HW1_sol

Vivek Shenoy: Brown University

SOLUTION 1.3

$$A_{AB} = \frac{\pi}{4}(2)^2 = 3.1416 \text{ in}^2$$

$$\sigma_{AB} = \frac{P}{A_{AB}} = \frac{P}{3.1416}$$

$$= 0.31831P$$

$$A_{BC} = \frac{\pi}{4}(3)^2 = 7.0686 \text{ in}^2$$

$$\sigma_{BC} = \frac{(2)(30) - P}{A_{AB}}$$

$$= \frac{60 - P}{7.0686} = 8.4883 - 0.14147P$$

Equating σ_{AB} to $2\sigma_{BC}$

$$0.31831P = 2(8.4883 - 0.14147P)$$

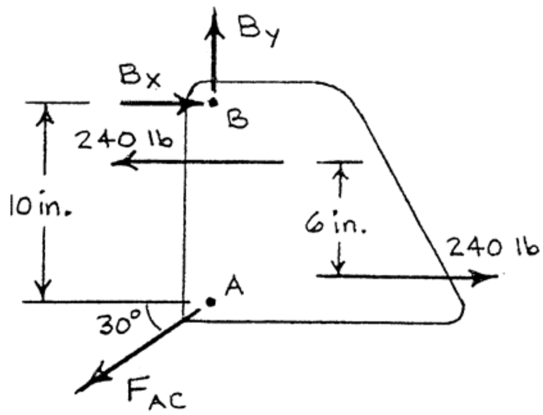
$P = 28.2$ kips ◀

Beer/Johnston, *Mechanics of Materials*, 6e © 2012. The McGraw-Hill Companies
Vivek Shenoy: Brown University

SOLUTION 1.9

SOLUTION

Free Body Diagram of Plate



Note that the two 240-lb forces form a couple of moment

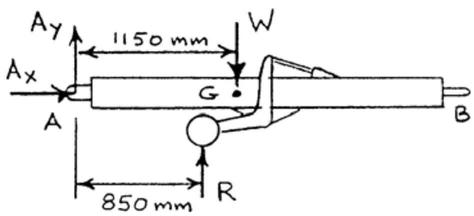
$(240 \text{ lb})(6 \text{ in.}) = 1440 \text{ lb} \cdot \text{in.}$

$$+\circlearrowright \Sigma M_B = 0: \quad 1440 \text{ lb} \cdot \text{in} - (F_{AC} \cos 30°)(10 \text{ in.}) = 0$$
$$F_{AC} = 166.277 \text{ lb.}$$

Area of link: $A_{AC} = \left(\frac{1}{16} \text{ in.}\right)\left(\frac{1}{4} \text{ in.}\right) = 0.015625 \text{ in.}^2$

Stress: $\sigma_{AC} = \frac{F_{AC}}{A_{AC}} = \frac{166.277}{0.015625} = 10640 \text{ psi}$ $\sigma_{AC} = 10.64 \text{ ksi}$ ◀

SOLUTION 1.13

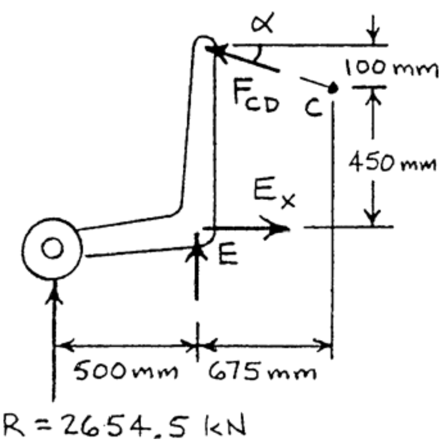


FREE BODY – ENTIRE TOW BAR:

$$W = (200\text{ kg})(9.81\text{ m/s}^2) = 1962.00\text{ N}$$

$$+\circlearrowleft \Sigma M_A = 0: \quad 850R - 1150(1962.00\text{ N}) = 0$$

$$R = 2654.5\text{ N}$$



FREE BODY – BOTH ARM & WHEEL UNITS:

