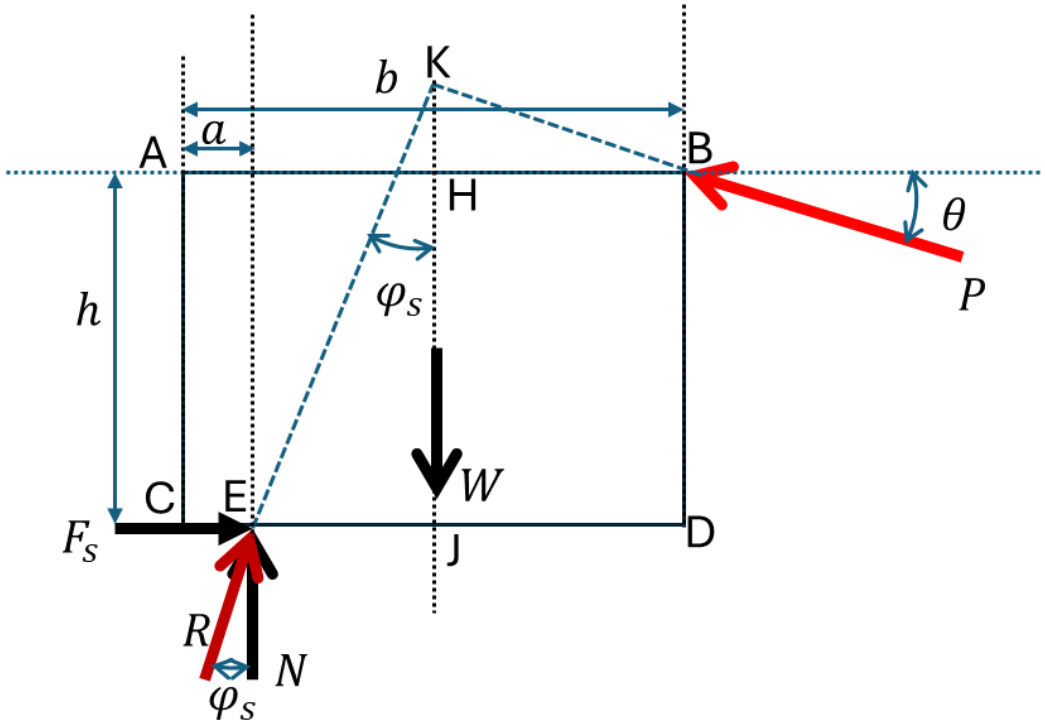
PROBLEM 1

Method-1:



$$\sum M_E = 0$$

$$\Rightarrow P\cos\theta \times h + P\sin\theta \times (b-a) - W\left(\frac{b}{2} - a\right) = 0$$

$$\Rightarrow P = \frac{W\left(\frac{b}{2} - a\right)}{h\cos\theta + (b-a)\sin\theta} = 173.91N$$

$$\sum F_y = 0$$

$$\Rightarrow N = W - P\sin\theta$$

$$\sum F_x = 0$$

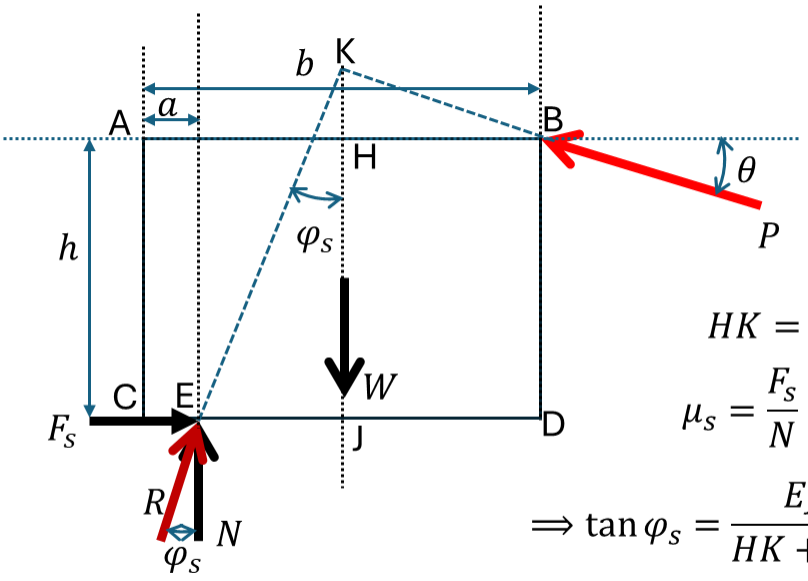
$$\Rightarrow F_s = P\cos\theta$$

$$\Rightarrow \mu_s N = P\cos\theta$$

$$\Rightarrow \mu_s = \frac{P\cos\theta}{W - P\sin\theta} = 0.377$$

Method-2

Force triangle:



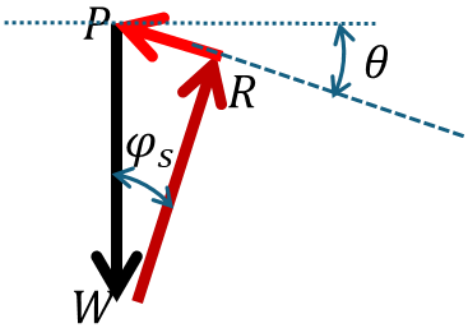
$$HK = \frac{b}{2}\tan\theta$$

$$\mu_s = \frac{F_s}{N} = \tan\varphi_s$$

$$\Rightarrow \tan\varphi_s = \frac{EJ}{HK + HJ} = \frac{\frac{b}{2} - a}{\frac{b}{2}\tan\theta + h}$$

$$\Rightarrow \mu_s = 0.377$$

Law of sines:



$$\frac{P}{\sin\varphi_s} = \frac{W}{\sin\left(\frac{\pi}{2} - \varphi_s - \theta\right)}$$

$$\Rightarrow P = \frac{W\sin\varphi_s}{\sin\left(\frac{\pi}{2} - \varphi_s - \theta\right)} = 173.91N$$

