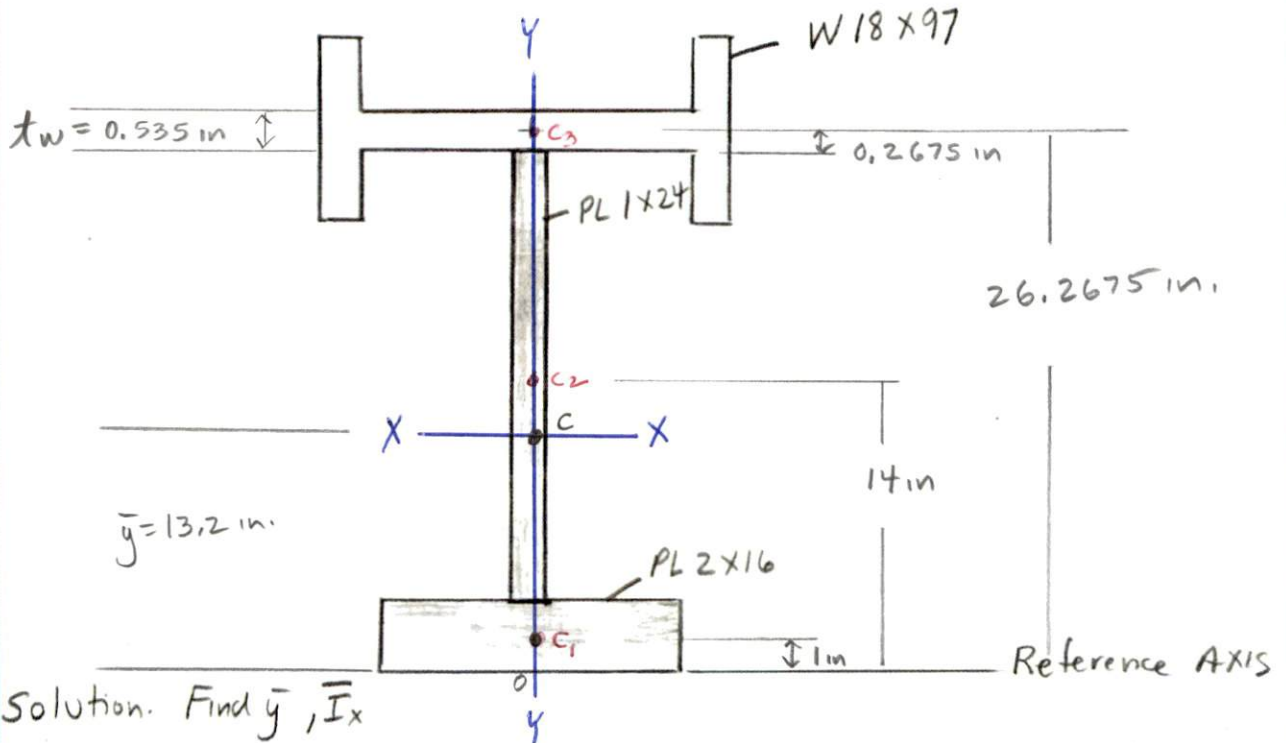


1. Calculate the moment of Inertia about the centroidal x - and the centroidal y -axes for the built-up structural steel shape shown.



Solution. Find \bar{y} , \bar{I}_x

Part	Area (in. ²)	y (in.)	Ay (in. ³)	$\bar{y}-y$ (in.)	$A(\bar{y}-y)^2$ (in. ⁴)	I_x (in. ⁴)
PL 2x16	32	1	32	12.2	4762.88	$\frac{bh^3}{12} = \frac{16(2^3)}{12} = 10.67$
PL 1x24	24	14	336	-0.8	15.36	$\frac{1(24^3)}{12} = 1152$
W18x97	28.5	26.2675	748.62375	-13.0675	4866.65	201
Σ	84.5		1116.62		9644.89	1363.67

$$\bar{y} = \frac{\Sigma Ay}{\Sigma A} = \frac{1116.62 \text{ in.}^3}{84.5 \text{ in.}^2} = 13.2 \text{ in}$$

