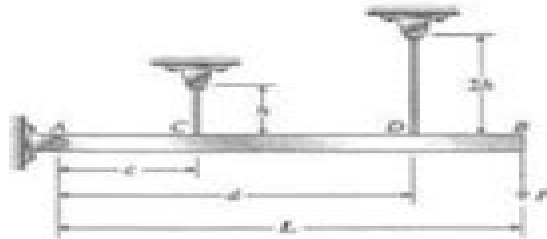
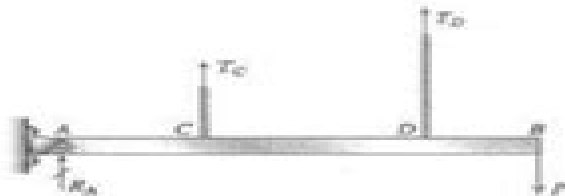


# Problem 2.4-21

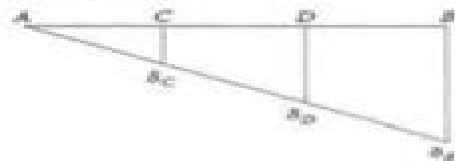


$h = 18 \text{ in.}$   
 $2h = 36 \text{ in.}$   
 $c = 20 \text{ in.}$   
 $d = 50 \text{ in.}$   
 $L = 66 \text{ in.}$   
 $E = 30 \times 10^6 \text{ psi}$   
 $A = 0.0272 \text{ in.}^2$   
 $P = 340 \text{ lb}$

FREE-BODY DIAGRAM



DISPLACEMENT DIAGRAM



EQUATION OF EQUILIBRIUM

$$\sum M_A = 0 \quad \curvearrowright \quad T_C(c) + T_D(d) = PL \quad (\text{Eq. 1})$$

EQUATION OF COMPATIBILITY

$$\frac{\delta_C}{c} = \frac{\delta_D}{d} \quad (\text{Eq. 2})$$

FORCE-DISPLACEMENT RELATIONS

$$\delta_C = \frac{T_C h}{EA} \quad \delta_D = \frac{T_D (2h)}{EA} \quad (\text{Eqs. 3, 4})$$

SOLUTION OF EQUATIONS

Substitute (3) and (4) into Eq. (2):

$$\frac{T_C h}{cEA} = \frac{T_D (2h)}{dEA} \quad \text{or} \quad \frac{T_C}{c} = \frac{2T_D}{d} \quad (\text{Eq. 5})$$

TENSILE FORCES IN THE WIRES

Solve simultaneously Eqs. (1) and (5):

$$T_C = \frac{2cPL}{2c^2 + d^2} \quad T_D = \frac{dPL}{2c^2 + d^2} \quad (\text{Eqs. 6, 7})$$

TENSILE STRESSES IN THE WIRES

$$\sigma_C = \frac{T_C}{A} = \frac{2cPL}{A(2c^2 + d^2)} \quad (\text{Eq. 8})$$

$$\sigma_D = \frac{T_D}{A} = \frac{dPL}{A(2c^2 + d^2)} \quad (\text{Eq. 9})$$

DISPLACEMENT AT END OF BAR

$$\delta_B = \delta_D \left( \frac{L}{d} \right) = \frac{2hT_D}{EA} \left( \frac{L}{d} \right) = \frac{2hPL^2}{EA(2c^2 + d^2)} \quad (\text{Eq. 10})$$

SUBSTITUTE NUMERICAL VALUES

$$2c^2 + d^2 = 2(20 \text{ in.})^2 + (50 \text{ in.})^2 = 3300 \text{ in.}^2$$

$$\begin{aligned} \text{(a)} \quad \sigma_C &= \frac{2cPL}{A(2c^2 + d^2)} = \frac{2(20 \text{ in.})(340 \text{ lb})(66 \text{ in.})}{(0.0272 \text{ in.}^2)(3300 \text{ in.}^2)} \\ &= 10,000 \text{ psi} \quad \leftarrow \end{aligned}$$

$$\begin{aligned} \sigma_D &= \frac{dPL}{A(2c^2 + d^2)} = \frac{(50 \text{ in.})(340 \text{ lb})(66 \text{ in.})}{(0.0272 \text{ in.}^2)(3300 \text{ in.}^2)} \\ &= 12,500 \text{ psi} \quad \leftarrow \end{aligned}$$

$$\begin{aligned} \text{(b)} \quad \delta_B &= \frac{2hPL^2}{EA(2c^2 + d^2)} \\ &= \frac{2(18 \text{ in.})(340 \text{ lb})(66 \text{ in.})^2}{(30 \times 10^6 \text{ psi})(0.0272 \text{ in.}^2)(3300 \text{ in.}^2)} \\ &= 0.0198 \text{ in.} \quad \leftarrow \end{aligned}$$

# **Mechanics Of Materials 9th Edition Solutions**

**Michael F. Ashby, Hugh Shercliff, David  
Cebon**



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