

Definition

- Roof is one of the most important elements of a building structure to provide protection to the inmates from the sun, rain, wind, etc.
- The roof also protects the interior of a building from direct exposure to the weather.



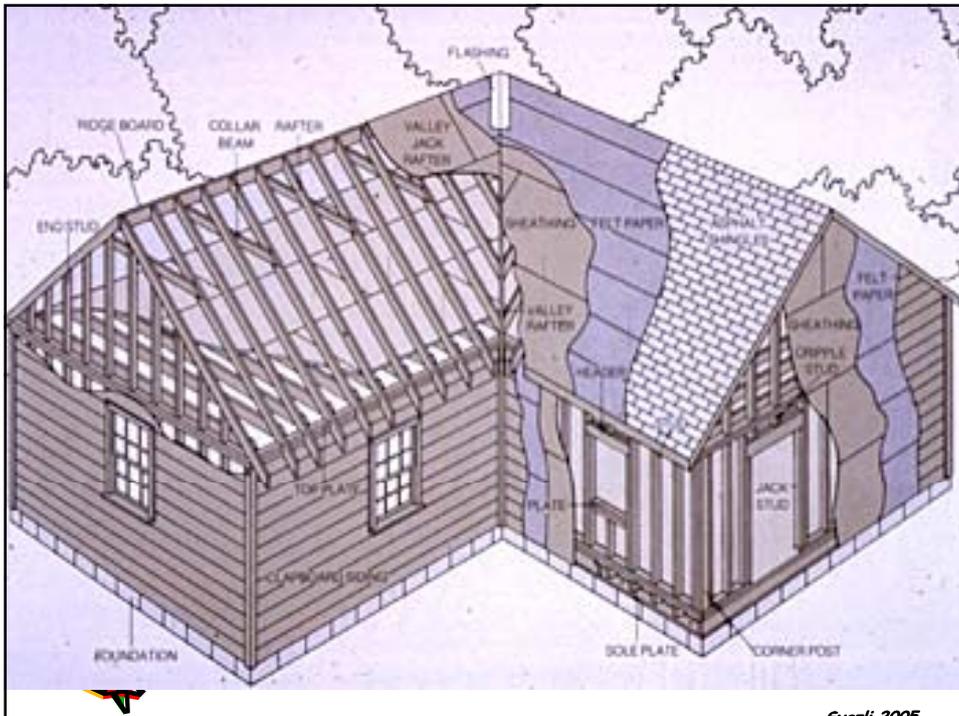
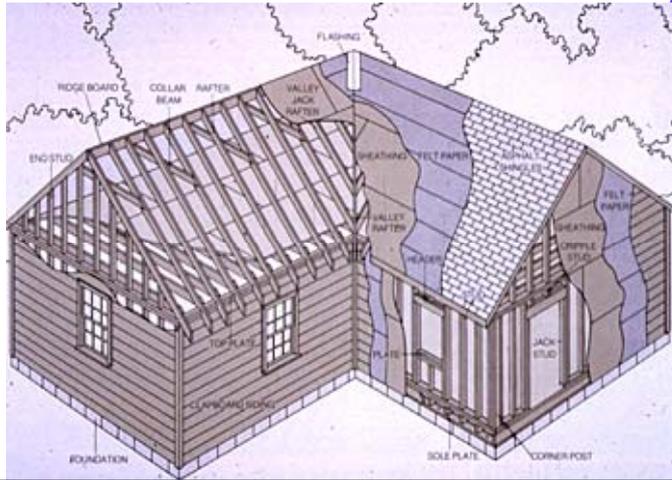
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A small illustration of a white house with a grey roof and a chimney, situated on a hillside with greenery and a body of water in the foreground. The house is reflected in the water. To the right of the illustration, the word "Definition" is written in a bold, black, sans-serif font. Below the title, there are two bullet points. The first bullet point states: "Roof is one of the most important elements of a building structure to provide protection to the inmates from the sun, rain, wind, etc." The second bullet point states: "The roof also protects the interior of a building from direct exposure to the weather." To the right of the text, a blue wavy line extends from the top right corner of the slide down towards the bottom right. In the bottom left corner, there are two crossed crayons, one yellow and one green. In the bottom right corner, the text "Svazli 2005" is written in a small, italicized font.

Basic Terminology:



- 1) Roof: the entire covering assembly
- 2) Roofing: that part of the roof which is exposed to the elements.
- 3) Pitch: rise over run
- 4) Substrate: the decking that carries the roofing material.
- 5) Eaves: roof overhangs
- 6) Ridge: the peak of two or more roof slopes
- 7) Valley: an inverse ridge
- 8) Ceiling: the finish material attached to the underside of the roof.



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The selections of roofs for buildings depend on factors below:

1. Type of building.
2. Type of foundation.
3. Roof Loads
4. Light exposure
5. Conduits
6. Future renovations.
7. Time taken to construct the roof
8. Maintenance
9. Economy.
10. Aesthetic
11. To avoid dampness, heat, sound, etc...



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Functions of roofs are as follows.

1. The identity of the building.
2. To prevent from dampness, heat, sound, etc...
3. To carry loads from the roofs, live load and dead load.
4. To provide protection from weather for workers working under any construction.
5. To allow light and air in and out of the building.
6. To place conduits.
7. For future renovations.



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Types of Roof

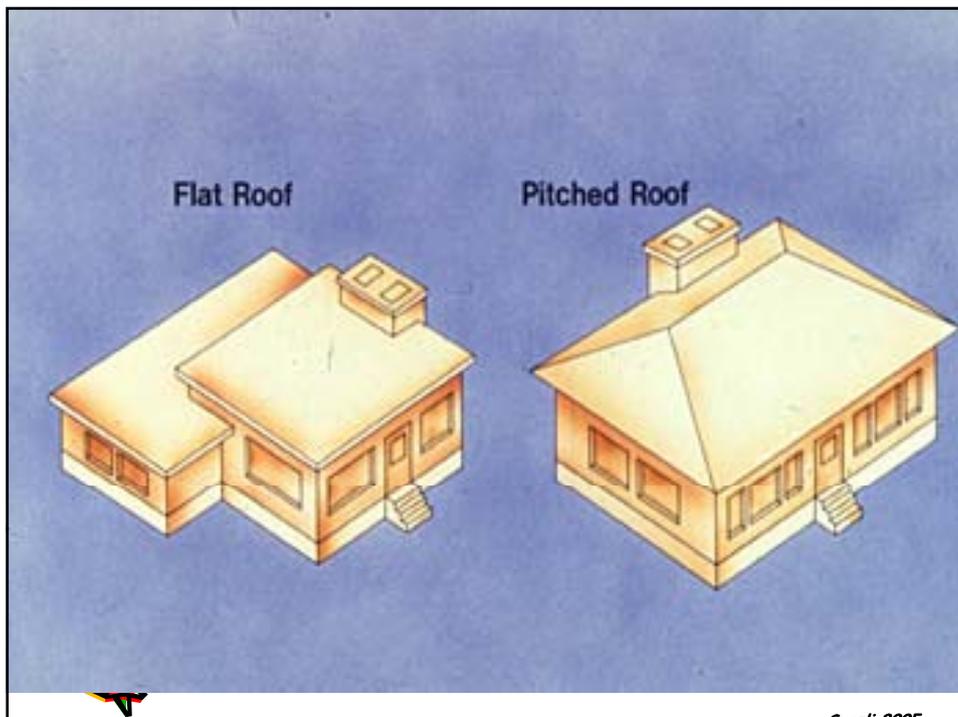
A. Sloping roof

1. Cable roof : slope in two directions, used for larger span.
2. Gambrel roof : slope in two directions, mostly used for buildings in hilly area.
3. Hipped roof : slope in four directions, mostly used in hilly areas.
4. Mansard roof : slope in four directions with a break in the slope, used in hilly areas and commercial buildings.
5. Shed roof/Lean-to-roof (single and double) : consists of common rafters which are inclined at 30°. One end of each common rafter is placed on wooden wall plates and the other end is nailed to wooden post plates. Used on sheds and veranda openings and suitable for spans up to 2.5 m.
6. Saw-tooth or North-light roof : a sloping roof having glazing fixed on the steep sloping sides, its steep sloping side is kept towards north direction. Generally used in factories where more light is required.

B. Shells : Shell Barrel Vault, domes.

C. Flat roof : slope of not more than $7\frac{1}{2}^{\circ}$ extensively used in plain areas where the rainfall is meager. Common flat roof is of reinforced cement concrete slab.

