ELEMENTS OF ARCHITECTURAL STRUCTURES: FORM, BEHAVIOR, AND DESIGN

ARCH 614
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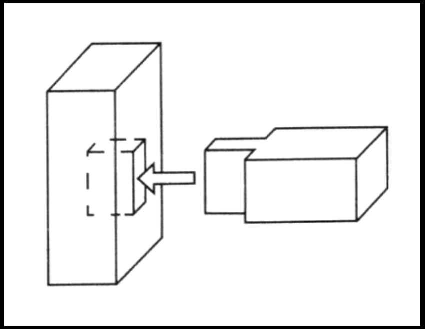
SPRING 2013

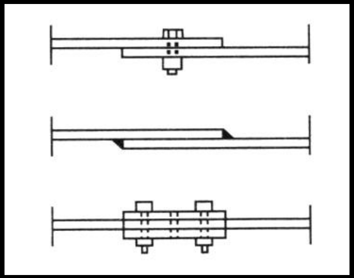
lecture
fifteen

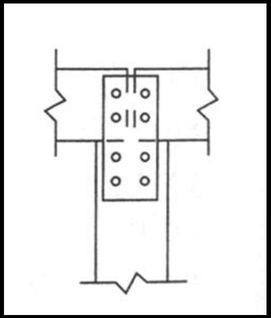
wood construction: connections

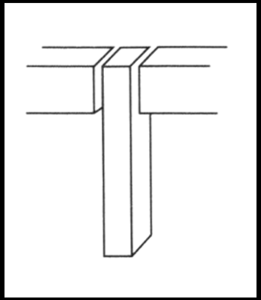
Connectors

- *joining*
  - *lapping*
  - *interlocking*
  - *butting*
- *mechanical*
  - *"third-elements"*





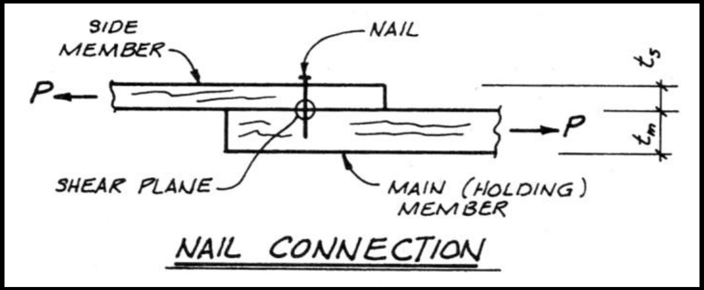


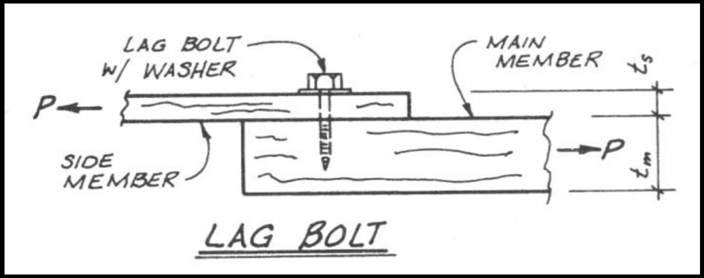


- *transfer load at a point, line or surface*
  - *generally more than a point due to stresses*

Wood Connectors

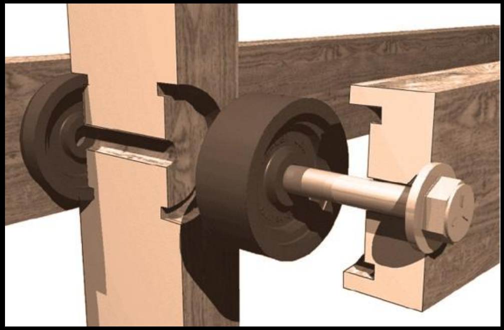
- adhesives
  - used in a controlled environment
  - can be used with nails
- mechanical
  - bolts
  - lag bolts or lag screws
  - nails
  - split ring and shear plate connectors
  - timber rivets

