Chapter 11 Steel Frame Construction

- Steel is a strong material, it performs well in tension and compression
- weakness of steel is fire, will melt in fire
- steel can be protected by the application of a zinc coating.

History

- Metal play a role in building until 19th century
- All-metal structure has first builded in late 18th century (Cast Iron Bridge)
- Steel became a valuable material that can make weapon and for building

The Material Steel

- steel contain less than three-tenths of 1 percent carbon
- More carbon will cause steel become brittle and harder

Iron Ore —smelting→ Steel
Blast Furnace

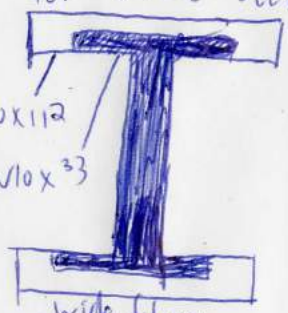
- molten iron will in liquid state to processing into steel

Production of Structural Shapes

- need to pass through roller
- steel has cut in length and labeled to show what kind of steel, it allows fabricator easier to look for what steel is need for the construction

American standard (I beam)
3"-24"

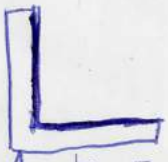
Wide flange



Wide flange
4"-42"
102 mm -1118 mm

Channel
3"-18"

Angle, Unequal Leg
2"-8"



Angle, Equal legs
2"-8"

Structural Tee

Bar
2"x2"

Bar round 2"

Bar 2"x6"

Plate

- Wide - flange (Tall and narrow) shape for columns and beams
  has many sizes and weights 4" - 44"
  9 lbs to 730 lbs

Cast Steel

- produce small amount and able to make many different shapes
- more expensive than rolled steel shapes

Cold-worked Steel

- improve the strength of steel

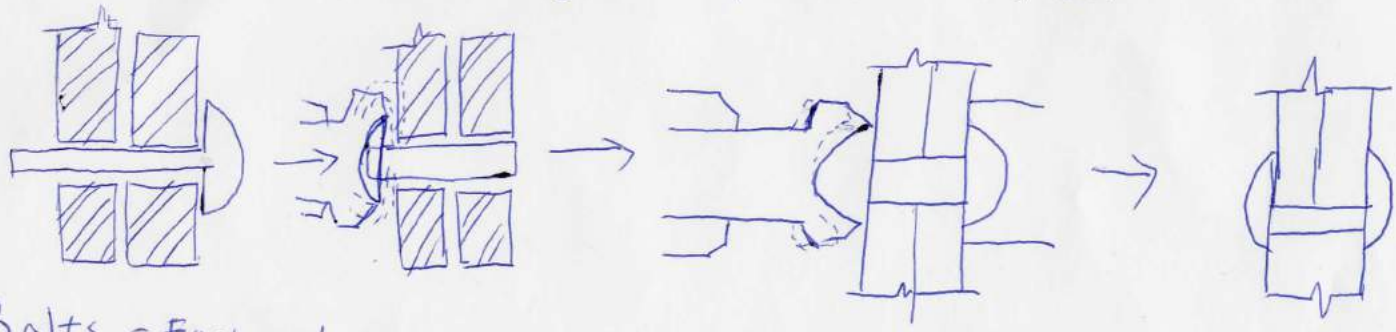
Open-Web Steel Joists - produced by strong steel

- K series joist, LH series joists
  span to 60 ft span to 90 ft

Joining Steel Members

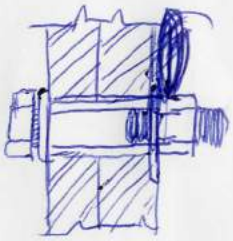
Rivets - more time, expensive

- Shapes can be join to building frame by rivet, bolts and welds.



