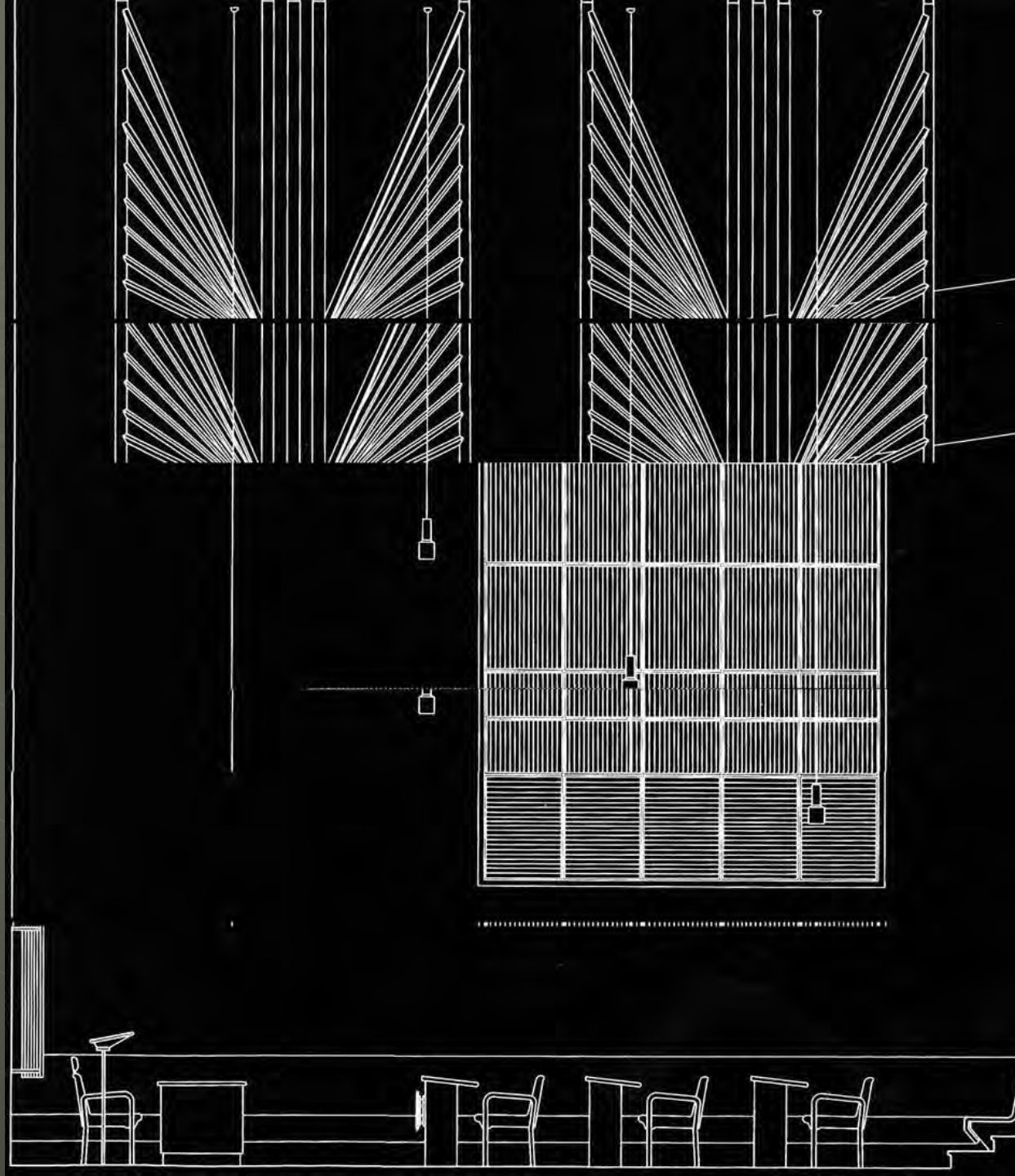
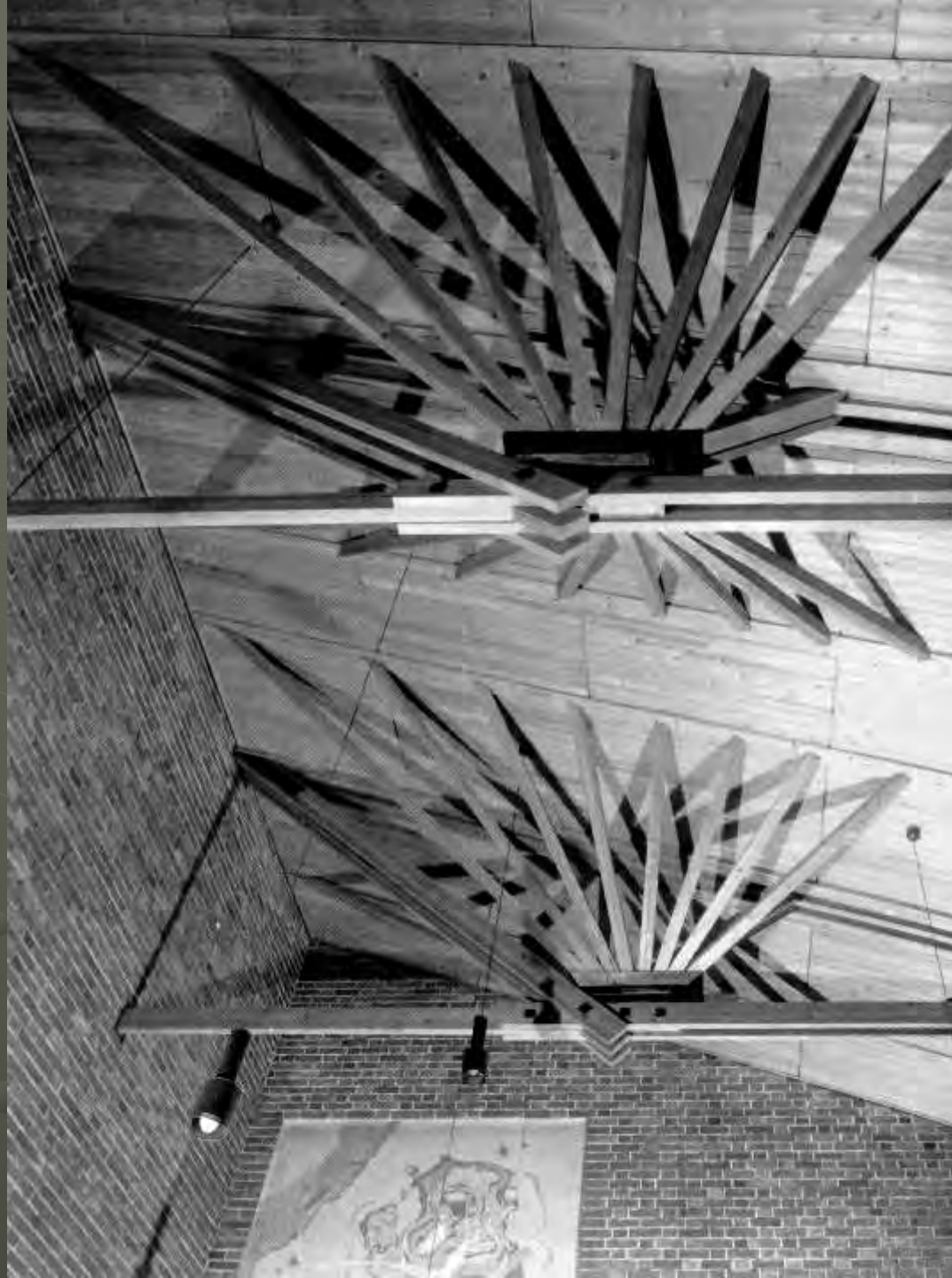


Technology and Environment 1

TIMBER ROOF STRUCTURES





Learning Outcomes

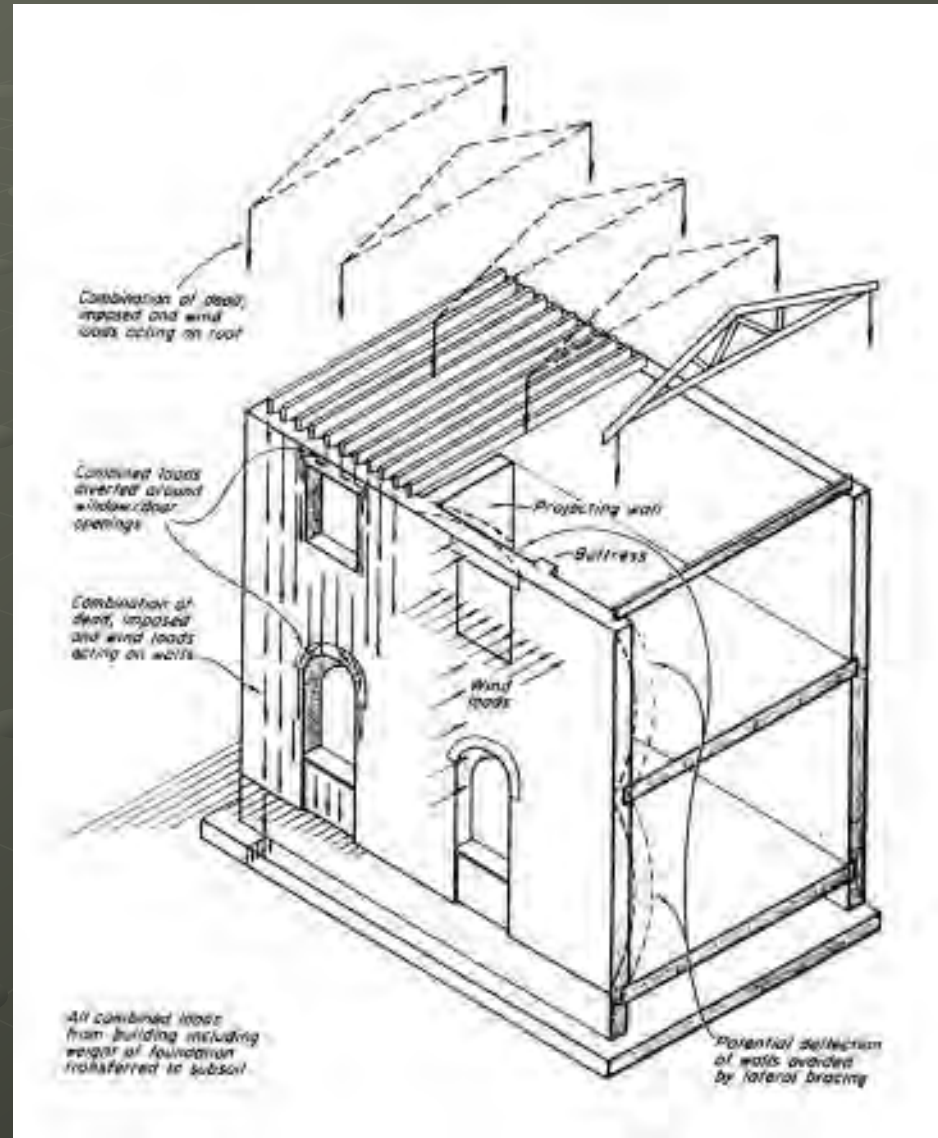
Aim

- To introduce the topic area of pitched roof construction for low rise domestic buildings.
- Become familiar with the basic design requirements
- **Learning objectives**
- Identify the design requirements for roof constructions and apply the knowledge to the development of studio and course work

Roof Functions

● Function

- Weather resistance - protection against rain and snow penetration and wind
- Structural support - support its own weight and the wind and snow loads imposed on it.
- Fire resistance - protection against spread of fire
- Insulation - provide insulation and a sealed envelope to the building, while avoiding condensation.
- Durability - should be designed to last in terms of choice of materials and detail design



Roof Types

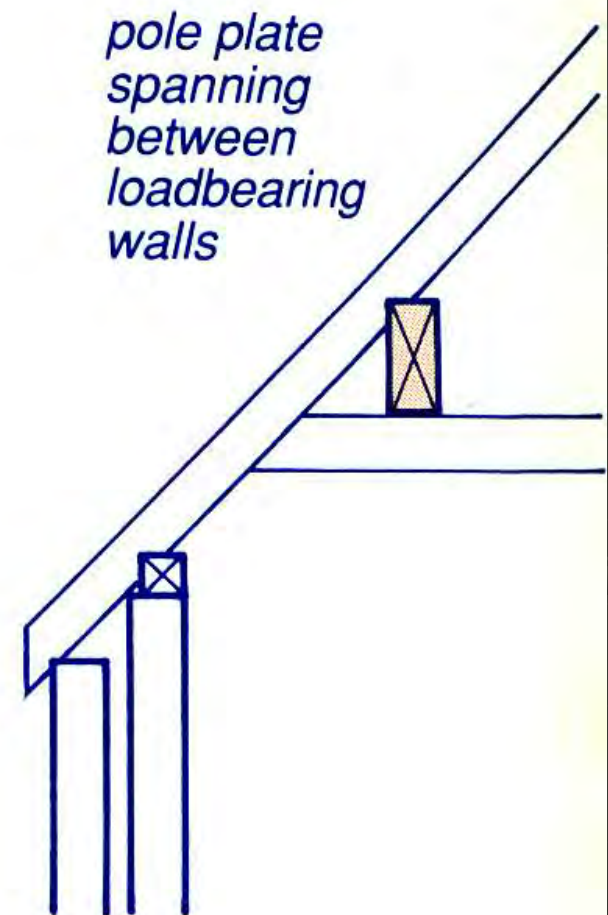
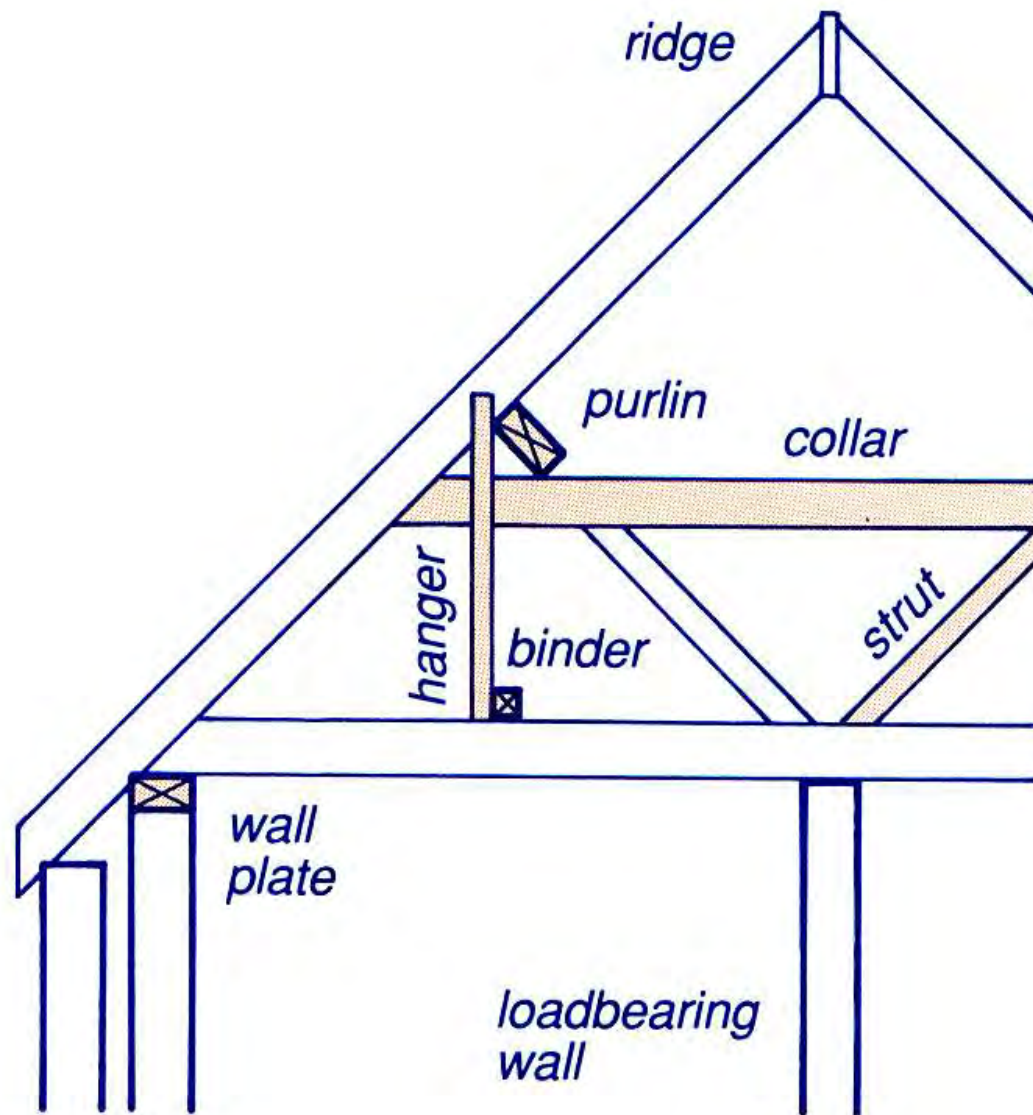
- 1. Pitched roof -are considered to have a pitch of between 10° and over 45° .
- 2. Flat roof – slope under 10°
- 3. Alternatives include - domes, vaulted roofs etc