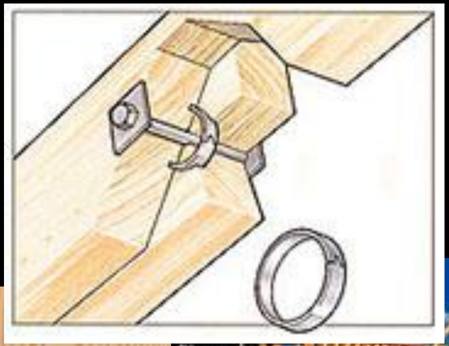


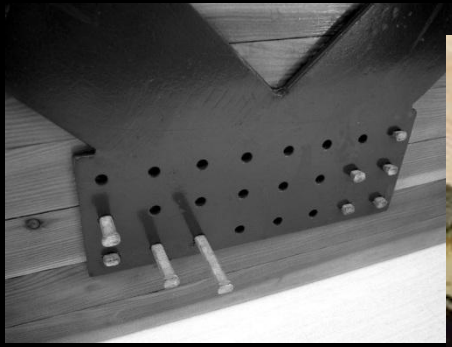


Wood Connections

- *mechanical*







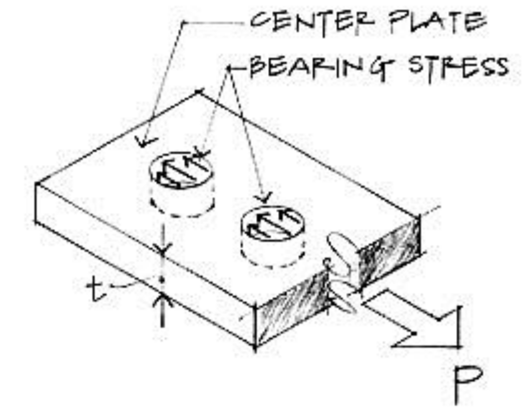
Bolted Joints

- connected members in tension cause shear stress

(a) Two steel plates bolted using one bolt.

(b) Elevation showing the bolt in

- connected members in compression cause bearing stress

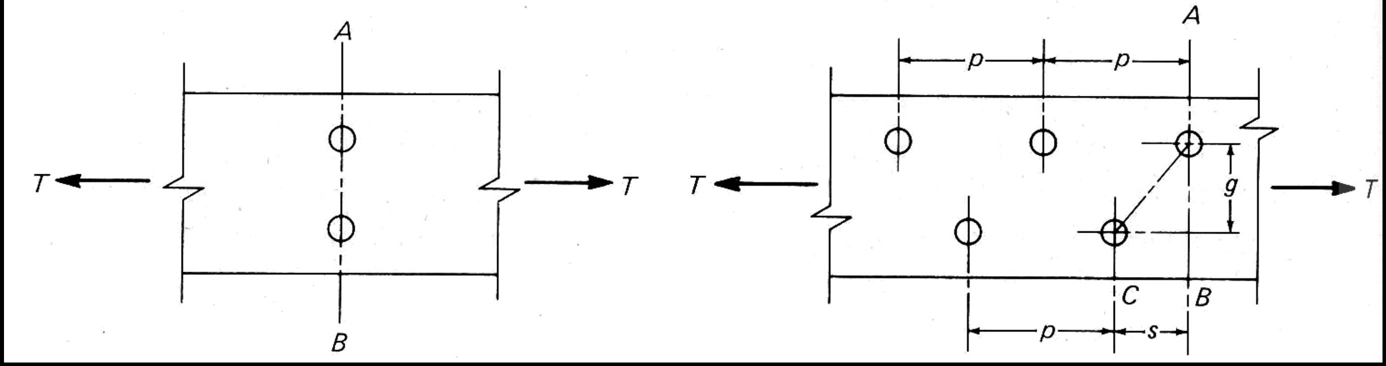


Bearing stress on plate.

