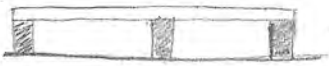
→ Reinforced concrete slabs

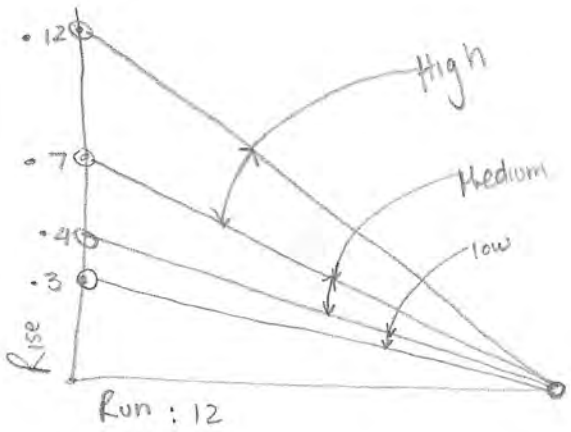
→ flat timber or steel trusses

 → Timber or steel beams & decking

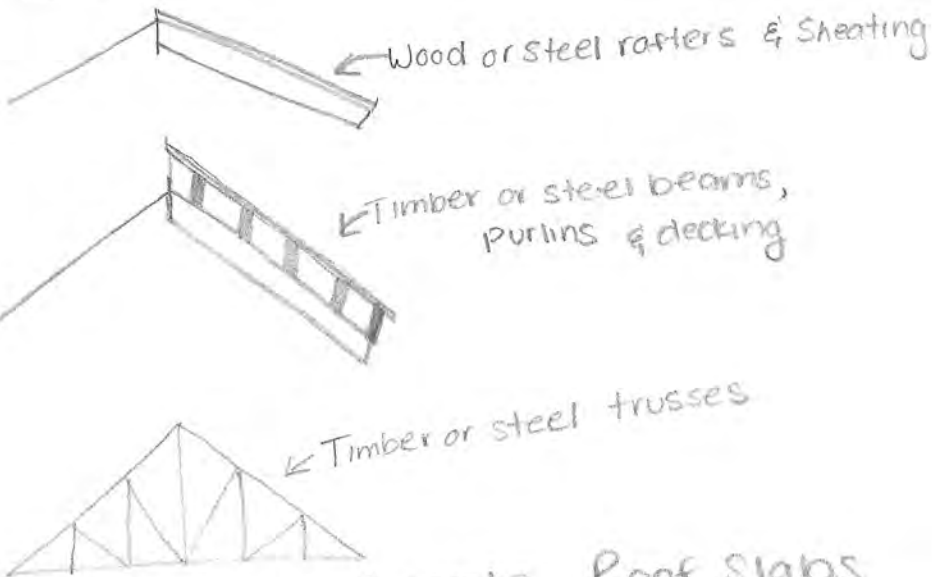
→ Wood or steel joists and sheating

# Sloping Roofs

- Sloping roofs may be categorized to
  Low-slope roofs—up to 3:12
  Medium to high 4:12 to 12:12
- Roof slope gets affected by the Roof material:
  Low → continuous membrane roofing
  Medium- High → shingles tiles or sheet materials.




Slope roof structure.




## 6.04 Reinforced Concrete Roof Slabs

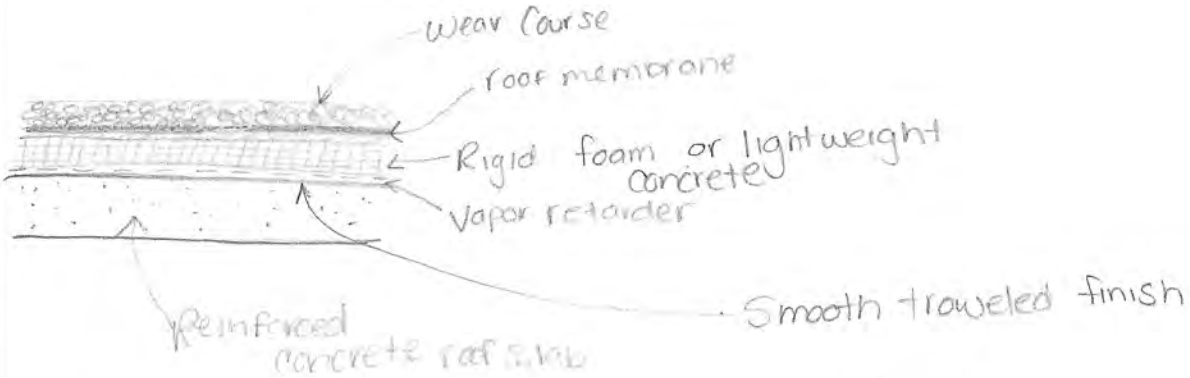
- These slabs are formed and site casted.
- Roof slabs are normally covered w/ a roof membrane
- Slope top of slab for drainage is 1/4" per foot
- They are supported by concrete columns, frames or bearing walls of masonry.

