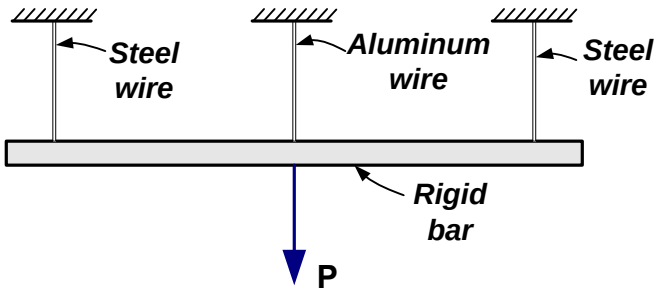
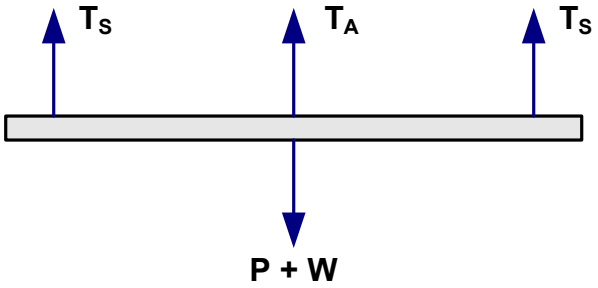


Solution:

Steel wire: ϕ_S = 1/8" ; σ_{allow} = 20 ksi ; $E_S = 30 \times 10^3$ ksi

Aluminum wire: ϕ_A = 3/16" ; σ_{allow} = 12 ksi ; $E_A = 10 \times 10^3$ ksi

Free-body Diagram:



1. Equation of equilibrium:

$$\sum F_y = 2T_S + T_A - P - W = 0 \quad \Rightarrow \quad T_A = -2T_S + P + W \tag{1}$$

2. Equation of compatibility:

$$\delta_S = \delta_A \quad \Rightarrow \quad \frac{T_S \times L}{E_S \times A_S} = \frac{T_A \times L}{E_A \times A_A} \quad \Rightarrow \quad T_A = \frac{E_A \times A_A}{E_S \times A_S} \times T_S \tag{2}$$

3. Criteria for material failure:

$$\sigma_S = \frac{T_S}{A_S} \le 20 \text{ ksi}, \qquad \sigma_A = \frac{T_A}{A_A} \le 12 \text{ ksi} \tag{3}$$

By equating T_A from both Eqs. (1) and (2):

$$-2T_S + (P + W) = \frac{E_A \times A_A}{E_S \times A_S} T_S \quad \Rightarrow \quad T_S \left[2 + \frac{E_A \times A_A}{E_S \times A_S} \right] = P + W$$

Solving for T_S from the above equation results in:

$$T_S = (P+W)\left(\frac{E_S \times A_S}{E_A A_A + 2E_S A_S}\right) \tag{4}$$

Substituting Eq. (4) into Eq. (1) results in:

$$T_A = (P+W) - 2(P+W)\frac{E_S A_S}{E_A A_A + 2E_S A_S} = (P+W)\left(\frac{E_A A_A}{E_A A_A + 2E_S A_S}\right) \tag{5}$$

Substituting Eqs. (4) and (5) into Eqs. (3) results in:

$$\sigma_S = \frac{T_S}{A_S} = (P+W)\left(\frac{E_S}{E_A A_A + 2E_S A_S}\right) = 20 \text{ ksi} \quad \Rightarrow \quad P = 596 \text{ lbs (governs!)}$$

$$\sigma_A = \frac{T_A}{A_A} = (P+W)\left(\frac{E_A}{E_A A_A + 2E_S A_S}\right) = 12 \text{ ksi} \quad \Rightarrow \quad P = 1{,}137 \text{ lbs}$$

where,

$$A_A = \frac{\pi\phi_A^2}{4} = \frac{\pi(3^2)}{4\times(16)^2} = 0.0276 \text{ in}^2; \quad A_S = \frac{\pi\phi_S^2}{4} = \frac{\pi(1^2)}{4\times(8)^2} = 0.0123 \text{ in}^2$$

$$E_A A_A + 2E_S A_S = 1{,}014 \text{ kips}$$

(Note: 1 kip = 1,000 lbs, 1 ksi = 1,000 psi)