lecture fourteen

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

- 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

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

- seen when 3 members are connected

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

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

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

Figure 5.12  A bolted connection in double shear.
Bearing Stress

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

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

- **twisting**

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

---

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

Taylor & Line 2002

www.timber.org.au
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

<table>
<thead>
<tr>
<th>TABLE 7.1 Lateral Load Capacity of Common Wire Nails (lb/nail)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side Member Thickness, $t_s$ (in.)</td>
</tr>
<tr>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Structural Plywood Side Members</td>
</tr>
<tr>
<td>⅜</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>½</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

*NDS*
Connectors Resisting Beam Shear

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

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

\[
nF_{\text{connector}} \geq \frac{VQ}{I} \cdot p
\]
Vertical Connectors

• isolate an area with vertical interfaces

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