## Edge of Concrete roof slab. 6.04

①


②


③

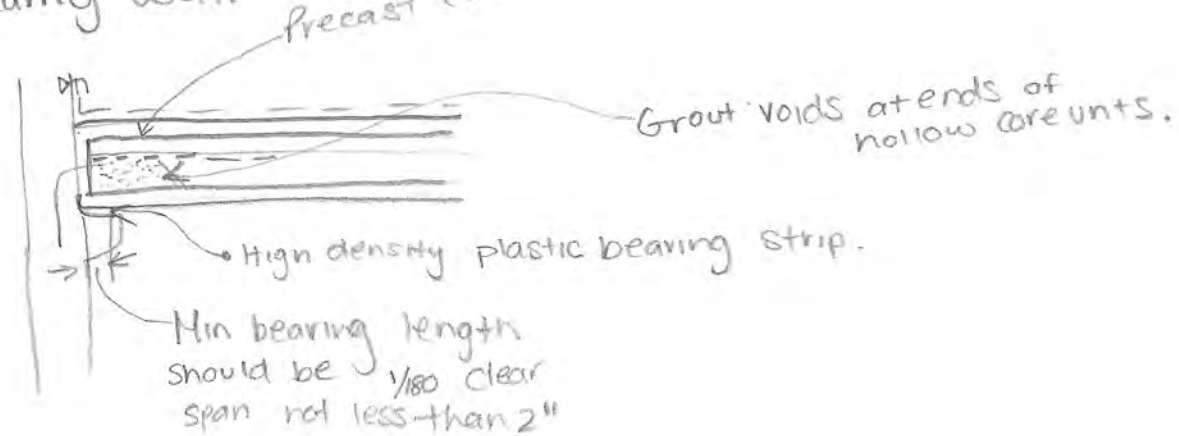




- Concrete can be designed in may ways (cast), such as folded plates, domes, and shell structures.

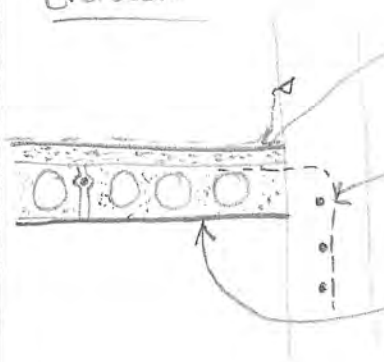
## 6.05 precast concrete

precast concrete roof system are similar in form and construction to precast floor system.

Bearing wall

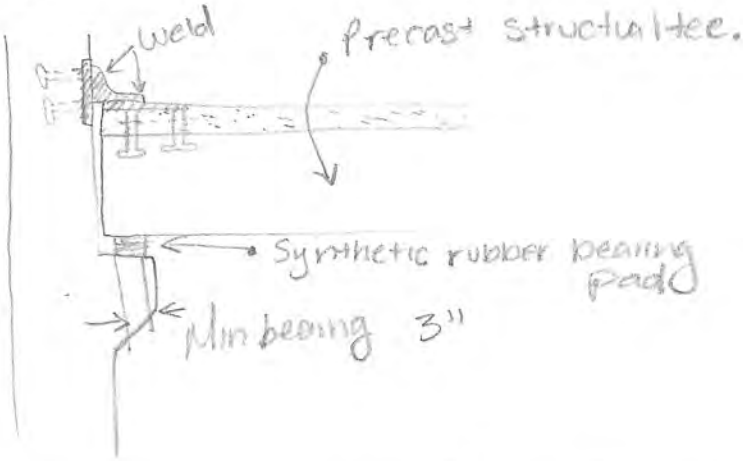


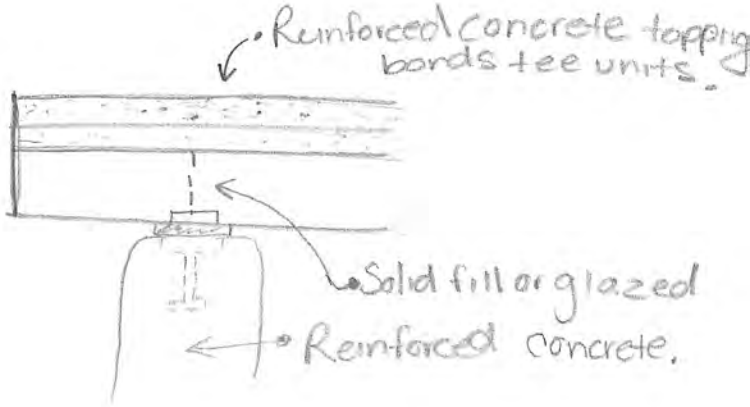
End wall



- Reinforced concrete 2" min
- hooked bars cast into slab edge slots @ 4'
- Underside of precast slabs may be caulked & painted.

