Note Title 2/15/2007

Steel Tension Members

(Chapter 3 Steel)

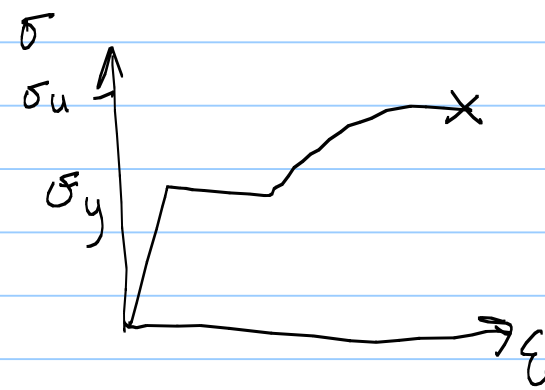
- Cables
- Trusses (Roof, Bridge)
- Bracing Members (Buildings, Bridges)

Common Types of Tension Members

LIMIT STATES -

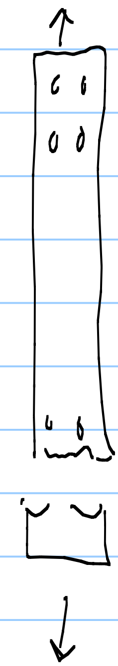
How can a tension member fail?

- Yielding (Serviceability)
- Fracture (Strength)
- Block Shear
- Bolt Failure



Yielding

Fracture



Strength General Eqn : $R_n = f(F, A)$
↳ stress

$\phi R_n = f(\phi, F, A)$

Yield Strength : $\phi R_n = \phi F_y A_g$

F_y = yield strength of material (A36, Grade 50) ↳ yield strength

A_g = total cross-sectional area, gross area

$\phi_{yielding} = 0.9$

Fracture Strength : $\phi R_n = \phi F_u A_e$

F_u = ultimate strength (Table 1-1 in textbook) use lowest table value

A_e = net effective area

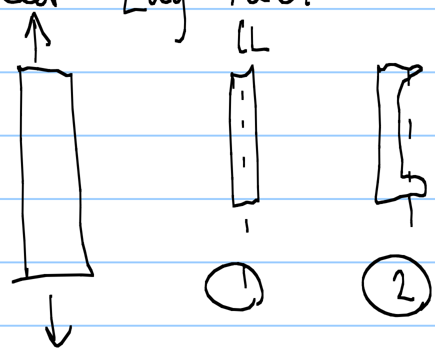
$\phi = 0.75$

$A_e = U A_n$

A_n = net area = total area minus bolt holes

U = shear lag factor

Sheer Lag Factor



→ Both have same area

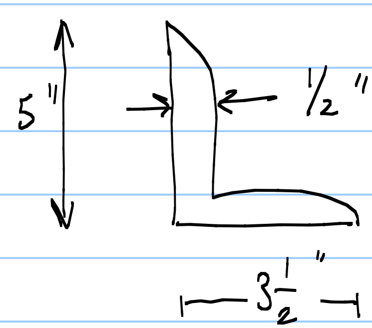
U accounts for cases where tension is not uniform because of unsymmetric members.

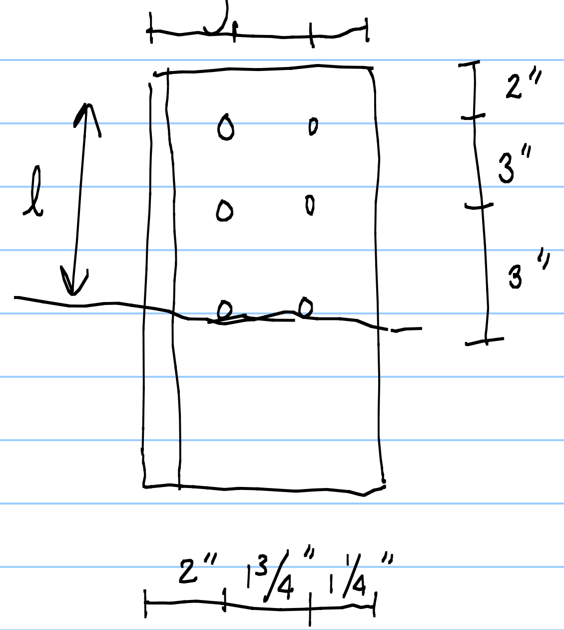
See Table D3.1

$$U = \begin{cases} 1 & \text{for plate or all parts connected (Case 1)} \\ 1 - \bar{x}/L & \text{for bolted connection (Case 2, 8*)} \\ \text{varies} & \text{for welded connection (Case 3, 4)} \end{cases}$$

*angles only

Example 1. Determine the tension capacity of an $L5 \times 3\frac{1}{2} \times \frac{1}{2}$ manufactured from Grade 50 steel. The angle is connected to a gusset plate through 6 $\frac{7}{8}$" diameter bolts in the configuration shown.





$\phi R_n = \phi F_y A_g$ (yielding)

$\phi R_n = \phi F_u A_e$ (fracture)

$F_y = 50$ ksi
$F_u = 65$ ksi

$A_g = 4.00 \text{ in}^2$

$\phi R_n = \phi F_y A_g = 0.9(50\text{ ksi})(4.00\text{ in}^2) = \boxed{180\text{ kips}}$ (yielding)

Fracture: $\phi F_u A_e$

$A_e = U A_n$

$A_n = A_g - \text{bolt holes}$

$A_n = 4.00 - 2(7/8 + 1/8)(1/2)$

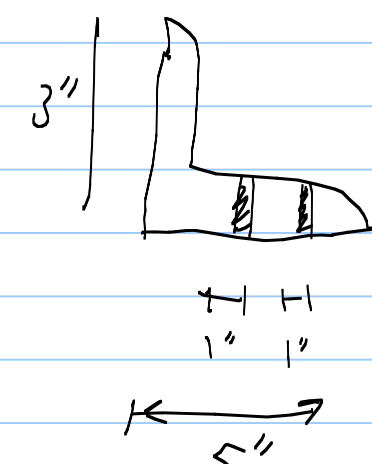
$A_n = 3.00\text{ in}^2$

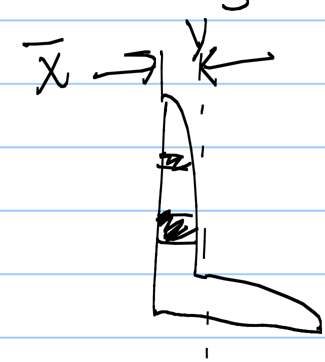
$U = 0.6 \text{ OR } 1 - \bar{x}/\ell$

ℓ = length of connection = 6"

$\bar{x} = 0.901\text{ in}$"

$U = 1 - \bar{x}/\ell = 1 - 0.901/6 = 0.85$





$\phi R_n = \phi F_u A_e$

$A_e = 2.55 \text{ in}^2$

$= 0.75(65)(0.85)(3.00)$

$\phi R_n = 124.3$ kips (fracture)