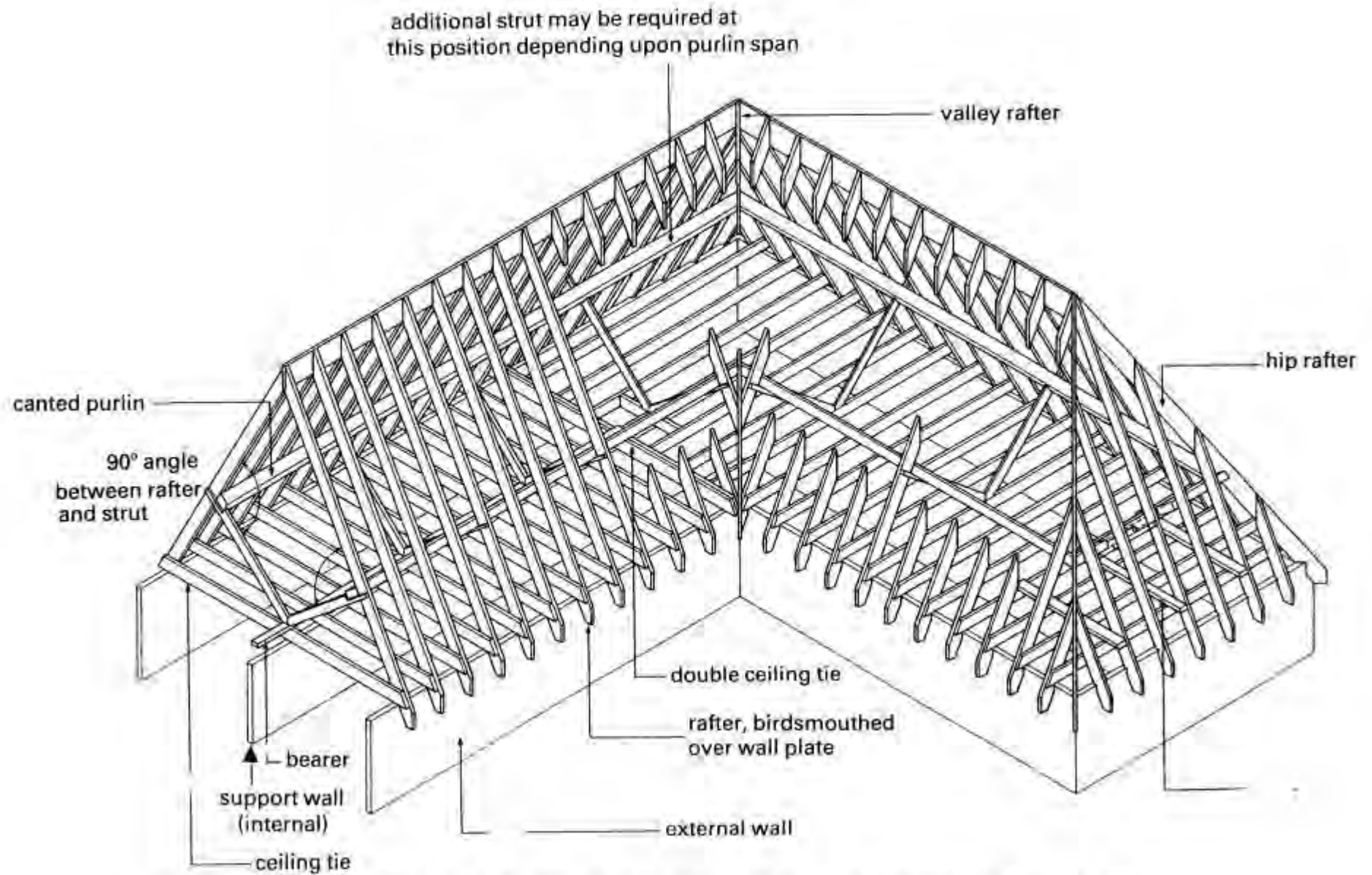
Hill House



Terminology

- Rafters - are the main sloping structural members of a roof
- Purlins - are the horizontal roof members that give the rafters intermediate support
- Ridge - is the highest horizontal element of the roof where the rafters meet
- Eaves - is the lowest section of the roof that overhangs the wall construction





Typical construction of purlin roof with strut, showing hip and valley details

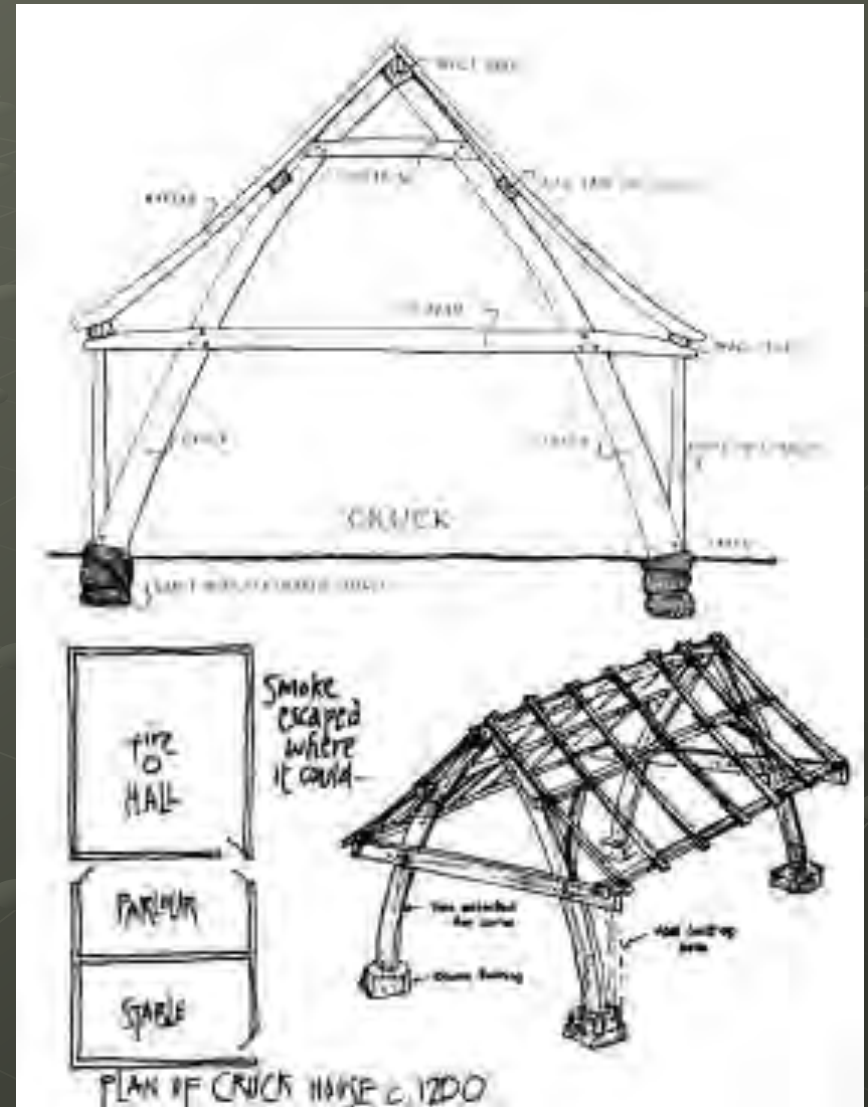
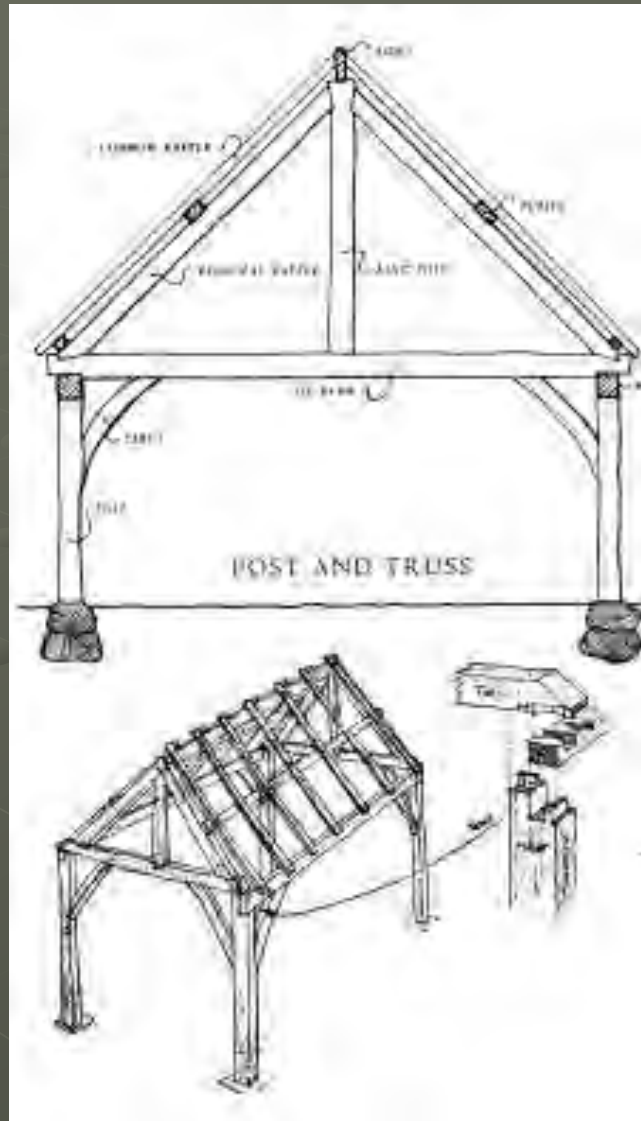


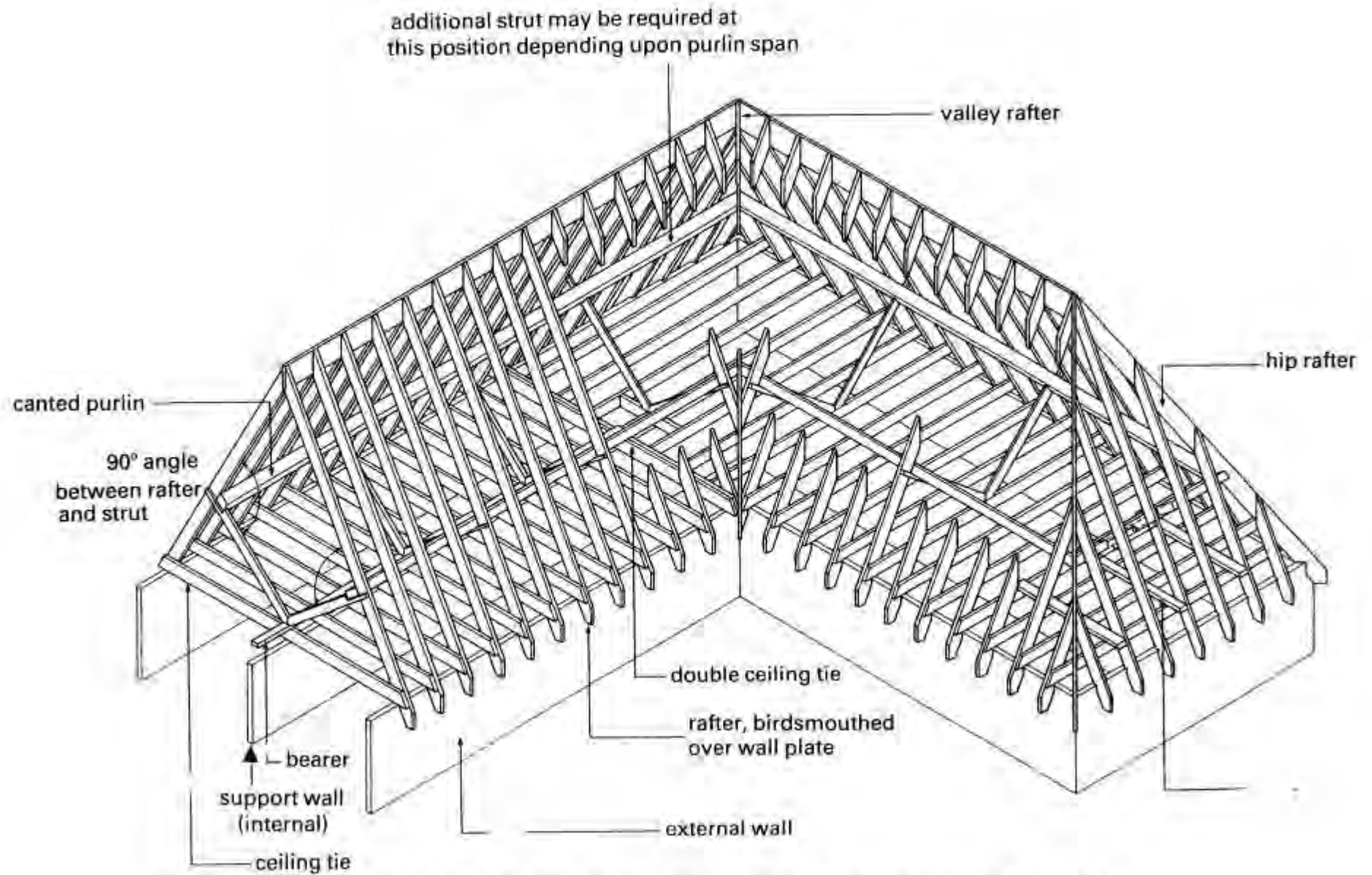
CUT ROOF

Cut roof construction

- Pitched roofs of timber constructions can be designed and constructed in a number of ways.
- Traditionally they were constructed on site with each piece cut and fitted to its neighbours.
- This type of construction requires considerable constructional skill and tends to use more material.