Barewall




## 6.15 Cementitous Roof Planks.

Cementitious roof planks are manufactured w/ portland cement, lightweight aggregate, an aerating compound & galvanized welded wire fabric

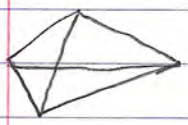
Thickness

2" – 4" w/ a span of 3'-8'

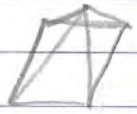
← Tongue - and groove edges

- An acoustical treatment may be cast in the underside & left exposed as the ceiling finish
- Channel slabs Thickness 2 3/4" – 4" w/ a span of 4'-12'
- Cementitious roof planks may also consist of wood fibers that are chemically processed & bonded under pressure w/ portland cement.

Space frames



Triangular Grid



Square Grid

hexagonal grid

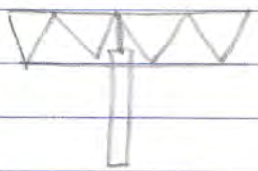
These a 3 of many diff patterns.

A space frame is a long-spanning 3D plate based of triangles, only to axial tension of compression.

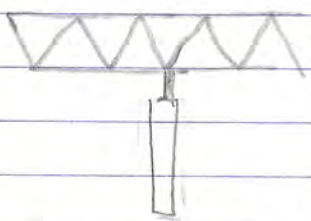
3 diff fabricated correctors
- Welded connection
- Bolted connection
- Threaded Connection

- the supporting bay for as space-frame should be square to make sure that it acts as a two way structure.

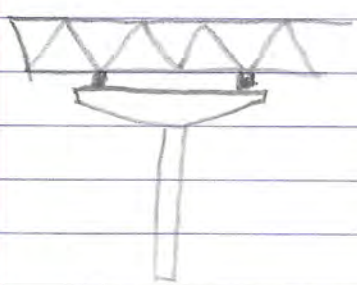
• top chord supported



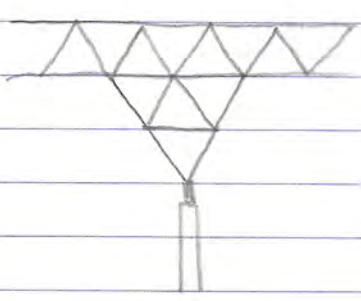
• Bottom-chord supported



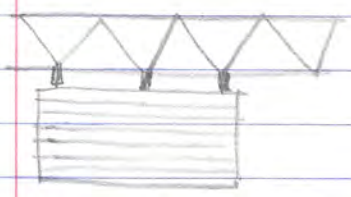
• four point cruciform



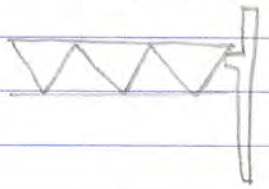
• frame capital



• interior wall



• Exterior wall



Open web steel joists
→ to resist uplifting wind forces, every joist is anchored to the supporting structure

→ horizantal bridging angles for K series joists are welded to the top and bottom Chords.
- the diagonal bridging angles are also welded or bolted to clip angles.

- Top and Bottom Chords parallel require a Slope roof so in order to obtain it the joist can be shortened or tamper with the insulating layer of Roof decking.

→ Bearing Walls : Parapet
→ Secure every roof joist to a steel bearing plate
→ Double treated wood plate w 1/2 anchor bolts

→ Metal Roof decking

flushedge : end wall
→ Structural Steel frame
→ has 2 1/8" fillet welds

Parapet Wall:
- Precast concrete or stone veneer
- Angle cast into cast edge of Concrete slab
- Metal slab closure
- Steel beam
- Fire proofing as required

- Metal Roof Decking
is corrugated to increase its stiffness & ability to span across open-web steel joists

- decking panels are puddle-welded or mechanically fastened to the supporting steel

- It is commonly used w/o a concrete topping

- to provide max surface area, the top flang should be wide and thten

① Ribbed Roof Decking
② Cellular Roof Decking

New material - that can be used in construction
- Carbon fiber
- plastic (recycled)

- Steel gives more strength; lets in more light gives a high level of transparence.

glare.
- metal that hat other material added on.

Cross bracing - is used for high structure for lateral loads.

molted Bronz early greeks.
Cast iron: stronger iron.

wrought iron: weaker metal
- Steel highly recycable.

Cast iron
wrought iron
Puddle iron
bessemer process
open hearth method

## 6.16 rafter framing

### Roof terminology

Ridge – a horizontal line at the top between 2 slope planes

Dormers – are protecting structures built out of the side of a sloping roof & housing a vertical window

