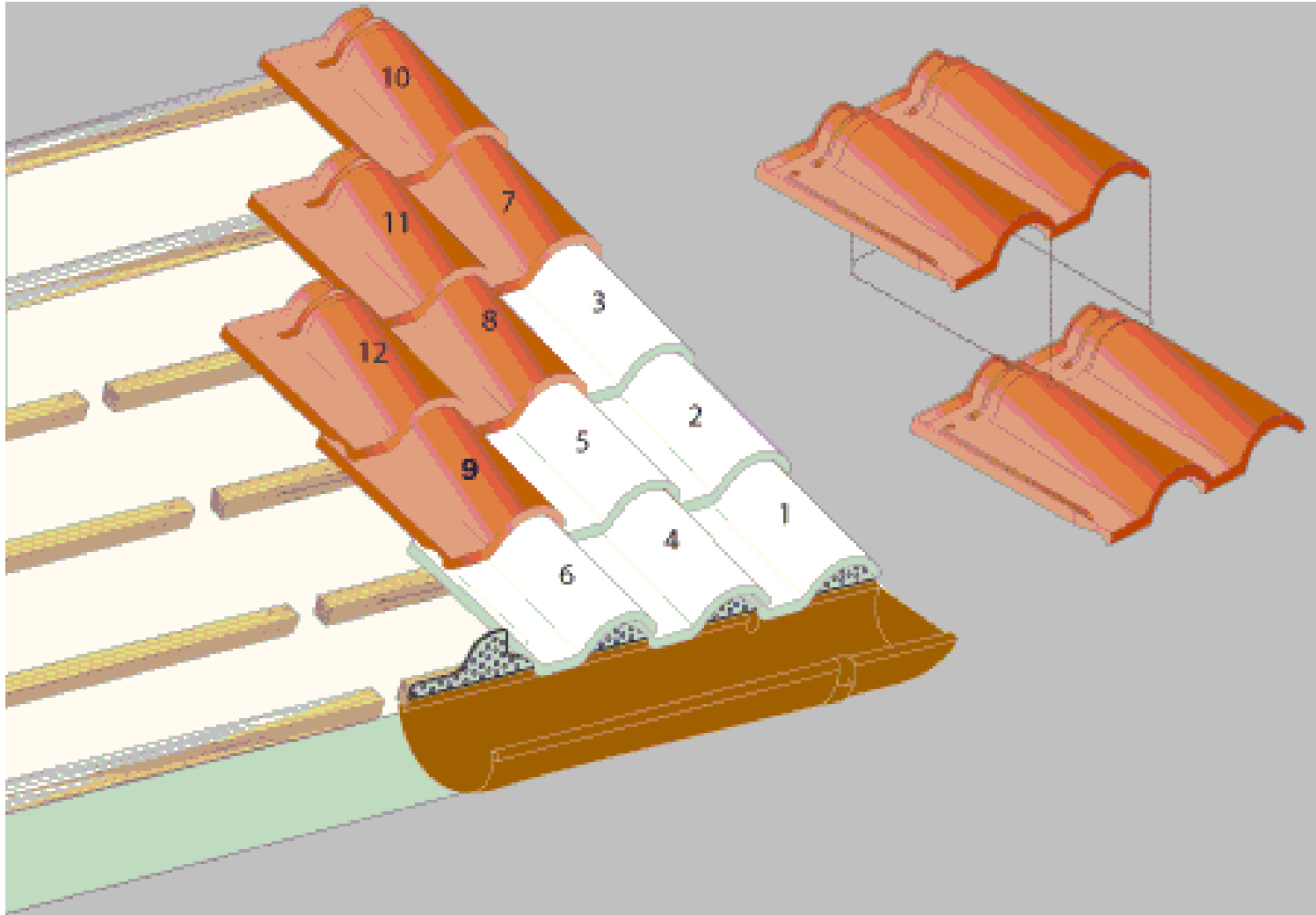


ITALIAN OR ALLAHABAD TILES

- These tiles are also used in pairs- flat broad bottom under-tile which alternate with convex curved over-tile.
- The under-tile is flat, tapered with upturned edges or flanges at the sides.



ITALIAN OR ALLAHABAD TILES



INTER-LOCKING TILES

- These tiles are available with patent locking devices, the object of which is to prevent their dislodgment even in most exposed condition.
- These tiles are machine made.