Tension Members

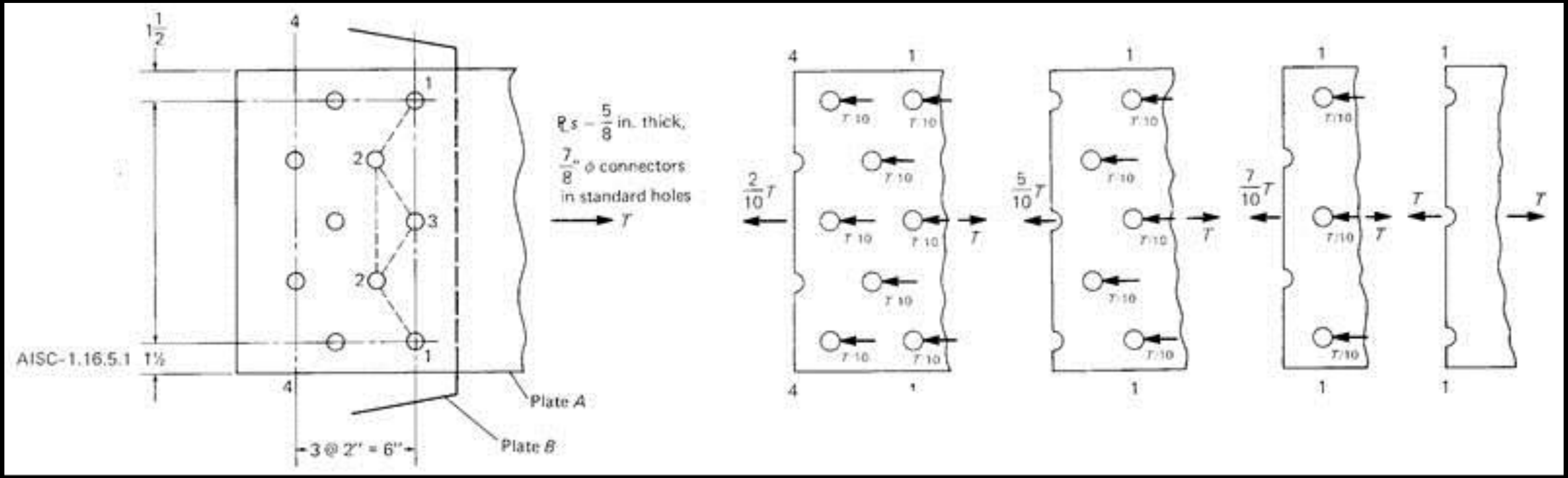
- *members with <u>holes</u> have reduced area*
- *increased tension stress*
- *A_e is effective net area*

