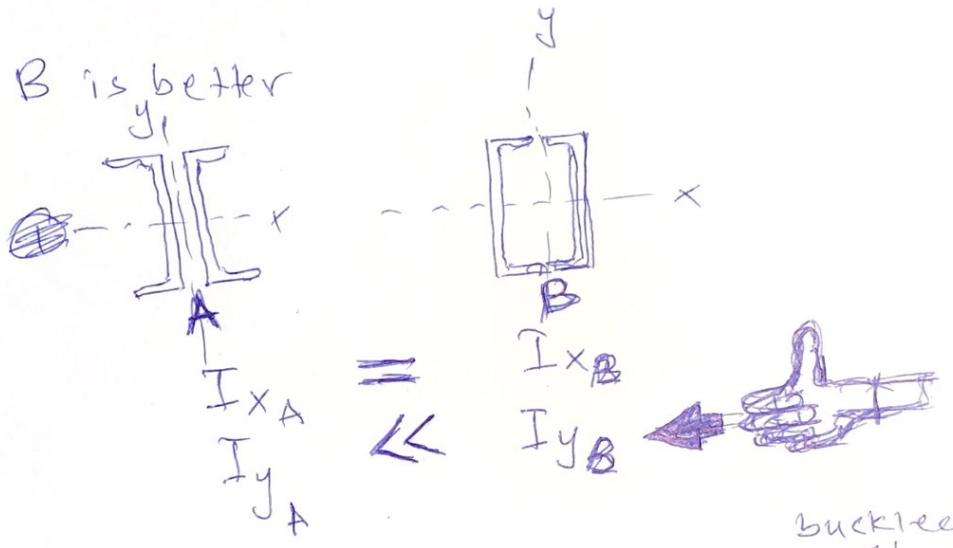
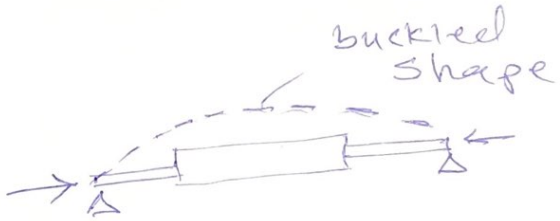
Question 1

(a) Unless they are short, compression members fail by buckling (local or overall)

(b) B is better



(c)

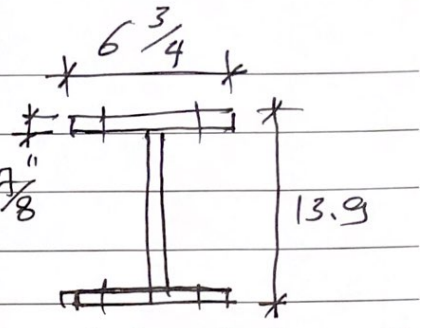


- compressed member
- fails by buckling
- Potential buckling produces largest displacement, and hence, largest moment in the middl segment ⇒ Provide larges cross-section to increase I (and A).

(d) cable and rod are tension-only members, and are flexible in nature. Applying the requirement $\frac{L}{r} < 300$ (to keep shape) produces unnecessary (unpractical) huge section. These members are typically long diagonals.

Problem 2

Evaluate full tensile capacity of W-shape 0.515



A572-Gr50 $F_y = 50$ ksi, $F_u = 65$ ksi

W14×38, $A = 11.2$ in^2

1. Yield criterion:

$\phi_t T_n = 0.9(50)(11.2) = \boxed{504}$ kips

2. Rupture

$\phi_t T_n = 0.75 F_u A_e$

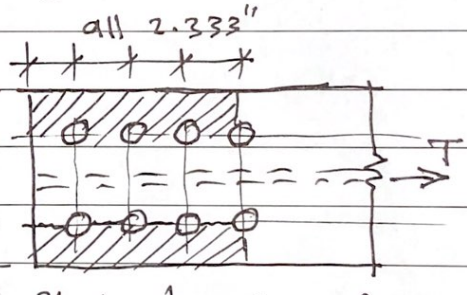
$A_n = 11.2 - 4\left(\frac{7}{8}+\frac{1}{8}\right)(0.515) = 9.14$

width/depth $< \frac{2}{3}$ → $U = 0.85$

$\phi_t T_n = 0.75(65)(0.85 \times 9.14) = \boxed{378.74}$ kips

3. Block shear

Take spacing and edge distances $= 2\frac{2}{3} d_b = 2.333$ in.



$R_n = 0.6 F_u A_{nv} + U_{bs} F_y A_{nt} \le 0.6 F_y A_{gv} + U_{bs} F_u A_{nt}$

$A_{gv} = [4(2.333)(0.515)] \times 4 = 19.612$ in^2

$A_{nv} = 19.612 - [3.5(\frac{7}{8}+\frac{1}{8})(0.515)] \times 4$

$= 12.4$ in^2

$A_{nt} = [2.333 - 0.5(\frac{7}{8}+\frac{1}{8})](0.515) \times 4 = 3.78$ in^2 Block shear mode in top and bottom flange

Subst.

$R_n = 0.6(65)(12.4) + 1.0(50)(3.78) \overset{?}{\le} 0.6(50)(19.612) + 1.0(65)(3.78)$

$672.6 < 834.06$ kips

$\phi R_n = 0.75(672.6) = \boxed{504.45}$ kips.

⇒ Rupture criterion controls & $\phi_t T_n = 378.74$

For one plate $(\phi_t T_n)_{plate} = \frac{378.74}{2} = 189.37$ kips

For the plate:

1. Yield: $\phi_t T_n \ge 0.9(50)(8 \times t) = 189.37 \Rightarrow t \ge 0.526$ in.
2. Rupture $\phi_t T_n \ge 0.75(65)(1.0) \times [8 - 2(\frac{7}{8}+\frac{1}{8})] \times t = 189.37$ $t \ge 0.65$"

⇒ Use $t_p = 0.65$ in

3. Block shear is OK, since similar mode as W shape but with larger width and thickness.

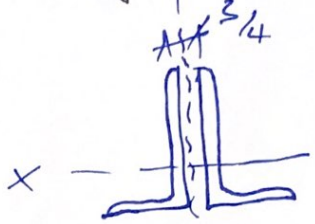
Problem 3

→ Not like ~~~~ tension members
The two angles must be taken together.

$r_x = 0.953$

$r_y = 1.03$

$A = 2.4\ in^2$



$I_x =$

$I_y =$

2L 3x2x 1/4 LLBB
A36
$A = 2.4\ in^2$

Truss member $\Rightarrow K_x = K_y = 1$

$$\frac{K_x L_x}{r_x} = \frac{(1)(6\times12)}{0.953} \quad , \quad \frac{K_y l_y}{r_y} = \frac{(1.0)(6\times12)}{1.03}$$

$75.55 > 69.9$

X-axis controls

$$4.71\sqrt{\frac{E}{F_y}} = 4.71\sqrt{\frac{29000}{36}} = 133.68 < \frac{KL}{r_x}$$

$\Rightarrow$ Member will fail by inelastic buckling

$$\Rightarrow F_{cr} = 0.658^{(F_y/F_e)} * F_y$$

$$F_e = \frac{\pi^2 E}{(K l_x / r_x)^2} = \frac{\pi^2 (29000)}{(75.55)^2} = 50.14$$

$$F_{cr} = (0.658)^{36/50.14} * 36 = 26.63\ ksi$$

$$\phi_c P_n = 0.9\,(26.63)\,(2.4) = 57.52\ K.$$

$\Rightarrow P = 57.52$ K.

$P_u = 57.52$ KIPS