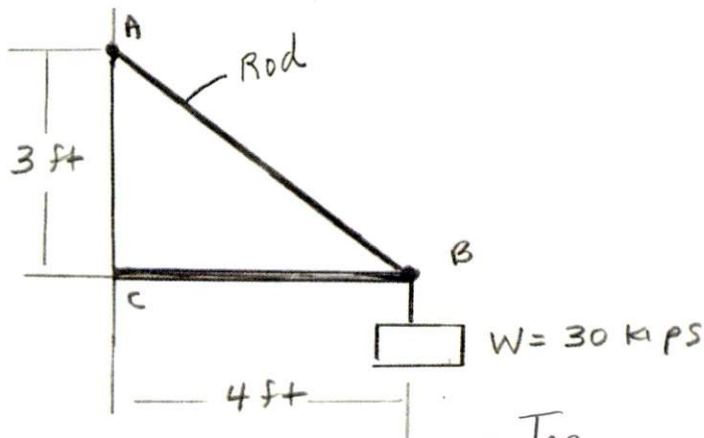
$$\bar{I}_x = \Sigma [I + A(\bar{y}-y)^2] = 1363.67 \text{ in.}^4 + 9644.89 \text{ in.}^4 = 11,008.56 \text{ in.}^4 \quad (11,009 \text{ in.}^4)$$

Find \bar{I}_y

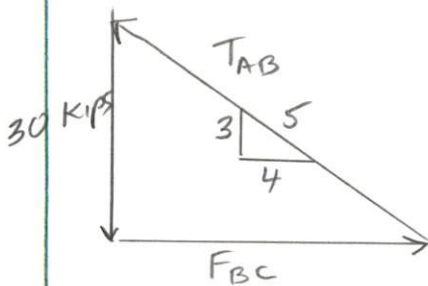
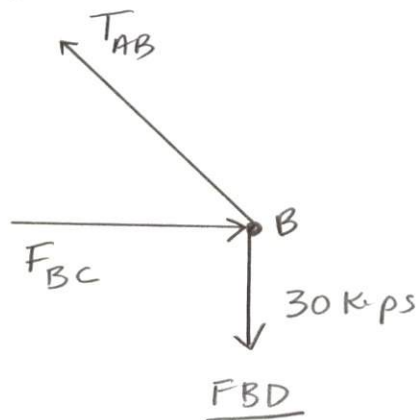
$$\bar{I}_y = \frac{2(16^3)}{12} + \frac{24(1^3)}{12} + 1750 \text{ in.}^4 = 682.67 + 2 + 1750 = 2434.67 \text{ in.}^4$$

(2435 in.⁴)

2. The Allowable tensile stress of the rod is 22 ksi. Find the diameter of the rod, to the nearest sixteenth of an inch.



Solution.



Force - Triangle

$$\frac{T_{AB}}{5} = \frac{30 \text{ kips}}{3}$$

$$T_{AB} = \frac{5}{3} (30 \text{ kips}) = 50 \text{ kips}$$

$$\frac{1}{16} = 0.6875$$

$$\frac{12}{16} = 0.75$$

$$\sigma_{AB} = \frac{T_{AB}}{A}$$

$$A = \frac{T_{AB}}{\sigma_{AB}} = \frac{50 \text{ kips}}{22 \text{ ksi}} = 2.273 \text{ in.}^2$$

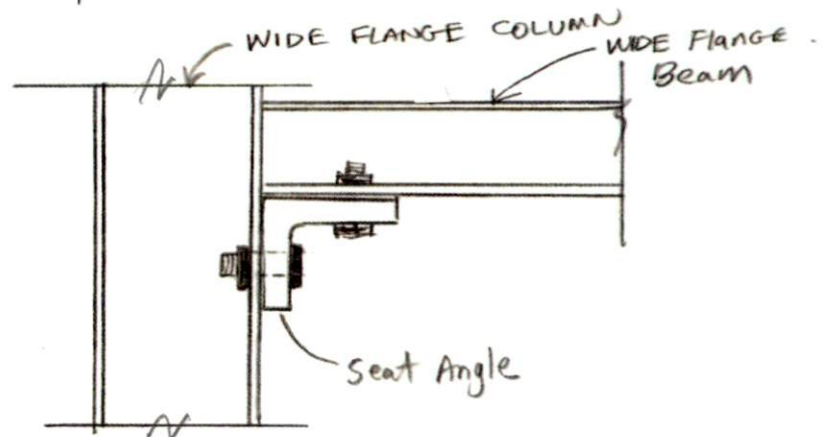
$$\frac{\pi d^2}{4} = 2.273 \text{ in.}^2$$