INTER-LOCKING TILES



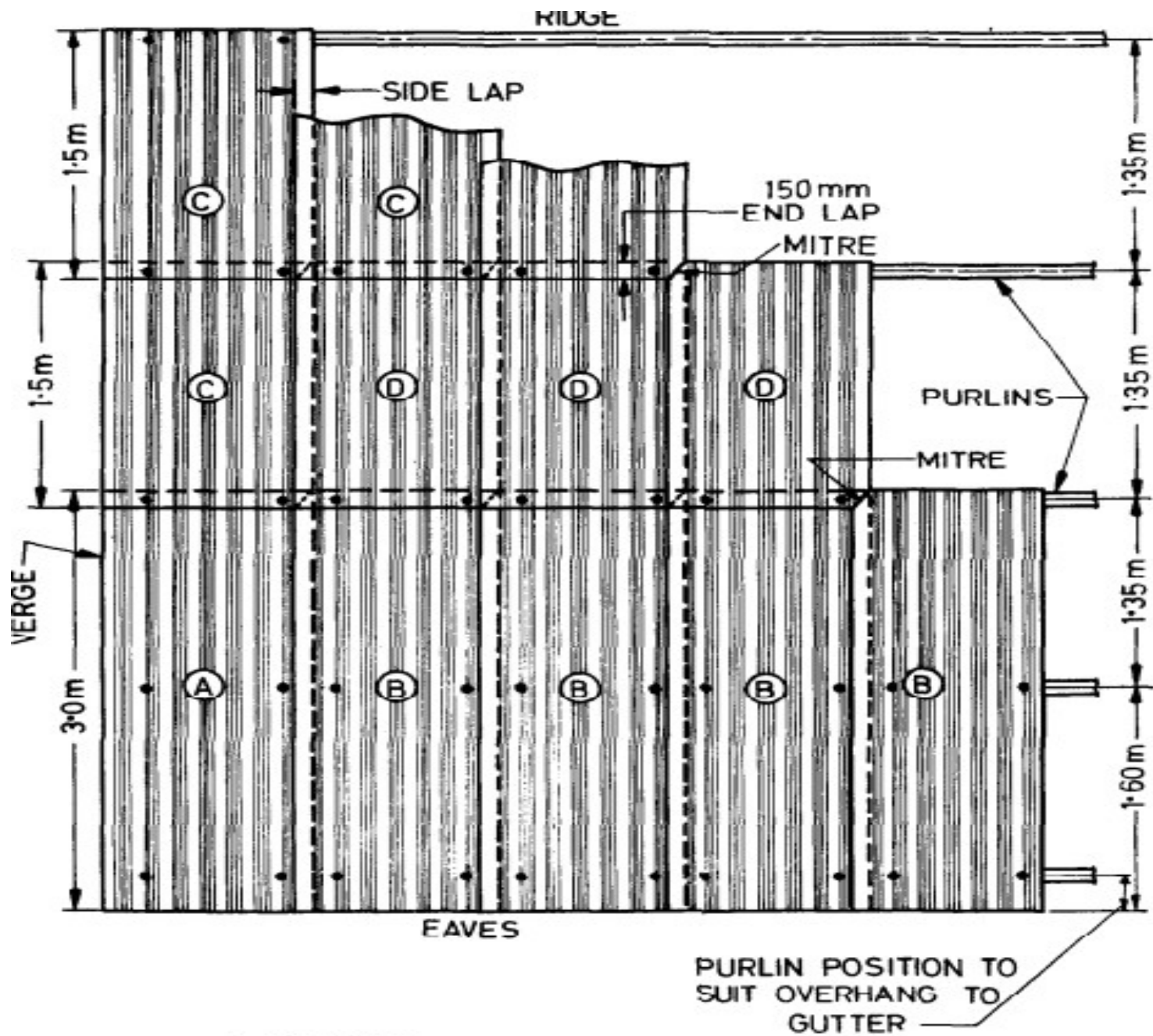
ASBESTOS CEMENT SHEETS

- These sheets are manufactured from asbestos fiber (@ 15%) & Portland cement.
- These sheets are now becoming popular for industrial buildings, factories, sheds, auditorium & even residential building.
- They are cheap, light weight, tough, durable, water tight, fire-resisting.
- The main advantage is that they are available in bigger units, hence supporting frame is also cheaper, easier and lighter.
- These sheets do not require any protective paint.
- Construction with A.C. sheets are very fast.