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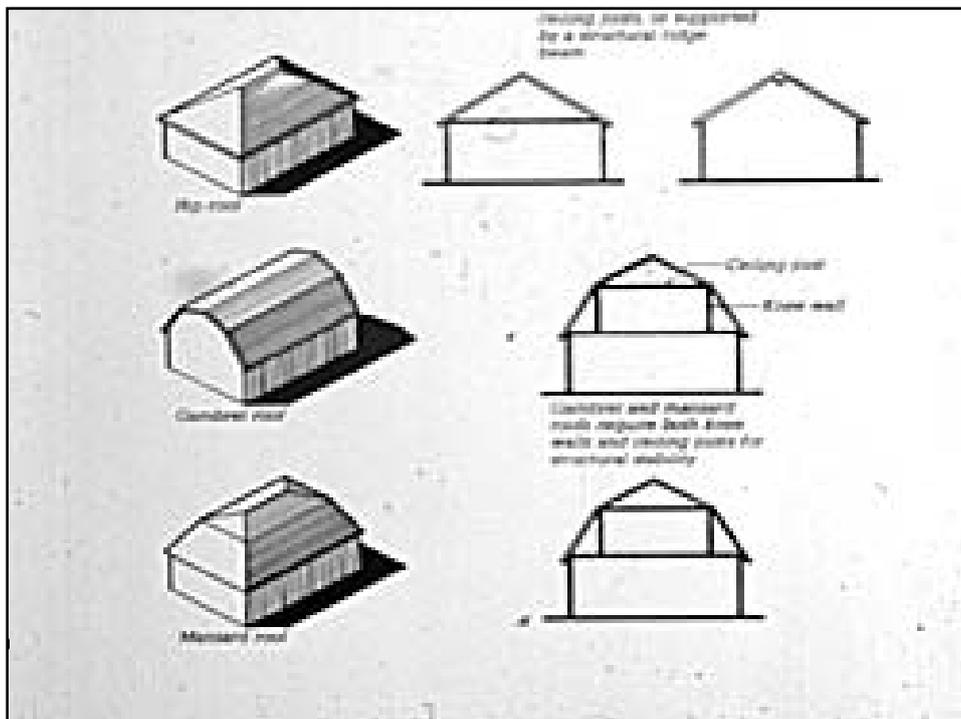
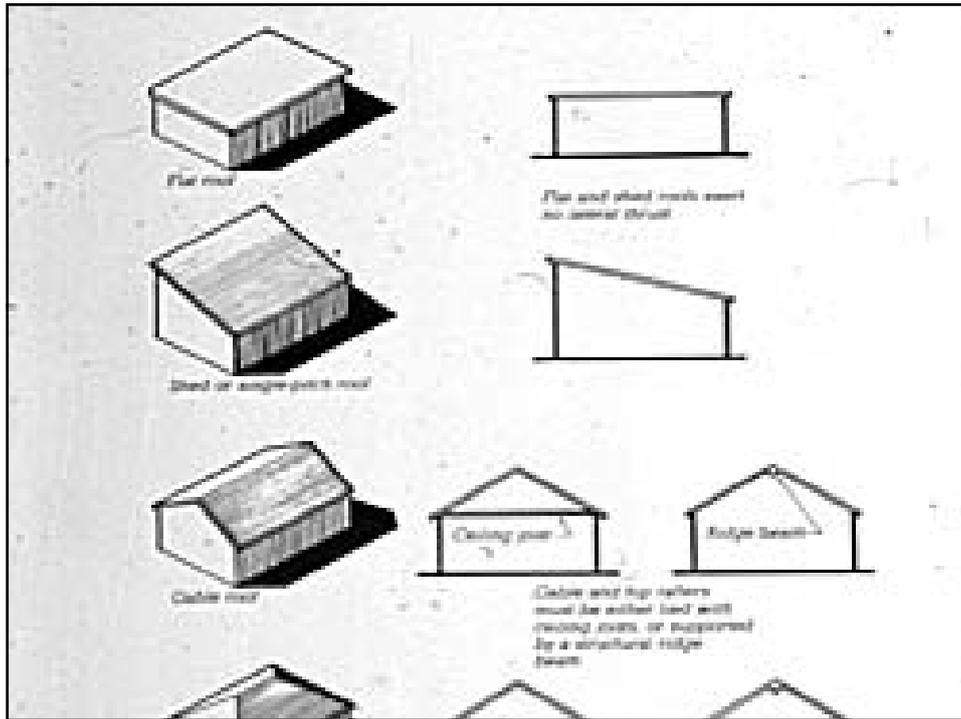


Basic types of roof designs:

- 1) Flat: must have a slight slope for drainage
- 2) Shed: a single slope
- 3) Gable: two slopes meeting at a ridge. Two walls extend up to the ridge.
- 4) Hip: two gables, a pyramid could be considered a hip roof.
- 5) Gambrel: four slopes in one direction, the typical barn roof.
- 6) Mansard: two gambrels. Basically is to the gambrel what the hip is to gable.

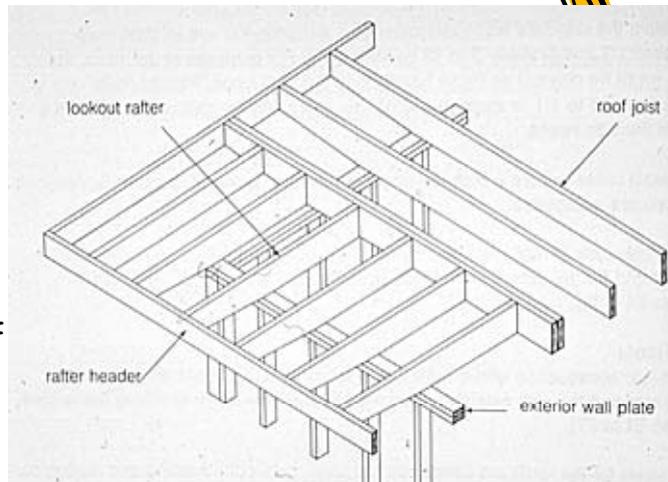


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Roof structure:

- Roof structure: Depending on the different type of structural system, roof structure can include the following:
 - a. Purlins
 - b. Rafters (roof joists)
 - c. Trusses
 - d. Beams
 - e. Girders



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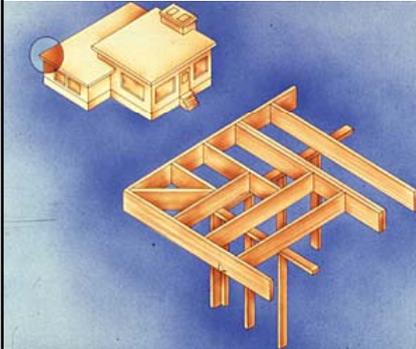
Important technical terms

1. Wall plate :
2. Ridge : The highest point or line of a sloping roof, where the two opposite sloping surfaces meet.
3. Rafters/common rafters : The members which support the covering material of a roof.
4. Purlins : The wooden or steel members laid horizontally to support the common rafters of roof.
5. Battens : The pieces of wood directly nailed to the common rafters.
6. Pitch : The inclination of the side of a sloping roof.
7. Eaves/overhang : The lowest edge of the surface of a sloping roof.



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Pitched roof design:



1) Determination of slope is based on the following factors:

- a. Type of roofing
- b. Presence of attic, or cathedral ceiling
- c. Cost
- d. Expected snow load

- 2) The basic design principle in the pitched roof is that by overlapping materials in the downslope direction, and by providing a waterproof surface, water will not sit, but will be forced to rub off the roofing surface.

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TRUSS

- A truss is a frame work of members arranged in triangles to form a roof system made either of timber or steel.



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TRUSS

A truss is a frame work of members arranged in triangles to form a roof system made either of timber or steel.