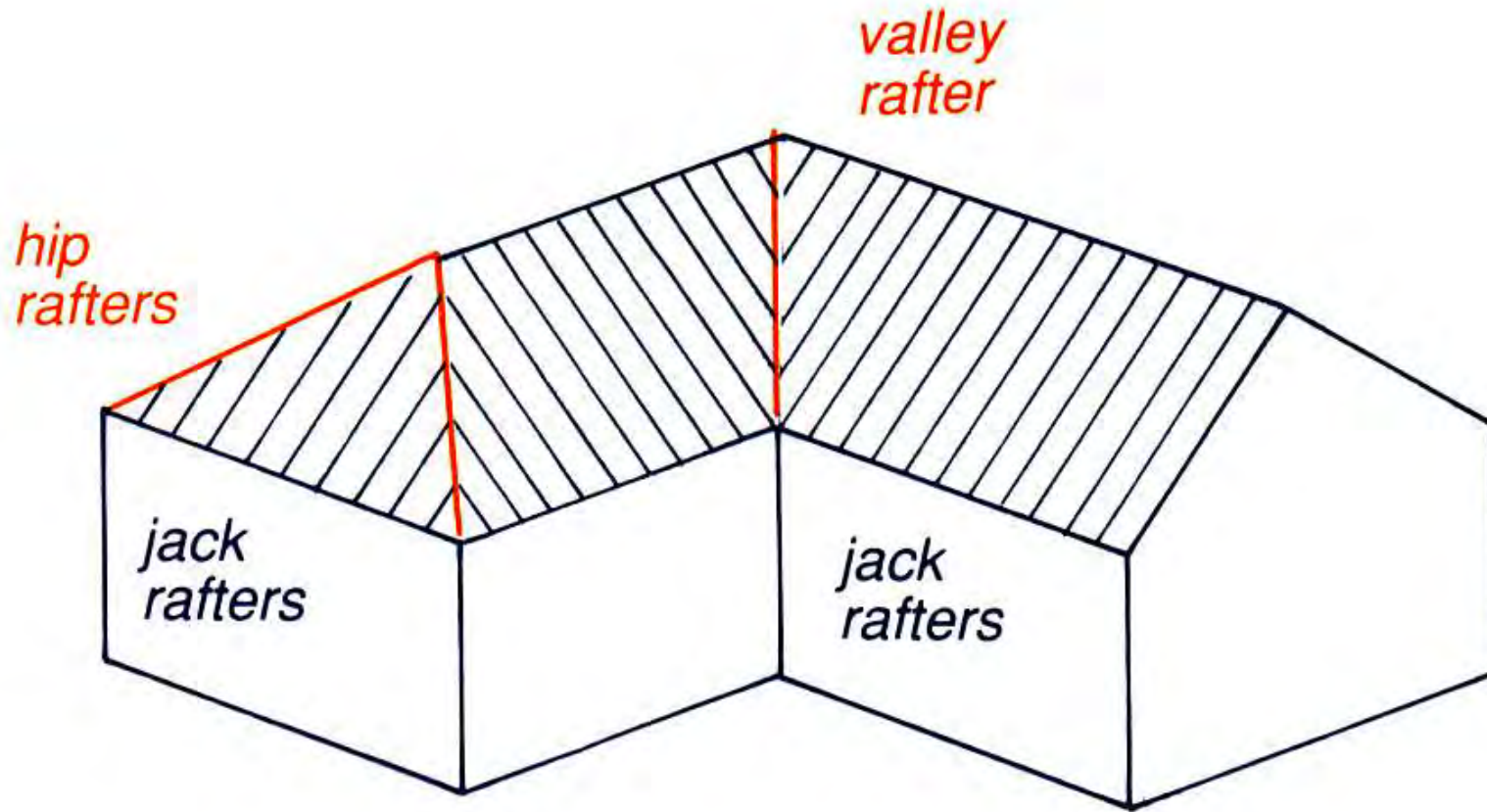
Early Timber Frame Construction





Typical construction of purlin roof with strut, showing hip and valley details

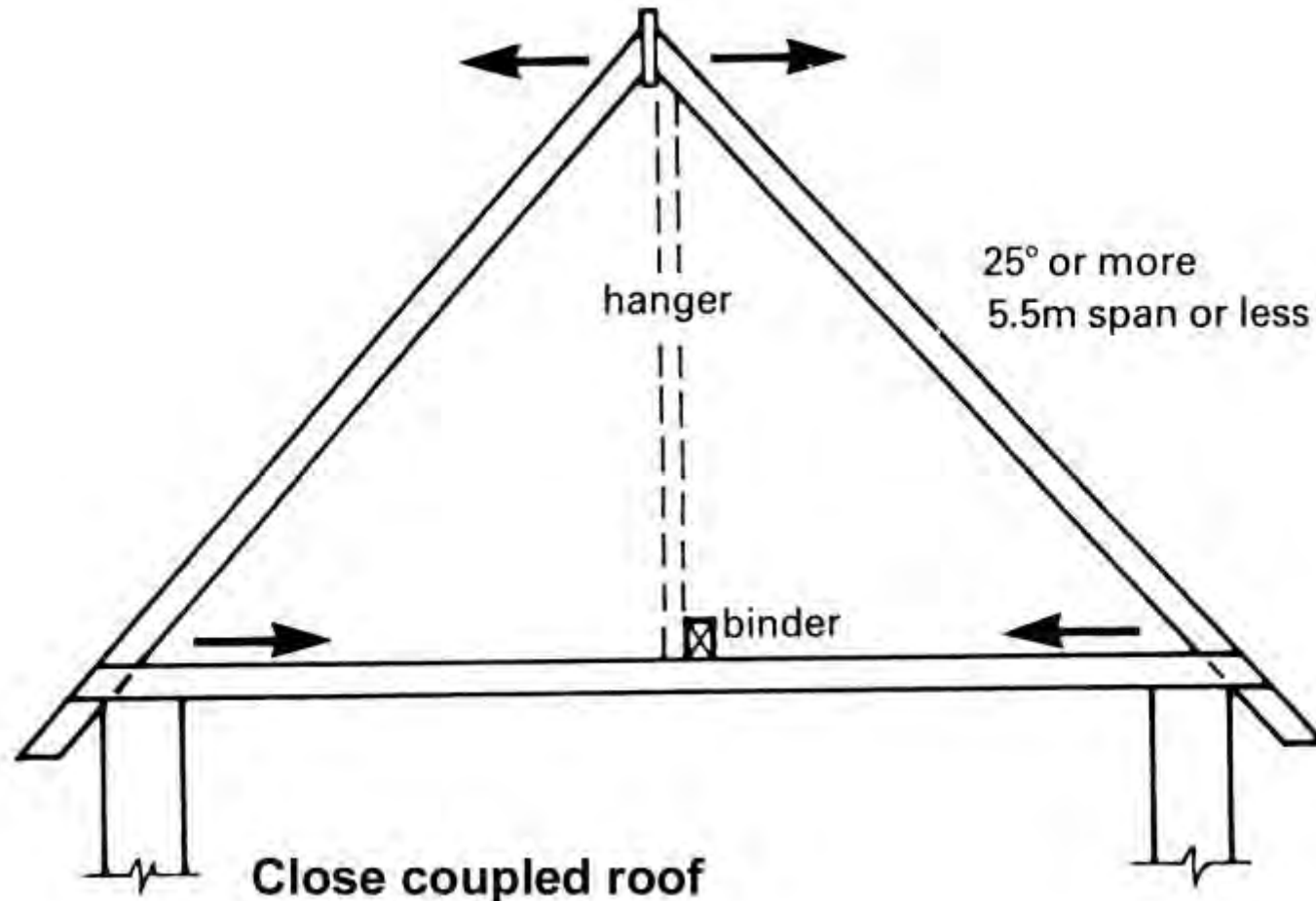
Hip, valley and gable



Modern Speculative Housing

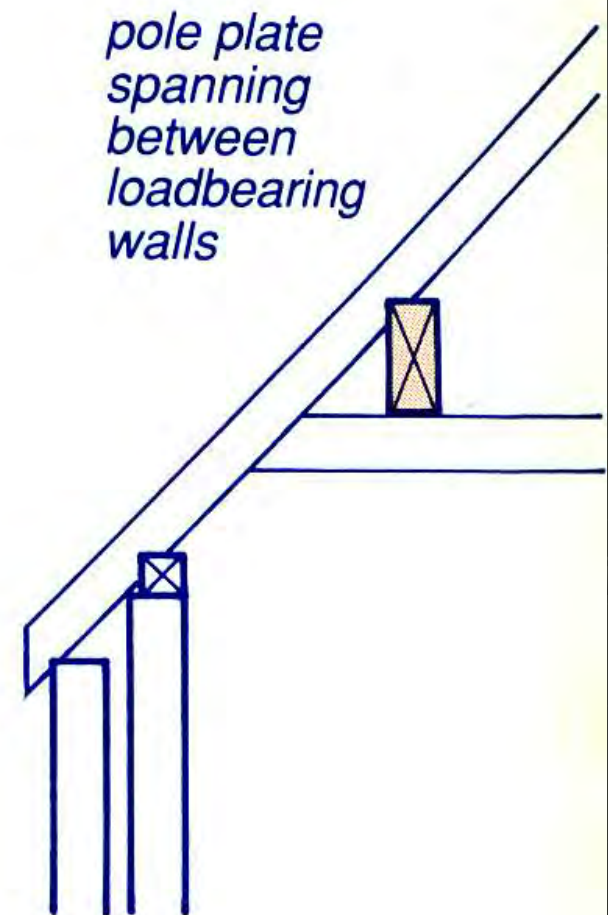
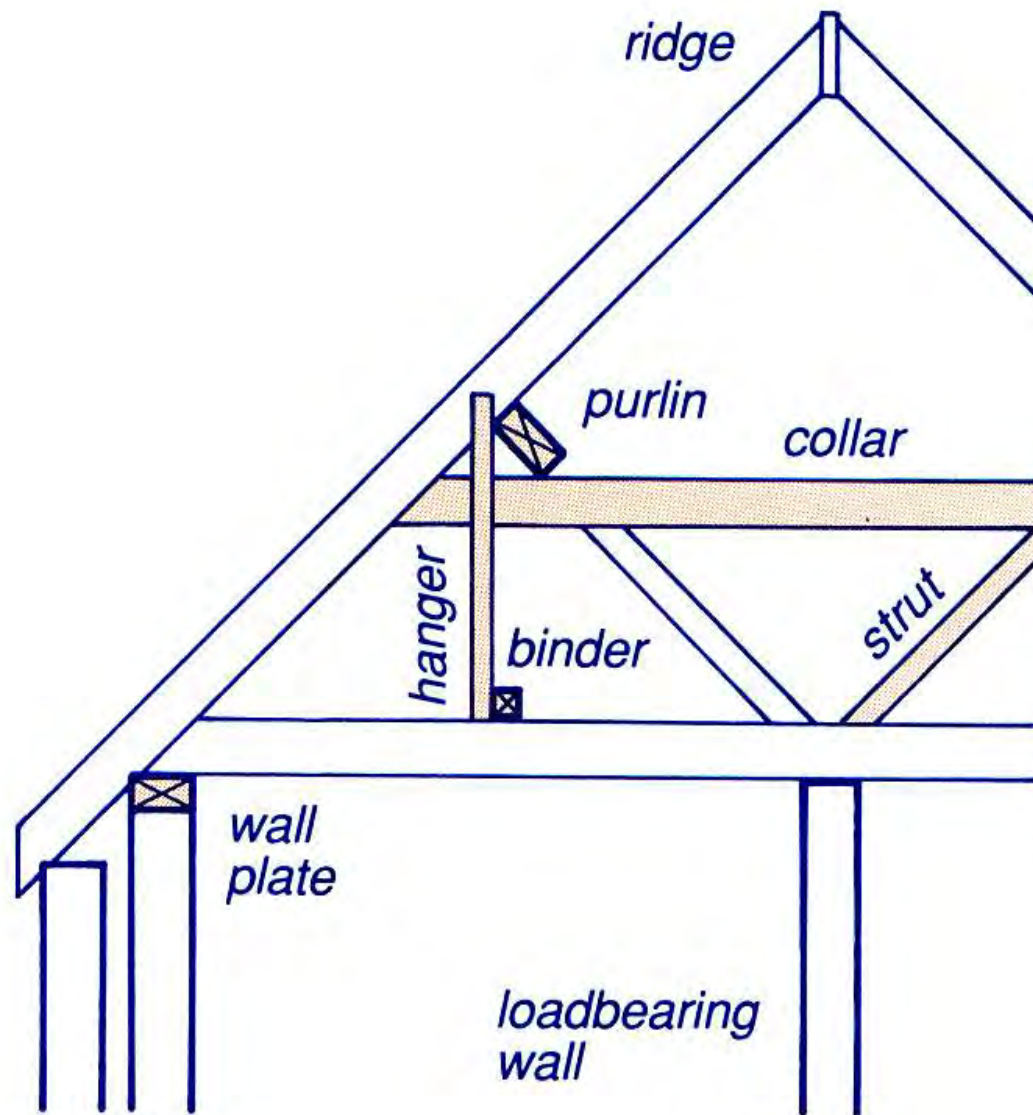


- Simplest form is the close coupled roof
- rafters bearing against each other at the ridge board with the load and the thrust at the eaves being resisted by the lateral strength of the wall.
- This form is little used now as modern lightweight cavity wall construction is unlikely to be adequate except for smallest spans.



Roof spans

- The larger the span the roof has to bridge, the more complex the roof structure and the more ties or collars are required to prevent the roof structure from sagging.
- Where additional support may be required intermediate *struts* may be used to transfer the weight of the roof on to intermediate walls.





TRUSSED ROOF

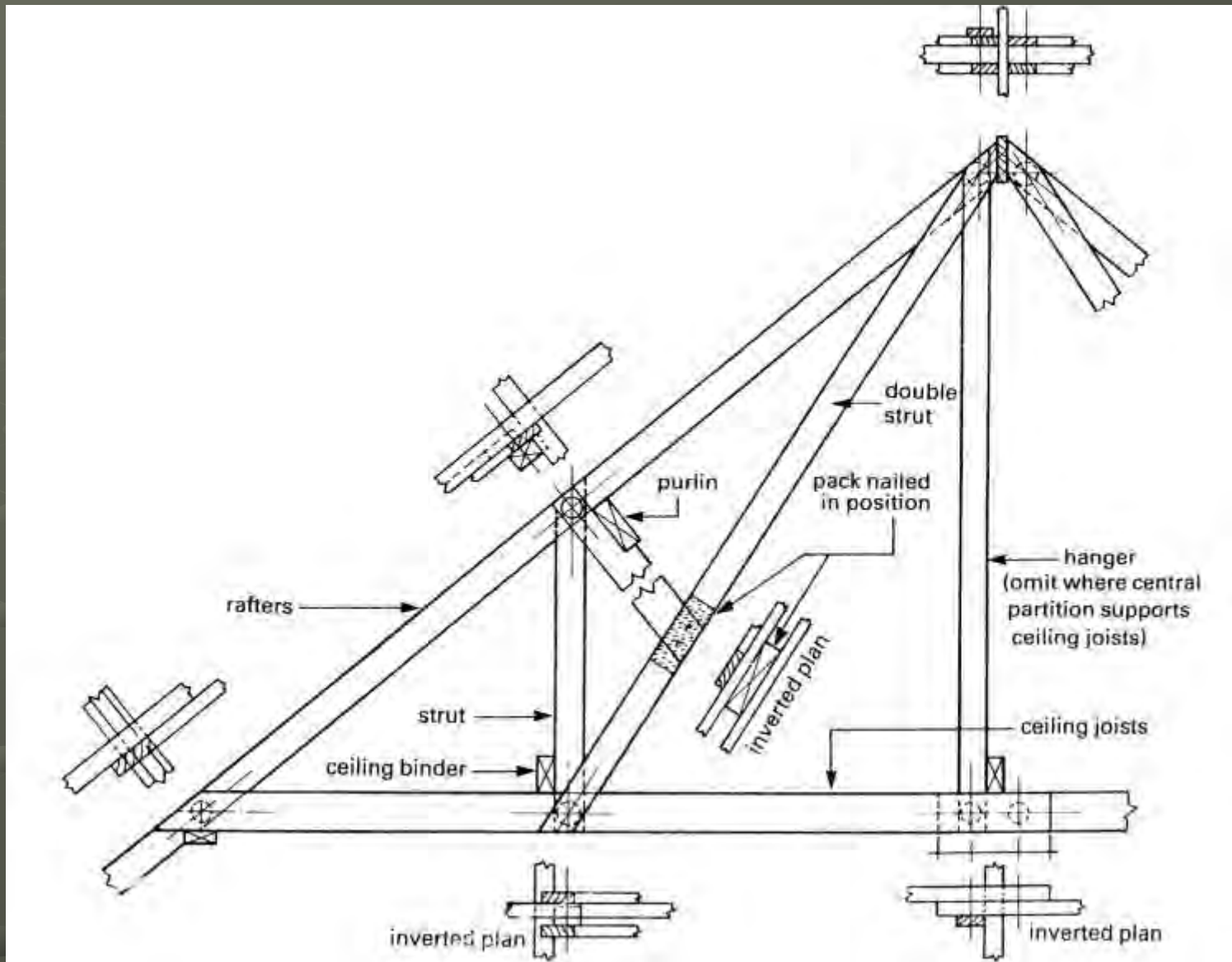
Trusses

- In order to simplify the geometry and speed of construction:
- Various forms of pre fabricated trusses were developed with the intermediate rafters and purlins cut and fitted on site.