ASBESTOS CEMENT SHEETS

- Following points should be noted while fixing A.C. sheets:-
- The A.C. sheets should be laid with smooth side upward.
- End lap and side lap should be properly maintained. General end lap is 15cm but this can be varied to suit purlin spacing.
- Purlin spacing and length of sheets should be properly checked before linked.
- The holes for fixing accessories should be drilled (not punched) in the crown of the corrugations. The diameter of the holes should be 3 mm greater than the diameter of the fixing bolt or screw. Thus 8mm dia. drilled holes and screwed lightly.



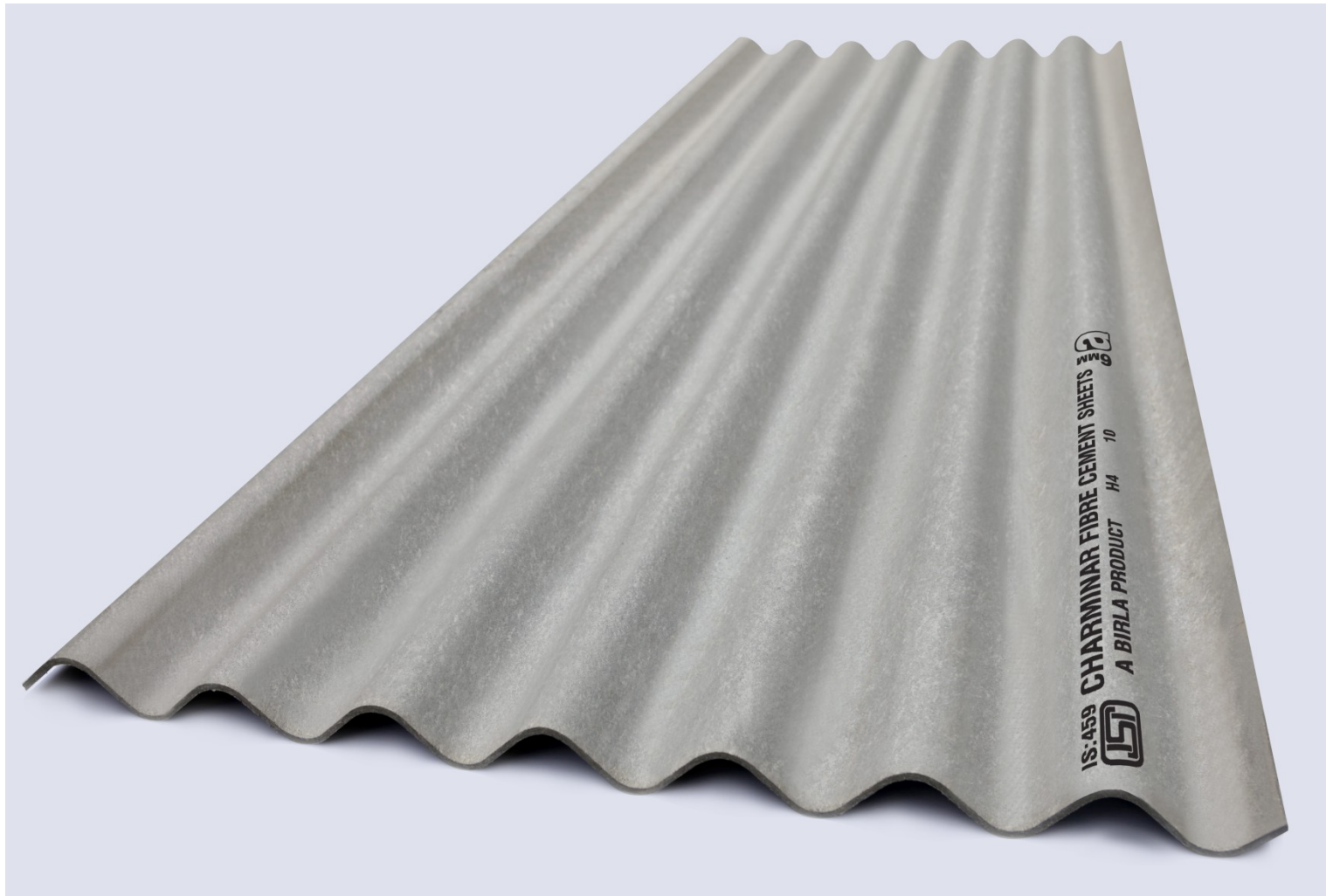
A - Layout sheet

ASBESTOS CEMENT SHEETS

- Bitumen washers should be provided under G.I. flat washer. The nuts of the screws or bolts are moderately tightened when 10 to 12 sheets have been laid. They should not be screwed very tight.
- Ridge capping should be secured to the ridge purlin.
- The sheets should be 'mitred' properly as required.
- The unsupported overhang of A.C. sheets should not exceed 30cm.



