

lecture
fifteen

wood construction:
connections



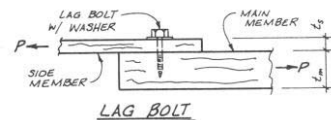
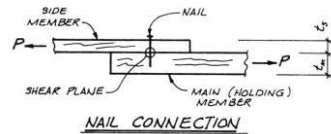
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Wood Connectors

- 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



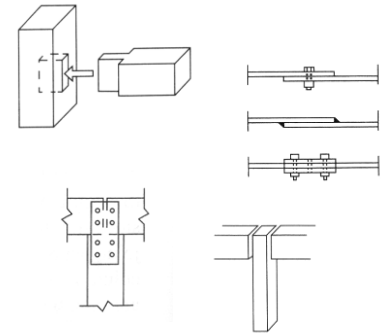
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Connectors

- joining
 - lapping
 - interlocking
 - butting
- mechanical
 - “third-elements”
- transfer load at a point, line or surface
 - generally more than a point due to stresses



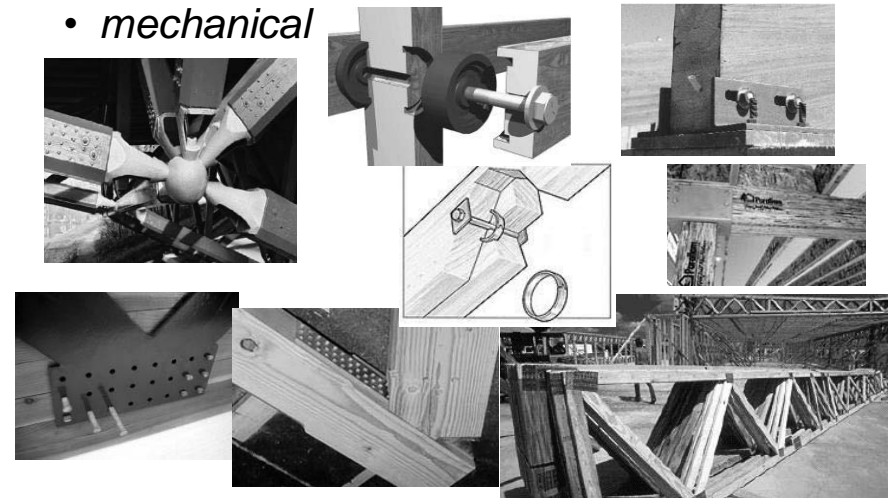
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Wood Connections

- mechanical



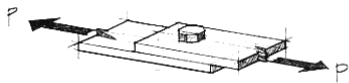
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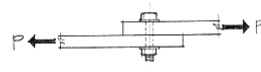
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Bolted Joints

- connected members in tension cause shear stress

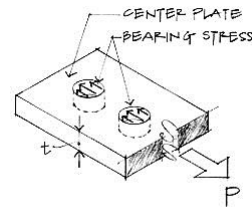


(a) Two steel plates bolted using one bolt.



(b) Elevation showing the bolt in

- connected members in compression cause bearing stress



Bearing stress on plate.

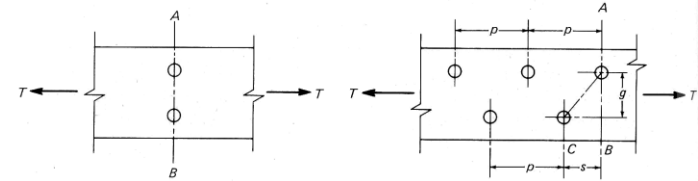
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Tension Members

- members with holes have reduced area
- increased tension stress
- A_e is effective net area $f_t = \frac{P}{A_e}$ (or $\frac{T}{A_e}$)



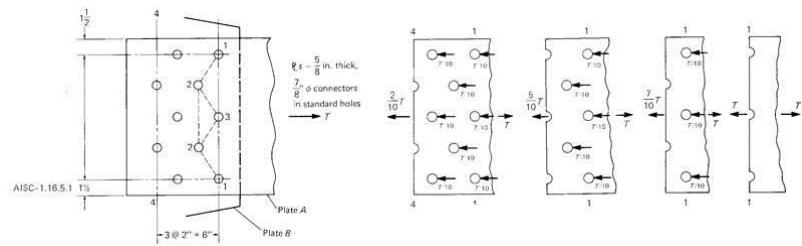
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Effective Net Area

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



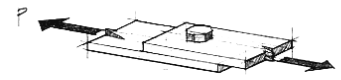
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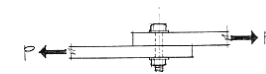
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Single Shear

- seen when 2 members are connected



(a) Two steel plates bolted using one bolt.



(b) Elevation showing the bolt in shear.