PROBLEM 2

Distributed load

$$w = w_0\left(1 - \frac{x}{L}\right) \quad \left(\text{Total} = \frac{1}{2}w_0 L\right)$$

$$\circlearrowleft \Sigma M_A = 0: \quad \frac{L}{3}\left(\frac{1}{2}w_0 L\right) - LB = 0 \quad \boldsymbol{B} = \frac{w_0 L}{6}\uparrow$$

$$\uparrow \Sigma F_y = 0: \quad A_y - \frac{1}{2}w_0 L + \frac{w_0 L}{6} = 0 \quad \boldsymbol{A_y} = \frac{w_0 L}{3}\uparrow$$

Shear: $V_A = A_y = \frac{w_0 L}{3}$

$$\frac{dV}{dx} = -w \rightarrow V$$

Then

$$= V_A - \int_0^x w_0\left(1 - \frac{x}{L}\right)dx$$

$$V = \left(\frac{w_0 L}{3}\right) - w_0 x + \frac{1}{2}\frac{w_0}{L}x^2$$

$$= w_0 L\left[\frac{1}{3} - \frac{x}{L} + \frac{1}{2}\left(\frac{x}{L}\right)^2\right]$$

$$x = L$$

$$V = -\frac{w_0 L}{6}$$

Note: At

$$V = 0 \text{ at } \left(\frac{x}{L}\right)^2 - 2\left(\frac{x}{L}\right) + \frac{2}{3}$$

$$= 0 \rightarrow \frac{x}{L} = 1 - \sqrt{\frac{1}{3}}$$

Moment: $M_A = 0$

$$\left(\frac{dM}{dx}\right) = V \rightarrow M = \int_0^x V dx = L\int_0^{x/L} V\left(\frac{x}{L}\right) d\left(\frac{x}{L}\right)$$

Then

$$M = w_0 L^2 \int_0^{x/L} \left[\frac{1}{3} - \frac{x}{L} + \frac{1}{2}\left(\frac{x}{L}\right)^2\right] d\left(\frac{x}{L}\right)$$

$$M = w_0 L^2 \left[\frac{1}{3}\left(\frac{x}{L}\right) - \frac{1}{2}\left(\frac{x}{L}\right)^2 + \frac{1}{6}\left(\frac{x}{L}\right)^3\right]$$

$$M\left(\text{at } \frac{x}{L} = 1 - \sqrt{\frac{1}{3}}\right)_{0\ max}^{2}$$

$$(a)\ V = w_0 L\ \left[\frac{1}{3} - \frac{x}{L} + \frac{1}{2}\left(\frac{x}{L}\right)^2\right] \blacktriangleleft$$

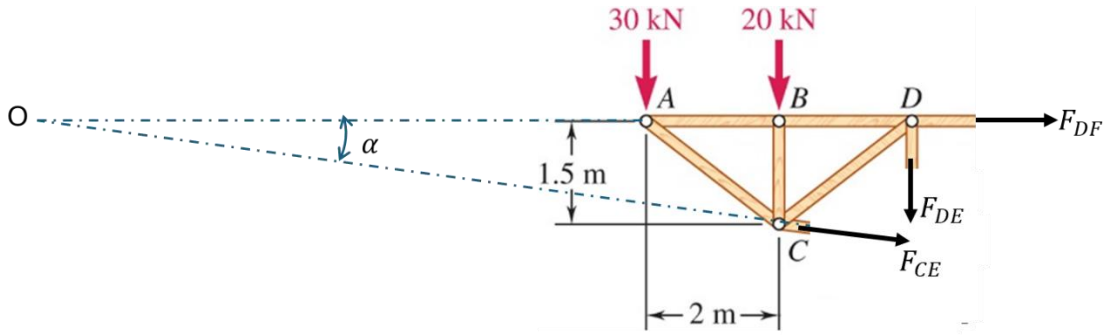
$$(b)\ M = w_0 L^2\ \left[\frac{1}{3}\left(\frac{x}{L}\right) - \frac{1}{2}\left(\frac{x}{L}\right)^2 + \frac{1}{6}\left(\frac{x}{L}\right)^3\right] \blacktriangleleft$$

$$(c)\ M_{max} \blacktriangleleft$$

$$\text{at } x = 0.423L \blacktriangleleft$$

PROBLEM 3

$$\alpha = tan^{-1}\left(\frac{1}{8}\right) = 7.1°$$



Member *DF*:

$$+\circlearrowleft \Sigma M_E = 0: \quad -F_{DF}(1.75\text{ m}) + (30\text{ kN})(4\text{ m}) + (20\text{ kN})(2\text{ m}) = 0$$

$$F_{DF} = +91.4\text{ kN} \quad F_{DF} = 91.4\text{ kN} \quad T \blacktriangleleft$$

Member *DE*:

$$+\circlearrowleft \Sigma M_O = 0: \quad -F_{DE}(14\text{ m}) - (30\text{ kN})(10\text{ m}) - (20\text{ kN})(12\text{ m}) = 0$$

$$F_{DE} = -38.6\text{ kN} \quad F_{DE} = 38.6\text{ kN} \quad C \blacktriangleleft$$