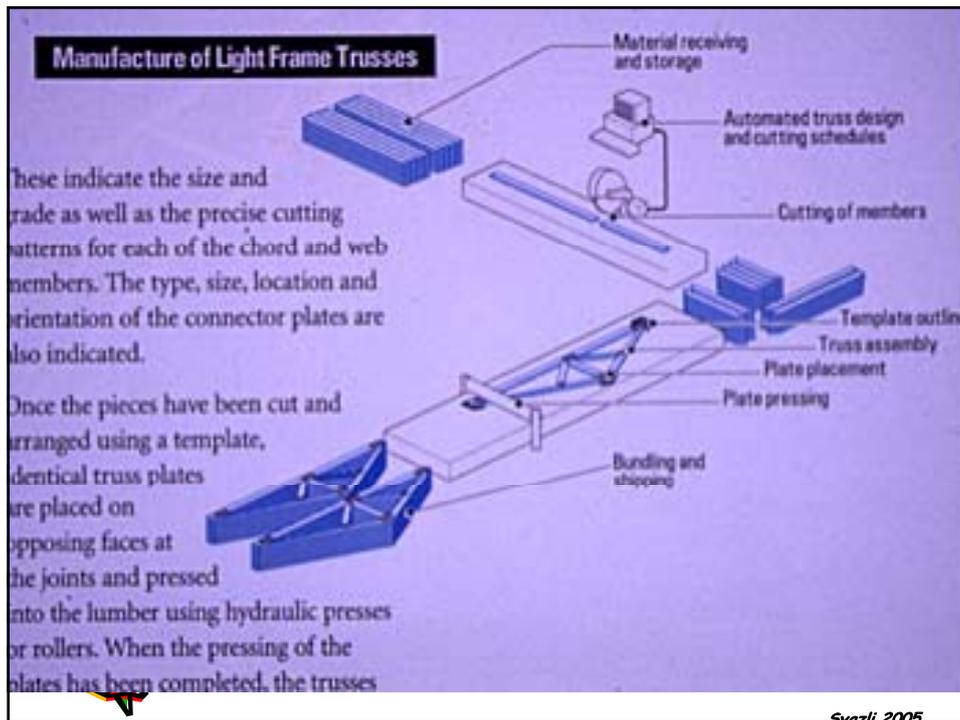


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Steel roof truss

- For greater spans timber trusses becomes heavy and it is economical to use steel trusses. Steel trusses are much stronger than timber trusses. They are more fire resisting and durable as they cannot be attacked by termites and are not subjected to dry rot. Joints in these trusses are more simple and satisfactory.
- Members of a steel roofs are constructed of mild steel and most of them consisting of angles because the angle sections can effectively resist both compressive and tensile stresses. Angles can be manufactured economically and connected conveniently.
- Instead of using T-sections for rafters, either one or two angles, placed back to back can be employed. One or two angles, back to back can be used as a tie beam.
- The members of a truss are connected together by means of riveting or bolting them over thin plates, called gusset plate. Nowadays, welding is done for connecting the members either with or without gusset plates.

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Points to be considered while constructing steel roof trusses.

1. Principle rafters should not be longer than 3 m between the struts.
2. All the purlins should be fixed at joints.
3. The struts should be as short as possible.
4. In case of horizontal tie, a camber of $\frac{1}{480}$ of the span is given to avoid the appearance of sagging.
5. Spacing of the steel trusses is kept 3 m up to 15 m span and $\frac{1}{5}$ th of the span beyond 15 m span.
6. Provision for expansion and contraction of the steel trusses due to variation of temperature should be made.

Some basic terminology used for trusses

Pitched (triangular) Truss

Parallel Chord (Flat) Truss

Basic Components of trusses

1. Top chord
2. Bottom chord
3. Bracing/strut

Truss Nomenclature

ROOF TRUSSES:
Light trusses are manufactured to suit virtually any roof profile. Pitched or flat, they are only limited to the load arrangements and the support locations.

FLAT TRUSSES:
Flat trusses, also known as parallel chord trusses, are an alternative to conventional wood floor joist systems and are a competitive option to open web steel joist systems. Parallel chord floor trusses may be designed with varying chord and web arrangements and bearing support details.

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Types of roof trusses

1. **King-post truss** : used for spans of 6 to 9 m. It consists of principle rafters, one end of which is fixed to head of king-post and the other end is bolted to the tie-beam. Common rafters are supported on purlins which are placed on the principle rafters. Eaves board along with a gutter are further strengthened by providing struts. Details of joints of a king post truss - see diagram.

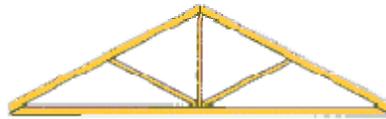
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Types of roof trusses



2. **Queen post truss** : used for spans varying from 9 m to 13.5 m. It consists of principle rafters, common rafters, purlins, etc., as in case of a king post truss, but the difference is that queen posts are placed at one-third of the span either end of the wall. The queen posts are connected with the help of a straining beam at the upper ends and by a straining sill at their lower end to prevent the movement of the post due to loads.

The principle rafters, struts, straining beam and straining sill act as compression members, whereas queen posts and the tie beams act as tension members. Details of joints of a queen post truss - see diagram.



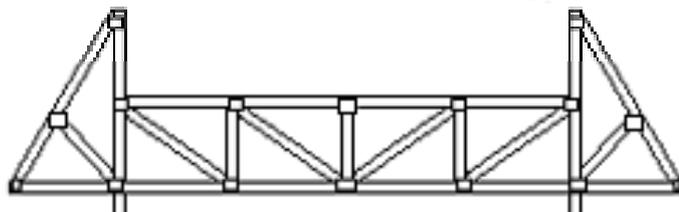
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Types of roof trusses



3. Mansard roof truss.

The truss is a combination of a king post truss and queen post truss. It is used to obtain the maximum space for living purposes. The general height of the roof is kept comparatively low. It has two different slopes. The lower slope should not be steeper than 750 and the upper slope not greater than 300. The construction of various joints is similar to the king post and queen post trusses - see diagram



Double Cantilever with Parapets

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Types of roof trusses

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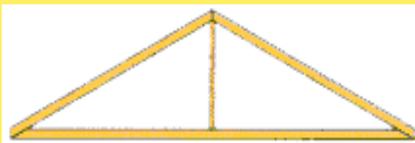
4. Other trusses. See diagrams.

Fink truss, double fink, scissors, Howe, saw-toothed and lattice truss.

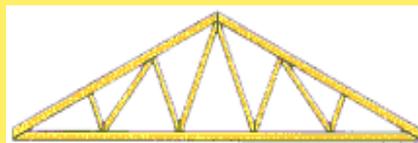
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STANDARD ROOF TRUSS SHAPES

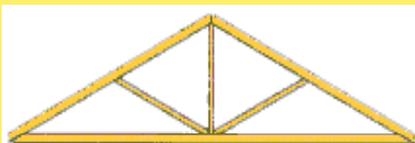
Kingpost



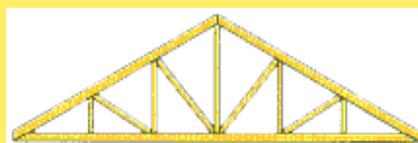
Double Fink



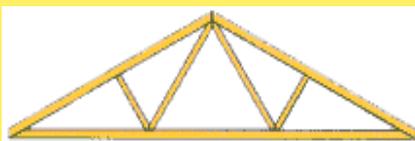
Queenpost



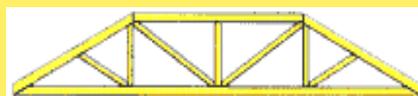
Double Howe



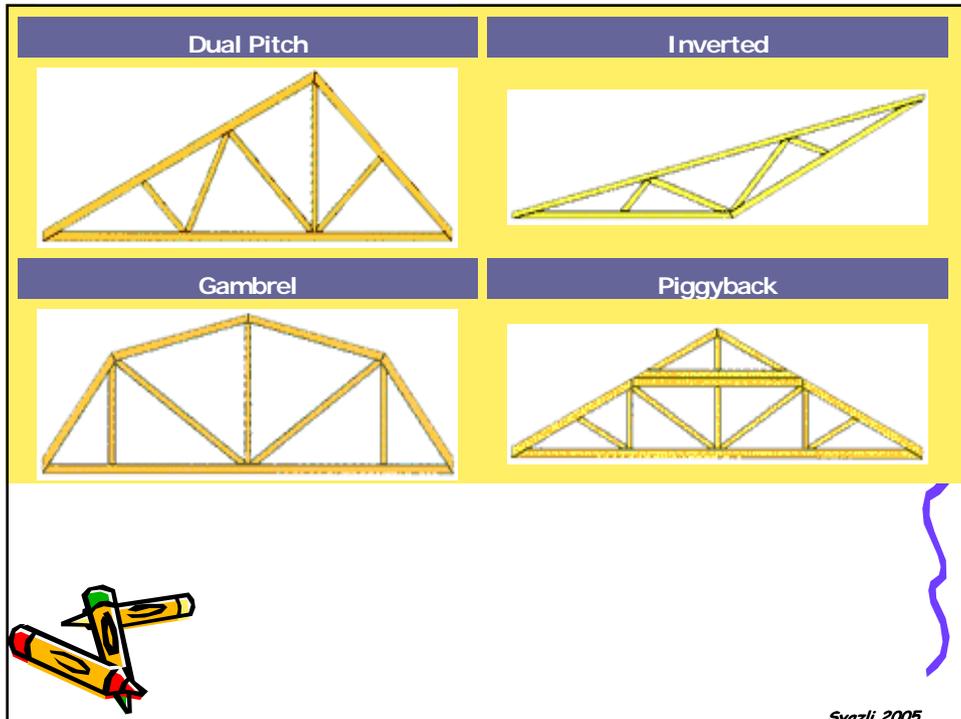
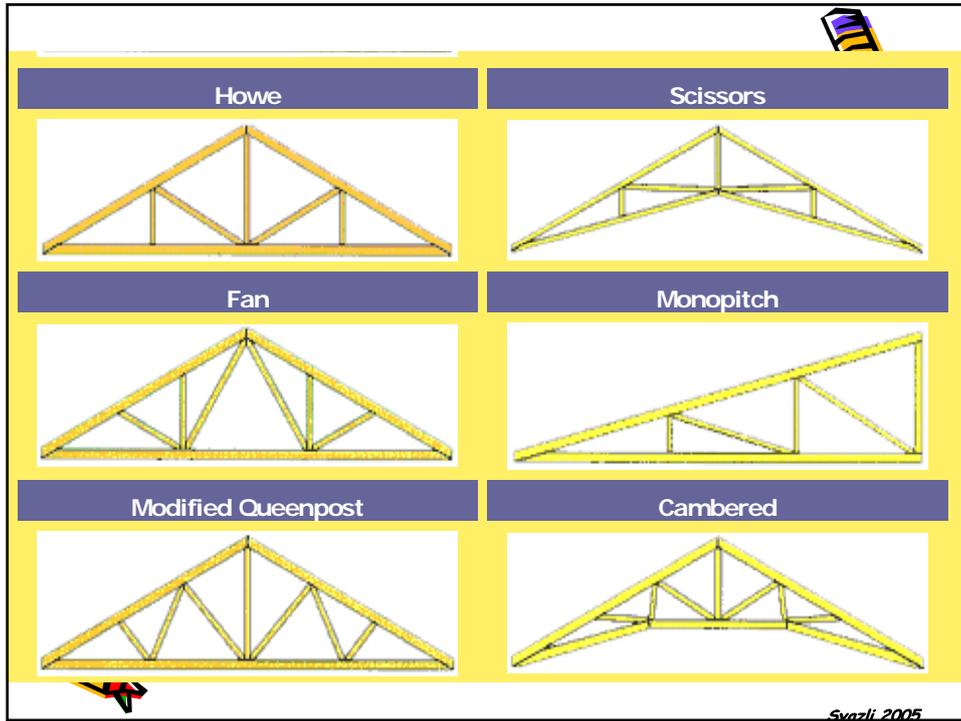
Fink