Roof trusses

- For the largest spans *roof trusses* are used to provide the required support.
- *Roof trusses* are essentially stiff triangular frames that are supported on the external walls of a building.
- NOTE: trusses of whatever kind do not constitute roofs - they have to be integrated with the roof structure in its entirety.

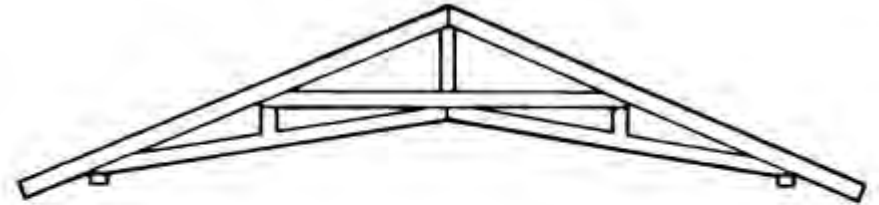
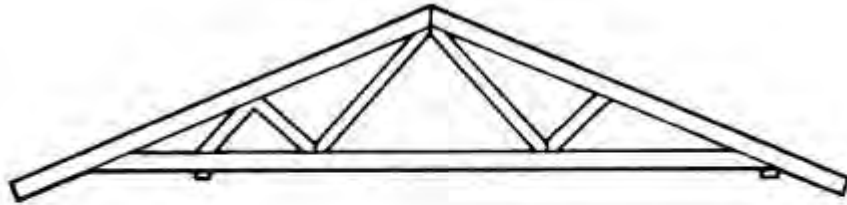
TRADA Truss



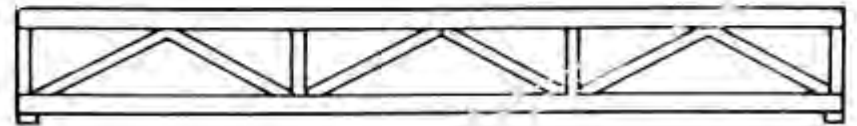
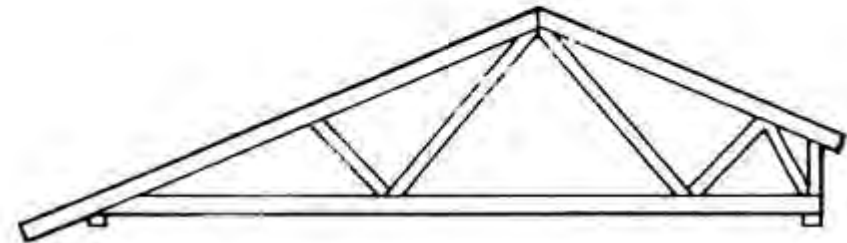
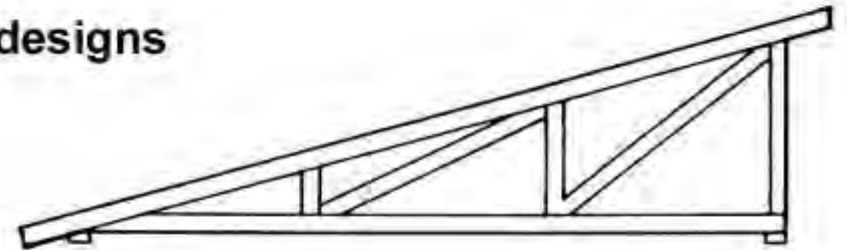
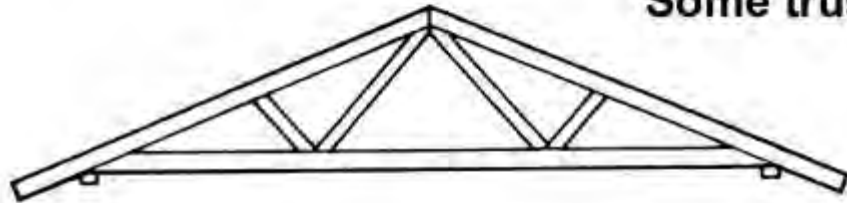
Trussed rafter roof

- The introduction of this type of roof from the United States in the early 1960s has effectively revolutionized the construction of roofs.
- Each trussed rafter consists of the sloping rafter members plus a ceiling member and the necessary intermediate framework (web members), the individual timbers being jointed with punched metal plate fasteners.

Roof truss designs



Some trussed rafter designs

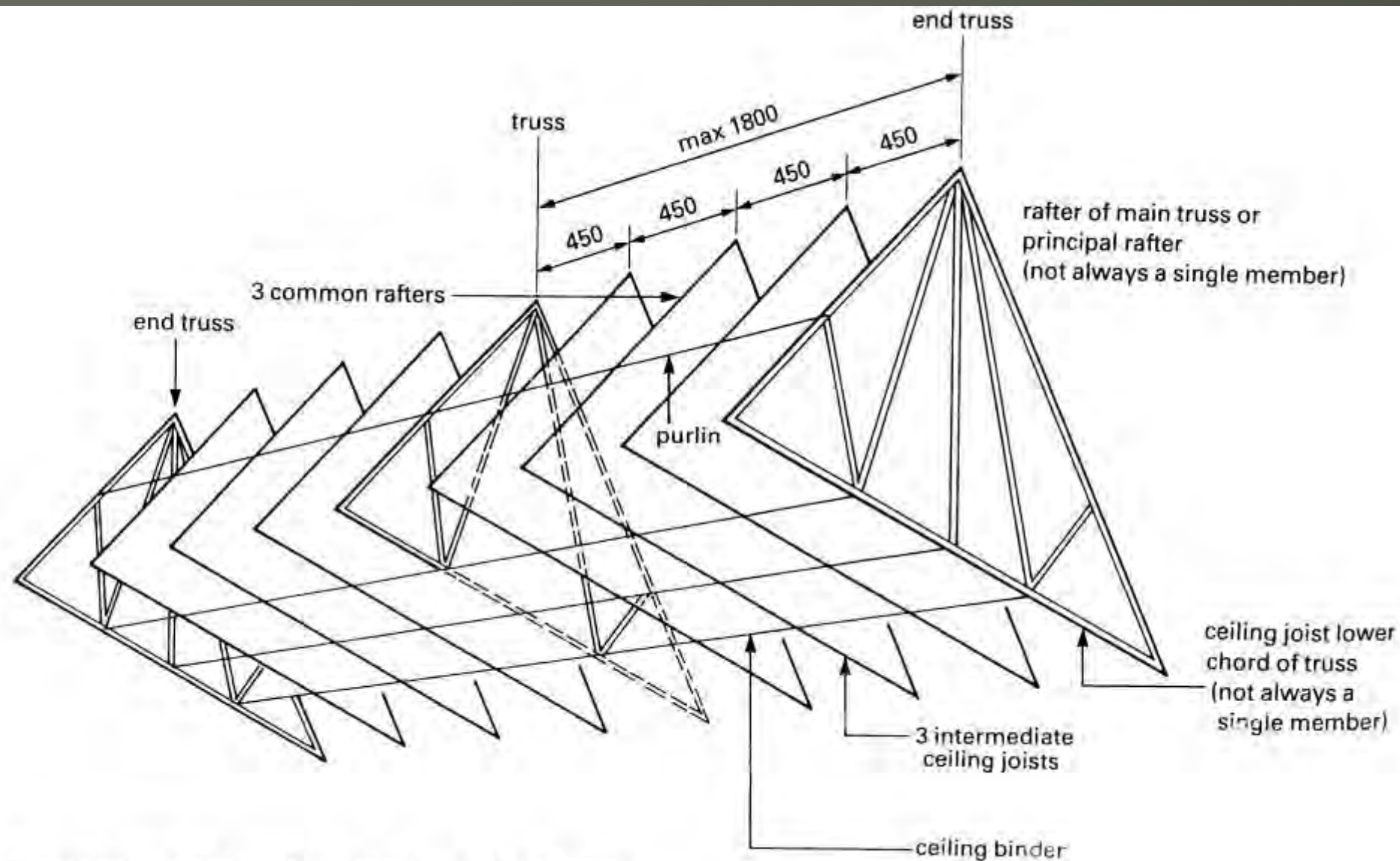


Roof trusses

- Modern trusses are often prefabricated off site (either entirely or partially) and can be installed at 1.8m centres with common rafters at 400mm centres.
- The main disadvantage of trussed roofs is that the roof space is difficult to use. Increasingly prefabricated roof panels are used to form roof structures; these leave the roof structure free for use.
- Trusses can be made in timber (mainly for domestic work) and also in steel (mainly for commercial buildings).
- The design principles are the same for both materials.

Trussed rafter construction

- Trussed rafters are fabricated from stress graded timber which is normally regularized to a constant thickness of 35 mm although thicker sections can be used if specified.
- The connector plates are punched from pre-galvanized steel plate or from stainless steel plate of approximately 1.0mm thickness



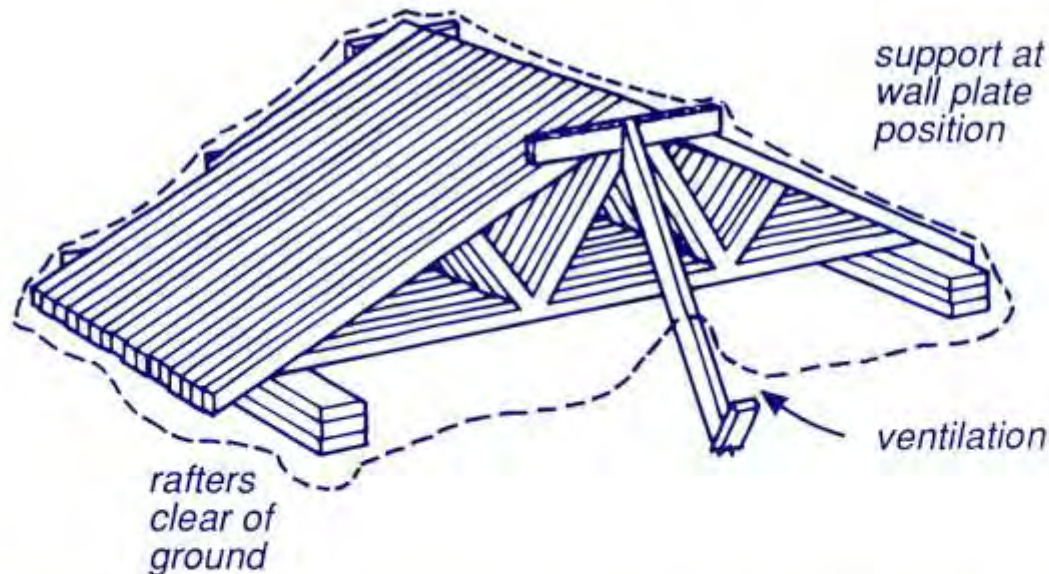
Typical TRADA standard roof design

Trussed rafters

- The timber members can be preservative treated if required.
- The largest normal span for trussed rafters is 16-18 metres although larger spans have been produced, the limitation being as much controlled by transportation and handling difficulties as by the structural requirements.
- The designer must provide details of the required span, the pitch, the tile load and details of tanks or other loads to be carried.
- Trussed rafters are normally spaced at either 450 or 600 mm centres.

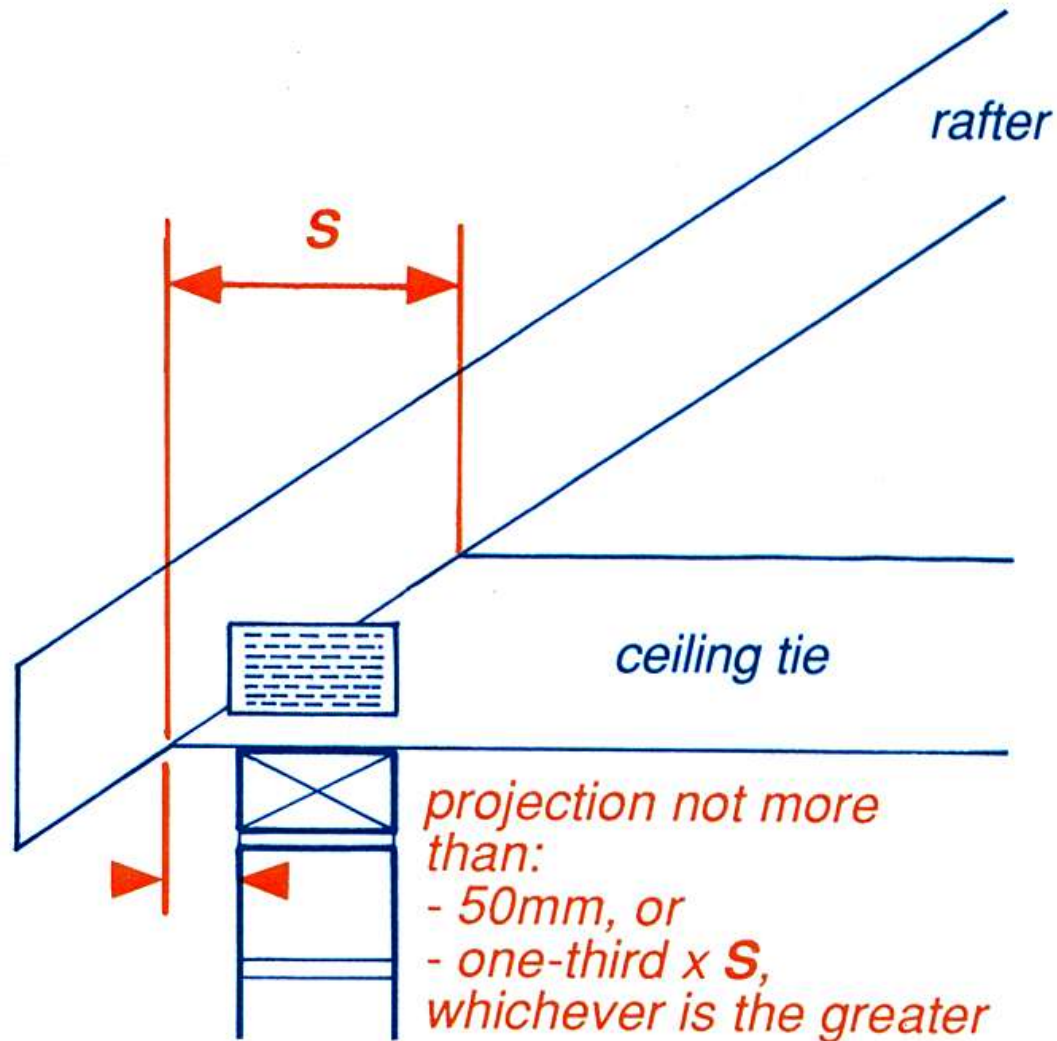
To avoid distortion and prevent damage, trussed rafters should be stored clear of the ground, either flat on level bearers placed under joints (for short term storage) or vertically and propped (for long term storage).

Trusses should be protected against weather to prevent corrosion of truss plates and deterioration of the timber. Ventilation should be provided.



Any damaged trussed rafters or trussed rafters with loose plates should be rejected, not repaired.