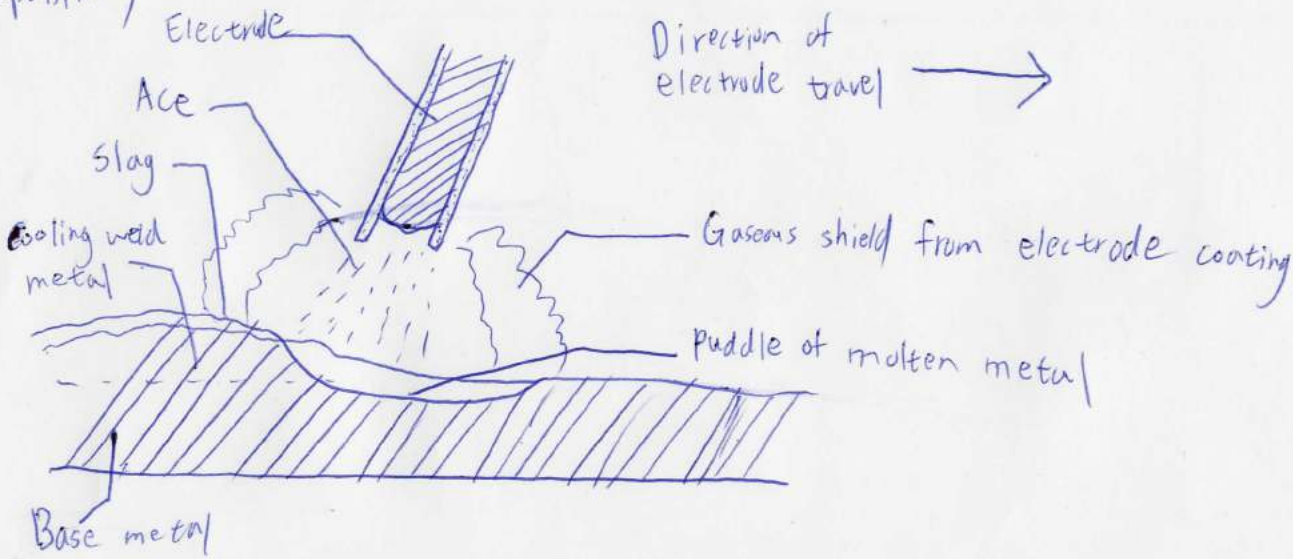
Bolts - Fast and easy

- develop higher strength
- inserted into holes 1/16 inch
- required only one worker for fastener section



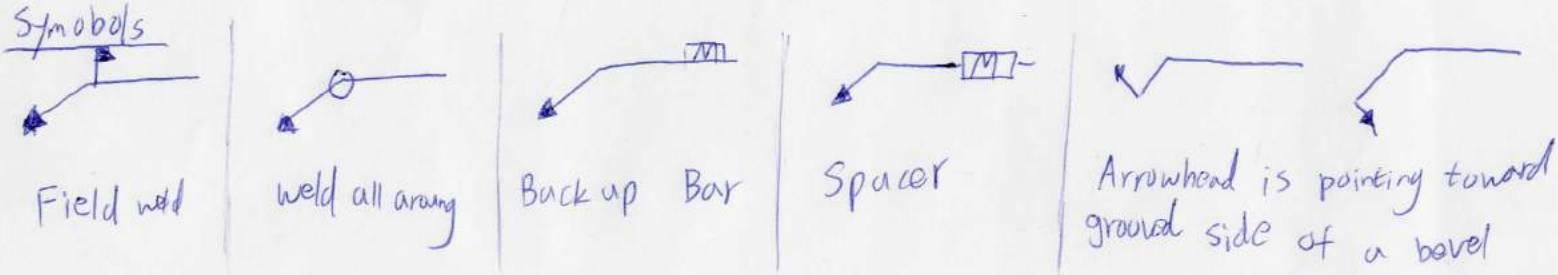
Welding

- Horrible weather can stop the action of welding
- greater capability



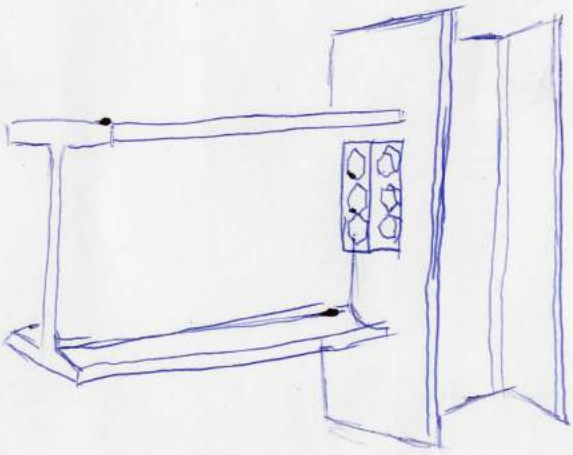
- strict to the worker, need to be trained and has skill and knowledge that is need.