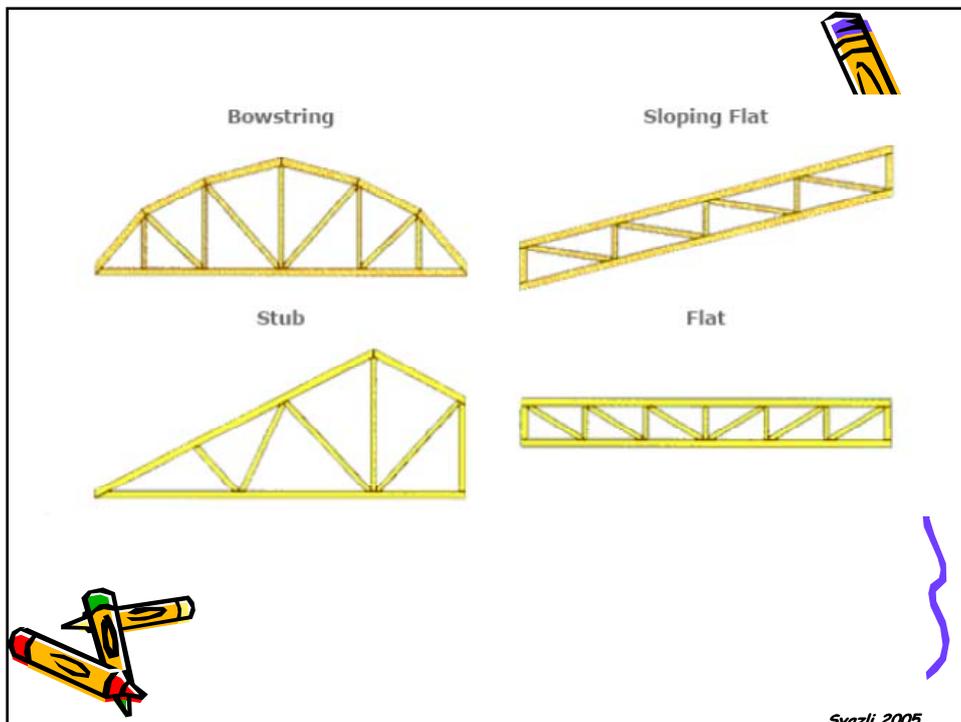
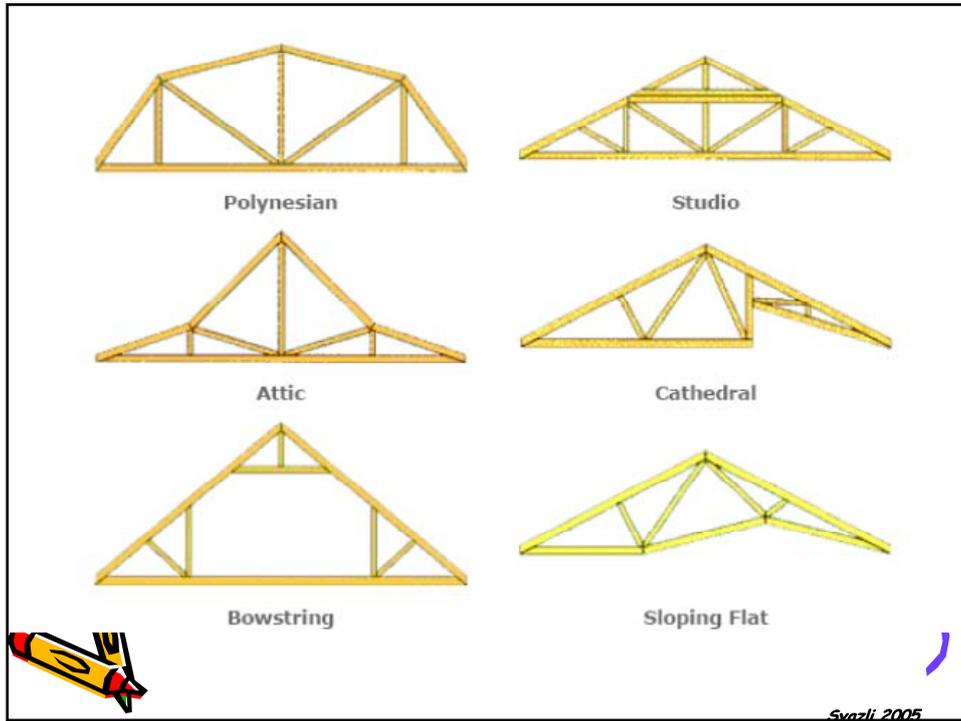