$$f_t = \frac{P}{A_e}\left(or\ \frac{T}{A_e} \right)$$



Effective Net Area

- likely path to "rip" across
- bolts divide transferred force too



Single Shear

- seen when 2 members are connected

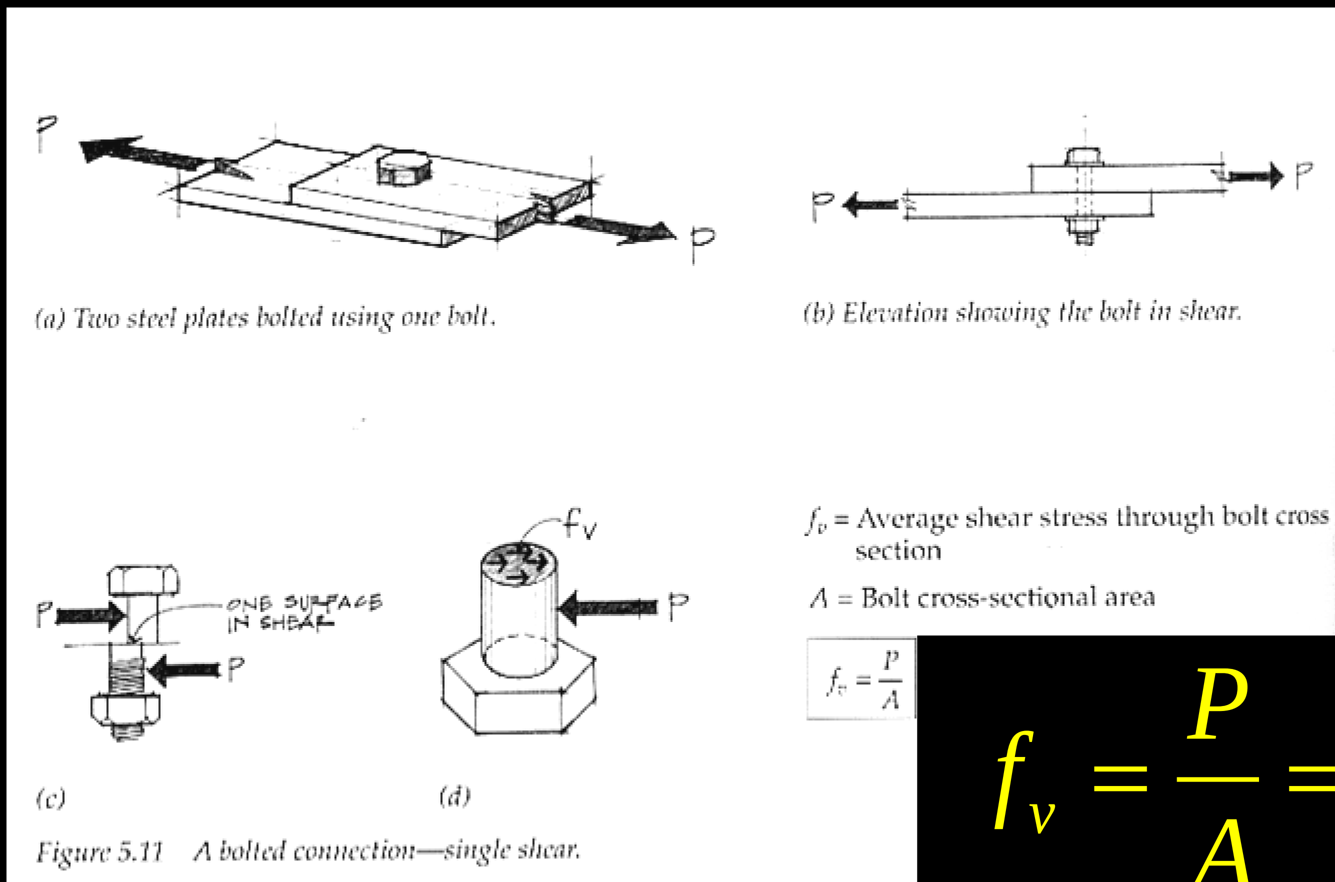


Figure 5.11 A bolted connection—single shear.

$$f_v = \frac{P}{A} = \frac{P}{\pi \, d^2/4}$$

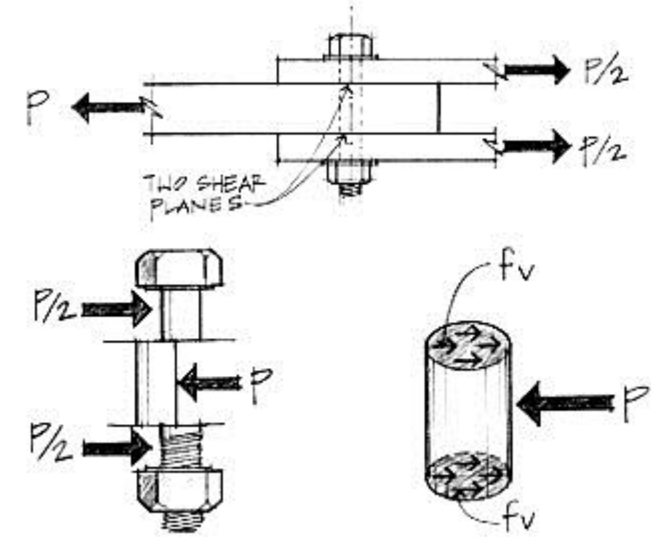
Double Shear

- *seen when 3 members are connected*

$$\Sigma F = 0 = -P + 2\left(\frac{P}{2}\right)$$

$$f_v = \frac{P}{2A}$$

(two shear planes)



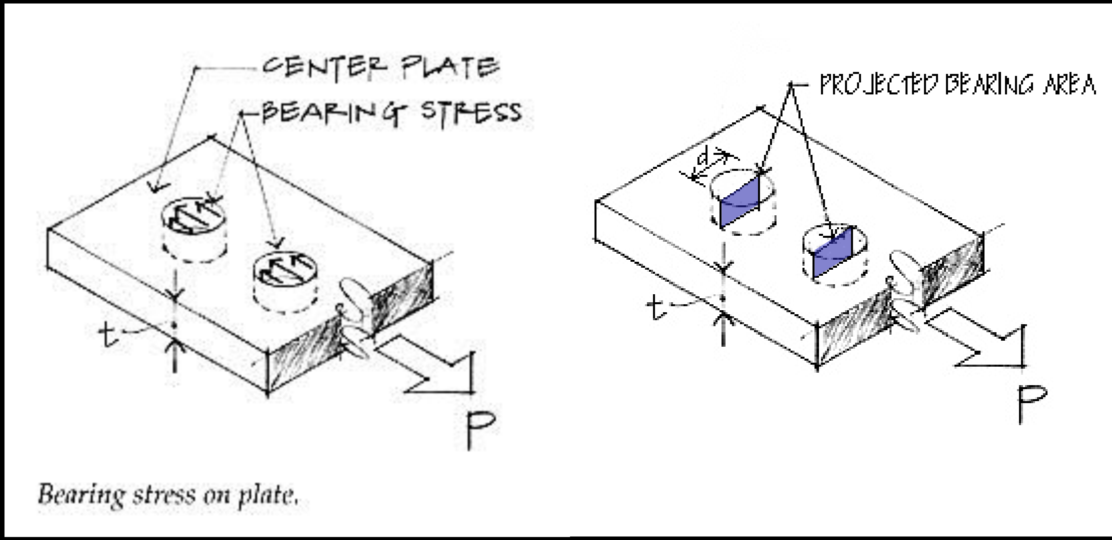
Free-body diagram of middle section of the bolt in shear.