Symobols



Typical Connection

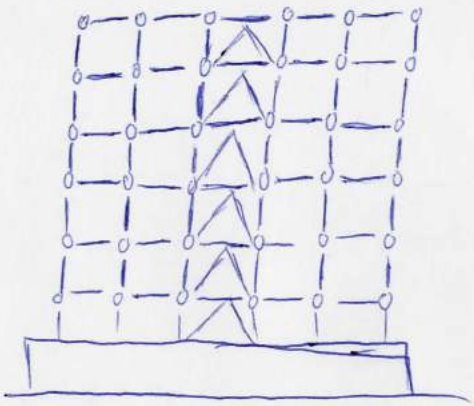
- Connection by angles, plates, or tee
- Shear connection - join only the web of the beam, not flanges (for vertical force and not in bending force.)
- Momement connection - connect beam flanges across the joint (for bending forces)



Bolted beam-to-column-flange shear connection

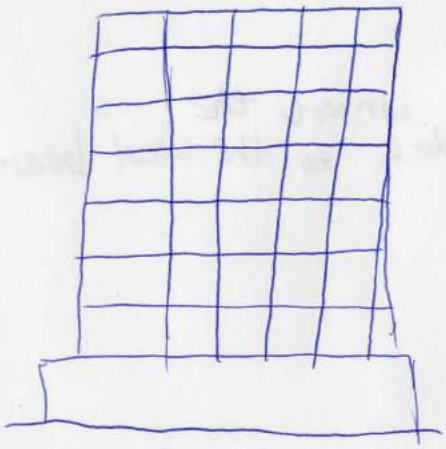
Stabilizing the Building Frame

- Braced Frames



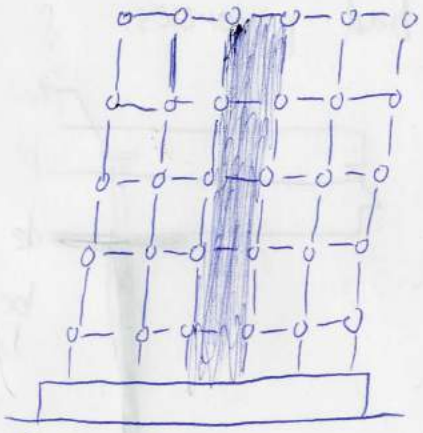
Triangle shape with rectangle frame

- Moment Resisting Frame



provide lateral stability

- Shear walls



Made of concrete and Steel

Fabricator

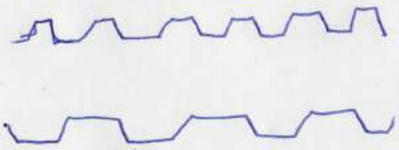
- design the size of steel for column and beam based on the detailed drawings
- Start to produce steel when the approved shop drawings correct and comments.
- Column plate girders and large components such like trusses has make in the shop and bring to the construction site.

Erector

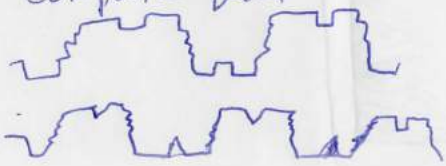
- fitting into a frame into building by bolting and welding
- use mobile crane for lifting entire building
- tower cranes is need for taller building