Gable – a triangular portion of wall enclosing the end of pitched roof

Rake – inclined, projecting edge of a sloping roof

Shed – a roof having a single slope

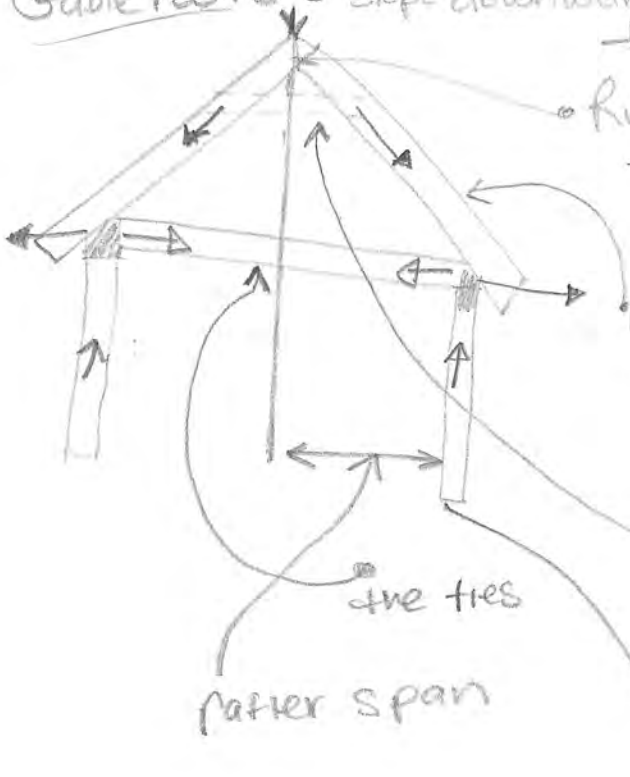
Eave – overhage lower edge of a roof

Soffit – underside of an overhanging roof eave.

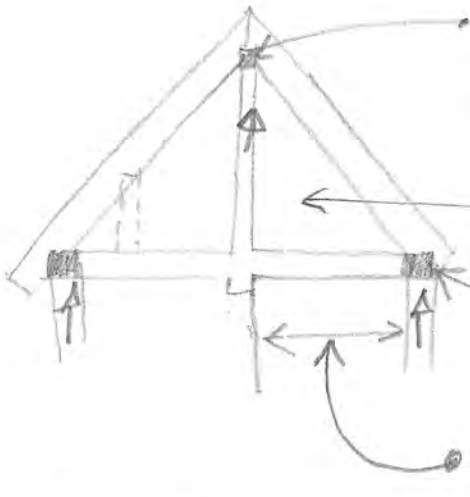
Vally – an intersection of 2 sloped roofs

Hip – Inclined projecting angle formed by 2 adjacent sloping sides.

Gable roofs – slope downwards in two parts from a central ridge, to form a gable at the end



- Ridge board – horizontal member to which the upper ends of the rafters are aligned & fastened
- Common rafters extend form a wall plate to a ridge board or ridge beam / covering a roof
- Collar ties unite 2 opposing rafters at a point below the ridge.
- the ties
- rafter span
- Load/bearing wall



- Ridge beam is a structural horizontal member supporting the upper ends of rafters at the ridge of Roof
- with sufficient headroom.
- Beam or load bearing wall
- Rater span

6.17. Rafter framing.

Hip Roofs

have sloping ends and sides meeting at an inclined projecting angle.

- Ridge board
- Common rafters
- valley jacks
- valley rafies
- hip rafter form the junction of the sloping sides
- Jack rafter - any rafter that is shorter than the full length
- Hip Jacks : extending from a wall plate to a hip rafter

Gambrel Roofs

Ridge board

Purlin

Common rafters

Rafter spans

- Ceiling joists
- Beams

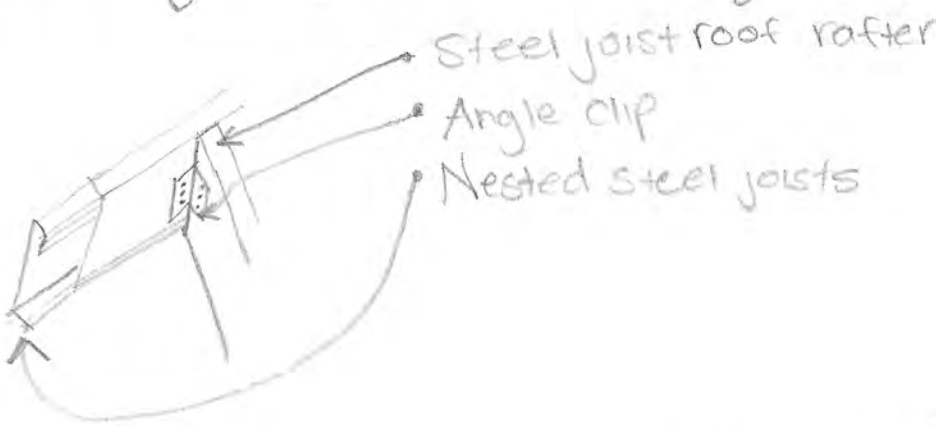
Flat Roofs

Roof joists

Double trimmer joist

lookout rafter support the roof overhang.

6.18 Light - gauge roof framing




- Roofs and ceilings may be constructed with light gauge steel membrane
- light gauge steel members may also be screwed or welded togther.
- Rafter span 12" 16" 24"
- Steel joist rafter
- Steel ceiling joist
- Anchor clips secure both rafters & ceiling joists to the top runner of the stud wal
- Soffit framed with light gauge

Gable dormer

- gable end wall of dormer may also be directly above & be an extension of the exterior wall as illustrated w/ the shed dormer.

Shed dormer

- Common rafter
- Ridge
- Double trimer rafter
- Nailer to carry
- Wall framing rests on top plate of exterior stud wall.