Figure 5.12 A bolted connection in double shear.

$$f_v = \frac{P}{2A} = \frac{P/2}{A} = \frac{P/2}{\pi d^2/4}$$

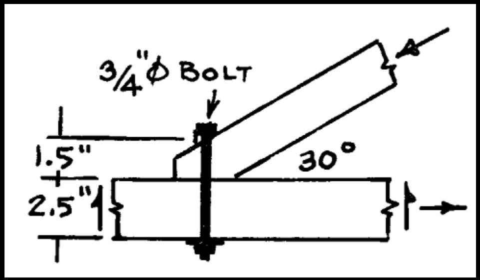
Bearing Stress

- compression & contact
- stress limited by species & grain direction to load
- projected area



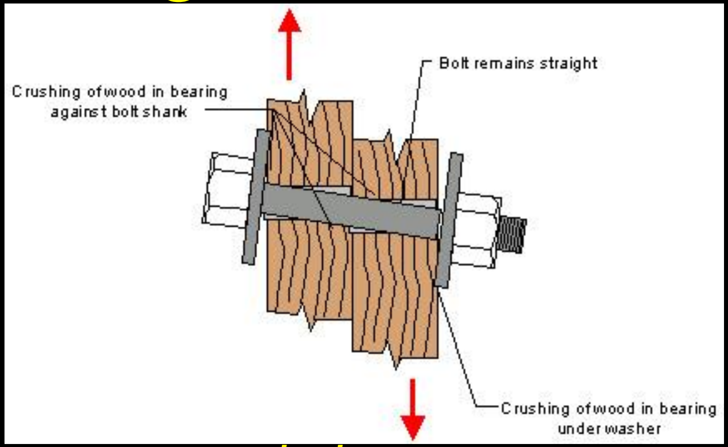
Bearing stress on plate.