Floor and Roof Decking

Form Deck



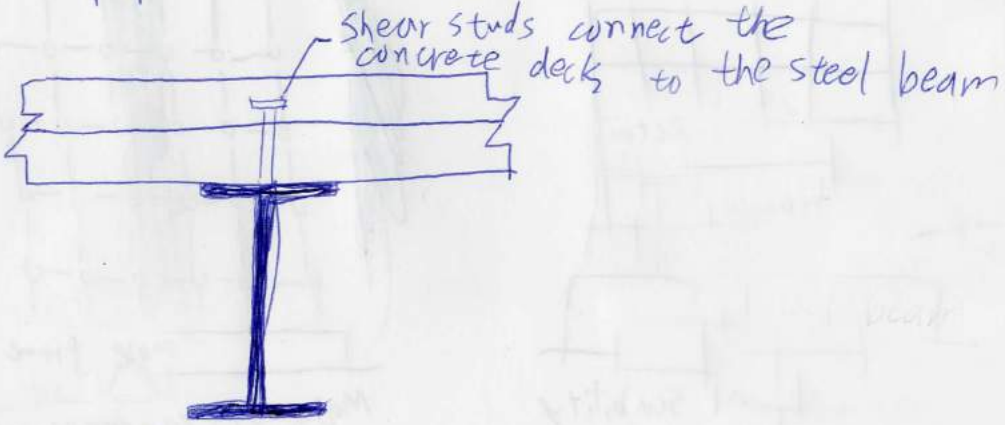
Composite Deck



Roof Deck

Concrete Decks

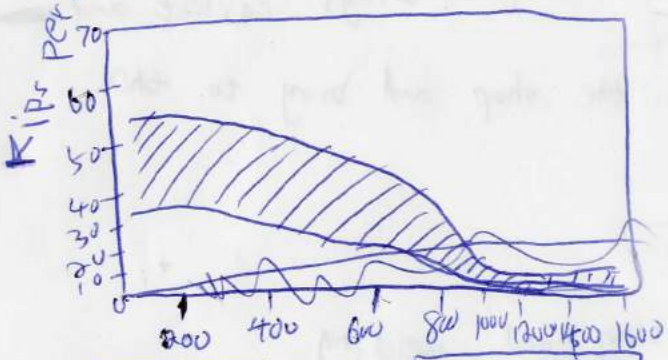
- pour concrete in place over removable plywood forms, so can change the concrete with better concrete when the original is under bad properties.

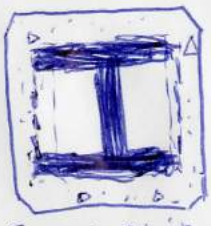


Composite beam construction

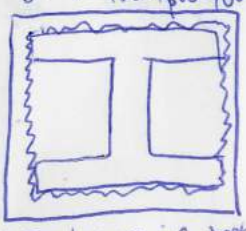
Fire Protection of Steel Framing

- covery steel beams and columns in brick masonry or poured concrete
  - absorb heat

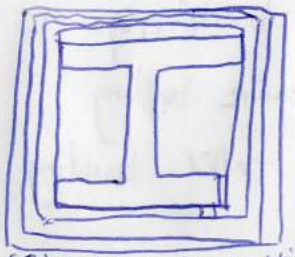




(A) Encasement in reinforced concrete



(B) Enclosure in metal lath and plaster



(C) Enclosure in multiple layers of gypsum board

(D) spray-on fireproofing

(E) Loose insulating fill inside a sheet metal enclosure

(F) water-filled box column made of a wide-flange shape with add steel plate

Trusses

- triangular arrangements of steel members
- carry light and heavy loads

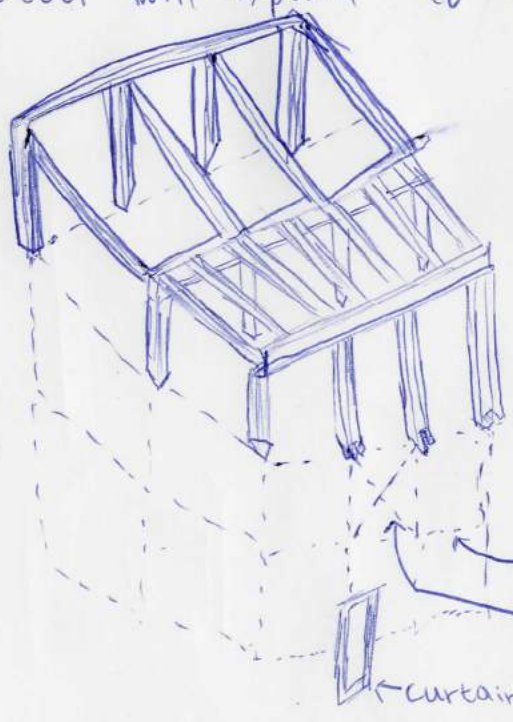
Arches

- Heavy arches has longest-span function
- longest single-span roof structuress can span 1225 ft.

Ching 4.14-4.22 5.35-5.38 6.06-6.14

Structural Steel Framing

- steel need to cut, shaped and drilled in order to use in the construction
- steel will exposed to fire and cause the building to collapse



