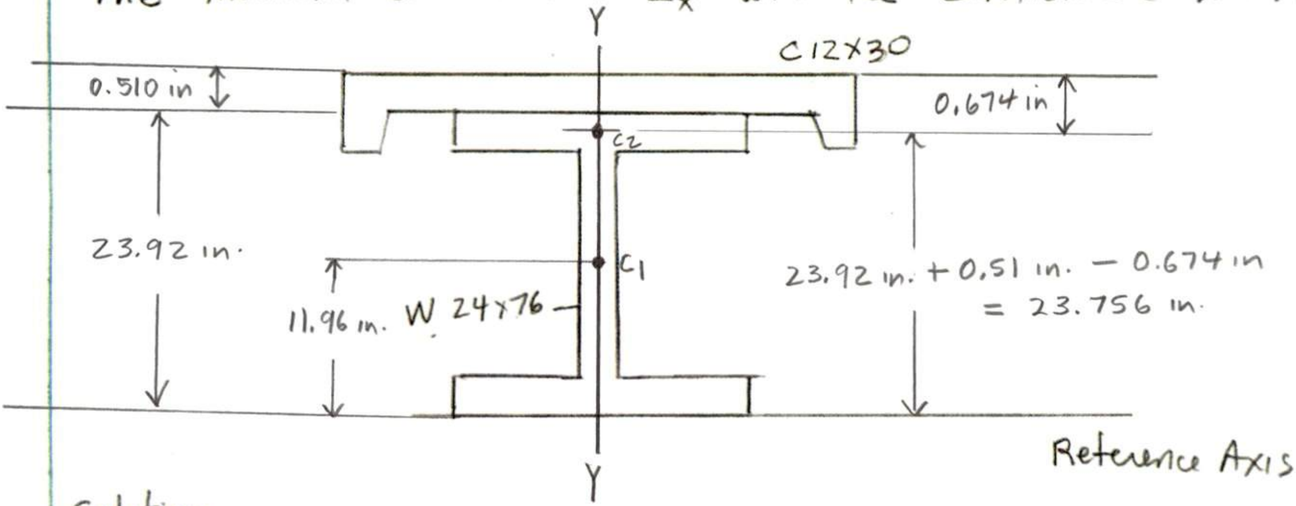
A column is constructed from a W 24×84 wide flange section and a C12×30 channel. Determine the moment of inertia $\bar{I}_x$ wrt the centroidal x-axis.



Solution.

Part	Area (in^2)	y (in)	Ay ($in.^3$)	$\bar{y}$−y (in.)	$A(\bar{y}-y)^2$ ($in.^4$)	I (in^4)
W24×76	22.4	11.96	267.904	3.34	249.89	2100
C12×30	8.82	23.756	209.528	−8.456	630.66	5.14
Σ	31.22		477.432		880.55	2105.14

$$\bar{y} = \frac{\Sigma Ay}{\Sigma A} = \frac{477.432 \text{ in.}^3}{31.22 \text{ in}^2} = 15.3 \text{ in}$$

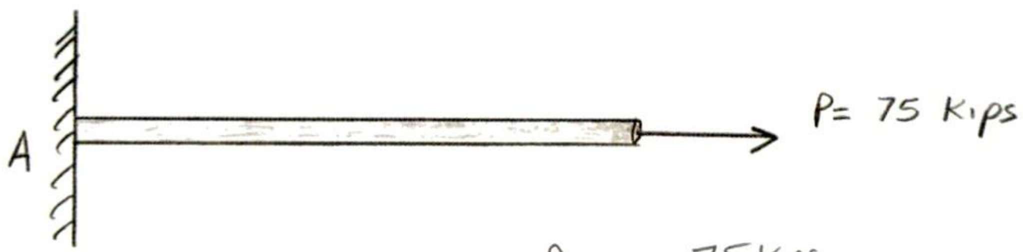
$$\bar{I}_x = \Sigma\left[I + A(\bar{y}-y)^2\right] = 2105.4 \text{ in.}^4 + 880.55 \text{ in.}^4$$

$$= \underline{\underline{2986}} \text{ in.}^4$$

Determine $\bar{r}_x$ about the horiz. centroidal axis

$$r_x = \sqrt{\frac{\bar{I}_x}{A}} = \sqrt{\frac{2986 \text{ in.}^4}{31.22 \text{ in.}^2}} = \underline{\underline{9.8}} \text{ in.}$$

Determine the sige of a round steel rod, to the nearest sixteenth of an inch, needed to support a tensile load of 75 kips if the allowable tensile stress of steel is 35 ksi.



$$\sigma = \frac{P}{A} \Rightarrow A = \frac{P}{\sigma} = \frac{75 \text{ kips}}{35 \text{ kip/in.}^2} = 2.143 \text{ in.}^2$$

$$\frac{\pi d^2}{4} = 2.143 \text{ in.}^2$$

$$d = \sqrt{\frac{2.143 \text{ in}^2 (4)}{\pi}} = 1.652 \text{ in}$$

$\frac{10}{16} = 0.625$

$\frac{11}{16} = 0.6875$

use $d = 1\text{-}\frac{11}{16}$ in.

