4A Solutions

3.58 $\frac{J}{c} = \frac{\frac{\pi}{2}c^4}{c} = \frac{\pi}{2}c^3 = \frac{\pi}{2}(0.75\text{ in.})^3 = 0.6627\text{ in}^3$

$P = 75\text{ hp} = 75(6600\text{ in·lb/s}) = 495\times10^3\text{ in·lb/s}$

(a) $f = 750\text{ rpm} = (750\text{ rpm})\frac{1\text{ s}^{-1}}{60\text{ rpm}} = 12.5\text{ s}^{-1}$

$T = \frac{P}{2\pi f} = \frac{495\times10^3\text{ in·lb/s}}{2\pi(12.5\text{ s}^{-1})} = 6303\text{ lb·in.}$

$\tau = \frac{Tc}{J} = \frac{T}{J/c} = \frac{6303\text{ lb·in.}}{0.6627\text{ in}^3} = 9.51\text{ ksi}$ ◀

(b) $f = 1500\text{ rpm} = 25.0\text{ s}^{-1}$

$T = \frac{P}{2\pi f} = \frac{495\times10^3}{2\pi(25.0)} = 3151.3\text{ lb·in.}$

$\tau = \frac{T}{J/c} = \frac{3151.3}{0.6627}$ $\tau = 4.76\text{ ksi}$ ◀

3.63 $f = 240\text{ rpm} = 4\text{ Hz}$, $G = 77\text{ GPa}$, $\tau = 50\text{ MPa}$, $L = 5\text{ m}$

$c_1 = 12.5\text{ mm}$, $c_2 = 30\text{ mm}$, $J = \frac{\pi}{2}(c_2^4 - c_1^4) = 1.234\times10^{-6}\text{ m}^4$

$\tau = \frac{Tc_2}{J}$; $T = \frac{J}{c_2}\tau = \frac{1.234\times10^{-6}\text{ m}^4}{0.030\text{ m}}(50\times10^6\text{ Pa})$

$T = 2056.7\text{ N·m}$

(a) Power transmitted

$P = 2\pi f T = 2\pi(4\text{ Hz})(2056.7\text{ N·m}) = 51.7\text{ kW}$ ◀

(b) Angle of twist

$\phi = \frac{TL}{JG} = \frac{(2056.7)(5)}{(1.234\times10^{-6})(77\times10^9)} = 0.10823\text{ rad} = 6.20°$ ◀

3.72 $D = 2\text{ in.}$, $d = 1.5\text{ in.}$, $c = \frac{d}{2} = 0.75\text{ in.}$, $T = 2.5\text{ kip·in.}$

$\frac{Tc}{J} = \frac{2T}{\pi c^3} = \frac{2(2.5\text{ kip·in.})}{\pi(0.75\text{ in.})^3} = 3.773\text{ ksi}$

(a) $r = 1/32\text{ in.}$

$\frac{D}{d} = \frac{2}{1.5} = 1.33$ $\frac{r}{d} = \frac{1/32}{1.5} = 0.0208$

From Fig. 3.31: $K = 2.10$

$\tau_{max} = K\frac{Tc}{J} = 2.10(3.773\text{ ksi}) = 7.92\text{ ksi}$ ◀

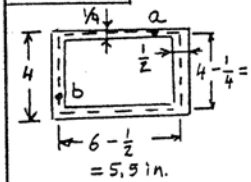
(b) $r = 3/16\text{ in.}$

$\frac{D}{d} = 1.33$ $\frac{r}{d} = \frac{3/16}{1.5} = 0.125$

From Fig. 3.31: $K = 1.31$

$\tau_{max} = K\frac{Tc}{J} = 1.31(3.773\text{ ksi}) = 4.94\text{ ksi}$ ◀

3.124



We use Eq. (3.53) $\tau = \frac{T}{2tA}$

with $T = 5\text{ kip·ft} = 60\times10^3\text{ lb·in.}$

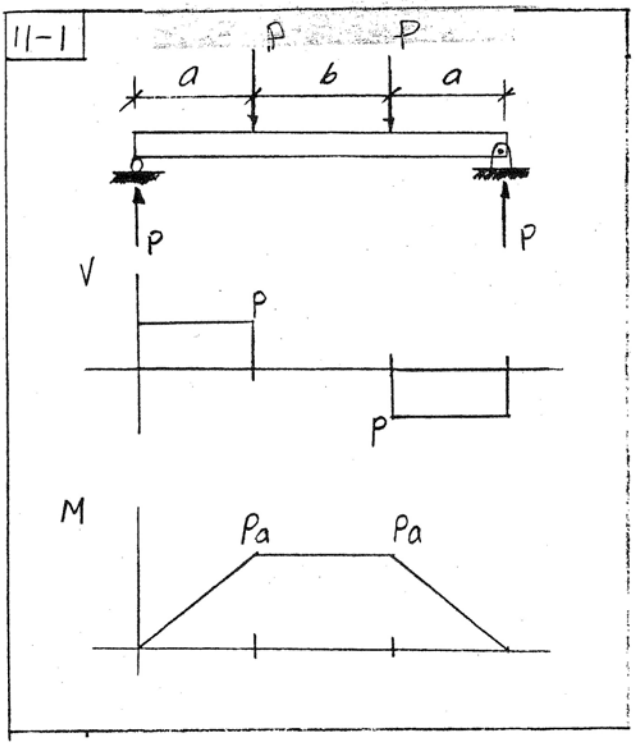
and $A = (5.5\text{ in.})(3.75\text{ in.}) = 20.625\text{ in}^2$

