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
**Bolted Joints**

- connected members in tension cause shear stress
- connected members in compression cause bearing stress

**Tension Members**

- members with holes 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
  \[ f_v = \frac{P}{A} = \frac{P}{\pi \frac{d^2}{4}} \]
**Double Shear**
- seen when 3 members are connected

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

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

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

(Figure 5.12: A bolted connection in double shear)

**Bolted Joints**
- twisting
- tear out
  - shear strength
  - end distance & spacing

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(Figure 3: Higher connection capacities can be achieved with increased timber spacings. Taylor & Line 2002)

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

\[ f_p = \frac{P}{A_{projected}} = \frac{P}{td} \]

(Figure: Bearing stress on plate)

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

(Figure: Lateral load, withdrawal load)
Nailed Joints

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

Connectors Resisting Beam Shear

- plates with
  - nails
  - rivets
  - bolts
- splices
- $V_{\text{longitudinal}} = \frac{VQ}{I}$
- $nF_{\text{connector}} \geq \frac{VQ_{\text{connected area}}}{I} \cdot p$

Vertical Connectors

- isolate an area with vertical interfaces

\[ nF_{\text{connector}} \geq \frac{VQ_{\text{connected area}}}{I} \cdot p \]