$$f_p = \frac{P}{A_{projected}} = \frac{P}{td}$$



Bolted Joints

- *twisting*



www.timber.org.au

- *tear out*
  - *shear strength*
  - *end distance & spacing*

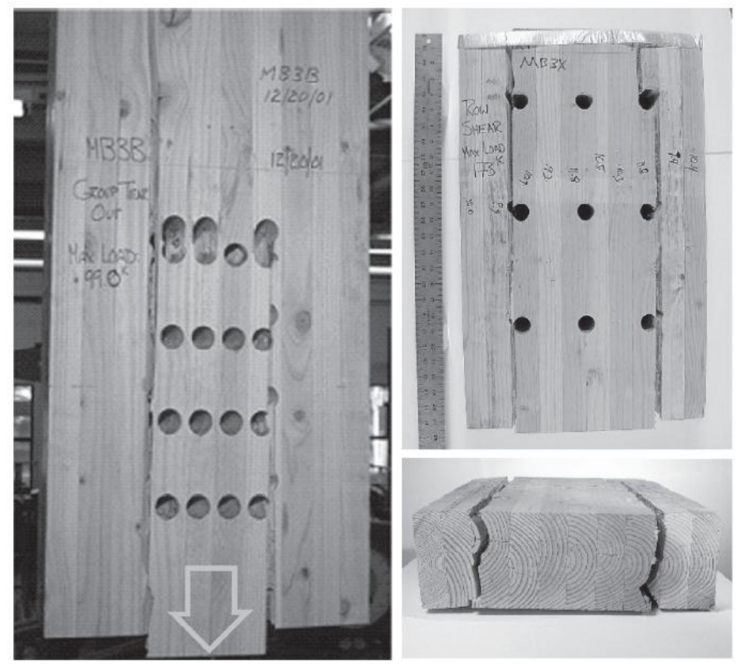
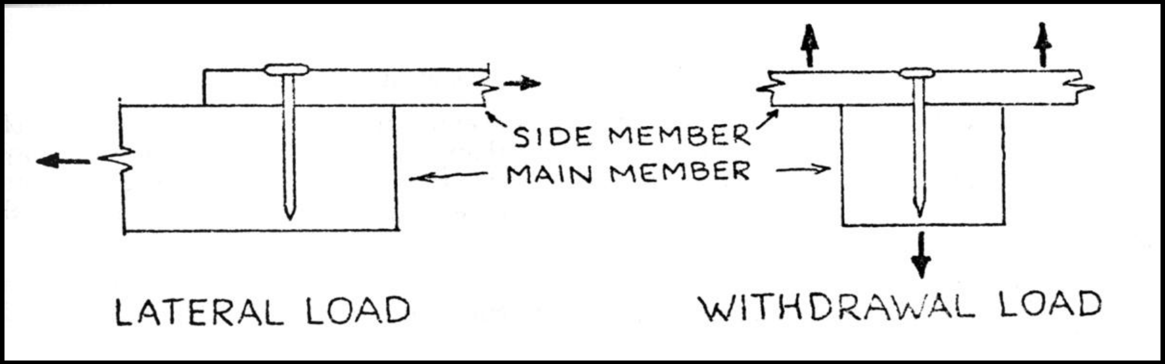


Figure 1.—Higher connection capacities can be achieved with increased fastener spacings.

Taylor & Line 2002

Nailed Joints

- *tension stress (pullout)*
- *shear stress nails presumed to share load by distance from centroid of nail pattern*



Nailed Joints

- *sized by pennyweight units / length*
- *embedment length*
- *dense wood, more capacity*

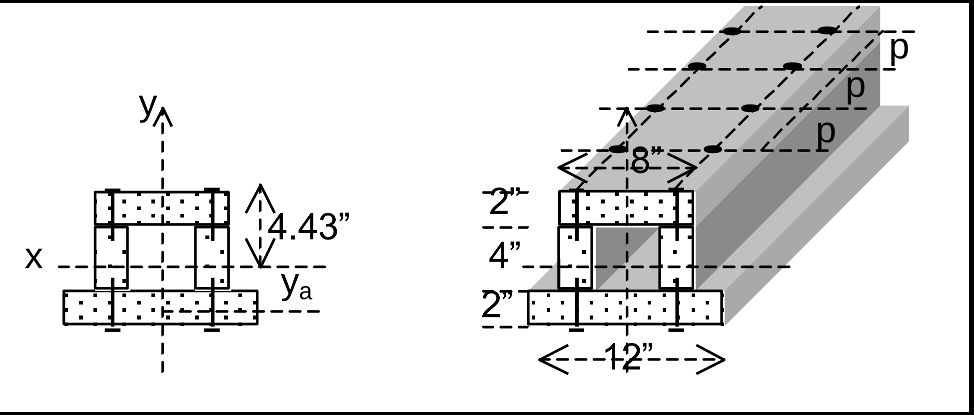
*NDS

TABLE 7.1 Lateral Load Capacity of Common Wire Nails (lb/nail)

Side Member Thickness, t_s (in.)	Nail Length, L (in.)	Nail Diameter, D (in.)	Pennyweight	Load per Nail for Douglas Fir-Larch G = 0.50, Z (lb)
Structural Plywood Side Members				
	2	0.113	6d	48
⅜	2½	0.131	8d	63
	3	0.148	10d	76
	2	0.113	6d	50
½	2½	0.131	8d	65
	3	0.148	10d	78
	3½	0.162	16d	92

Connectors Resisting Beam Shear

- plates with
  - nails
  - rivets
  - bolts
- splices
- V from beam load related to $V_{longitudinal}$



$$\frac{V_{longitudinal}}{p} = \frac{VQ}{I}$$

$$nF_{connector} \geq \frac{VQ_{connected\ area}}{I} \cdot p$$

Vertical Connectors

- *isolate an area with vertical interfaces*

$$nF_{connector} \geq \frac{VQ_{connected\,area}}{I} \cdot p$$