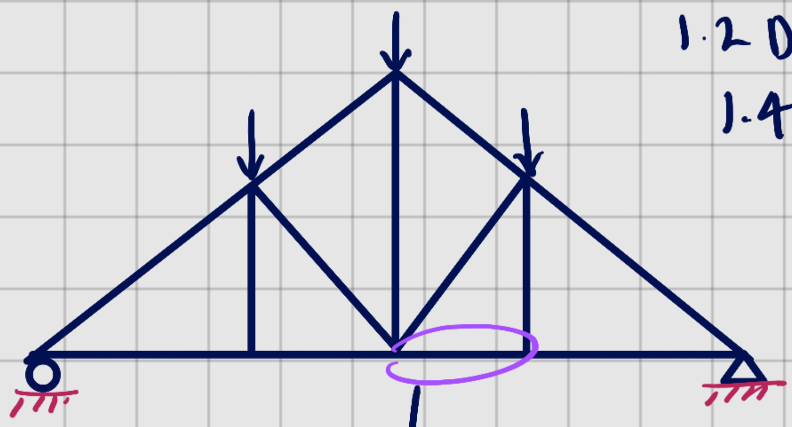
Recap:

Types of loads: Dead, Live, snow, earthquake, wind



$1.2D + 1.6L$
$1.4D$

$\hookrightarrow P_D, P_L$ (internal tensile forces)

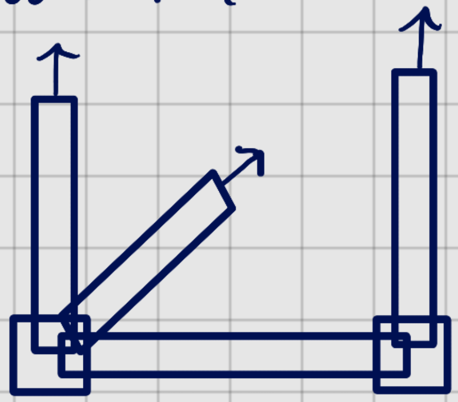
$$\underbrace{P_D = 15K, \; P_L = 20K}_{P_u}$$

$$P_u = \max \begin{cases} 1.2P_D + 1.6P_L = 50K \\ 1.4D = 21K \end{cases} = 50K$$

$P_u = 50K \leq \phi P_n$, P_n: nominal strength/capacity

ϕ: capacity factor

Zoom in:



Two failure modes:

