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

\[
f_t = \frac{P}{A_e} \left( \text{or} \frac{T}{A_e} \right)
\]

Effective Net Area

- likely path to “rip” across
- bolts divide transferred force too

Single Shear

- seen when 2 members are connected

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

- seen when 3 members are connected

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

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

\[ \text{Free-body diagram of middle section of the bolt in shear.} \]

**Bolted Joints**

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

**Bearing Stress**

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

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

**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)**

<table>
<thead>
<tr>
<th>Side Member Thickness</th>
<th>Nail Length, L (in.)</th>
<th>Nail Diameter, D (in.)</th>
<th>Pennyweight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4</td>
<td>2</td>
<td>0.113</td>
<td>6d</td>
</tr>
<tr>
<td></td>
<td>2 1/2</td>
<td>0.131</td>
<td>8d</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.148</td>
<td>10d</td>
</tr>
<tr>
<td>1/2</td>
<td>2</td>
<td>0.113</td>
<td>6d</td>
</tr>
<tr>
<td></td>
<td>2 1/2</td>
<td>0.131</td>
<td>8d</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.148</td>
<td>10d</td>
</tr>
<tr>
<td></td>
<td>3 1/2</td>
<td>0.162</td>
<td>12d</td>
</tr>
</tbody>
</table>

*Structural Plywood Side Members*  
*Douglas Fir-Larch*  
*Q = 0.30, 2.0 (in)*

Connectors Resisting Beam Shear

• plates with  
  – nails  
  – rivets  
  – bolts

• splices
• V from beam load related to $V_{longitudinal}$

\[
\frac{V_{longitudinal}}{I} = \frac{VQ}{p}
\]

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

Vertical Connectors

• isolate an area with vertical interfaces