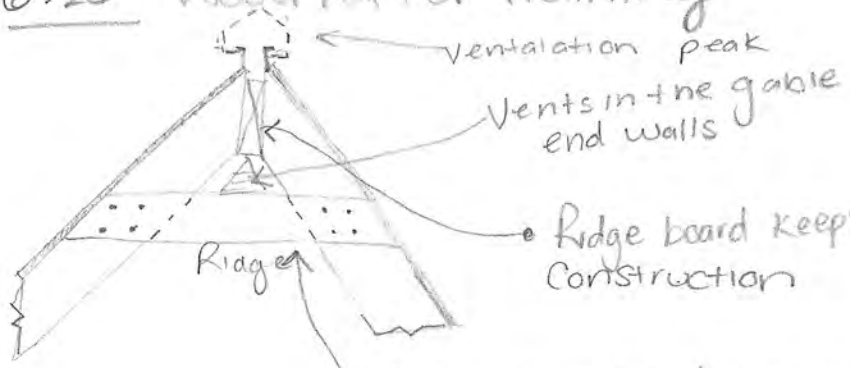
6.19 wood rafters

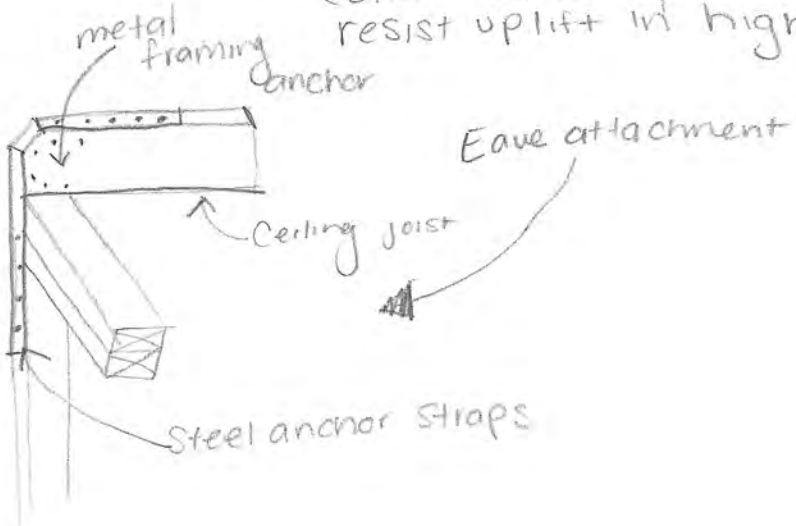
Roof structures framed w/ wood rafters are an essential subsystem of wood light-frame construction.

- Barge of fly rafters are the end rafters in the part of a gable roof
- Double header
- Double rafters for large openings.

- Wood light-framing is combustible, it must rely on roofing and ceiling materials for its fire resistance rating

6.20 Wood rafter framing

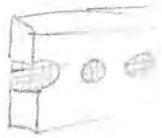


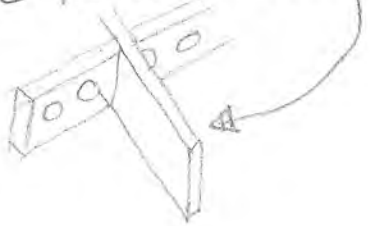
6.21 Wood Rafter framing

Exposed rafter

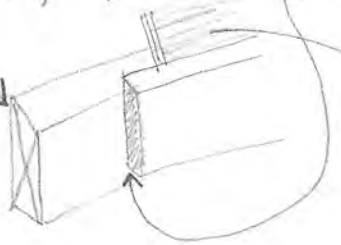
- Blocking w/ screened vent holes



- Exposed rafters



header, fascia is the broad, flat surface of the outer edge of a roof



Roof sheathing

Rafter tail

Wide vented Soffit

- Common rafters
- Top plate of stud wall frame
- 2x ledger
- frieze board
- Continous screened or slotted vent strip
- fasica
- headr
- Lookout
- Soffit of plywood or tag boards.

Narrow Vented Sofit

Wall sheathing
frieze board

Closed Rake

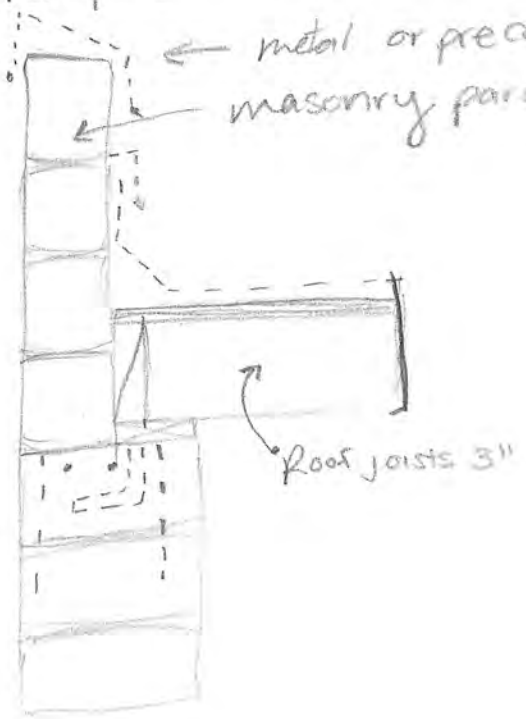
Roof sheathing
Blocking
Metal drip edge
Rake trim
frieze board
Lookout rafter
fly rafter

