ARCHITECTURAL STRUCTURES: FORM, BEHAVIOR, AND DESIGN
ARCH 331
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lecture

seventeen

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 holes have reduced area
- increased tension stress
- \( A_e \) is effective net area

\[
\sigma = \frac{P}{A_e} \left( \text{or} \frac{T}{A_e} \right)
\]
Effective Net Area

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

• seen when 2 members are connected
Double Shear

- seen when 3 members are connected

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

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

*NDS

<table>
<thead>
<tr>
<th>TABLE 7.1 Lateral Load Capacity of Common Wire Nails (lb/nail)</th>
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<tbody>
<tr>
<td>Side Member Thickness, $t_s$ (in.)</td>
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<td>-------------------------------</td>
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<tr>
<td>Structural Plywood Side Members</td>
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<tr>
<td>$\frac{3}{8}$</td>
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<td>$\frac{1}{2}$</td>
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Connectors Resisting Beam Shear

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

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

\[
\frac{p}{I} \geq \frac{VQ_{connected\ area}}{I} \cdot p
\]
Vertical Connectors

- isolate an area with vertical interfaces

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