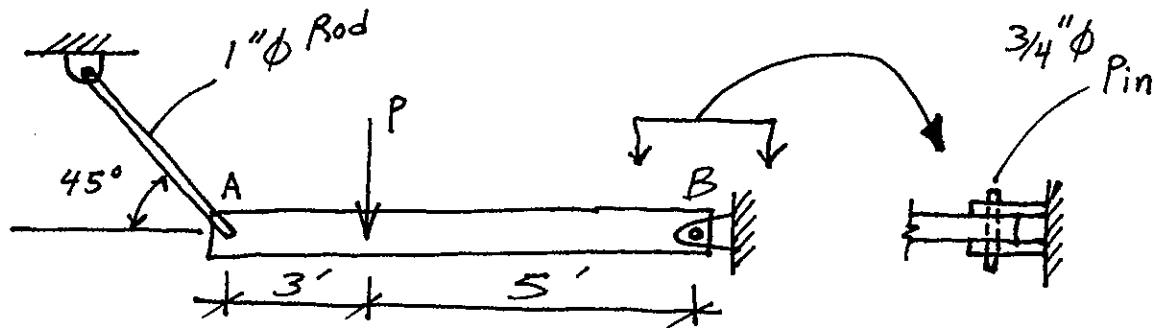


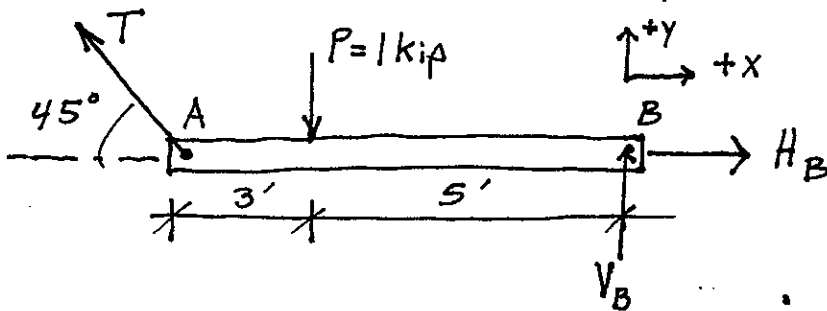
### Example Problem

What value of  $P$  can be applied to the beam so that the rod stress does not exceed  $\sigma_a = 20 \text{ ksi}$  and the pin stress does not exceed  $\tau_a = 14 \text{ ksi}$ ?



Solution:

- Draw FBD of Beam (Let  $P = 1 \text{ kip}$  for now)



- Determine Unknowns - Use equilibrium Equations

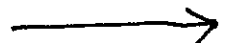
$$\rightarrow \sum F_x = 0; \Rightarrow -T \cos 45 + H_B = 0$$

$$+\uparrow \sum F_y = 0; \Rightarrow T \sin 45 - 1 + V_B = 0$$

$$\odot \sum M_A = 0; \Rightarrow -3(1) + 8V_B = 0 \Rightarrow V_B = \frac{3}{8} \text{ kips}$$

$$\Rightarrow T = \frac{1 - 3/8}{\sin 45} = 0.8839 \text{ kips}$$

$$\Rightarrow H_B = 0.8839 \cos 45 = 0.6250 \text{ kips}$$



- Determine Resultant force at the pin.

A diagram showing a pin joint at the origin of a coordinate system. A vertical arrow pointing up is labeled  $V_B = 3/8 \text{ kips}$ . A horizontal arrow pointing right is labeled  $H_B = 0.6250 \text{ kips}$ . A dashed arrow pointing into the first quadrant is labeled  $V = \text{resultant} = \sqrt{V_B^2 + H_B^2} = 0.7289 \text{ kips}$ .

- Determine Rod stress and pin stress

$$\text{Area Rod} = \frac{\pi (1)^2}{4} = 0.7854 \text{ in}^2 = A_r$$

$$\text{Area Pin} = \frac{\pi (0.75)^2}{4} = 0.4418 \text{ in}^2 = A_p$$

$$\text{Rod Stress} = \sigma = \frac{T}{A_r} = \frac{0.8839 \text{ kips}}{0.7854 \text{ in}^2} = 1.125 \text{ Ksi}$$

$$\text{Pin Stress} = \tau = \frac{V}{2A_p} = \frac{0.7289 \text{ kips}}{2(0.4418) \text{ in}^2} = 0.8249 \text{ Ksi}$$

(Notice pin is in double shear)

- By proportions determine the allowed value of P.

→ Consider the rod first

$$\frac{P}{\sigma} = \frac{1 \text{ kips}}{1.125 \text{ Ksi}} = \frac{P_a}{\sigma_a} = \frac{P_a}{20 \text{ Ksi}} \Rightarrow P_a = \frac{20 \text{ Ksi} \cdot \text{kips}}{1.125 \text{ Ksi}} = 17.8 \text{ kips}$$

↑ given

→ Consider the pin

$$\frac{P}{\tau} = \frac{1 \text{ kips}}{0.8249 \text{ Ksi}} = \frac{P_a}{\tau_a} = \frac{P_a}{14 \text{ Ksi}} \Rightarrow P_a = \frac{14 \text{ Ksi} \cdot \text{kips}}{0.8249 \text{ Ksi}} = 17.0 \text{ kips}$$

↑ given

- Conclusion

The pin limits the load P that can be applied to the beam. The limiting value is  $P = 17.0 \text{ kips}$