ME 323: Mechanics of Materials ***Homework Set H03***

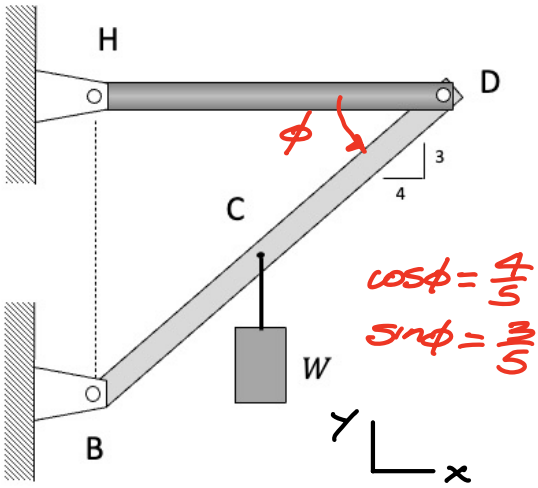
Summer 2024 ***Assigned/Due: June 12/June 14***

The frame shown is made up of members DH and BD. Member BD supports a block of weight W at its midpoint C. Member DH has a cross-sectional area of A and is made up of two pieces that are spliced together as shown in the figure at an angle of $\theta = 30°$. All pins in the frame have a diameter of d. All pin connections are single-sided. Consider the weights of the members to be negligible compared to the weight of the block.

a) Determine the axial stress in member DH of the frame.

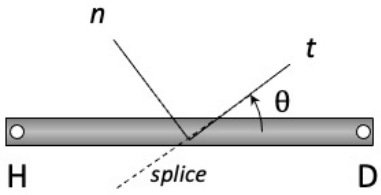
b) Determine the shear stress in pins B and D of the frame.

c) Determine the normal (n) and tangential (t) components of stress along the splice joint in member DH.

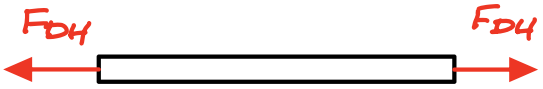


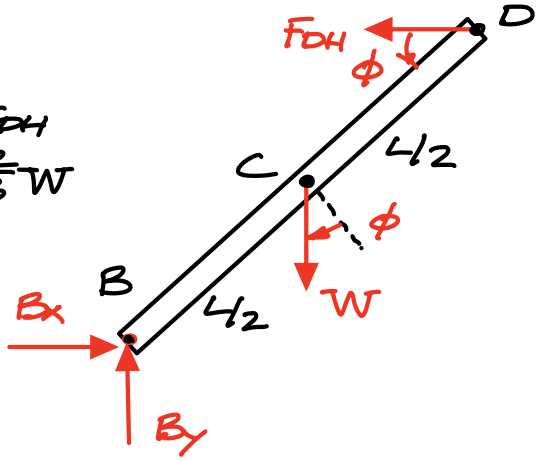
$\cos\phi = \frac{4}{5}$

$\sin\phi = \frac{3}{5}$



a) Individual FBDs of DH and BD, as shown.





Equilibrium:

- $\Sigma M_B = -(W\cos\phi)\frac{L}{2} + (F_{DH}\sin\phi)L = 0$

  ↳ $F_{DH} = \frac{W}{2}\cot\phi = \frac{2}{3}W$

- $\Sigma F_x = B_x - F_{DH} = 0 \Rightarrow B_x = F_{DH} = \frac{2}{3}W$

- $\Sigma F_y = B_y - W = 0 \Rightarrow B_y = W$

$$\sigma_{DH} = \frac{F_{DH}}{A} = \frac{2W}{3A}$$

b) Shear stress in pin D:

$$\tau_D = \frac{F_{DH}}{\pi(d/2)^2} = \frac{8W}{3\pi d^2}$$

Shear stress in pin B:

$$\tau_B = \frac{\sqrt{B_x^2 + B_y^2}}{\pi(d/2)^2} = \frac{\sqrt{\left(\frac{2}{3}W\right)^2 + W^2}}{\pi d^2/4} = \frac{4\sqrt{13}}{3}\frac{W}{\pi d^2}$$

c) $\sigma = \frac{F_{DH}\sin\theta}{A/\sin\theta}$

$= \left(\frac{2W}{3}\right)\frac{\sin^2\theta}{A}$ ($\sin^2\theta = 1/4$)

$= \frac{2}{3}\frac{W}{A}$

$\tau = \frac{F_{DH}\cos\theta}{A/\sin\theta}$

$= \left(\frac{2W}{3}\right)\frac{\cos\theta\sin\theta}{A}$ ($\cos\theta\sin\theta = \sqrt{3}/4$)

$= \frac{1}{2\sqrt{3}}\frac{W}{A}$