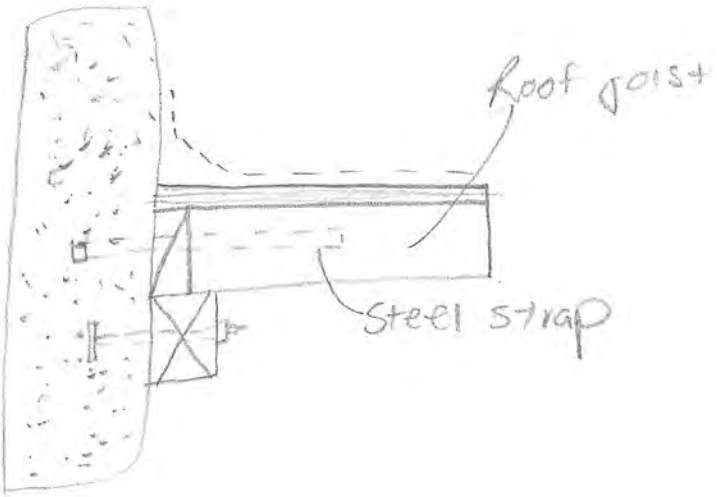
Rake Overhang

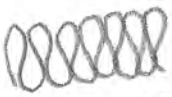
- Common rafter
- Blocking
- Gable end wall
- Roof sheathing
- frieze board.

6.22 wood rafter framing

Parapets



Thermal insulation

6.24 Wood plank-and-Beam framing

- System typically use the same supporting grid of posts or columns as do plank & beam floor systems.
- Roof beams may be supported by
  - Timber, steel or concrete columns
  - Timber on steel girders
  - A reinforced concrete or masonry bearing wall

Rule of thumb.

- Solid Sawn wood beams span/15 →
  width 1/3 to 1/2
- Glue laminated span/20 →
  width 1/4 to 1/3

- Overhangs possible; limit to 1/4 backspan
- Structual fram requires bracing of the wall, floor & roof plans against lateral winds.

6.25 Roof beams with slope.

Plank and beam roof structure can be framed in many way, depending on the direction & spacing of the roof beams,

- Roof beams
- Purling
- roof decking

- roof beams may be spaced further apart & support a series of purling

Roof beams — perpendicular to Slope

- Roof beams support a conventional system of wood rafters

- Roof beams are spaced close enough to be spanned w/ wood decking.

farther apart, beams can support a series of sec. beams parallel w/ slope.

6.26. Post beam connections.

Ridge Connection

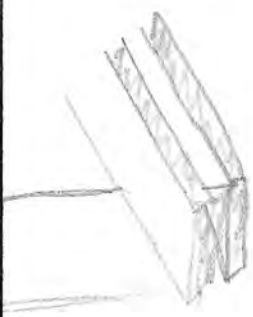
for flatter slopes, use a metal strap or plate to tie together.

Post Beam Connection.

Plate

Woodpost

Space wood beam



Solid beam

- Solid wood tie
- requered metal strap to secure the post beam.

Post beam Conn.

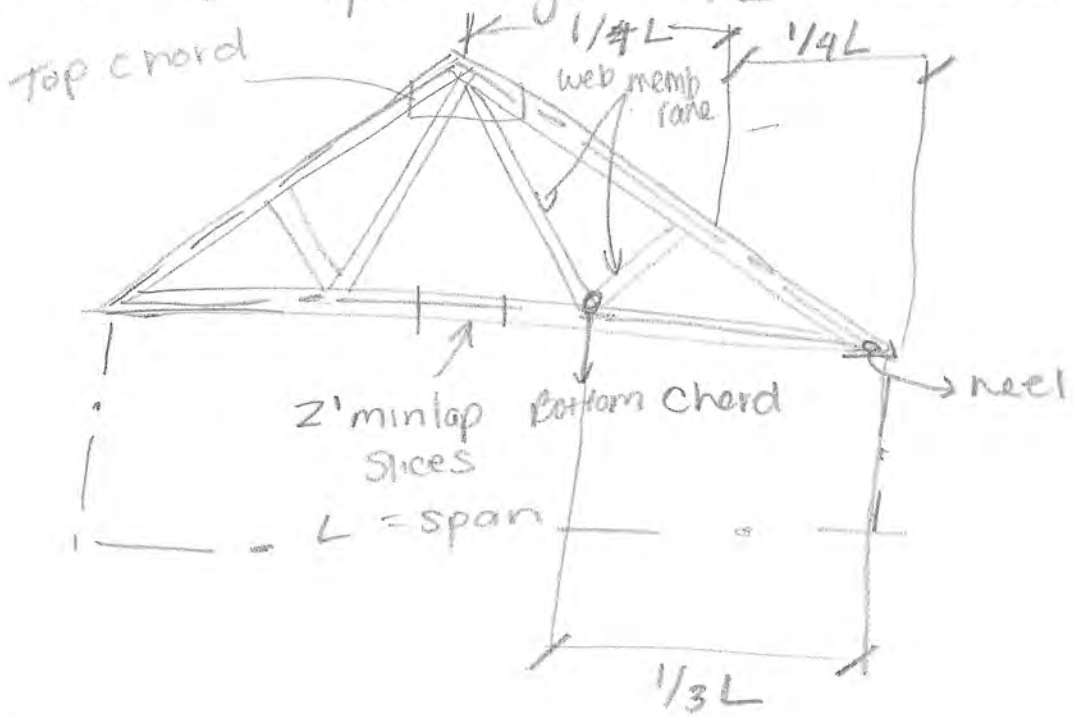
- Plate
- Solid wood
- metal tie strap or gusset
- metal framing angle
- Solid wood beams.