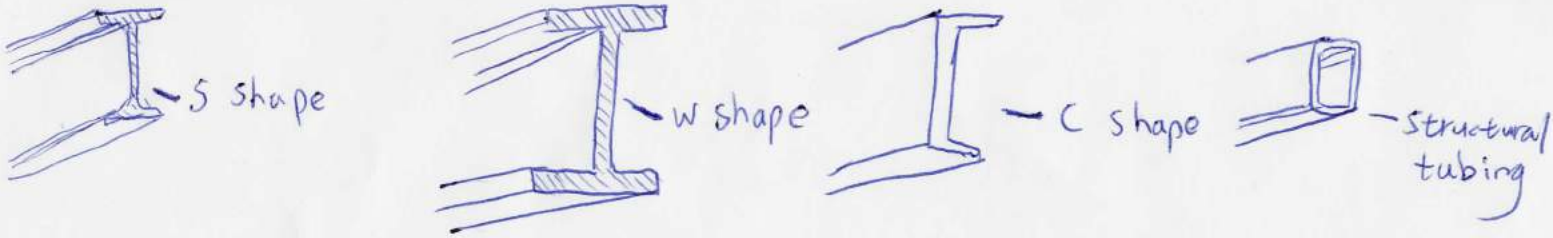
One-way Beam system

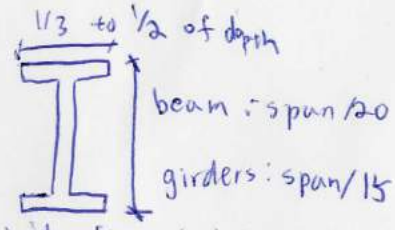
-span range 20' - 32'

Two-way Beam system

- long-spanning plate girders for carry primary beam in large, column space

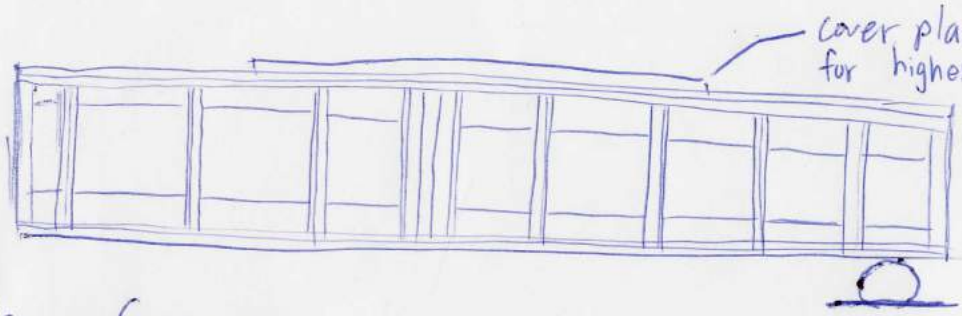
Steel Beams





wide-flange (W) shape

- resist bending and shear forces



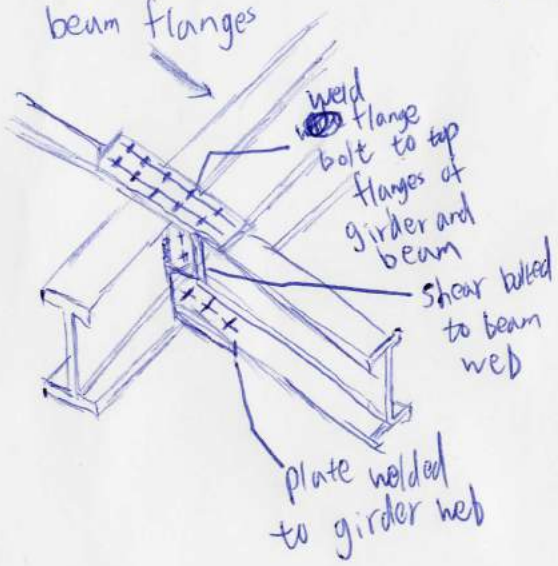
Steel Beam Connections

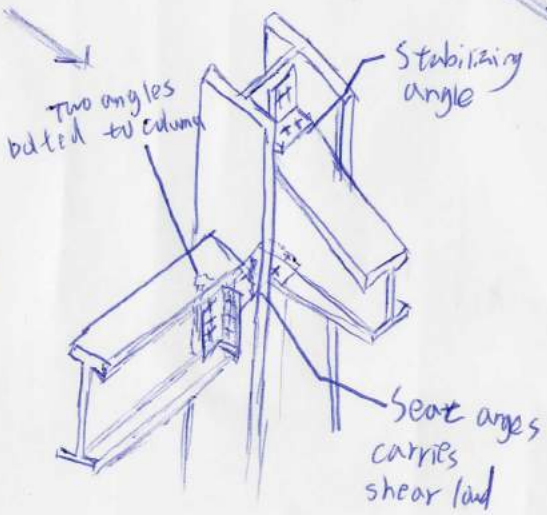
- bolted and welded, the choice of steel connections is basically about economy.
- Moment connection, shear connection, and semi-rigid connection

