SOLUTION

ME 323: Mechanics of Materials **Homework Set H04**

Summer 2024 **Assigned/Due: June 13/June 17**

The truss shown below is loaded with a force P at joint C. Member (1) of the truss is made up of two components that are joined with a pin having a diameter of d with a yield strength in shear of τ_Y.

a) Determine the loads carried by the three members of the truss.

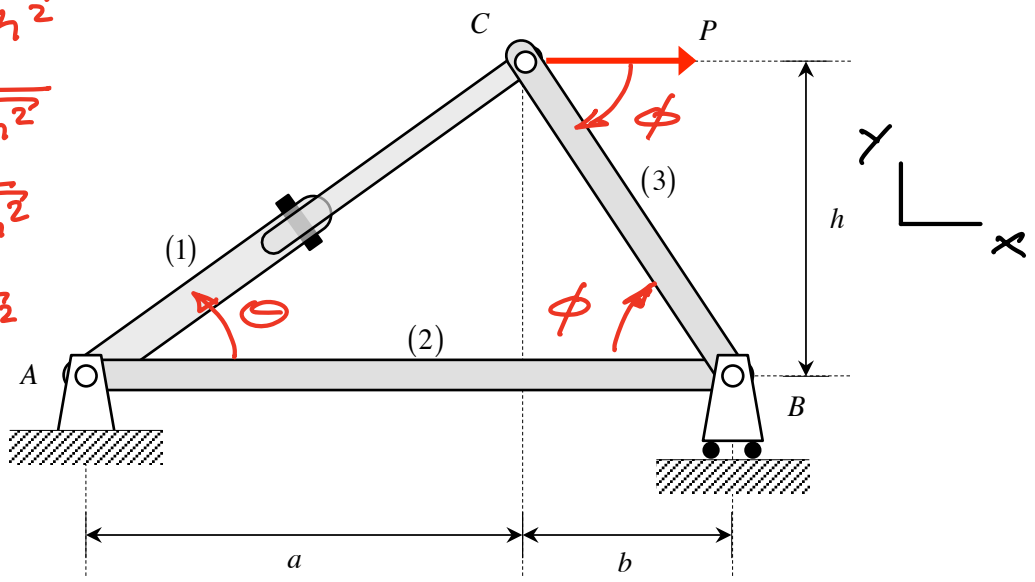
b) Determine the minimum diameter d of the pin joining the two components of member AC such that the material of the pin does not yield with a factor of safety of FS.

$\cos\theta = \frac{a}{\sqrt{a^2+h^2}}$

$\sin\theta = \frac{h}{\sqrt{a^2+h^2}}$

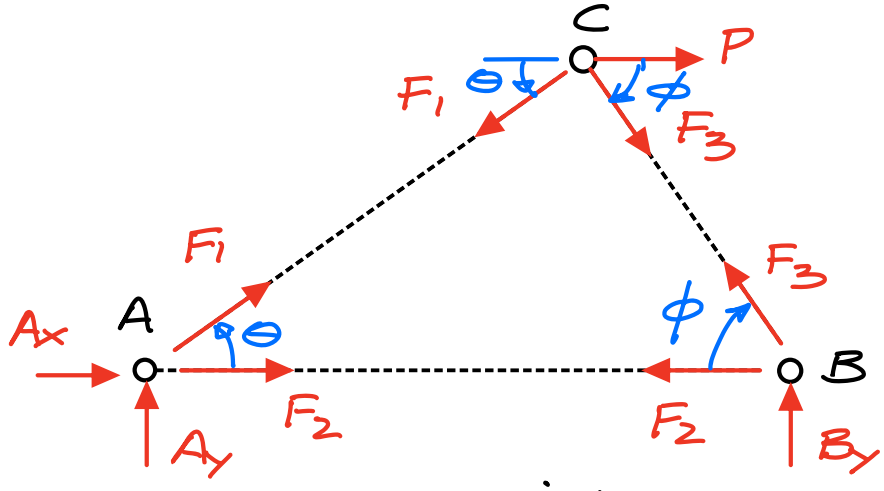
$\cos\phi = \frac{b}{\sqrt{b^2+h^2}}$

$\sin\phi = \frac{h}{\sqrt{b^2+h^2}}$



Use the following parameter values in your analysis: $a = 16/15\ ft$, $b = 3/5\ ft$, $h = 4/5\ ft$, $P = 20\ kips$, $FS = 2$ and $\tau_Y = 18\ ksi$.

a) Method of joints



$\circlearrowleft$: $\sum F_y = -F_1\sin\theta - F_3\sin\phi = 0 \Rightarrow F_1 = \frac{\sin\phi}{\sin\theta} F_3$

$\sum F_x = -F_1\cos\theta + F_3\cos\phi + P = 0 \Rightarrow$

$\left[\frac{\sin\phi\cos\theta}{\sin\theta} + \cos\phi\right] F_3 = -P \Rightarrow$

$$F_3 = -\left[\frac{\sin\theta}{\sin\phi\cos\theta + \sin\theta\cos\phi}\right] P$$ ← F_3

$$\Rightarrow F_1 = \left[\frac{\sin\phi}{\sin\phi\cos\theta + \sin\theta\cos\phi}\right] P$$ ← F_1

$\underline{B}$: $\sum F_x = -F_3\cos\phi - F_2 = 0 \Rightarrow$

$$F_2 = \left[\frac{\sin\theta\cos\phi}{\sin\phi\cos\theta + \sin\theta\cos\phi}\right] P$$ ← F_2

b) $$\tau_{pin} = \frac{|F_1|/2}{A} = \frac{|F_1|}{2\pi(d/2)^2} = \frac{2|F_1|}{\pi d^2}$$

$$FS = \frac{\tau_Y}{\tau_{pin}} = \frac{\pi d^2}{2F_1}\tau_Y \Rightarrow$$

$$d_{min} = \sqrt{\frac{2|F_1|(FS)}{\pi\tau_Y}}$$

$$= \sqrt{\frac{2(FS)}{\pi\tau_Y}\left(\frac{\sin\phi}{\underbrace{\sin\phi\cos\theta + \sin\theta\cos\phi}_{\sin(\theta+\phi)}}\right)}$$ ← d_{min}