Post beam Con

- wood post
- diagonal brace to support overhang.
- Spaced wood beam
- Solid blocking
- Connection made w/ bolts
- ends of roof beam may be shaped for ornamental effect

Example of Belgian Truss

- Trusses usually don't exceed 5 memoranes
- are 2x o 3x materials $3\frac{5}{8}$" min face width for 2-$\frac{1}{2}$" split rings $5\frac{1}{2}$" min for 4" split rings.




## Heel joints

- member & joint details are determined based on truss type, load pattern, span, grad & species of lumber.
- To prevent secondary shear the load at a joint should pass throught a common node.
  - Steel angles
  - Top plate
  - Steel bearing plate
  - Solid or built up column support
  - split ring connectors.

Roof Section @ Ridge

- Ridge Beam
- Shear plate connectors w/ a through-bolt & washers
- wood decking spans across roof beams.
- Rigid foam insulation over vapor retarder
- Roofing materials must be secured w/ long enough to penetrate.
- Solid infill or glazed opening
- Fascia optional

6.28 Wood trusses.

- Contrast to monoplanar trussed rafters, heavier wood trusses can be assembled by layering multiple members & joining them at the panel points w/ split-ring connection.
- Vertical sway bracing may be required to adjacent trusses to provide resistance against lateral wind
- Horizontal cross bracing may be required.

- Composite trusses have timber compression members & steel tension members.
- Truss rods are metal tie rods that serve as tension membrans
- Trussed beams are timber beams stiffened by a combination of diagonal truss rods & either Compression struts.

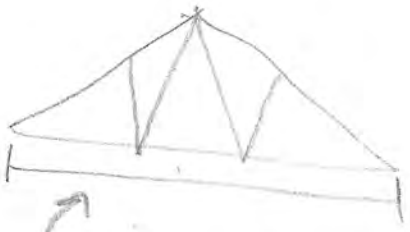
6.30 wood trussed rafters

They are pre engineered and shop fabricated mohoplanar trusses.

- typicall 2x4s ; 2x6s used for the top chord.
- Trussed rafters may be supported by timber or steel beams or by stud framed or masonry
- Lateral bracing is required.

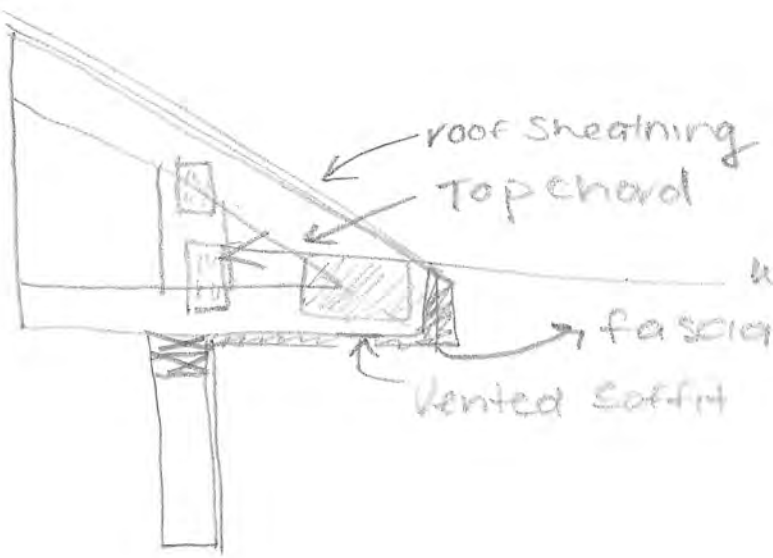
Pitch range 2:12 to 8:12

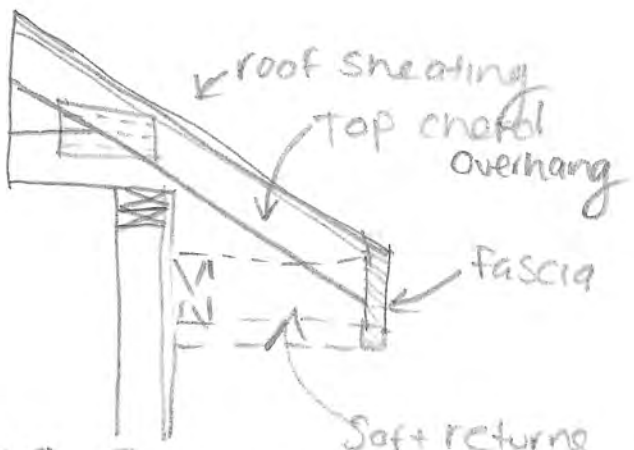
depth span /10 to /20



span from 20' to 32"