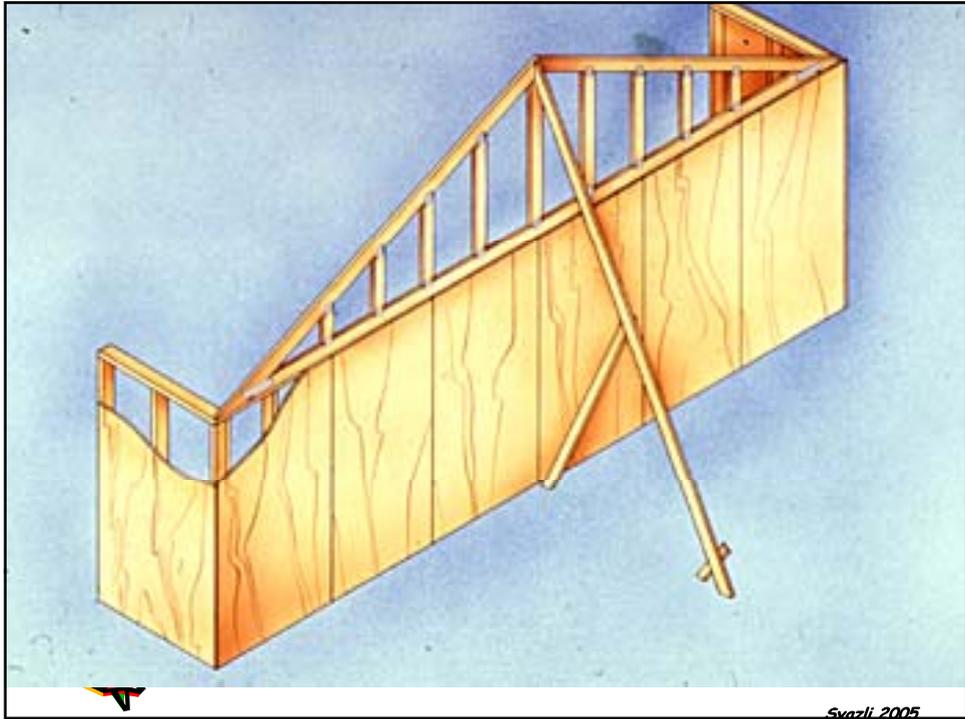
Hip

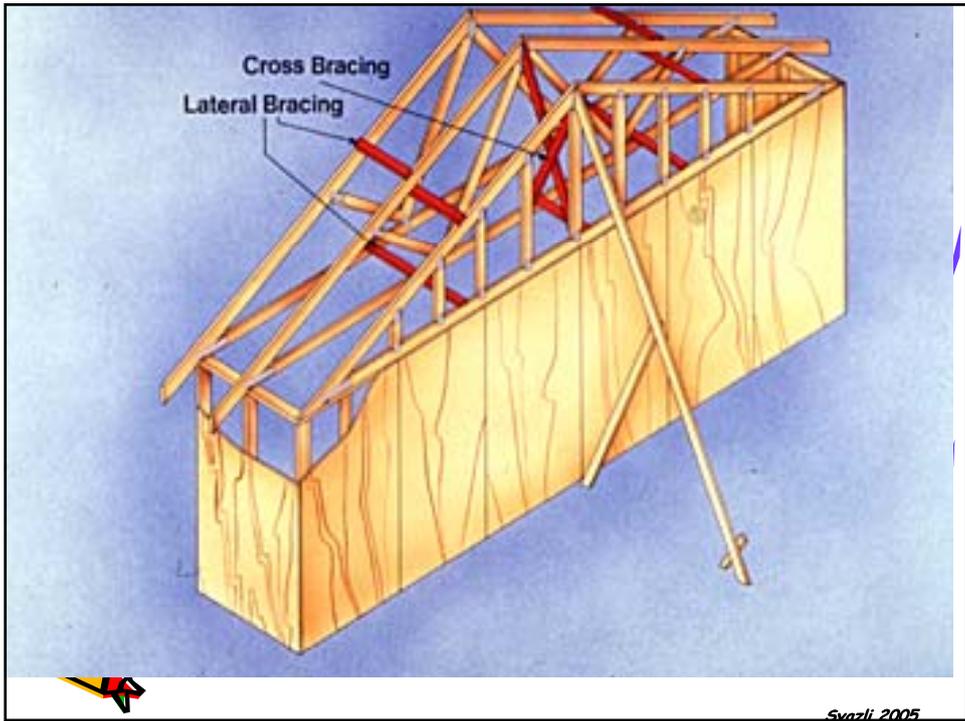


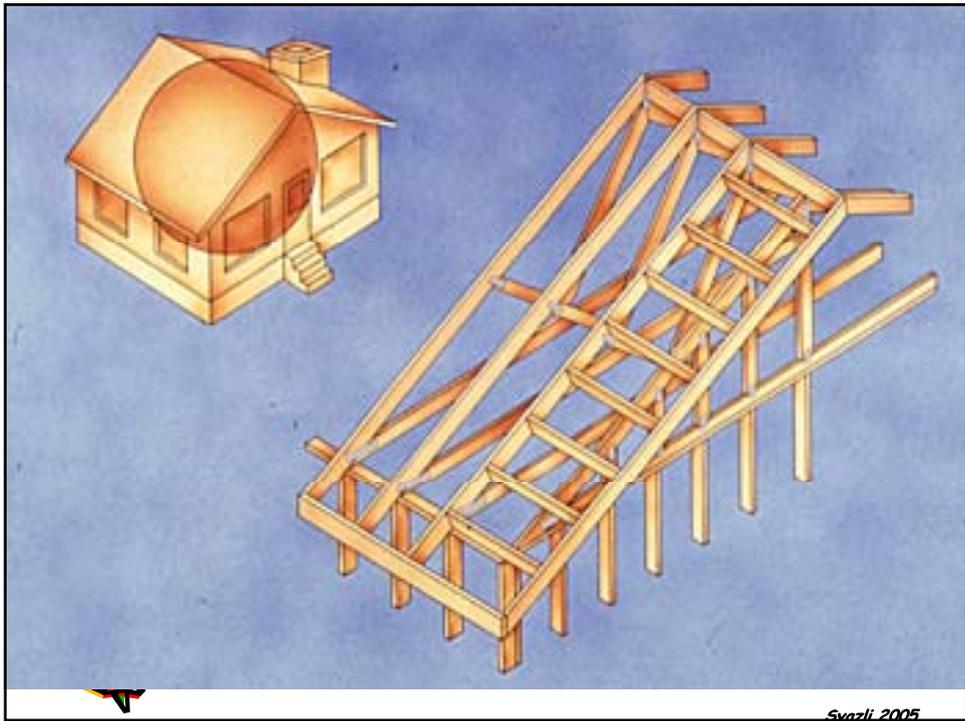
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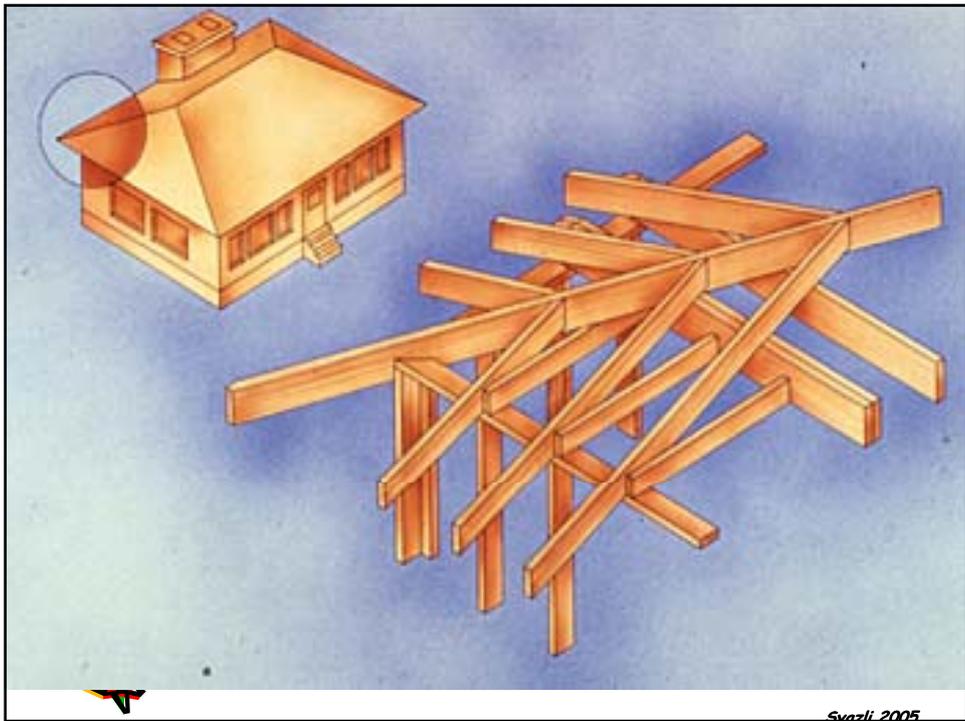
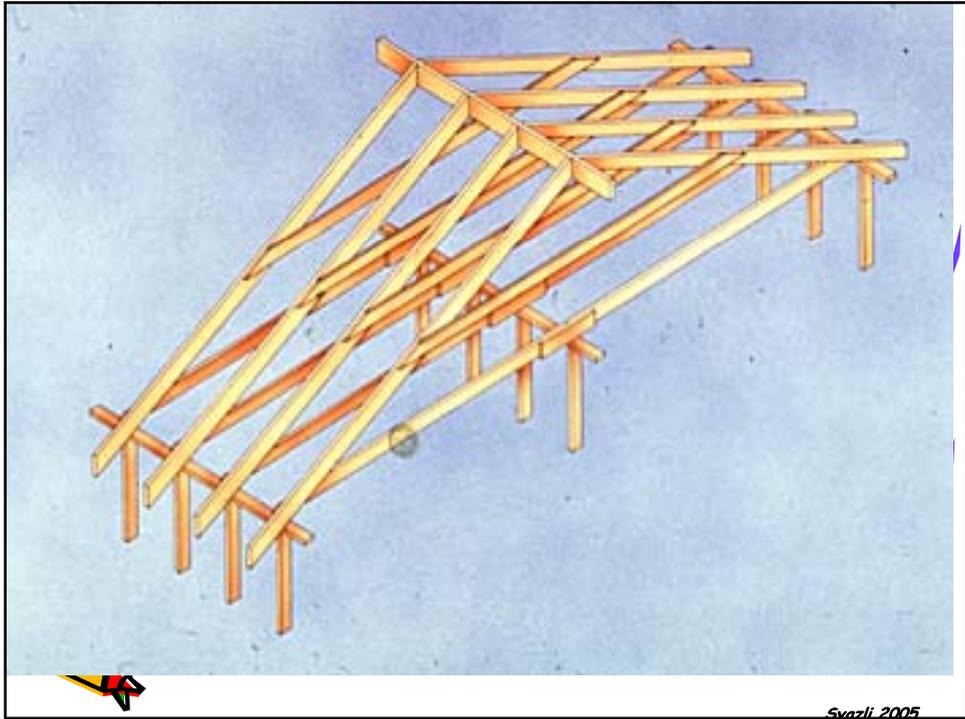