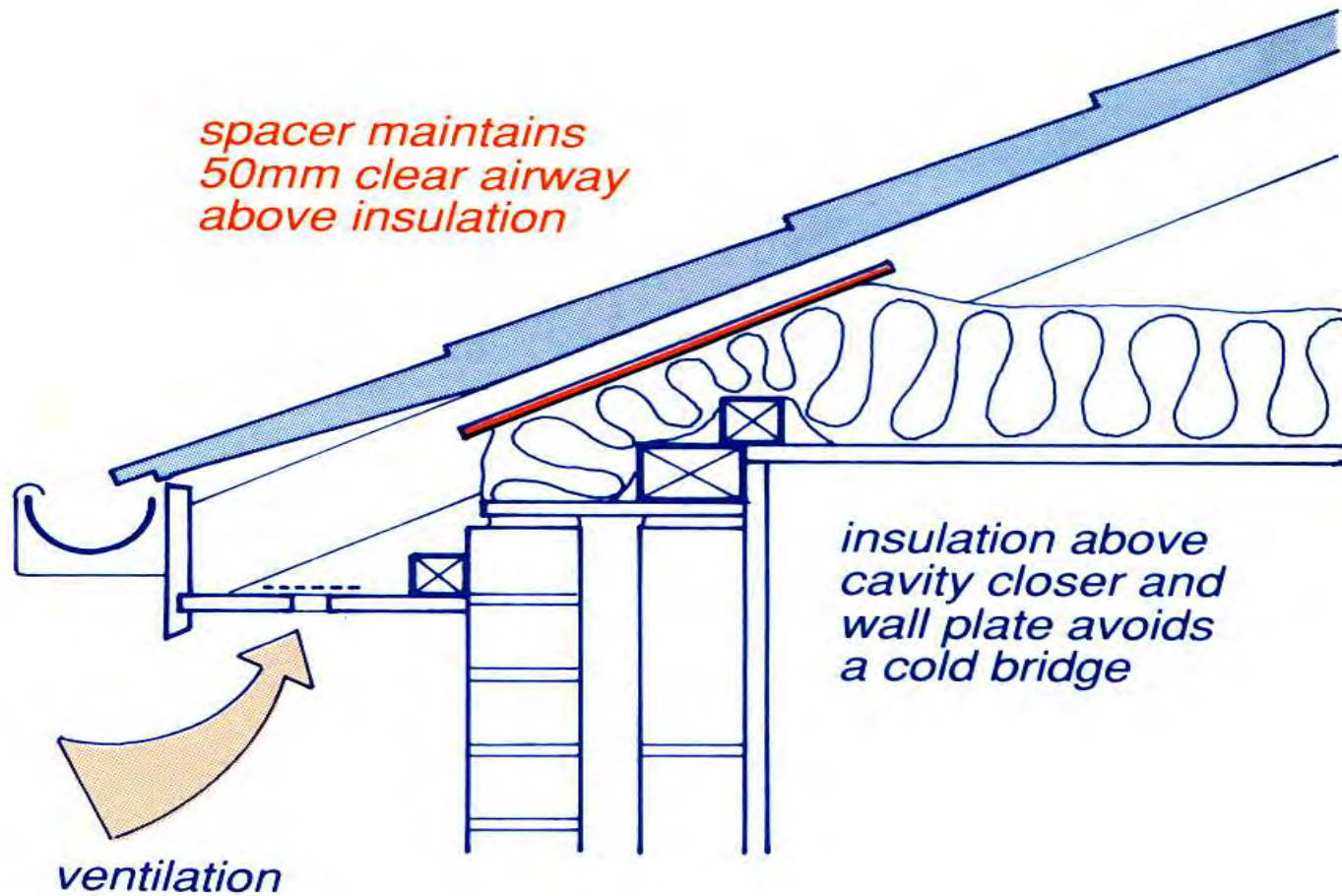
Build tolerances/ accuracy



Roof Constructions

- The standard build-up of a roof includes (from the inside out)
- 1. Supporting structure
- 2. Sarking felt / membrane - secondary protection layer
- 3. Battens
- 4. Roof covering - primary protection layer

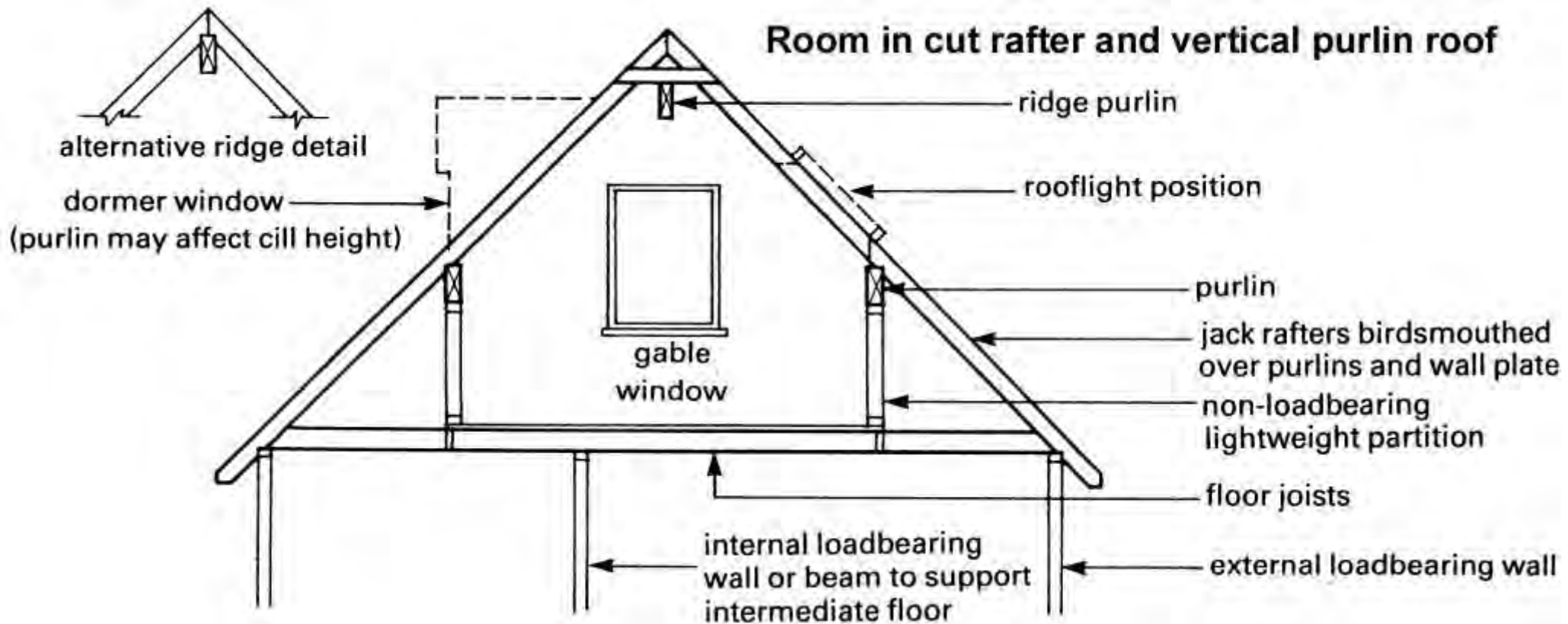
Eaves Detail





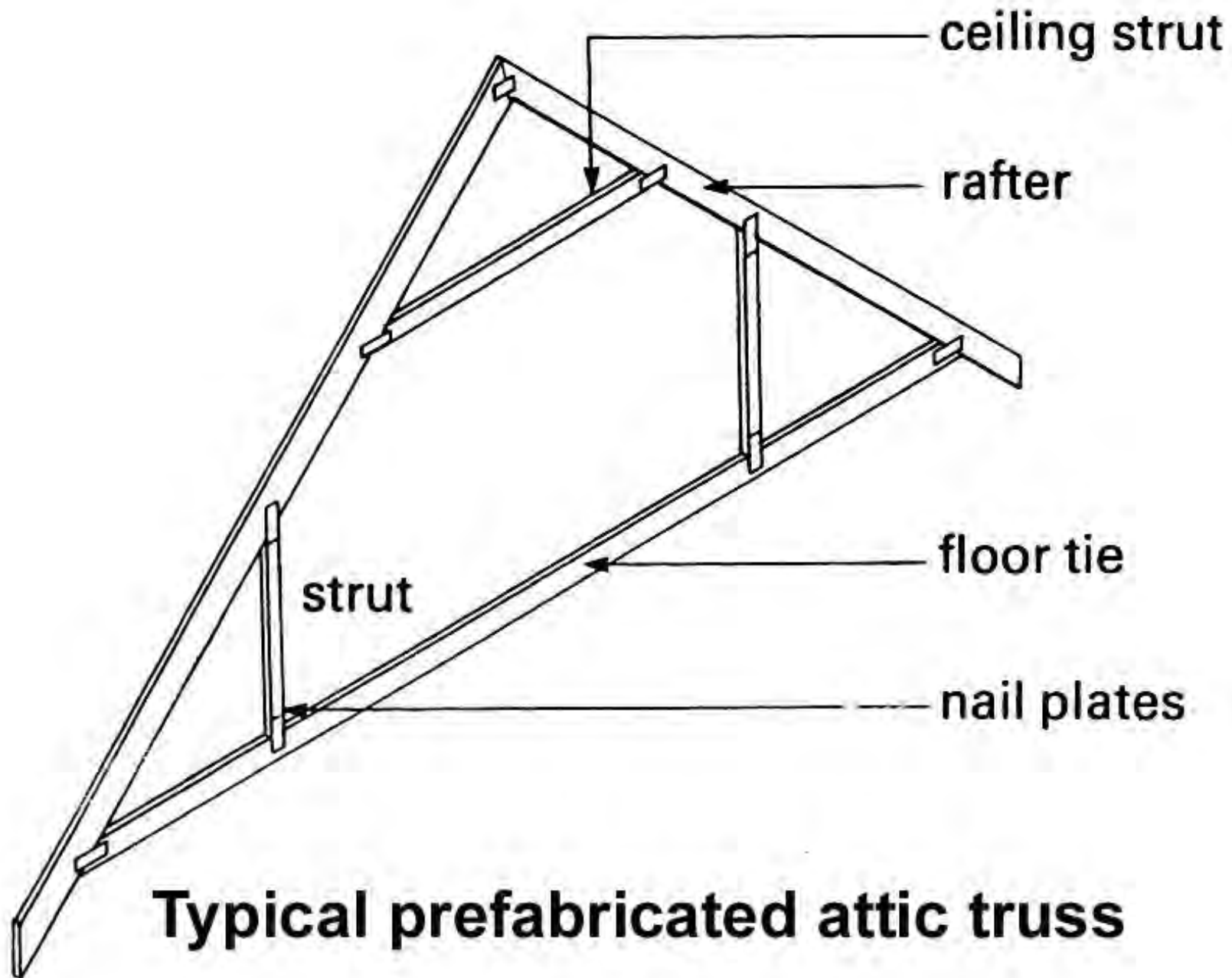
ROOF FEATURES

Room in the roof



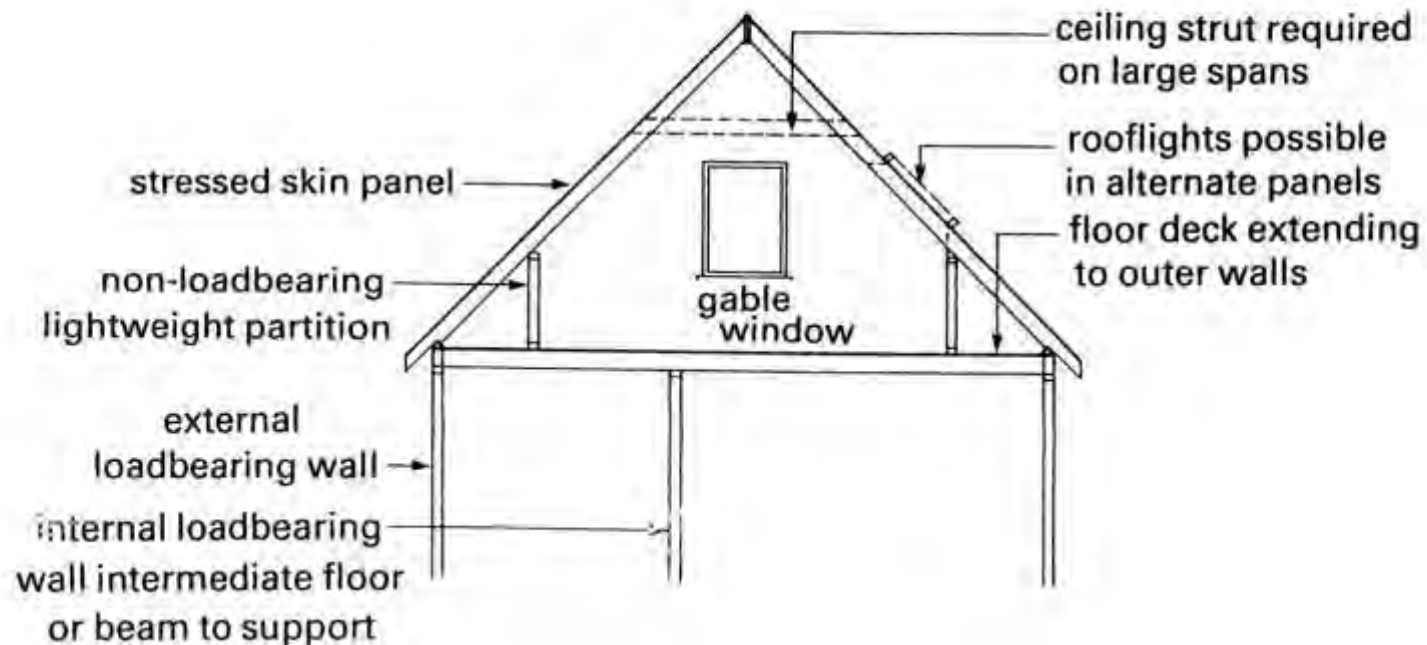
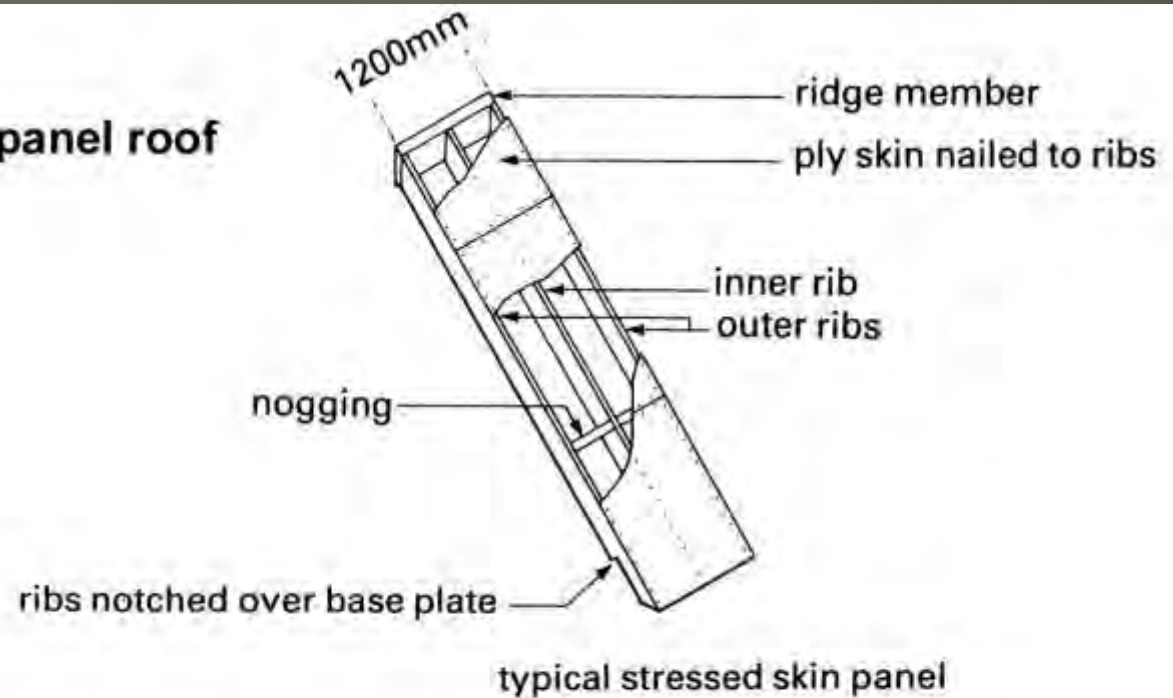
Room in the roof

- The Building Regulation requirements for the height of habitable rooms define the floor areas related to the ceiling areas at defined heights. These requirements will determine the room size.
- Rooms in the roof can be provided in traditional cut-roof construction using either canted or vertical purlins.
- Or prefabricated attic trusses or
- Or use of stressed skin panels.