If the above steel rod has a modulus of Elasticity of $E = 29 \times 10^6$ psi, determine the strain.

$$\sigma = \frac{P}{A} = \frac{75 \text{ kips}}{\frac{\pi (1.6875 \text{ in})^2}{4}} = 34 \text{ ksi} < 35 \text{ ksi}$$

(proportional limit)

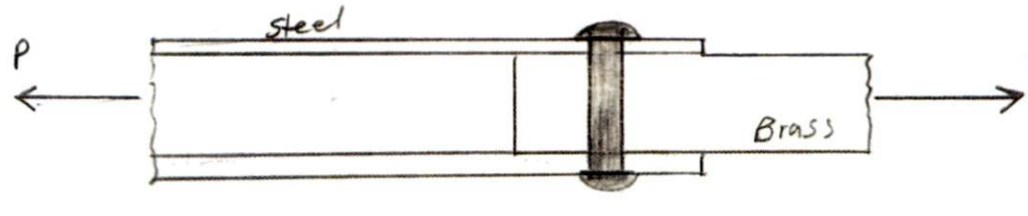
$\Rightarrow$ Hooke's Law Applies

From Hooke's Law

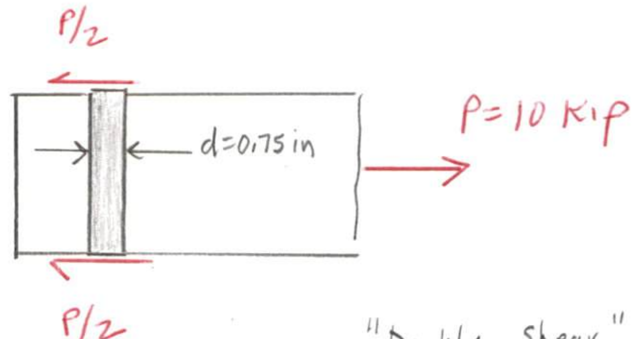
$$E = \frac{\sigma}{\epsilon}$$

$$\epsilon = \frac{\sigma}{E} = \frac{34\,000 \text{ psi}}{29 \times 10^6 \text{ psi}} = 0.00117$$

A brass tube with an outside diameter of 2.00 in. and a wall thickness of 0.375 in. is connected to a steel tube with an inside diameter of 2.00 in. and a wall thickness of 0.250 in. by using a 0.750 in.-diameter pin as shown. Determine the shearing stress in the pin when the joint is carrying an axial load of 10 kip.



Solution.



"Double Shear"

FBD

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

$$= \frac{\frac{P}{2}}{\frac{\pi (0.75\text{ in})^2}{4}} = \frac{5\text{ Kip}}{0.7854\,(0.75\text{ in.})^2} = \frac{5\text{ Kip}}{0.4418\text{ in.}^2}$$

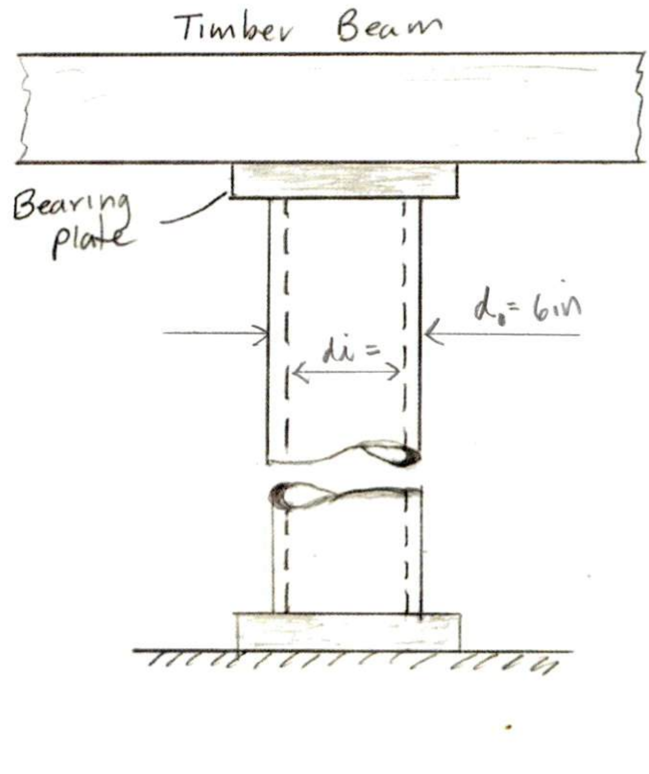
$$= \underline{\underline{11.32\text{ ksi}}}$$

The steel pipe column shown has an outside diameter of 6 in. and a wall thickness of $19/32$ in. The load imposed on the column by the timber beam is 34 kips.

Determine

(a) the average bearing stress at the surface between the steel pipe column and the steel bearing plate.

(b) the diameter of a circular bearing plate if the average bearing stress between the steel bearing plate and the wood beam is not to exceed 0.4714 ksi.



$\frac{19}{32} = 0.59375$

$d_i = 6 - 1.1875$
$= 4.8125$ in

Solution.

(a) Determine the area between the steel column and the bearing plate

$$A_b = \frac{\pi}{4}\left(d_o^2 - d_i^2\right) = \frac{\pi}{4}\left[(6\,\text{in})^2 - (4.8125\,\text{in})^2\right]$$
$$= 10.08\ \text{in}^2$$

$$\sigma_b = \frac{P}{A_b} = \frac{34\ \text{kips}}{10.08\ \text{in}^2} = \underline{3.37}\ \text{ksi}$$

(b)

$$\sigma_b = \frac{F}{A_b}$$

$$A_b = \frac{F}{\sigma_b}$$

$$= \frac{34 \text{ kip}}{0.4714 \text{ ksi}}$$

$$A_b = \frac{\pi d^2}{4} = 72.126 \text{ in.}^2$$

$$d = \sqrt{\frac{72.126 \text{ in.}^2 (4)}{\pi}}$$

$$= \underline{\underline{9.583}} \text{ in.}$$