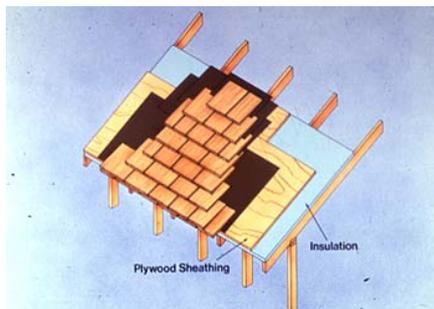




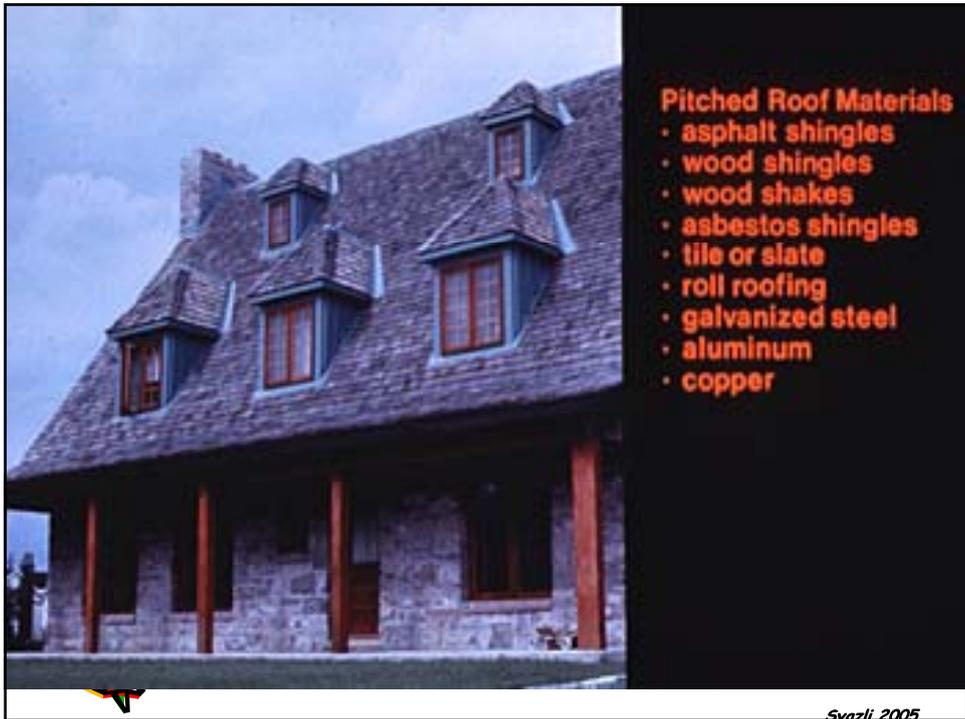
- **Detail of common connections of steel roof trusses** : no common rafter is required when corrugated sheets are used as roofing coverings. They are fixed directly to steel purlins. See diagram.
- Roof covering materials
 1. Tiles : spacing of 600 mm c/c for rafter with batten of 300 mm c/c. See diagram.
 2. Asbestos corrugated cement sheet : main rafter at 1800 mm c/c and intersect rafter 900 to 1200 mm c/c. See diagram.
 3. Metal sheets/decking : see diagram.