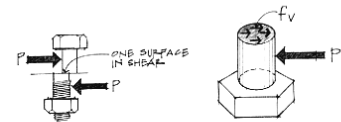


Figure 5.11 A bolted connection—single shear.

f_v = Average shear stress through bolt cross section

A = Bolt cross-sectional area

$$f_v = \frac{P}{A}$$

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

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Double Shear

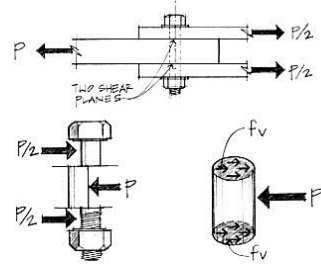
- seen when 3 members are connected

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

$$f_v = \frac{P}{2A}$$

(two shear planes)

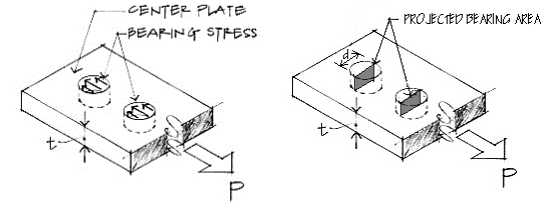
$$f_v = \frac{P}{2A} = \frac{P/2}{A} = \frac{P/2}{\pi d^2/4}$$



Free-body diagram of middle section of the bolt in shear.
Figure 5.12 A bolted connection in double shear.

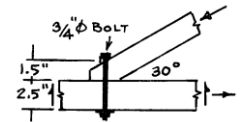
Bearing Stress

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



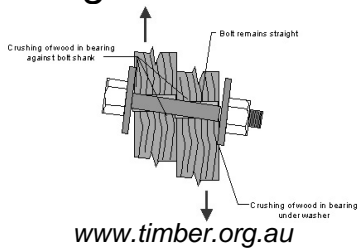
Bearing stress on plate.

$$f_p = \frac{P}{A_{projected}} = \frac{P}{td}$$



Bolted Joints

- twisting



- tear out
 - shear strength
 - end distance & spacing

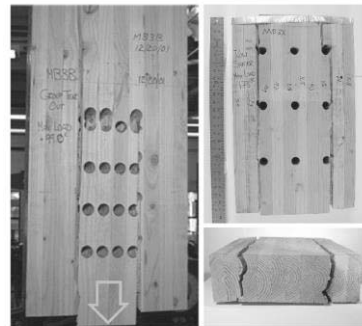
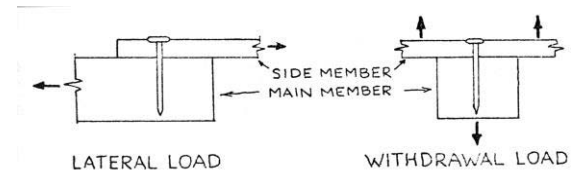


Figure 1.—Higher connection capacities can be achieved with increased fastener spacings.

Taylor & Line 2002

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 7.1 Lateral Load Capacity of Common Wire Nails (lb/nail)

Side Member Thickness, t_s (in.)	Nail Length, L (in.)	Nail Diameter, D (in.)	Pennyweight	Load per Nail for Douglas Fir-Larch $G = 0.50, Z$ (lb)
<i>Structural Plywood Side Members</i>				
3/8	2	0.113	6d	48
	2 1/2	0.131	8d	63
	3	0.148	10d	76
1/2	2	0.113	6d	50
	2 1/2	0.131	8d	65
	3	0.148	10d	78
	3 1/2	0.162	16d	92

*NDS

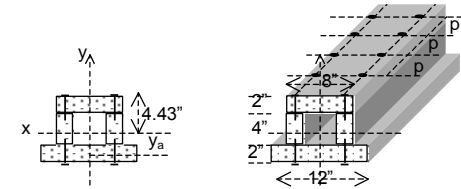
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Connectors Resisting Beam Shear

- plates with
 - nails
 - rivets
 - bolts



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

$$\frac{V_{longitudinal}}{p} = \frac{VQ}{I}$$

$$nF_{connector} \geq \frac{VQ_{connected\ area}}{I} \cdot p$$

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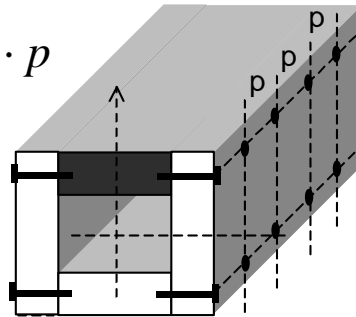
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Vertical Connectors

- isolate an area with vertical interfaces

$$nF_{connector} \geq \frac{VQ_{connected\ area}}{I} \cdot p$$



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