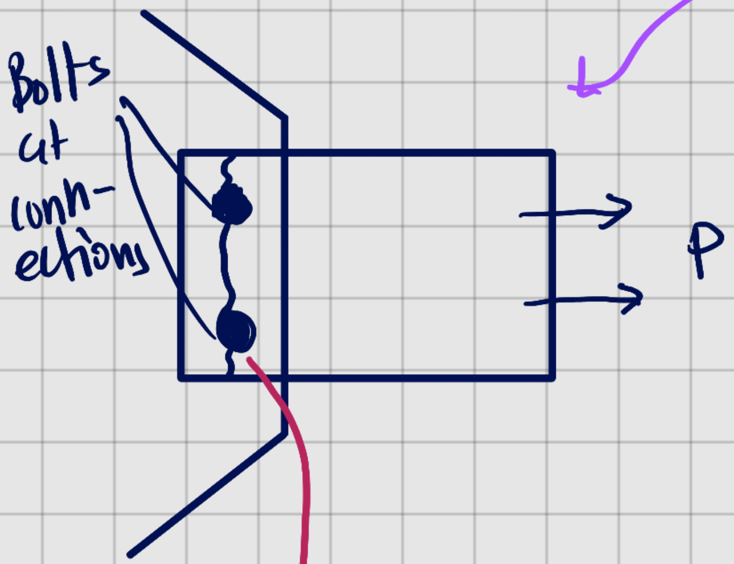
1) gross yield

↳ $P_n = \underbrace{F_y \cdot A_g}_{\text{yield stress}}$ gross area

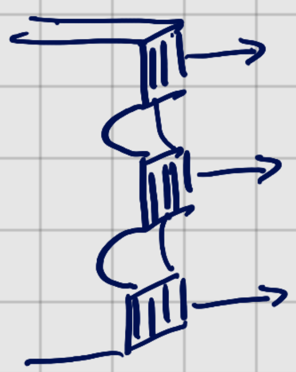
2) Net Section Fracture

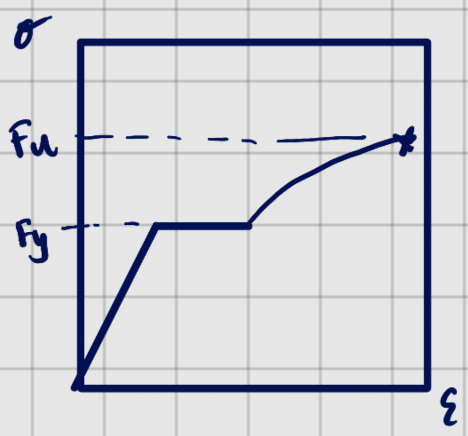
↳ $P_n = F_u \cdot A_{net}$,

$A_{net} = (A_g - A_{holes})$



reduced area





- net section fracture is more concerning because it can happen suddenly due to smaller area

- gross yield

↳ $\phi = 0.9$

- net section fracture

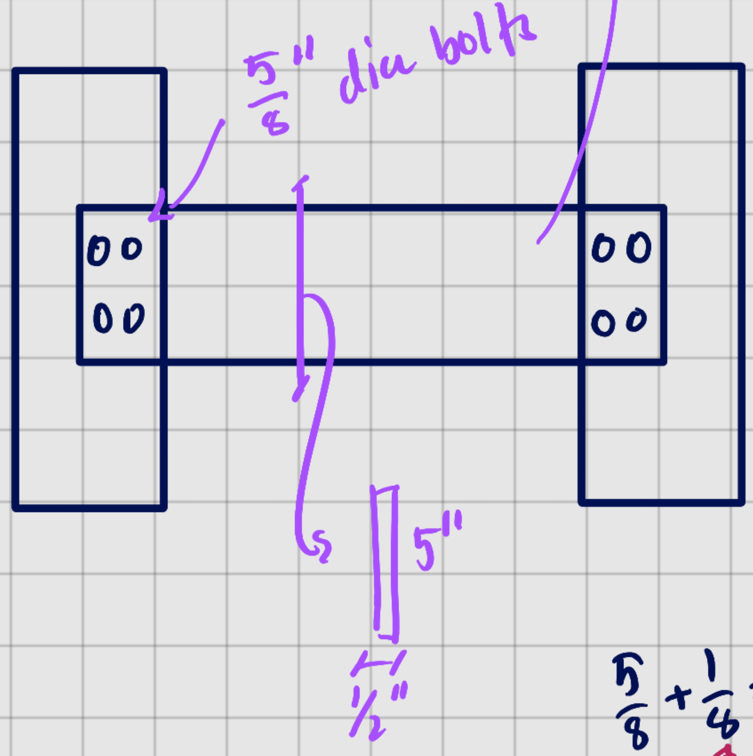
↳ $\phi = 0.75$

$P_u = 50K$

Assume A36 steel

$\hookrightarrow F_y = 36\ ksi,$

$F_u = 58\ ksi$



Gross Yield

$\hookrightarrow P_n = 0.9(\overset{ksi}{36})(\overset{in^2}{5 \times \tfrac{1}{2}})$