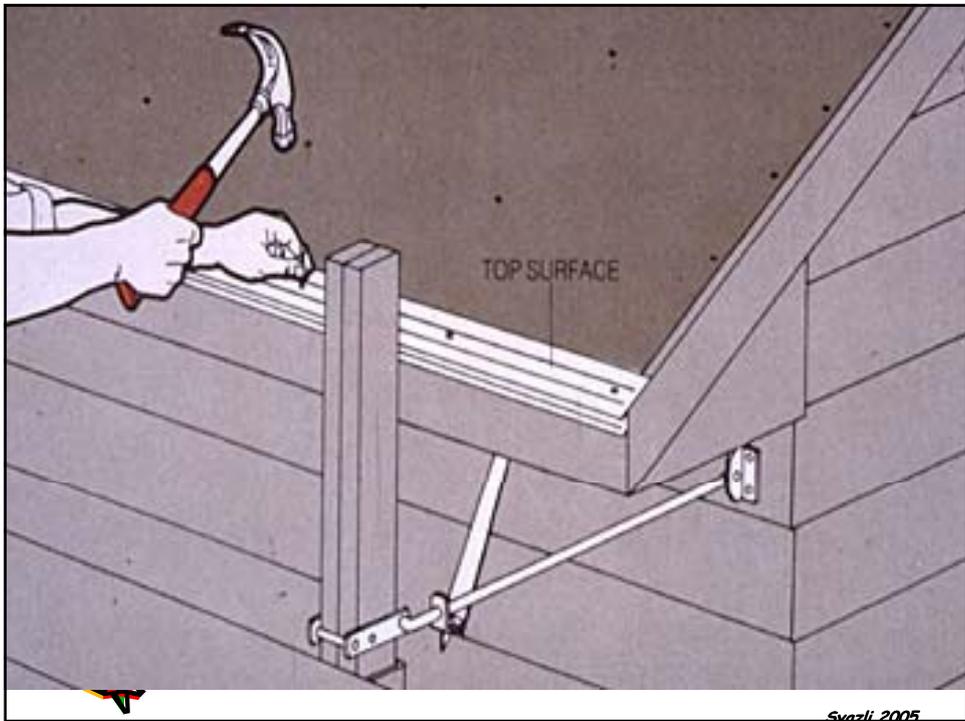


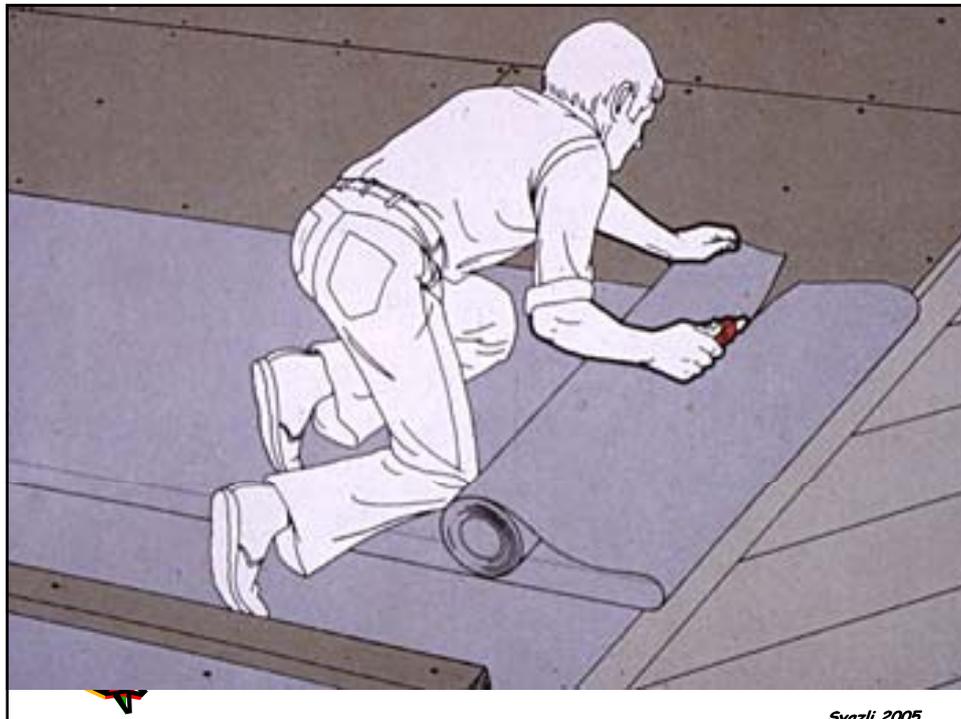
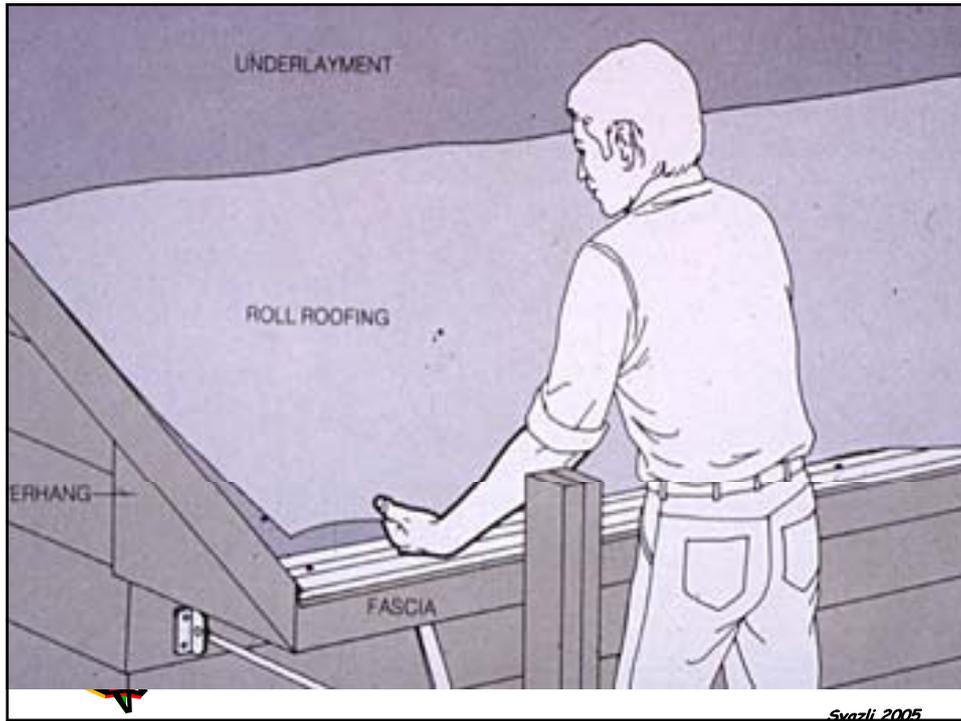
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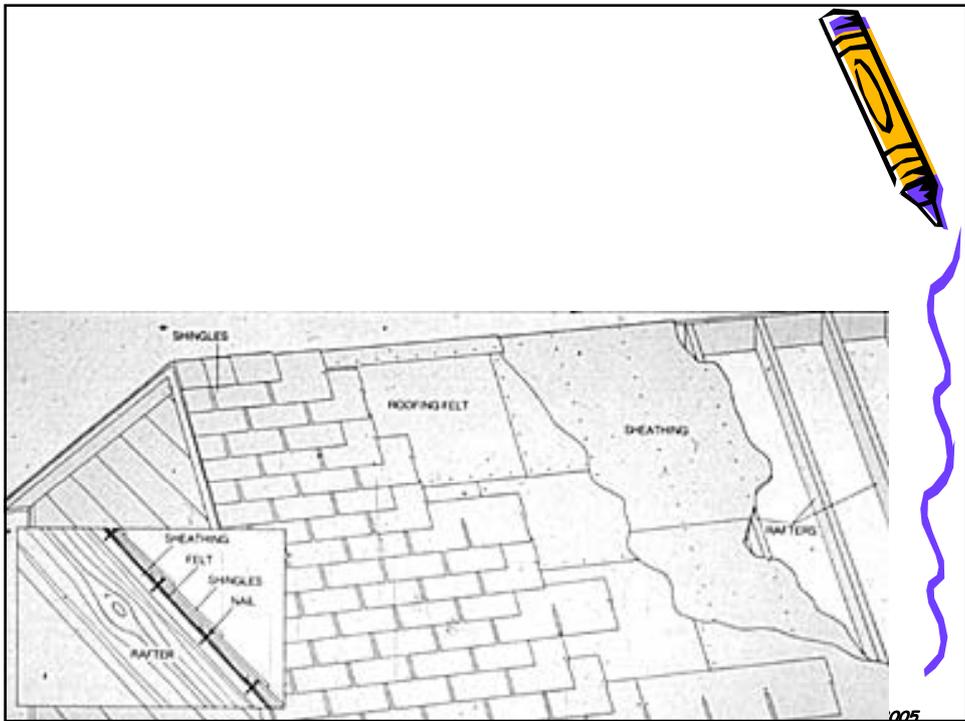
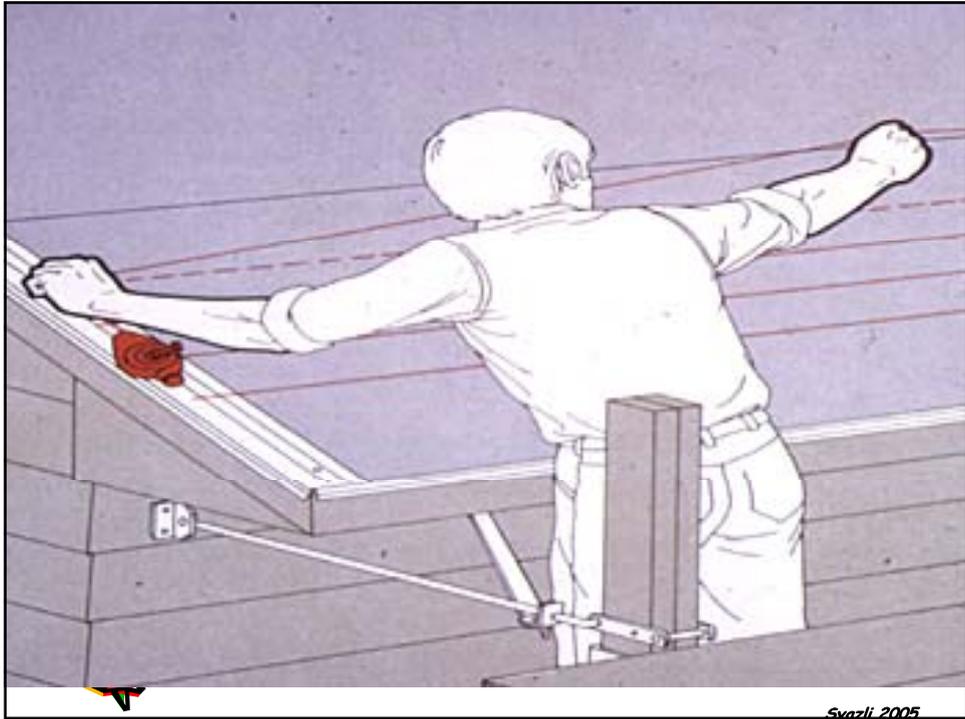


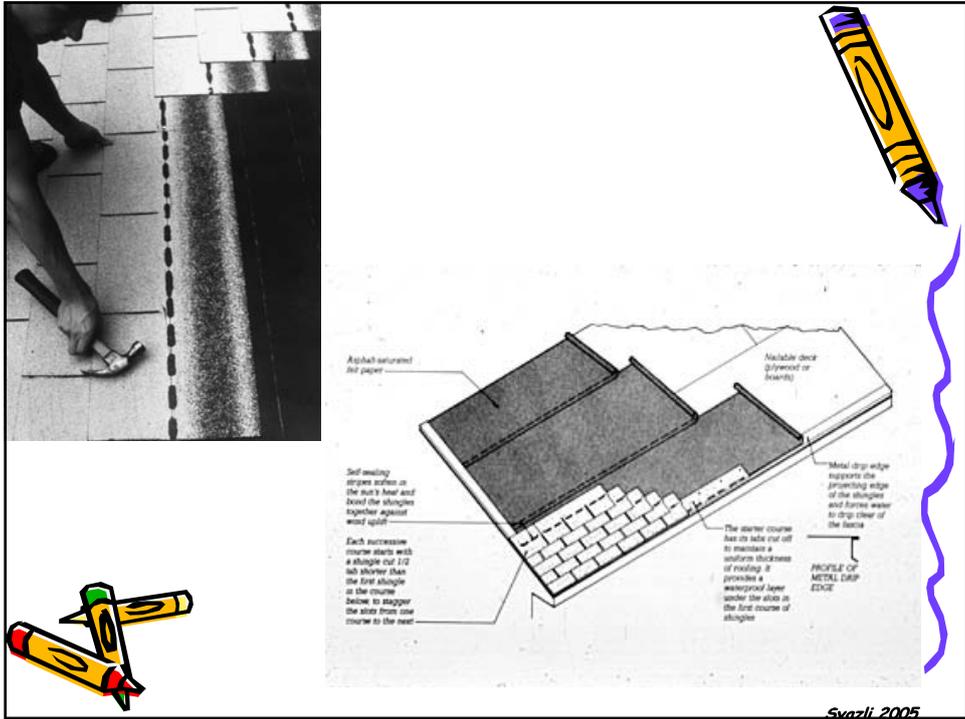
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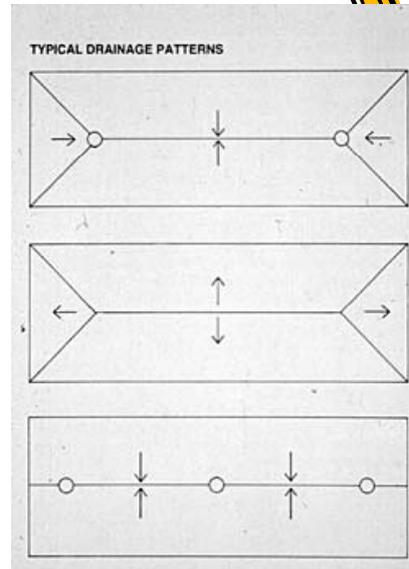






Flat roof design

- 1) A roof is designated as flat if its slope is less than ten degrees.
- 2) Flat roofs have traditionally been used in hot climates where water accumulation is not a problem.
- 3) They were generally unknown in northern climates before the end of the last century.



