Truss Maximum Load Calculation

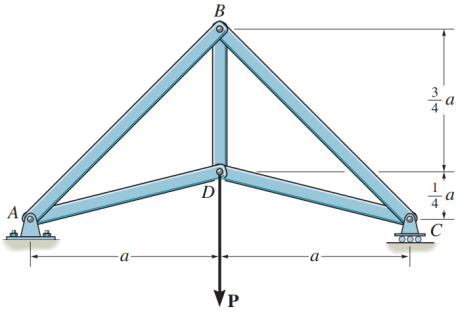
Step 1

Given parameters:

$$F_{AB} = 800\,\text{lb}, \quad T = 2000\,\text{lb}, \quad a = 6\,\text{ft}$$

Key distances:

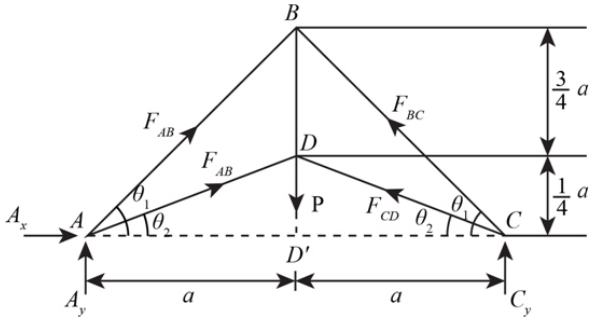
$$d_1 = \tfrac{3}{4}a, \quad d_2 = \tfrac{1}{4}a, \quad d_3 = a, \quad d_4 = a$$



We need to find the maximum load P the truss can support.

Step 2

Free body diagram:



Step 3

Calculate θ_1:

$$\tan\theta_1 = \frac{d_1 + d_2}{d_3} = \frac{\frac{3}{4}a + \frac{1}{4}a}{a} = 1$$

$$\theta_1 = \tan^{-1}(1) = 45^\circ$$

Step 4

Calculate θ_2:

$$\tan\theta_2 = \frac{d_2}{d_3} = \frac{\frac{1}{4}a}{a} = 0.25$$

$$\theta_2 = \tan^{-1}(0.25) \approx 14.03^\circ$$

Step 5

Moment equilibrium about A:

$$C_y(2a) - Pa = 0 \Rightarrow C_y = \frac{P}{2}$$

Step 6

Vertical force equilibrium:

$$A_y + \frac{P}{2} - P = 0 \Rightarrow A_y = \frac{P}{2}$$

Step 7

Horizontal force equilibrium:

$$A_x = 0$$

Step 8

Horizontal forces at A:

$$F_{AD}\cos 14.03^\circ - F_{AB}\cos 45^\circ = 0$$

$$0.970F_{AD} = 0.707F_{AB} \Rightarrow F_{AB} = 1.372F_{AD} \quad (1)$$

Step 9

Vertical forces at A:

$$-1.372F_{AD}\sin 45^\circ + F_{AD}\sin 14.03^\circ + \tfrac{P}{2} = 0$$

$$P = 2(0.970 - 0.242)F_{AD} \Rightarrow F_{AD} = 0.687P \quad (2)$$

Step 10

Substitute (2) into (1):

$$F_{AB} = 1.372(0.687P) = 0.943P$$

$$800 = 0.943P \Rightarrow P = 848.36\,\text{lb}$$

Step 11

Calculate F_{AD}:

$$F_{AD} = 0.687(848.36) = 582.8\,\text{lb}$$

Step 12

Forces at D:

$$582.8\sin 14.03^\circ + 582.8\sin 14.03^\circ + 848.36 - F_{BD} = 0$$

$$F_{BD} = 141.0 + 141.0 + 848.36 = 1130.4\,\text{lb}$$