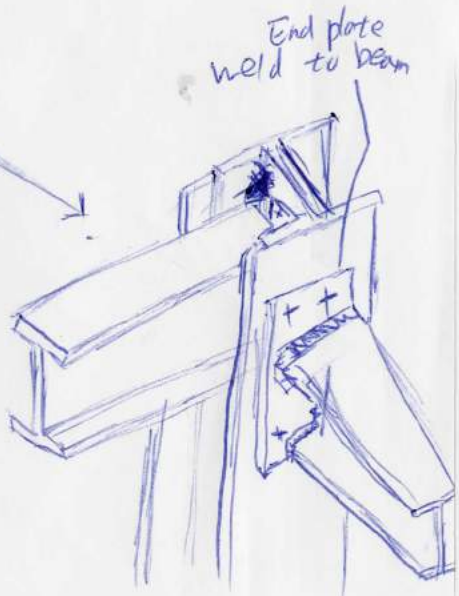
↓ hold original angle under loading by bolted to the beam flanges

↓ resist to shear and movable under gravity loads

↓ beam and girder connection



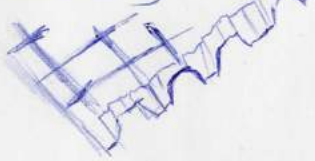




Metal Decking

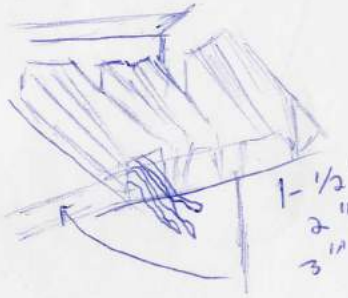
- increase stiffness and capability
- decking panel support by steel joist or beams with bolting action.
- When deck is for transfer lateral loads to shear wall, it must be welded to steel support

Form Decking - permanent formwork for a reinforced concrete slab until the slab don't need help anymore



Composite Decking - bonded with embossed rip patterns

Cellular Decking - welding a corrugated sheet to form a series of spaces or raceways,



span /24

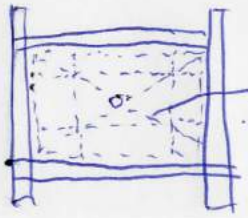
1-1/2" spanning 6' to 12'
2" 6' to 12'
3" 10' to 16'

Structural Steel Framing

- difficult to work on site and need to change the size by cut, shaped and drilled
- Column spacing = beam or girder spans

Fire resistence coating for steel

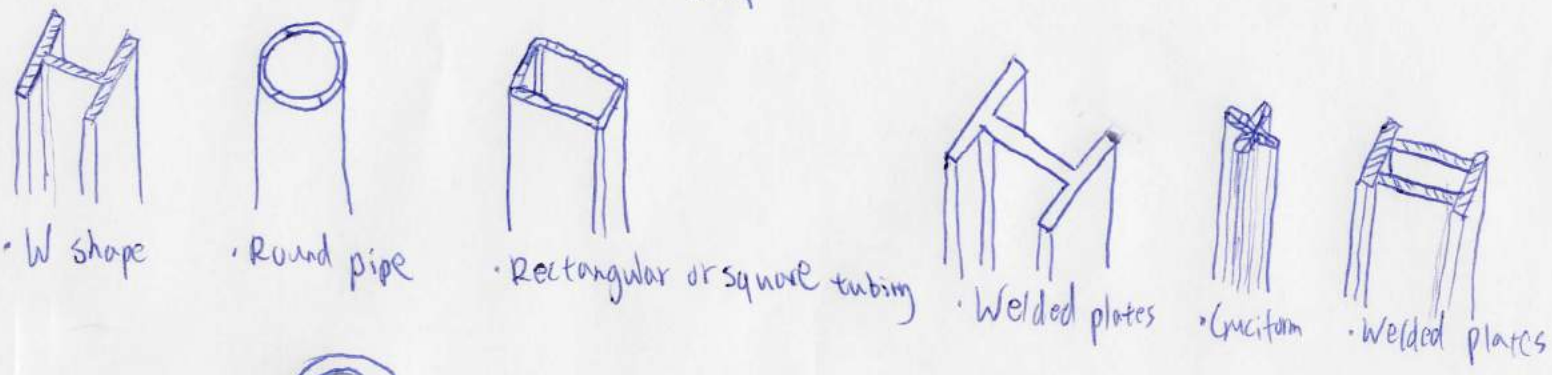
- Panels of curtain wall support by columns along or spandrel beam or edges of floor slabs

