Solution

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

Summer 2025 **Assigned/Due: June 18/June 23**

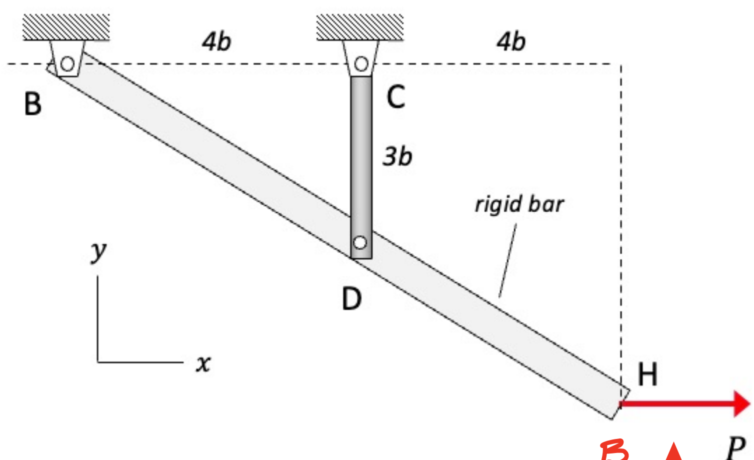
The frame shown is made up of members BH and CD, with member CD being vertical. A horizontal force P acts at end H of member BH. Member CD has a cross-sectional area of A and is made up of two pieces that are spliced together as shown in the figure at an angle of $\phi = 30°$. All pins in the frame have a diameter of d, and all pin connections are single-sided. Consider the weights of the members to be negligible compared to the applied load on the frame.

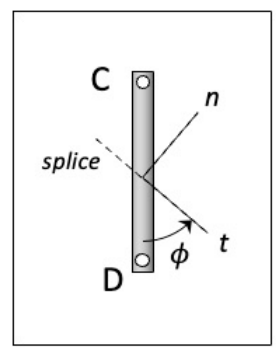
a) Determine the axial stress in member CD of the frame.

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 CD.

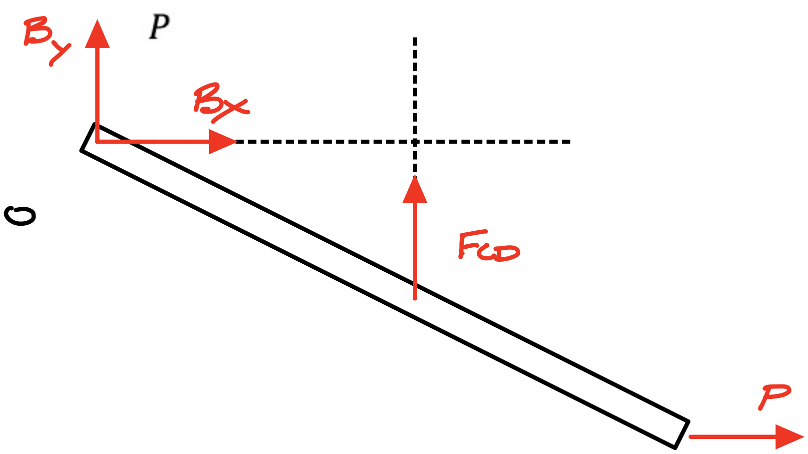
Express all answers in terms of the given parameters of d and P. If these parameters are given in terms of SI units, verify that all your answers have the correct units.





FBD

BDH:



• $\Sigma M_B = F_{CD}(4\cancel{b}) + P(6\cancel{b}) = 0$

(1) $\hookrightarrow F_{CD} = -\frac{3}{2}P$

• $\Sigma F_x = B_x + P = 0$

(2) $\hookrightarrow B_x = -P$

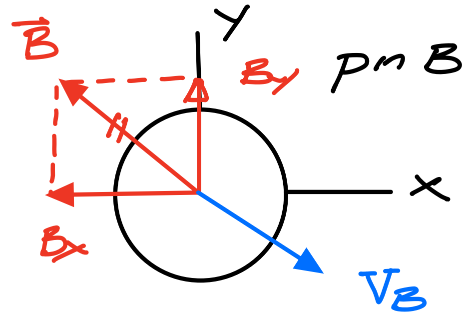
• $\Sigma F_y = B_y + F_{CD} = 0$

(3) $\hookrightarrow B_y = -F_{CD} = \frac{3}{2}P$

Part a)

$$\sigma_{CD} = \frac{F_{CD}}{A} = -\frac{3}{2}\frac{P}{A} \quad (C)$$

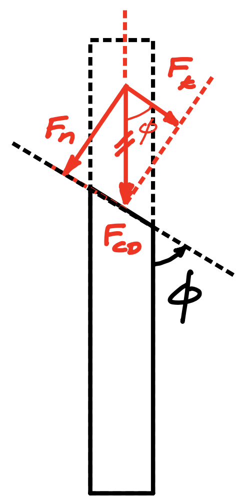
Part b)



- $$V_B = \sqrt{B_x^2 + B_y^2}$$
$$= \sqrt{(-P)^2 + \left(\tfrac{3}{2}P\right)^2}$$
$$= \frac{\sqrt{13}}{2} P$$
$$\tau_B = \frac{V_B}{A} = \frac{\sqrt{13}}{2} \frac{P}{\pi (d/2)^2} = 2\sqrt{13} \frac{P}{\pi d^2} \longleftarrow \tau_B$$

- $$V_D = |F_{CD}| = \frac{3}{2} P$$
$$\tau_D = \frac{V_D}{A} = \frac{3P/2}{\pi (d/2)^2} = \frac{6P}{\pi d^2} \longleftarrow \tau_D$$

Part c)



From figure to the right:

$$F_t = F_{CD} \cos\phi = -\frac{3}{2} P \cos\phi$$
$$F_n = F_{CD} \sin\phi = -\frac{3}{2} P \sin\phi$$
$$A_c = \frac{A}{\sin\phi}$$

$$\therefore \quad \sigma = \frac{F_n}{A_c} = \frac{-\frac{3}{2} P \sin\phi}{A/\sin\phi}$$
$$= -\frac{3}{2} \frac{P}{A} \sin^2\phi = -\frac{3}{8} \frac{P}{A} \longleftarrow \sigma$$

$$\tau = \frac{F_t}{A_c} = \frac{-\frac{3}{2} P \cos\phi}{A/\sin\phi} = -\frac{3}{2} \frac{P}{A} \sin\phi \cos\phi$$
$$= -\frac{3\sqrt{3}}{8} \frac{P}{A} \longleftarrow \tau$$

UNITS

For a), b) and c), the answers are all in terms of N/m^2. Checks.