$= \underline{81\ K}$

Net section fracture

$\hookrightarrow P_n = 0.75(\overset{ksi}{58})$

$\frac{5}{8} + \frac{1}{4} = \frac{3}{4}$ $\quad in^2\left(\frac{1}{2}\left(5 - \frac{3}{4} \times 2\right)\right)$

bolt tolerance

$= 0.75(58)(1.75)$

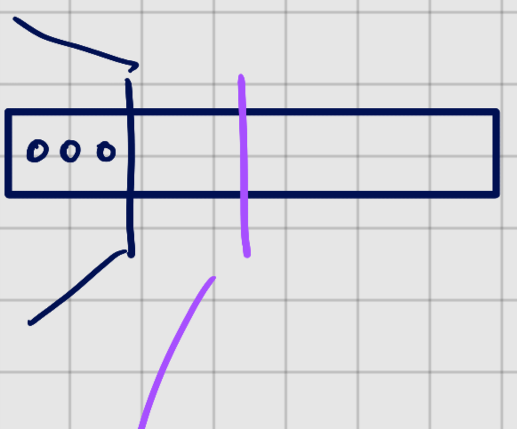
$= \underline{76.125\ k}$

Member does not yield for $P_u = 50$ ksi because $P_u \leq 81$ K and $P_u \leq 76.125$ K

$P_D = 35k,\ P_L = 15k$

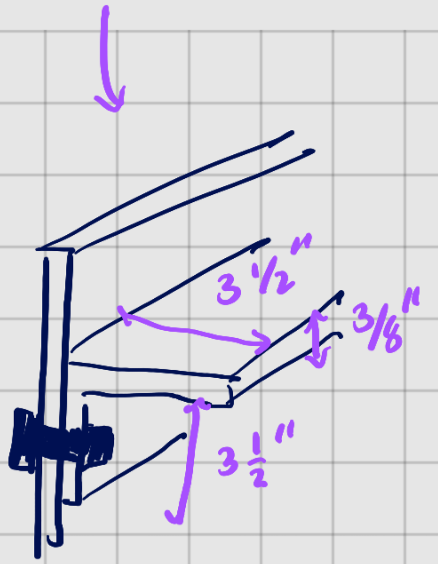
A36, L $3\tfrac{1}{2} \times 3\tfrac{1}{2} \times \tfrac{3}{8}$

$\Rightarrow P_u = \max \begin{cases} 1.2P_D + 1.6P_L \\ 1.4P_D \end{cases} = 66k$



G.Y. $\Rightarrow 0.9\, F_y A_g$

N.S.F $\Rightarrow 0.75\, F_u A_{net}$



⇒ G.Y.

↳ $P_n = 0.9(36)(2.5) = 81K$

⇒ N.S.F

↳ $P_n = 0.75(58)(2.5 - \frac{3}{8})$

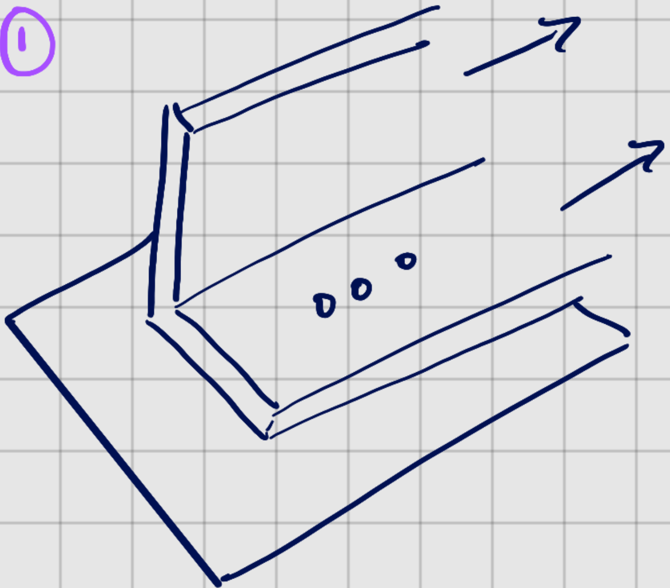
$P_n = 92.44K$

$A = 2.5\,in^2$ (from table)