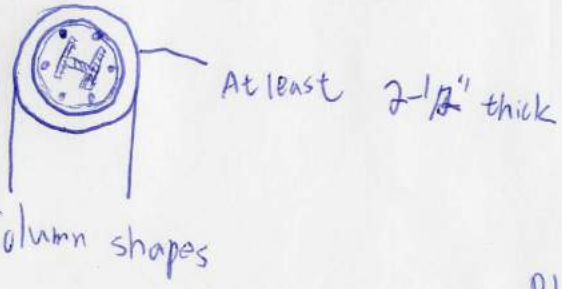


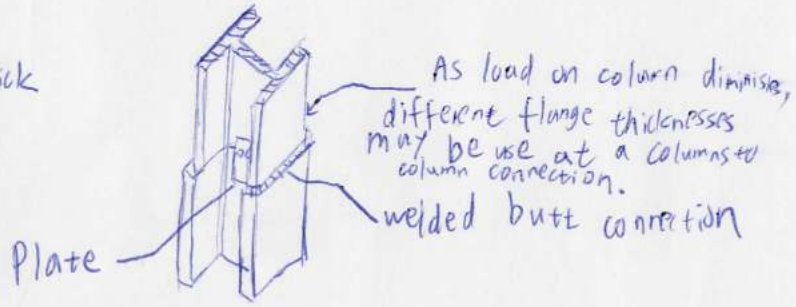
Diagonal will affect wall units

Steel Columns

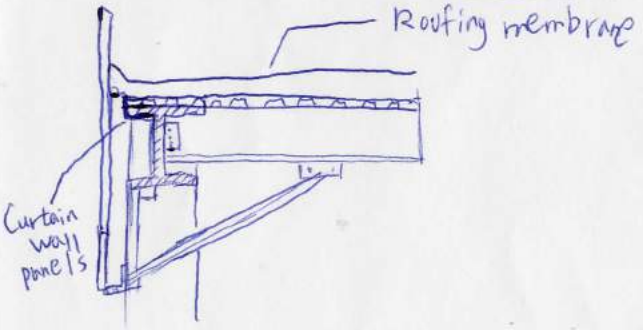
- Wide-flange shape is common to use in a construction
  - can use for bolted and welded connection