$$d = \sqrt{\frac{2.273 \text{ in.}^2 (4)}{\pi}} = 1.7011 \text{ in.}$$

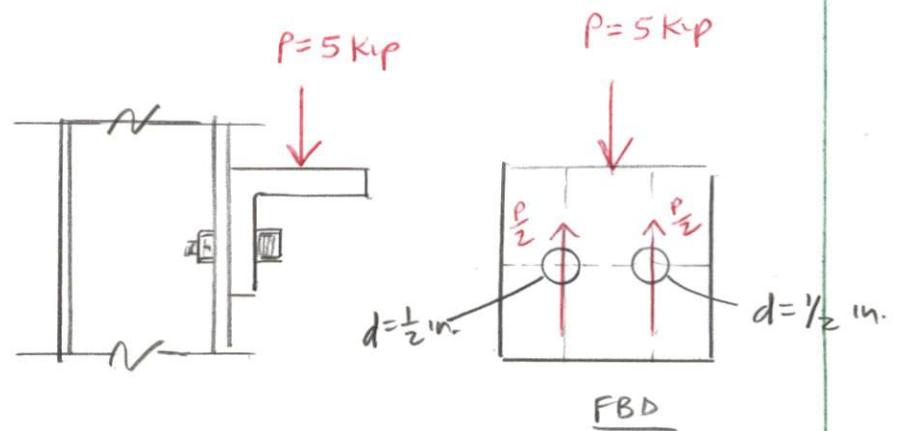
$$\text{use } d = 1 \frac{12}{16} \text{ in.}$$

$$\text{or } d = 1.75 \text{ in.}$$

3. A typical method of temporarily securing a steel beam onto a column is by using a seat angle with bolts through the column flange. Two $\frac{1}{2}$ in. diameter bolts are used to fasten the seat angle to the column. The bolts must carry the beam load of $P = 5$ kip in single shear. Determine the average shear stress developed in the bolts.



Solution.



$$\begin{aligned} \tau &= \frac{P}{A} \\ &= \frac{\frac{5 \text{ kip}}{2}}{\frac{\pi (0.5 \text{ in})^2}{4}} = \frac{5 \text{ kip}}{0.393 \text{ in}^2} = \underline{\underline{12.7 \text{ ksi}}} \end{aligned}$$

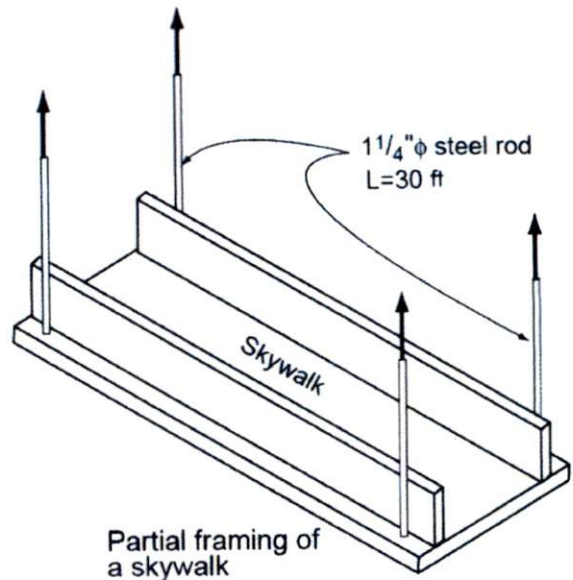
4. A skywalk uses a system of four $1\frac{1}{4}$ in. circular steel rods with an equal amount of load being carried by each to support the dead and occupancy loads. If the maximum allowable tensile stress of the rod is 22 ksi and $E_{\text{steel}} = 29 \times 10^3$ ksi, determine the following:

(a) the allowable load capacity in each rod

$$\sigma = \frac{P}{A} \Rightarrow P = \sigma A$$

$$P = 22 \text{ ksi} \left(\frac{\pi (1.25 \text{ in})^2}{4} \right)$$

$$= 27 \text{ kips}$$



(b) if the rods supporting the skywalk are 30 ft in length, how much elongation would occur if the rod was loaded to its maximum allowable stress limit

$$\delta = \frac{PL}{AE} = \frac{\sigma_{\text{allow}} \cdot L}{E} = \frac{22 \text{ ksi} \left(30 \text{ ft} \times \frac{12 \text{ in}}{\text{ft}} \right)}{29 \times 10^3 \text{ ksi}}$$

$$= 0.273 \text{ in.}$$

(c) the ultimate load capacity of the rod at failure assuming A36 steel.

$$\sigma_u = 58 \text{ ksi}$$

Table A-7(a)

$$P_{\text{ult.}} = \sigma_u A = 58 \text{ ksi} \left(\frac{\pi (1.25 \text{ in})^2}{4} \right)$$

$$= 71.2 \text{ kip}$$