$$\tan\alpha = \frac{100}{675} \qquad \alpha = 8.4270°$$

$$+\circlearrowleft \Sigma M_E = 0: \quad (F_{CD}\cos\alpha)(550) - R(500) = 0$$

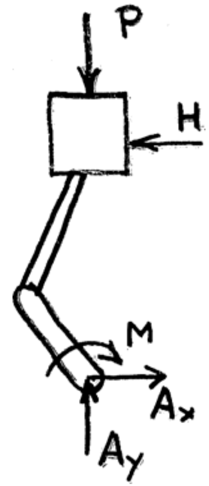
$$F_{CD} = \frac{500}{550\cos 8.4270°}(2654.5\text{ N})$$

$$= 2439.5\text{ N} \quad \text{(comp.)}$$

$$\sigma_{CD} = -\frac{F_{CD}}{A_{CD}} = -\frac{2439.5\text{ N}}{\pi(0.0125\text{ m})^2}$$

$$= -4.9697\times 10^6\text{Pa} \qquad \sigma_{CD} = -4.97\text{ MPa} \blacktriangleleft$$

SOLUTION 1.14

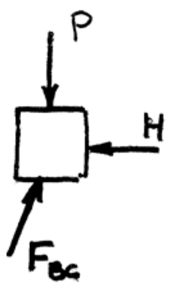


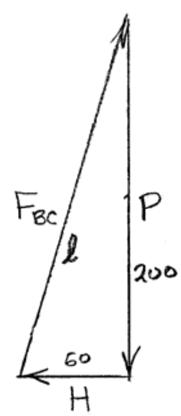
Use piston, rod, and crank together as free body. Add wall reaction H and bearing reactions A_x and A_y.

$$+\circlearrowleft \Sigma M_A = 0 : \quad (0.280 \text{ m})H - 1500 \text{ N} \cdot \text{m} = 0$$

$$H = 5.3571 \times 10^3 \text{N}$$

Use piston alone as free body. Note that rod is a two-force member; hence the direction of force F_{BC} is known. Draw the force triangle and solve for P and F_{BE} by proportions.





$$l = \sqrt{200^2 + 60^2} = 208.81 \text{ mm}$$

$$\frac{P}{H} = \frac{200}{60} \qquad \therefore \quad P = 17.86 \times 10^3 \text{N}$$

(*a*) $P = 17.86$ kN ◀

$$\frac{F_{BC}}{H} = \frac{208.81}{60} \qquad \therefore \quad F_{BC} = 18.643 \times 10^3 \text{ N}$$

Rod BC is a compression member. Its area is

$$450 \text{ mm}^2 = 450 \times 10^{-6} \text{m}^2$$

Stress,

$$\sigma_{BC} = \frac{-F_{BC}}{A} = \frac{-18.643 \times 10^3}{450 \times 10^{-6}} = -41.4 \times 10^6 \text{Pa}$$

(*b*) $\sigma_{BC} = -41.4$ MPa ◀

SOLUTION 1.18

Seven surfaces carry the total load $P = 7.6 \text{ kN} = 7.6 \times 10^3$.

Let $t = 22$ mm.

Each glue area is $A = dt$

$$\tau = \frac{P}{7A} \qquad A = \frac{P}{7\tau} = \frac{7.6 \times 10^3}{(7)(820 \times 10^3)} = 1.32404 \times 10^{-3} \text{m}^2$$

$$= 1.32404 \times 10^3 \text{mm}^2$$

$$d = \frac{A}{t} = \frac{1.32404 \times 10^3}{22} = 60.2$$

$d = 60.2$ mm ◀

Beer/Johnston, *Mechanics of Materials*, 6e © 2012. The McGraw-Hill Companies
Vivek Shenoy: Brown University