Soffited Eave




Overhanging Eave may be fabricated

Envelop: the enclosure

- The envelop can be dependent from the structure:
- (EX) the mason domino
- They have to protect

SHELTER

Water - snow / rain

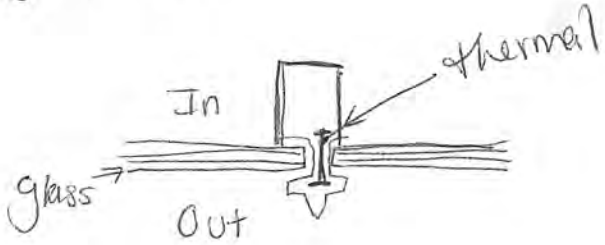
Sun - heat / cold → radiation

Wind

pervious → water can go thaurgh it

empervious → water cann't go throughs it.

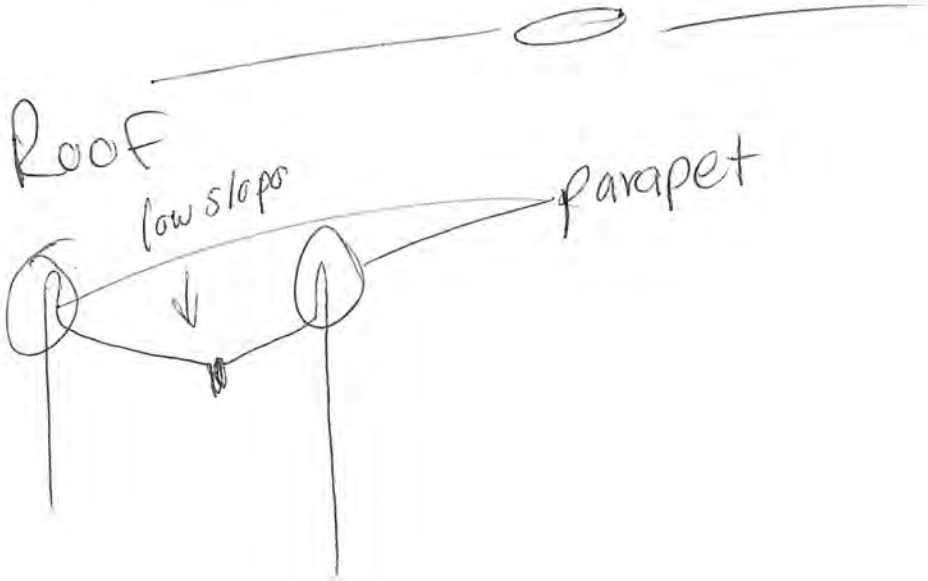
membrane → EPDM:




- The envelop has a very important in the thermal temp.
- make the building more passive
  self sustainable
  effecient

Roofs

membrane & insulation



Jennifer Reyes

6.02

## Roof System

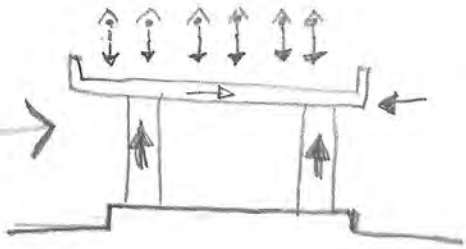
It functions as the primary sheltering element for the interior space. • form & slope of the roof must be related to the roof type.

- types of Roof
  - Shingles
  - Tiles
  - continous membrane

- The roof should also control the passage of moisture vapor.
- depending on type of construction roof must resist the spread of fire.

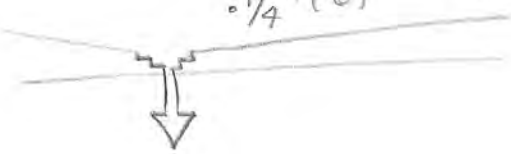
- The structer of the roof must be constructed to the span accross space.

- Roof must carry its own weight & weight of any attached equipment; including rain and snow.
- gravity loads come from the roof system b/c of this the layout must correspond to the column & bearing walls.



- Form of a Roof structure

Flat, Pitched, gabled hipped, broad, Sheltering or rhythmically } these have a impact on the image of a building.

## Roof Slopes 6.03

- Flat roofs require a continous membrane roofing material (slope: 1/4" per ft)
- Slope achieved by inclining the structural membranes or tampering the layer of thermal insulation.