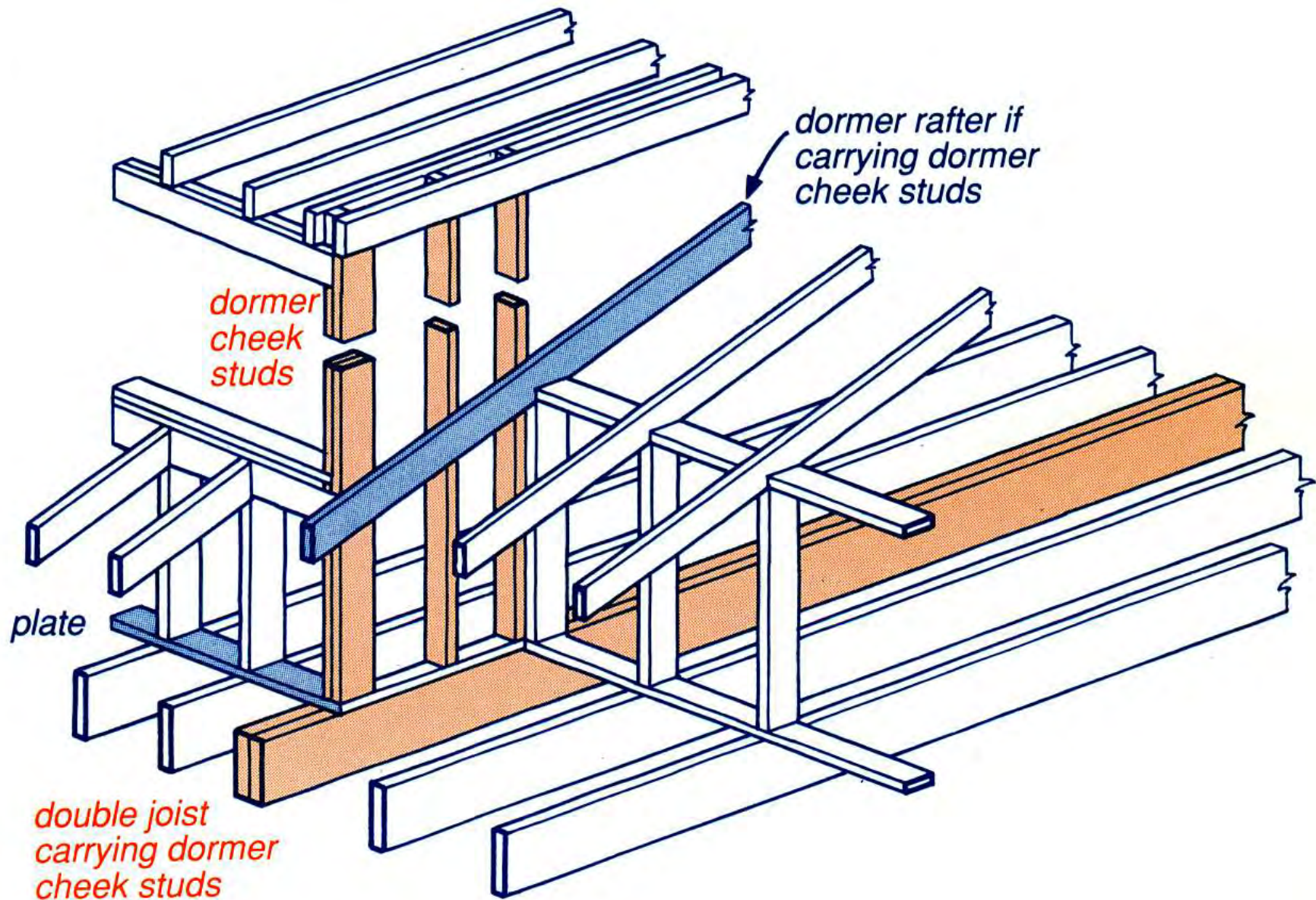


Typical prefabricated attic truss

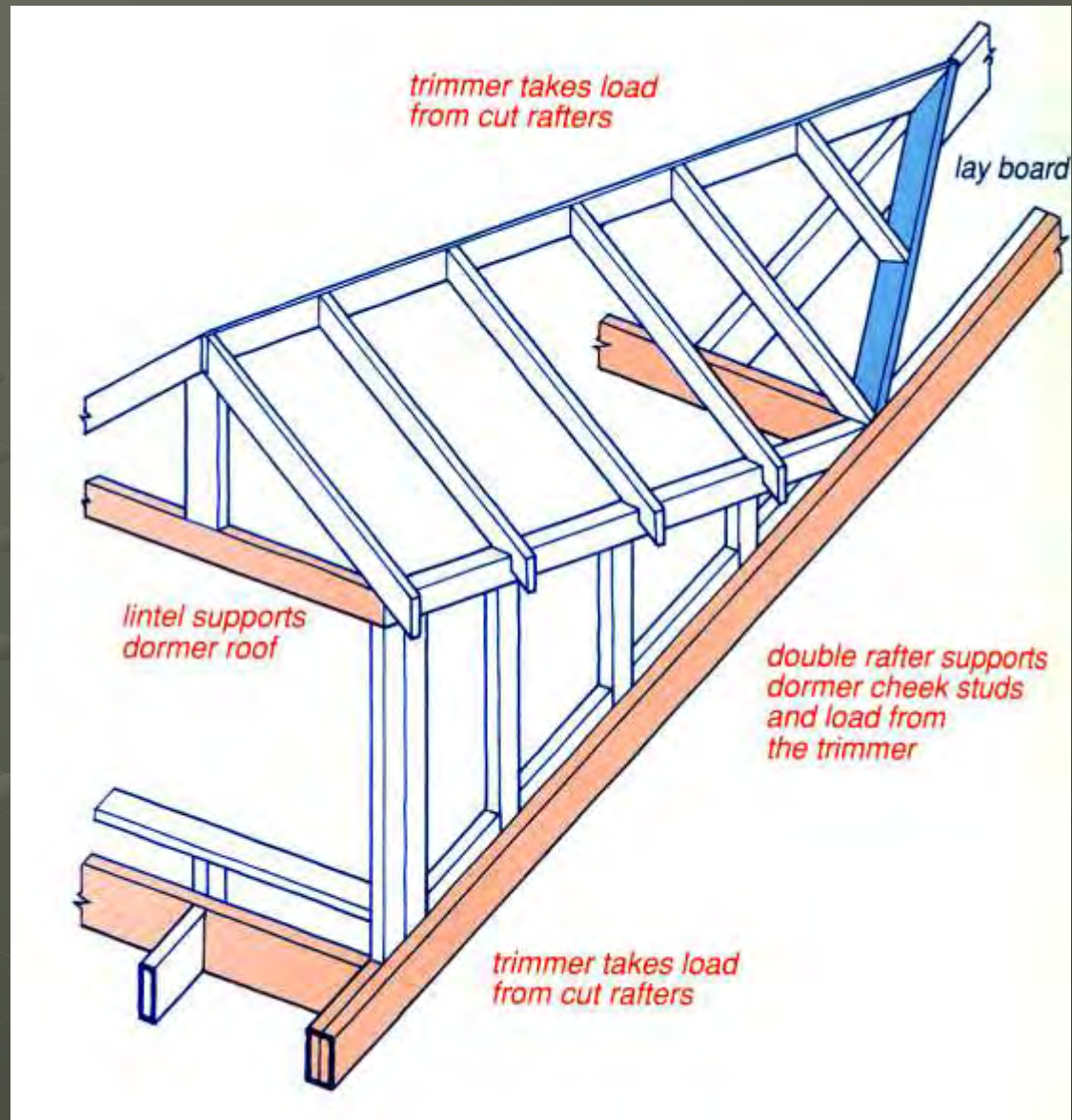
Typical stressed skin panel roof

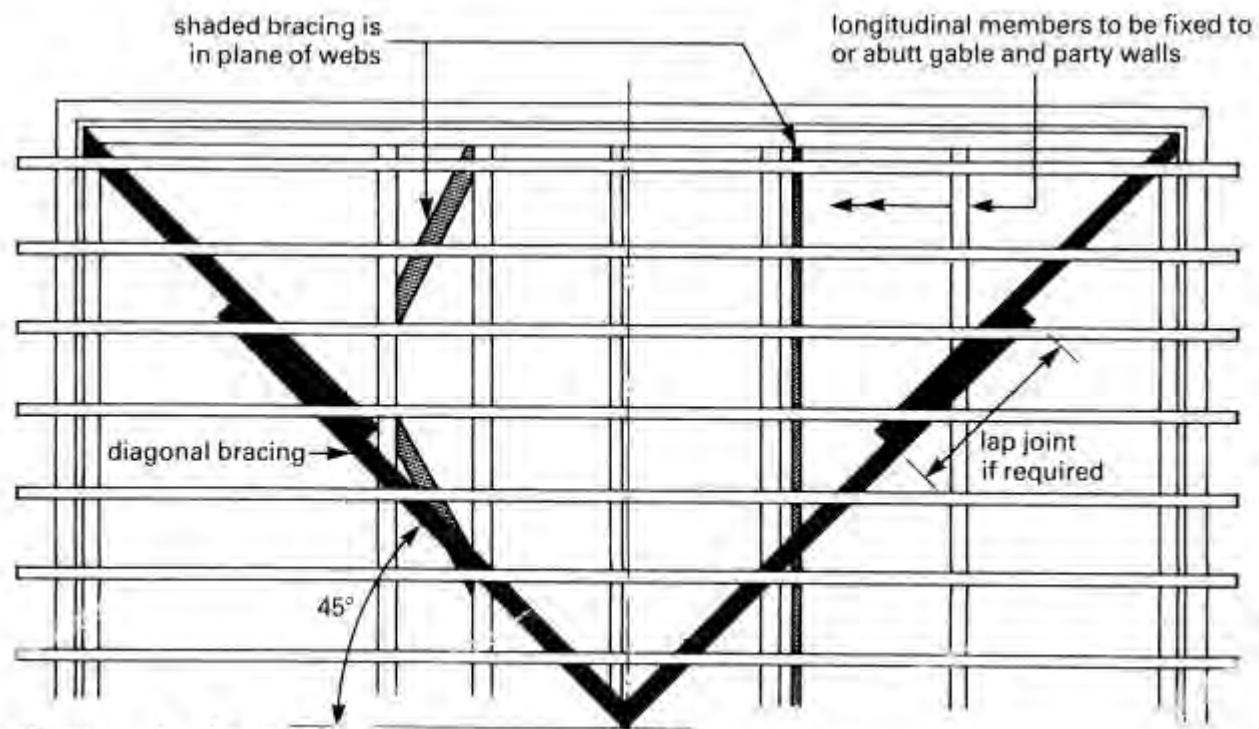
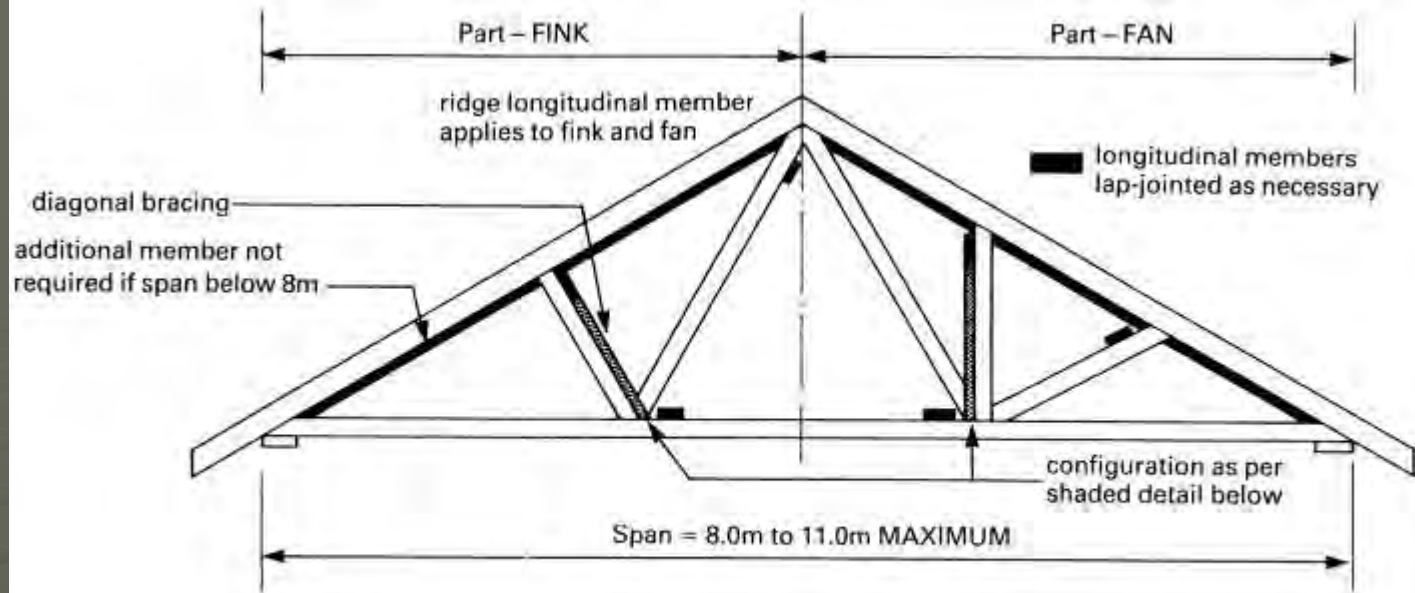


