Wood 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
**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
  \[ f_t = \frac{P}{A_e} \quad \text{or} \quad \frac{T}{A_e} \]

**Effective Net Area**
- likely path to “rip” across
- bolts divide transferred force too

**Single Shear**
- seen when 2 members are connected
Double Shear

- seen when 3 members are connected

\[ \Sigma F = 0 = -P + 2(P/2) \]

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

Bolted Joints

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

Nailed Joints

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

Bearing Stress

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

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

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

<table>
<thead>
<tr>
<th>Side Member Thickness, ( t ) (in.)</th>
<th>Nail Length, ( L ) (in.)</th>
<th>Nail Diameter, ( D ) (in.)</th>
<th>Pennyweight</th>
<th>Load per Nail for Douglas Fir-Larch, ( Q = 0.30 \text{ lb.} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{3}{4} )</td>
<td>2</td>
<td>0.113</td>
<td>6d</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>2( \frac{1}{2} )</td>
<td>0.131</td>
<td>8d</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.148</td>
<td>10d</td>
<td>76</td>
</tr>
<tr>
<td>( \frac{1}{2} )</td>
<td>2</td>
<td>0.113</td>
<td>6d</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>2( \frac{1}{2} )</td>
<td>0.131</td>
<td>8d</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.148</td>
<td>10d</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>3( \frac{1}{2} )</td>
<td>0.162</td>
<td>16d</td>
<td>92</td>
</tr>
</tbody>
</table>

*NDS

Connectors Resisting Beam Shear

- plates with
  - nails
  - rivets
  - bolts
- splices
- \( V \) from beam load related to \( V_{\text{longitudinal}} \)

Vertical Connectors

- isolate an area with vertical interfaces

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