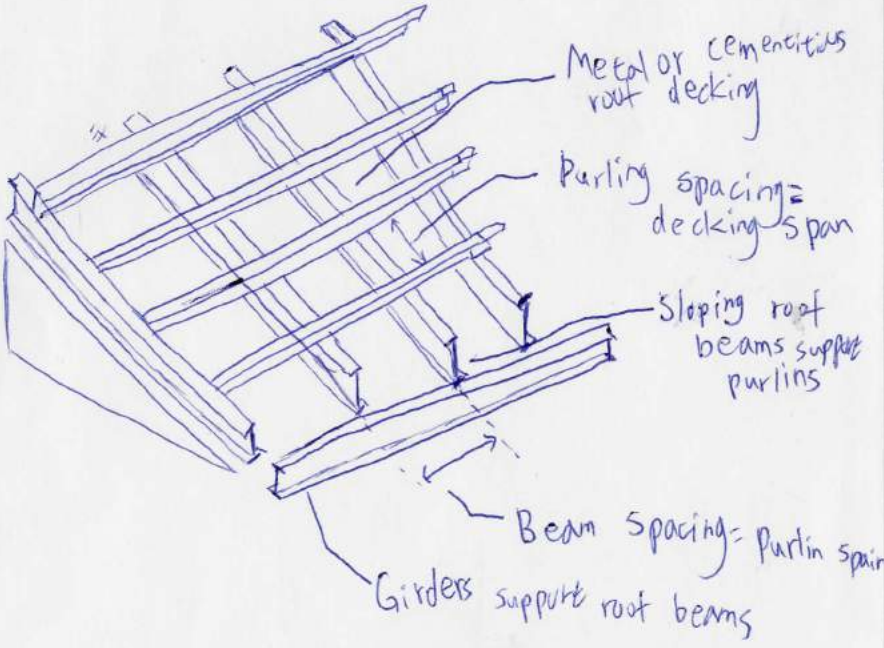






Structural Steel Roof Framing



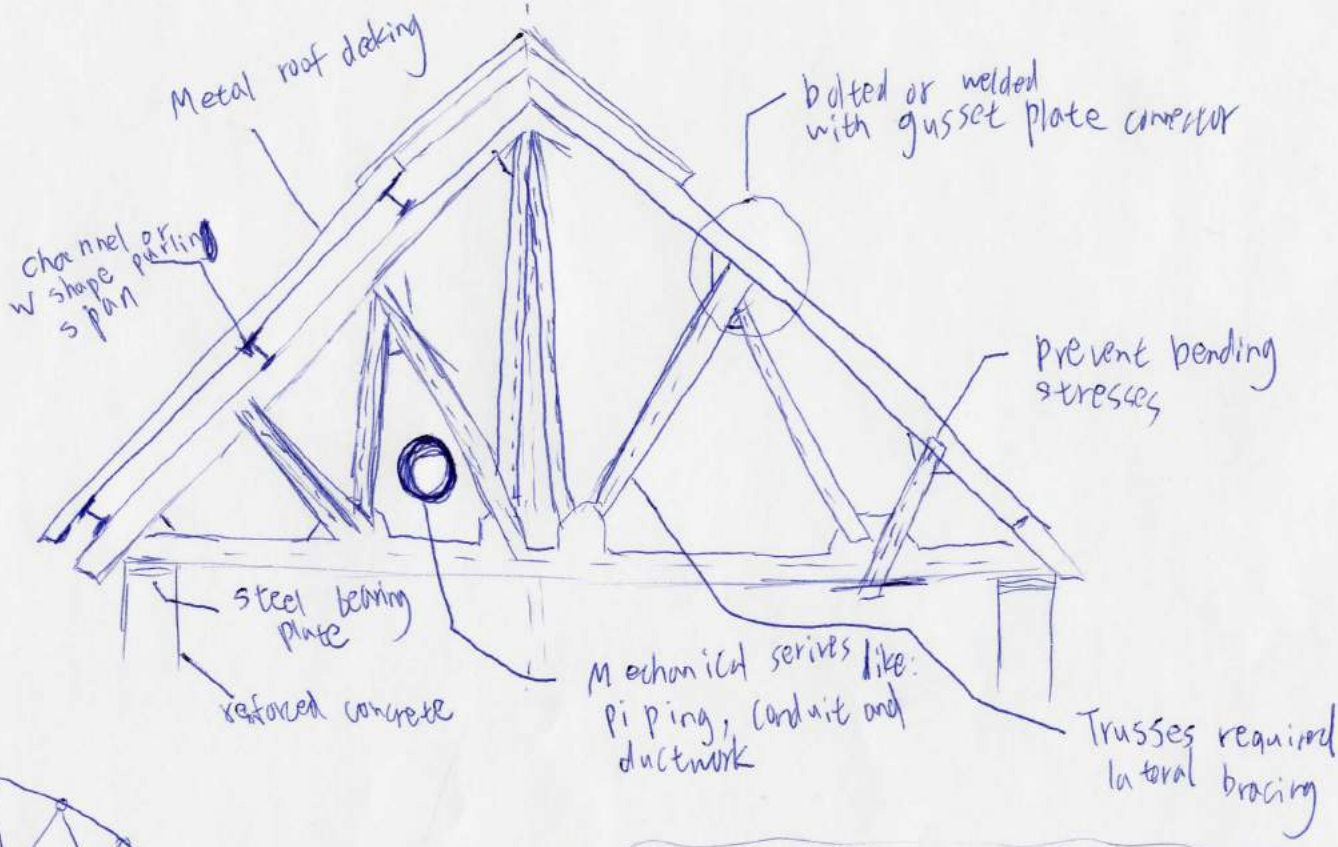


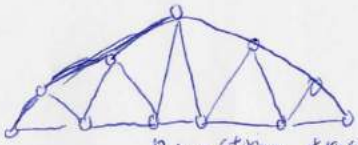
Steel Rigid Frames

- two columns and a beam or girder connect at joints
- provide resistence to lateral force in the planes
- perpendicular to frames

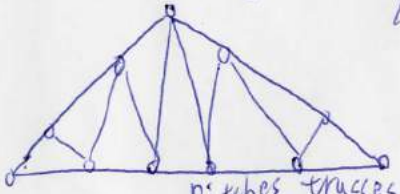
Steel Trusses

- process by welding or bolting





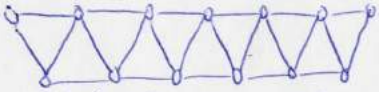
Bowstring trusses span 16-18



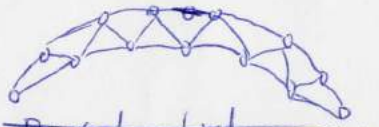
pitches trusses span 14-15

Truss Types

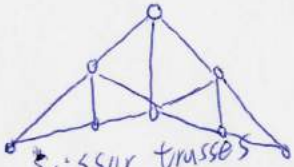
Flat trusses
- not effient as pitched or bowstring trusses.



Warren trusses
- equilateral triangles



~~Raised chord trusses~~
Crescent trusses
- top and bottom curving from common point



Scissor trusses
- tension extend from foot of each top