Dormer construction

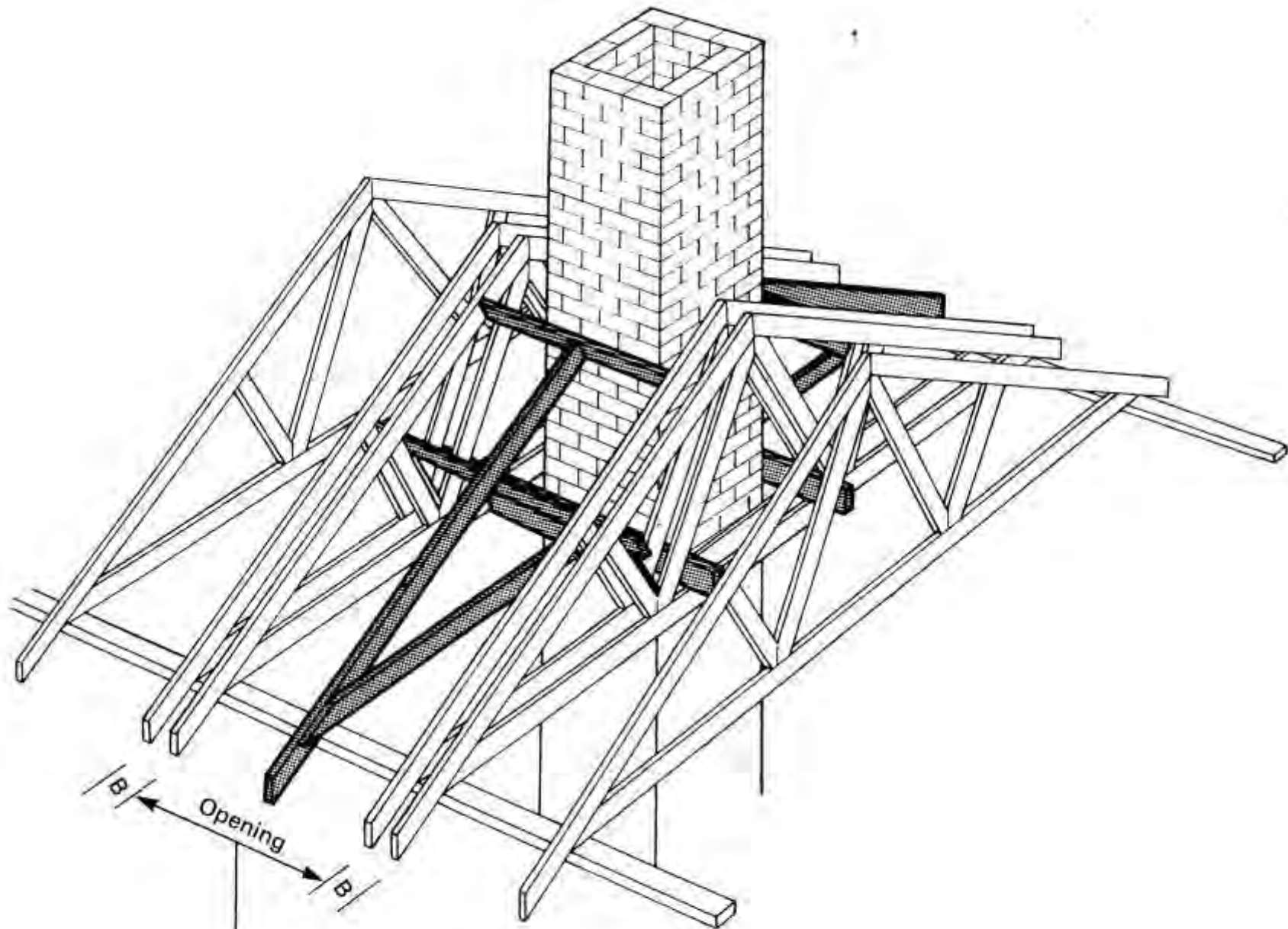


Dormer construction



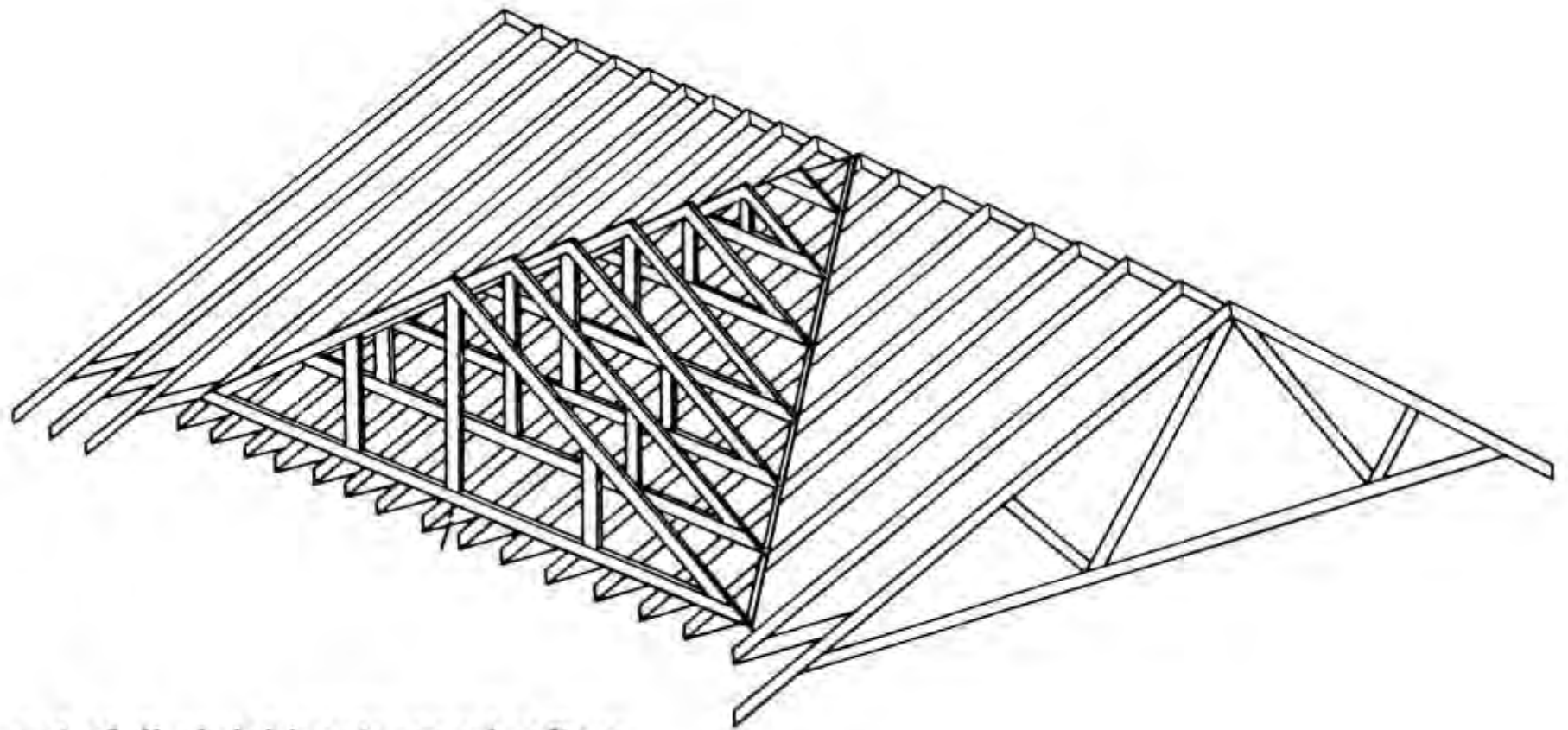


Bracing of trussed rafter roofs

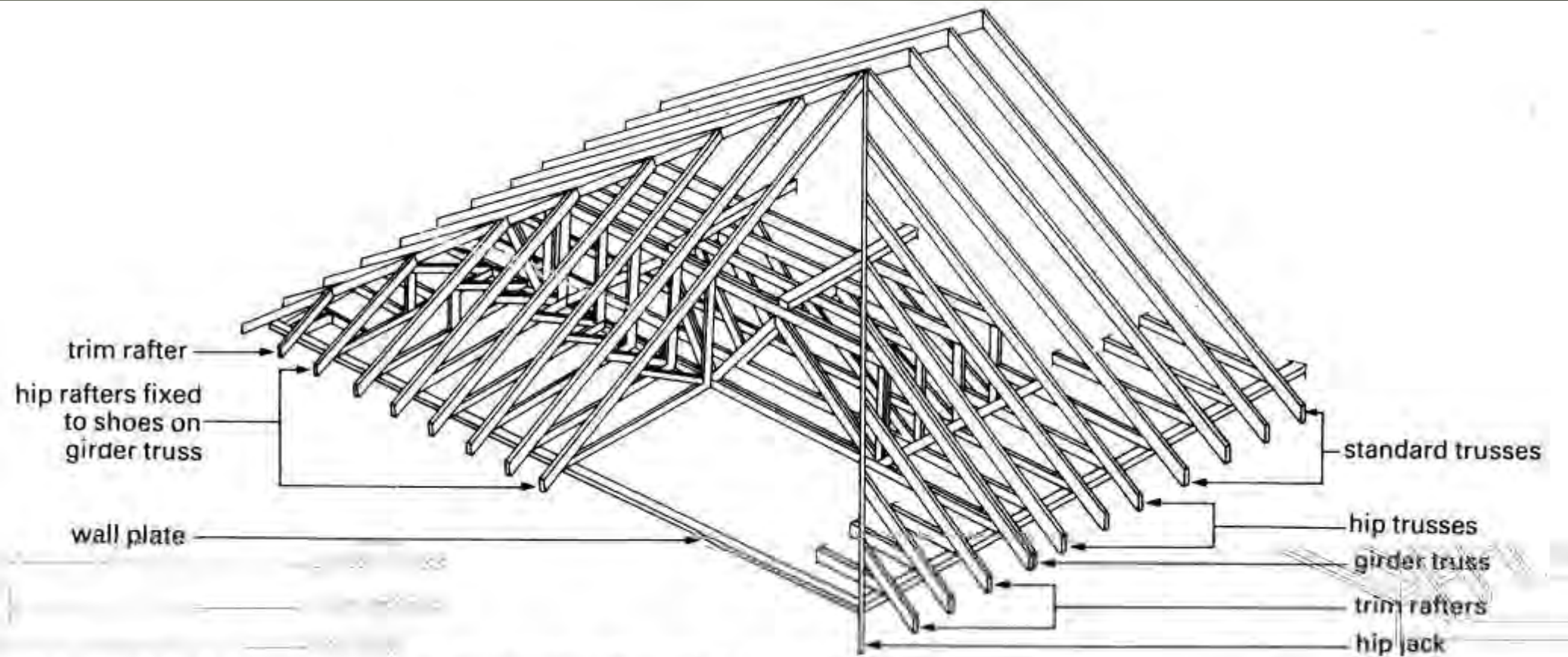


B maximum is equal to twice the design truss spacing less the opening width

Chimney opening in trussed rafter roof

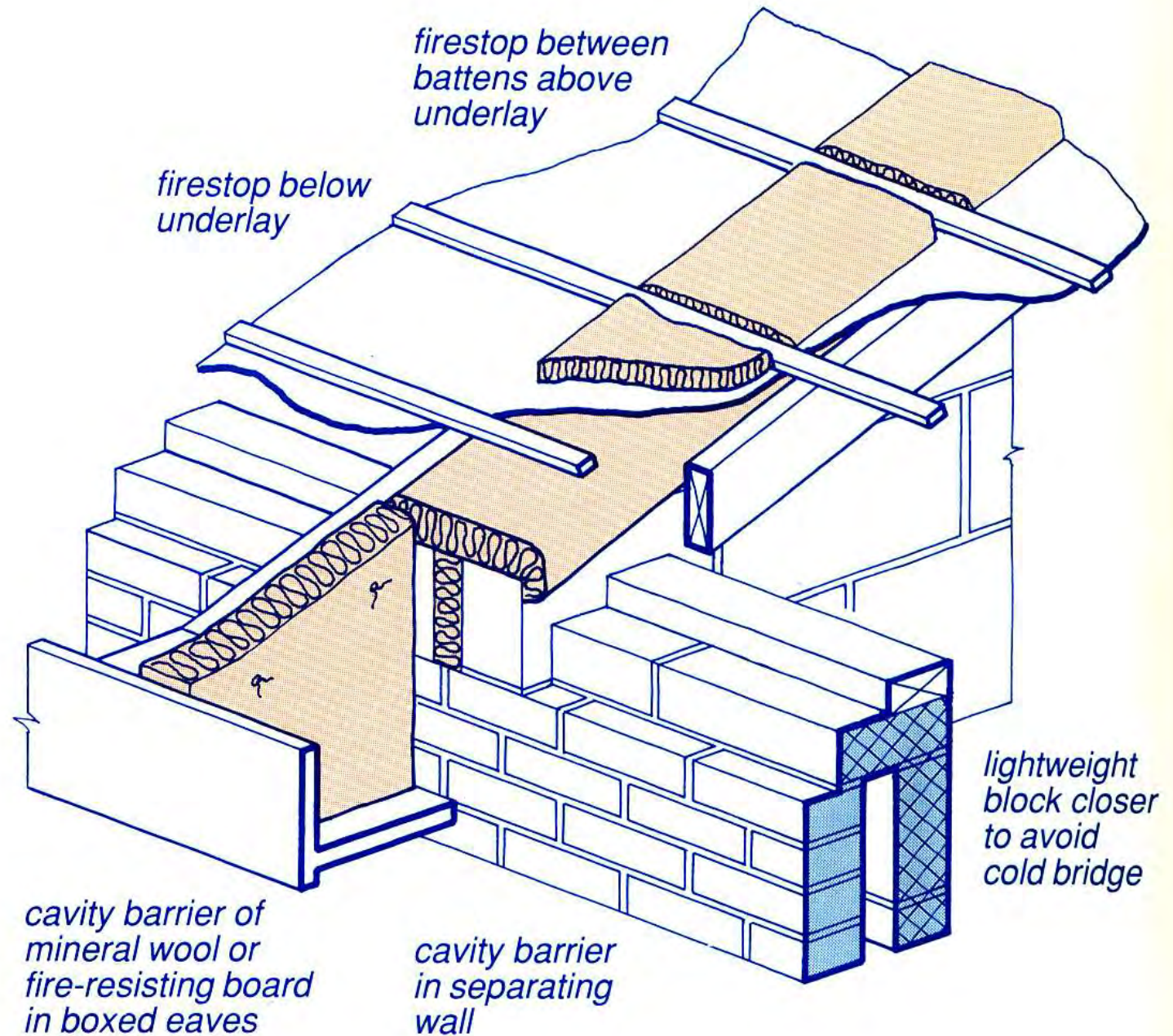


Valley set of diminishing trussed rafters



Typical hip construction in trussed rafter roofs

FIRE Party wall



INSULATION

- Roofs are classified as *cold roofs* and *warm roofs* (flat roofs can also be classified as *inverted warm roofs*).
- A *cold roof* construction is where the insulation is placed so that the structural supports are not insulated (therefore remain cold).
- For pitched roofs there are two possible positions for the insulation:
 - 1. Between the floor joists - results in a cold, ventilated attic
 - 2. Between or directly below the rafters - results in a usable roof space
- A *warm roof* is where the structure as well as the internal space is insulated. The insulation has to be placed on top or between the structural members.

Cold roof ventilation

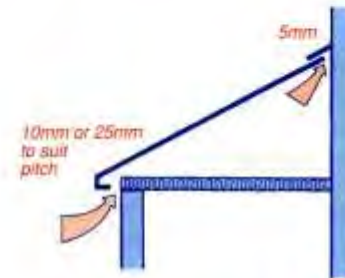
Ventilation should be provided on opposite sides of the roof space, equivalent to a continuous gap of the width shown in the following drawings:



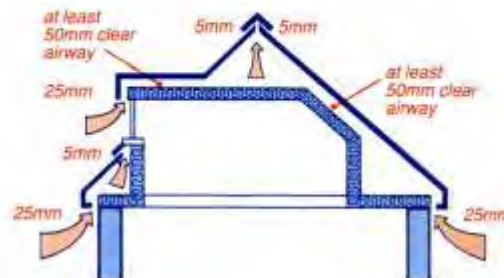
ROOF PITCH OVER 15°



ROOF PITCH BELOW 15°



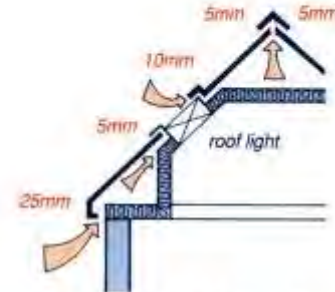
MONO-PITCHED ROOF



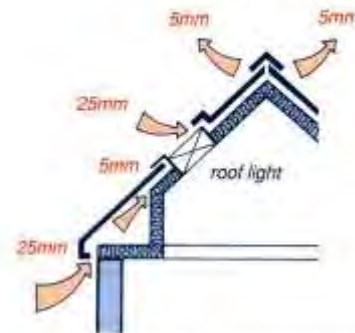
ROOM-IN-THE-ROOF (flat roof dormer)

Warm roof ventilation

Where the ceiling is partially or completely sloping and the ventilation path is blocked, the roof void should have additional ventilation openings immediately below and above the block.