ASBESTOS CEMENT SHEETS



GALVANIZED IRON CORRUGATED SHEETS (G. I. SHEETS)

- G.I. sheets are also widely used.
- They are stronger than A.C. Sheets.
- Due to higher cost, they are replaced by A.C. sheets.
- They are not used for slopes flatter than 1 in 4.
- G.I. sheets are made from iron sheets which are galvanized with zinc to protect them from rusting action of water & wet weather.
- These sheets are fixed in a manner similar to A. C. sheets.



LIGHT WEIGHT ROOFING

- The wide span industrial structures, it is desirable to reduce the weight of roof , so that structural framing can be economical.
- The light weight roofing materials are of two types:-
 - A) Sheeting:-
 - i) Aluminum Sheet
 - ii) Asbestos cement sheet
 - B) Decking:-
 - i) Wood Wool
 - ii) Straw board
 - iii) Aluminum alloy and Steel decking



WOOD WOOL

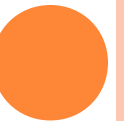
- It is made from wood fibres interwoven together & cement bonded under pressure in mould.
- They are available in the form of slabs, having thickness 12 to 100mm, 0.6m width & up to 3.9m length.
- It has good sound absorbing & thermal insulation properties.



WOOD WOOL



WOOD WOOL CEMENT BOARD



WOOD WOOL



STRAW BOARD



ADVANTAGES OF STEEL TRUSSES OVER TIMBER TRUSSES.

- The sections comprising of a steel truss are readily available in the required dimensions, resulting in minimum wastage of material.
- Steel trusses are light in weight and can be fabricated in any shape depending upon structural and architectural requirements.
- Steel trusses are stronger and more rigid in comparison to timber trusses. The members are equally strong in tension as well as in compression.
- Steel trusses can be used over any span, while timber trusses are suitable only up to 15m span.



ADVANTAGES OF STEEL TRUSSES OVER TIMBER TRUSSES

- Steel trusses are fire proof.
- Steel trusses are termite proof.
- Steel trusses are most resistant to other environmental agencies and have longer life.
- The fabrication of steel trusses is easier and quicker since the sections can be machined and shaped in the workshop and then transported to the construction site for erection.



FLAT ROOF

- A roof which is nearly flat is known as flat roof.
- It should be noted that no roof can be laid perfectly level.
- The roof must slope in one direction or the other to cause rain water to flow off rapidly and easily.
- The construction of flat roof is same as that of floors except that the top surface is made slightly sloping in case of flat roofs.



ADVANTAGES OF FLAT ROOFS

- The roof can be used as terrace for playing, gardening, sleeping and for celebrating functions.
- Construction and maintenance is easier.
- They can be easily made fireproof in comparison to pitched roof.
- They avoid the enclosure of the triangular space. Due to this, the architectural appearance of the building is very much improved.
- Flat roofs have better insulating properties.



ADVANTAGES OF FLAT ROOFS

- They require lesser area of roofing material than pitched roofs.
- They are more stable against high winds.
- They do not require false ceiling, which is essential in pitched roof.
- Flat roofs are proved to be overall economic.
- In multistoried buildings, the flat roof is only choice. Since overhead water tanks and other services are located on the terrace.
- The construction of upper floors can be easily done over flat roofs, if so required in future.



DISADVANTAGES OF FLAT ROOFS

- They are vulnerable to heavy temperature variations, specially in tropics, due to which cracks are developed on the surface. These cracks may lead to water penetration latter, if not repaired in time.
- It is difficult to locate and rectify leak in flat roof.
- The speed of flat roof construction is much slower than the pitched roof.
- The initial cost of flat roof is more than pitched roof.
- The flat roofs exposes the entire building to the weather agencies, while the projecting elements of pitched roofs provide some protection to the building.



DISADVANTAGES OF FLAT ROOFS

- The span of flat roof is restricted, unless intermediate columns are introduced. Pitched roofs can be used over large spans without any intermediate column.
- The self weight of flat roof is very high. Due to this the sizes of beams, columns, foundations and other structural members are heavy.
- They are unsuitable at the places of heavy rainfall.
- They are highly unsuitable to hilly areas or other areas where there is heavy snowfall.