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Flat Roof

- **Advantages** of flat roof design:
 - 1) No space lost below roof, i.e. no dead space
 - 2) Less material is used than in a sloped roof
 - 3) The rooftop is potentially useful as a terrace, or sleeping porch
 - 4) Potentially pleasing appearance
 - 5) Easier to build than a sloped roof
- **Disadvantages** of flat roof design:
 - 1) Roof elements can not overlap, hence waterproofing must be more complex, and more thorough
 - 2) Drainage is not automatic
 - 3) Support of snow load must be insured



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Weatherproofing the flat roof:

- 1) The flat roof relied on some kind of membrane for keeping moisture out. In dry climates this is done with clay tiles, but in Canada asphalt, or rubber is necessary.
- 2) Flat roofs are never actually flat, a subtle slope directs standing moisture to drains at edges, or inside



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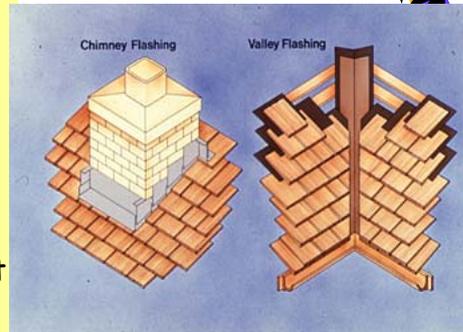
- Flat roof structure:
Depends on the spanning capability of the substrate. The following are approximate spanning abilities of common decking systems in Canada:
 - 1) Plywood- 40 cm to 60 cm
 - 2) 5 cm tongue and groove cedar boards- 1.2 m
 - 3) Metal corrugated decking- up to 4 m
 - 4) Precast gypsum planks- up to 1 m



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Flashing

- Flashing is special material used to make sure that no moisture leaks in those areas of a roof that are particularly vulnerable to penetration. Areas where flashing is commonly used:
 - 1) Wherever the roof is pierced by a chimney, skylight, air or plumbing vent
 - 2) Where roofs meet walls
 - 3) At the edges of flat roofs where they meet parapet walls (a wall that extends above the level of the roof)



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- Materials from which flashing is made of:
 - 1) galvanized metal
 - 2) aluminum
 - 3) copper
 - 4) building paper



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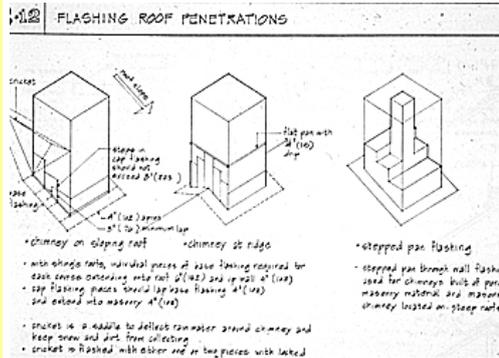


Flashing Design

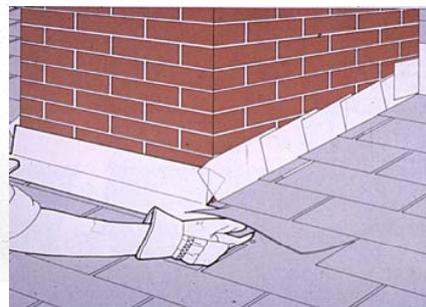
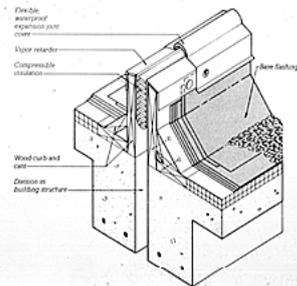


1) **Sloped roofs:** it is important to design flashing so that it throws the water downslope, and does not rely on mastic.

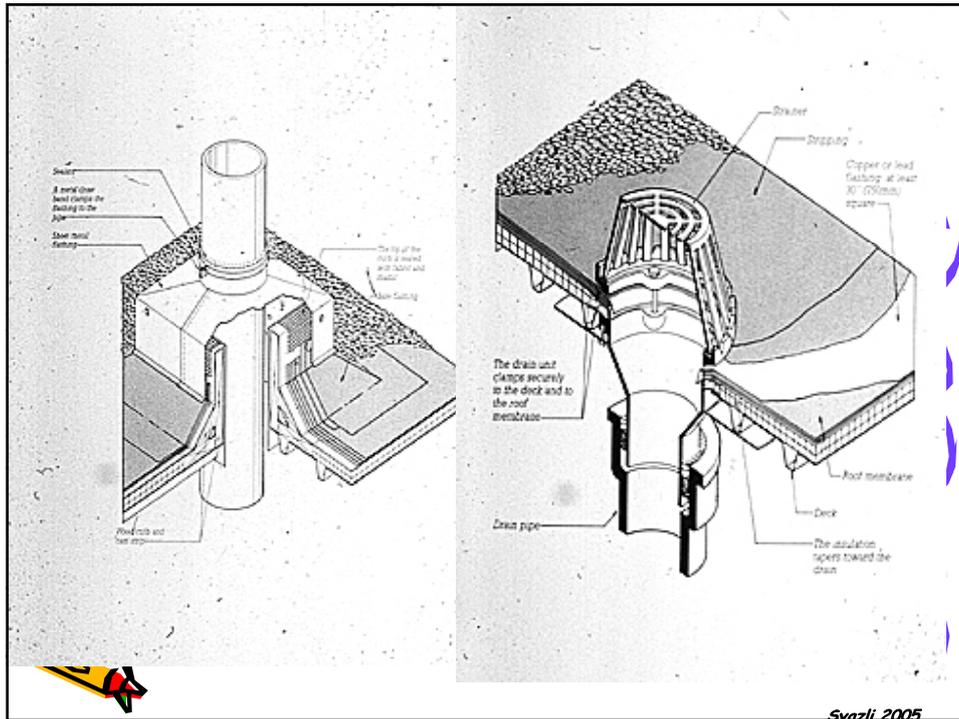
2) **Flat roofs:** it is important that flashing be extended above the level at which you expect snow or water to accumulate.



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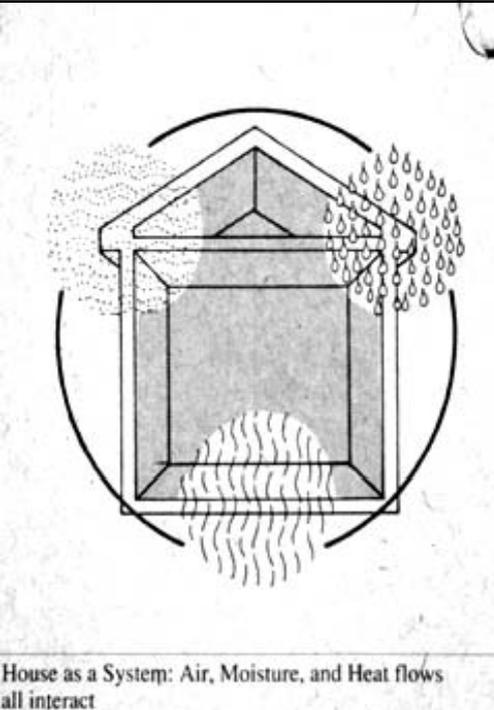


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Insulation:

- Because hot air rises, roofs lose more heat than walls, and thus require greater degree of insulation.
- There is a multitude of different locations for the insulation in a roof, some of which are listed here.



Sloped roofs insulation location:

- - 1) Resting above ceiling.
 - 2) Attached between rafters
 - 3) Between the substrate and the roofing (a particularly useful method of the rafters are to be exposed, but may result in overheating in the summer)



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- Flat roofs insulation location:
 - 1) Between substrate and roofing
 - 2) Resting above roofing material (with ballast provided to keep it from moving)



Ventilation

- Attic areas, or just dead areas in the roofs constructed of trusses, are generally provided with ventilation systems to allow in outside air.
- Vents are generally located under the eaves, at the gable ends, at the ridge, or by fans.



- Two main reasons for keeping the attic at outside temperature are as follows:
 - Summer heat
 - Winter humidity