ROOM-IN-THE-ROOF (partially sloping ceiling)



ROOM-IN-THE-ROOF (completely sloping ceiling)



PITCHED ROOF DORMER

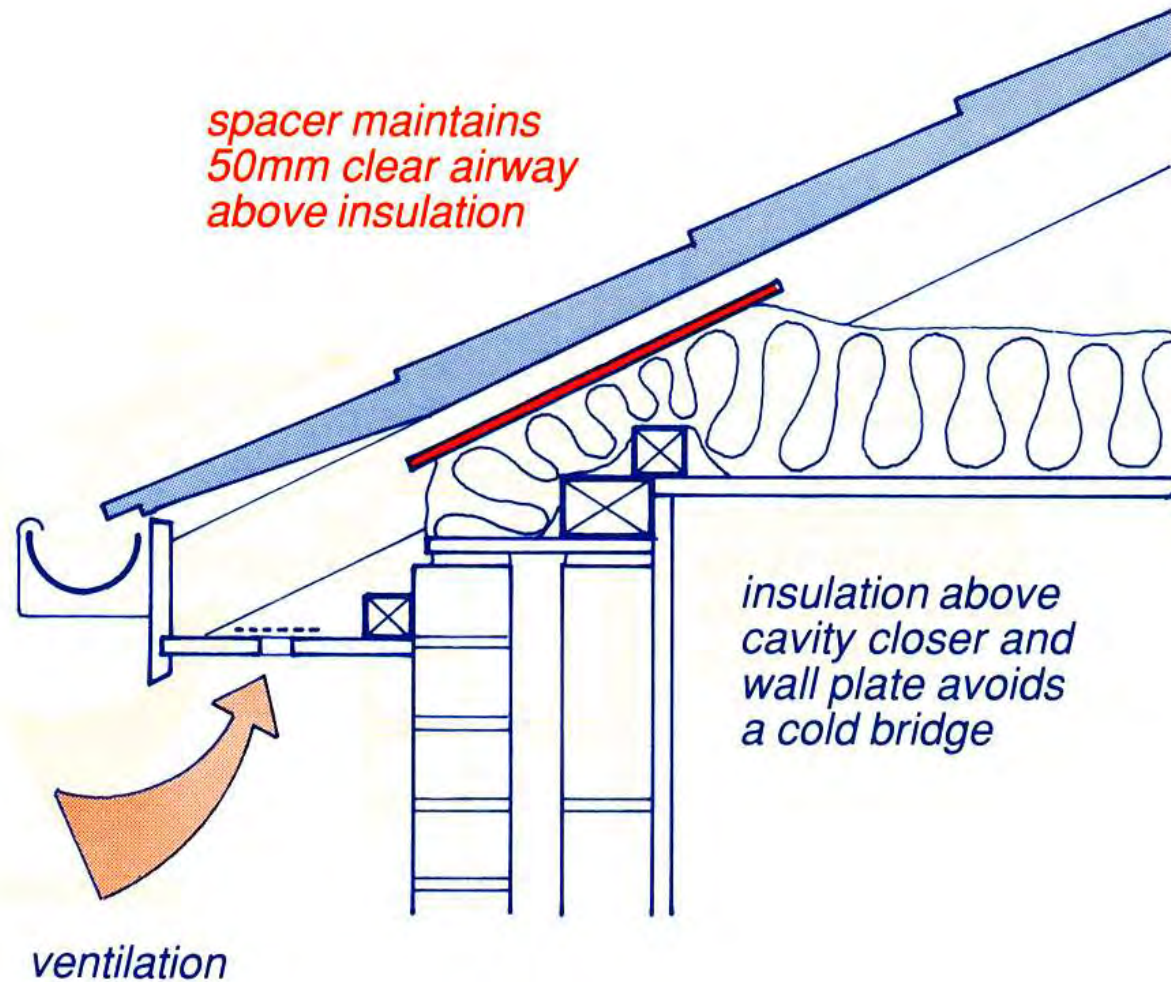
Condensation

- The relative humidity and vapour pressure inside buildings is normally higher than outside.
- The water vapour will pass through most materials and may condense at some point in the roof structure.

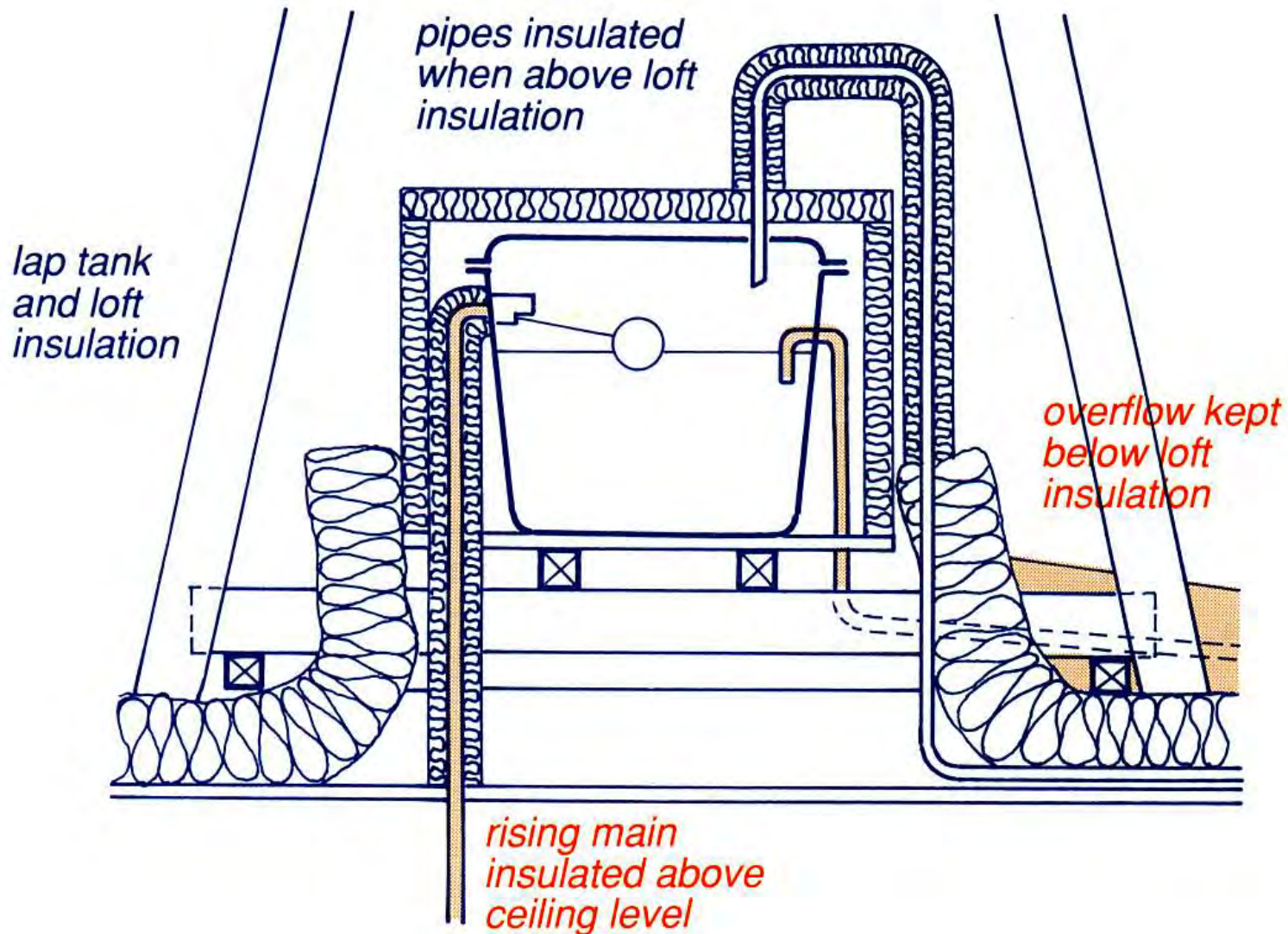
Condensation

- To avoid condensation
- this is done by providing a ventilation gap above the insulation and below the sarking felt or membrane OR
- to avoid the need for this ventilation gap a 'breathable' membrane can be used.
- 'Breathable' membranes let vapour through, but not water, so can be used as the second protection layer in the roof build-up.

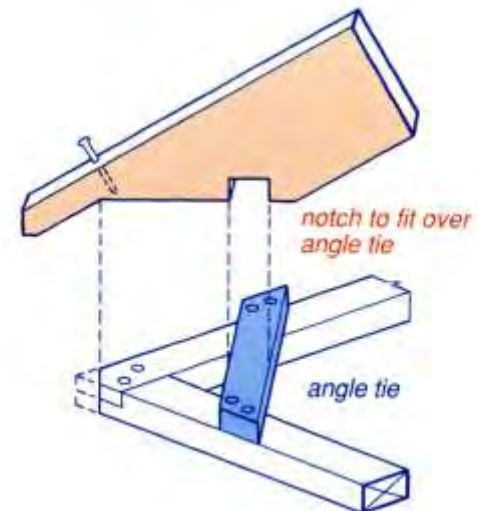
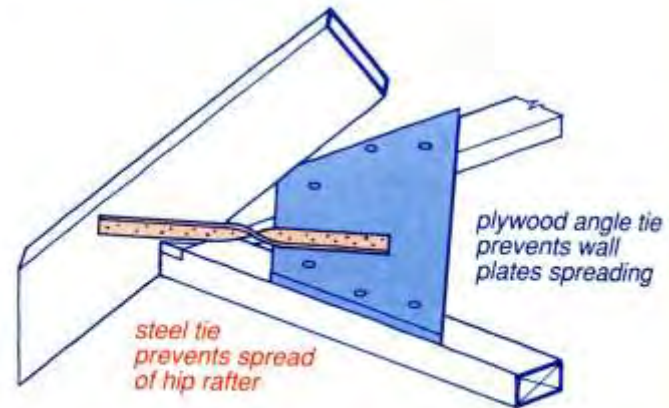
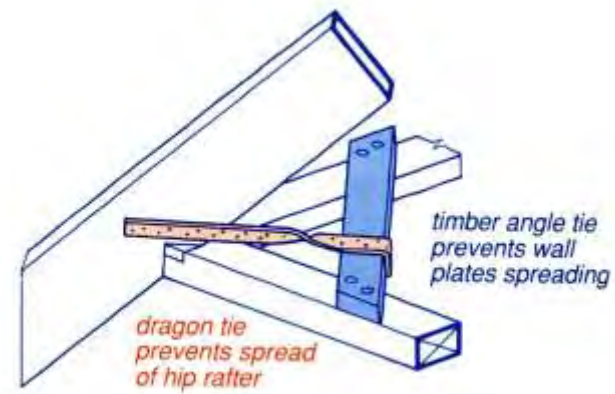
Eaves Ventilation



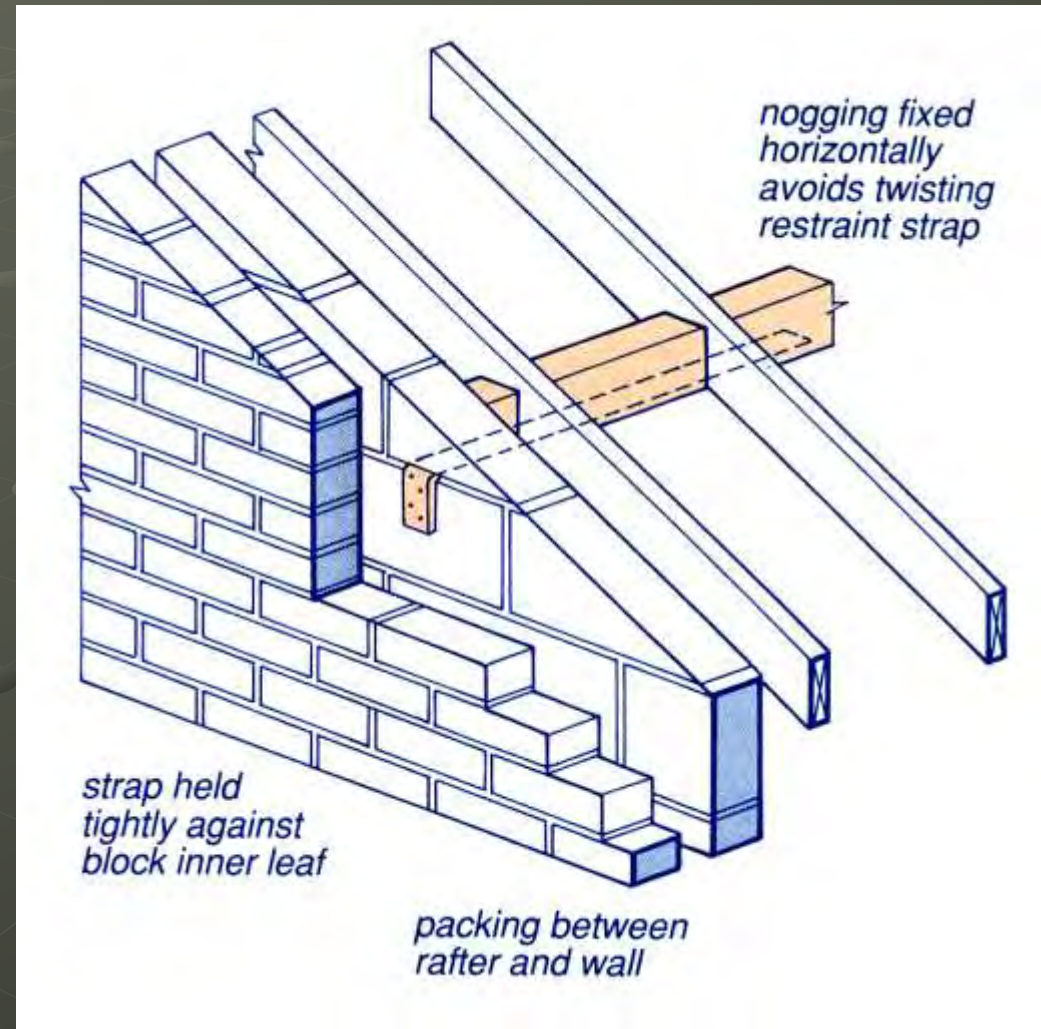
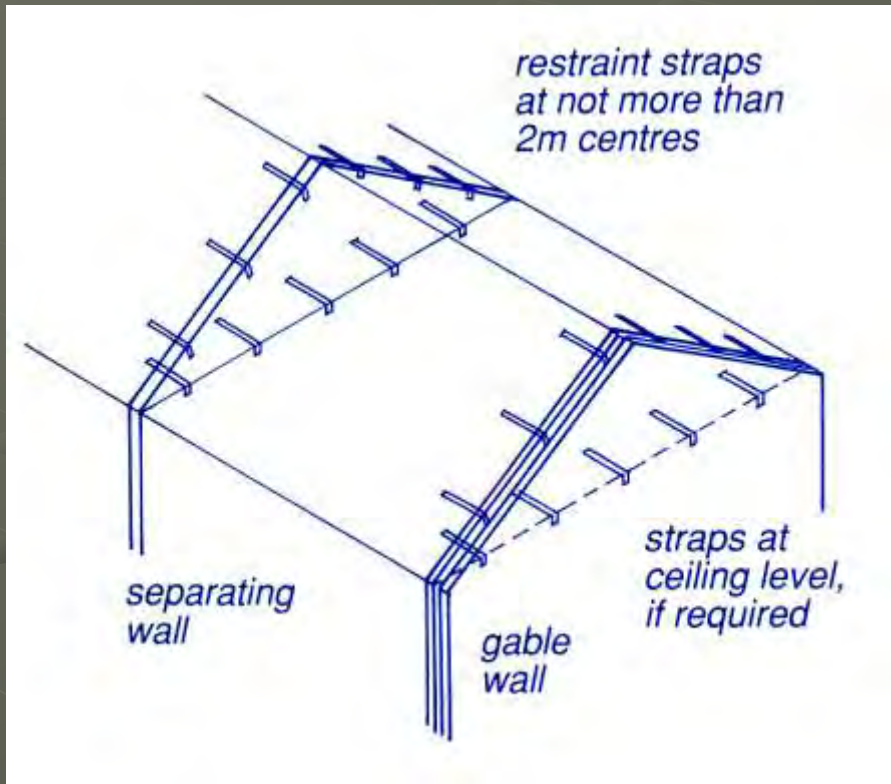
Ensure water tanks are insulated



Hip details



Restraint strapping



Modern Speculative Housing



Reading List & further info

- **D Osbourn.** *Introduction to building*, in Mitchell's Building Series. Longman, Harlow 1993.
- **Jack Stroud Foster.** *Structure & fabric Part 1*, in Mitchell's Building series, 6th edition. Longman, Harlow 2000
- **W.B. McKay.** *Building Construction Volumes 1-4*. Longman.
- **The Building Regulations Part A**
- TRADA Timber Research and Development Association www.trada.co.uk