$P_u = 66K \le 92.44k$,

$P_u = 66k \le 81K$

1



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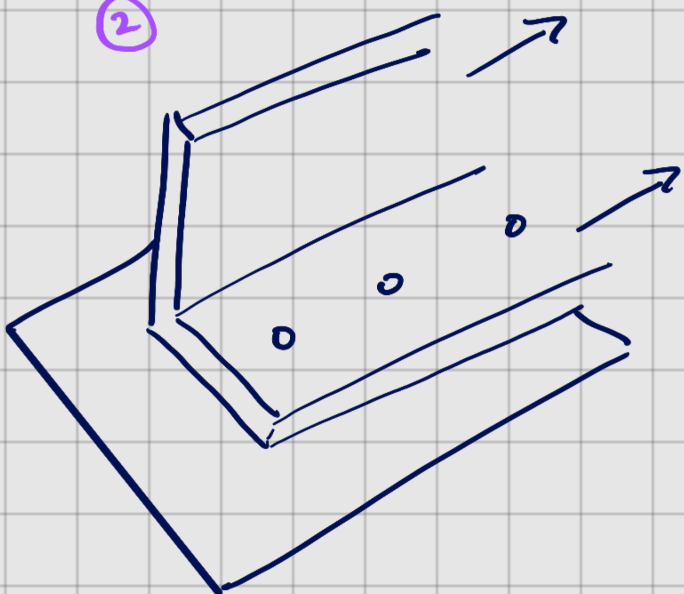
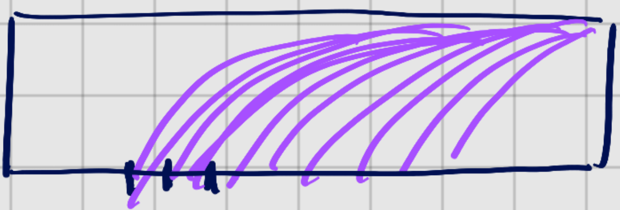
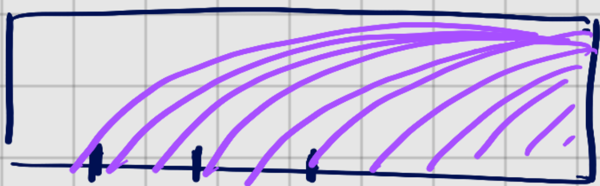






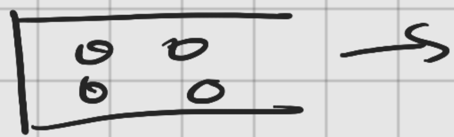
- Shear - lag factor

↳ N.S.F. ⇒ $P_u = 0.75 \times F_u \times \underbrace{A_e}$ effective area

↳ $A_e = U \cdot A_n$, U: shear-lag factor/ connection efficiency factor

How to calculate U:

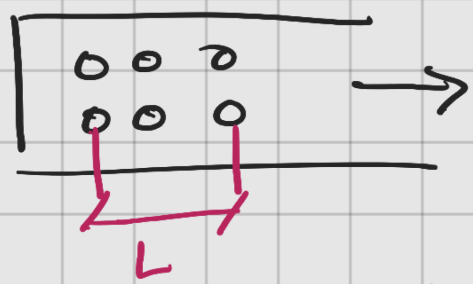
- longer connection, $U\uparrow$
- taller member cross-section, $U\downarrow$
- if 2 bolt rows



↳ $U = 0.75$

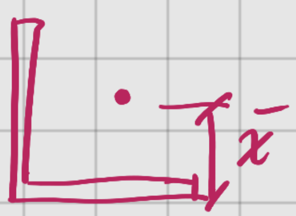
- if 3+ bolt rows

↳ $U = 1 - \frac{\bar{x}}{L} \le 0.9$



Use 0.9 if calculation > 0.9

- $\bar{x}$ is distance of bottom to centroid of cross-section



- if flat cross section

↳ $U = 1$