Stress at a: $t = \frac{1}{4}\text{ in.}$ $\tau_a = \frac{60\times10^3}{2(0.25)(20.625)}$ $\tau_a = 5.82\text{ ksi}$ ◀

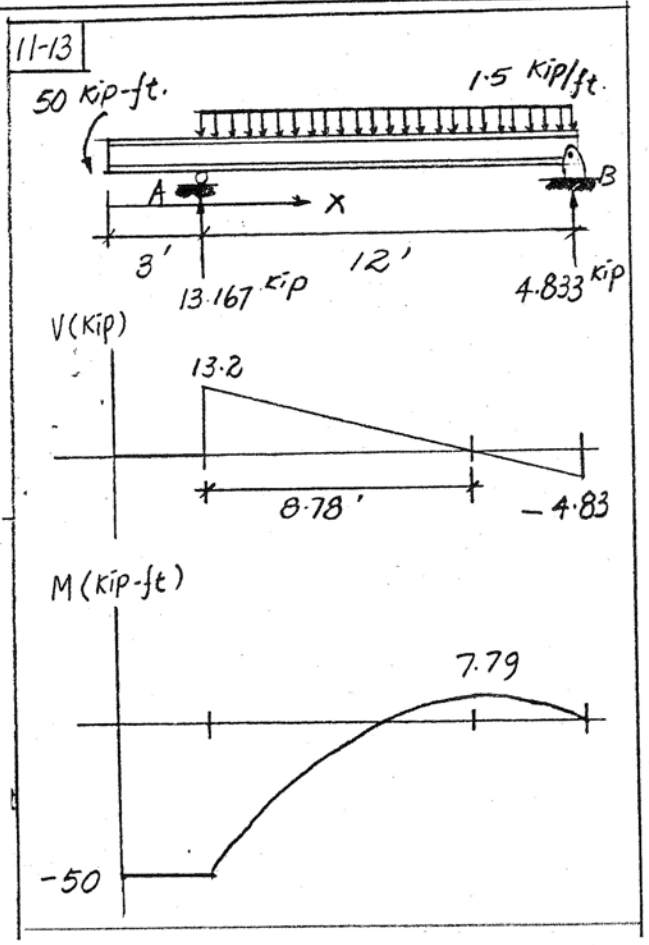
Stress at b: $t = \frac{1}{2}\text{ in.}$ $\tau_b = \frac{60\times10^3}{2(0.5)(20.625)}$ $\tau_b = 2.91\text{ ksi}$ ◀

4B Sol.

11-1



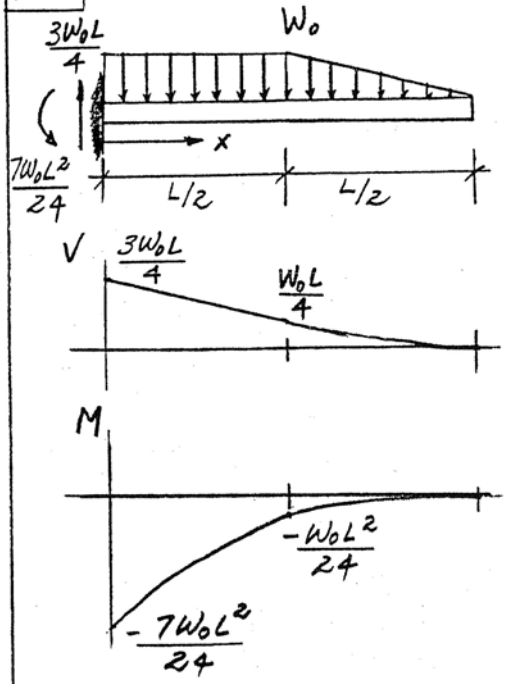
11-13



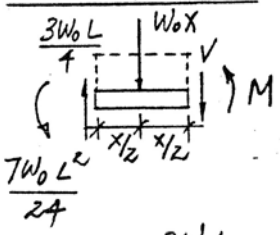
4/3 Sol Cont.

Additional 4A S.P.

11-23



For $0 \le x < L/2$



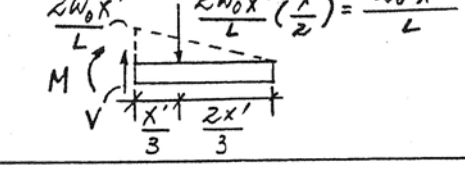
$+\uparrow \Sigma F_y = 0 \quad \frac{3W_0L}{4} - W_0x - V = 0$

$V = \frac{3W_0L}{4} - W_0x$

$\circlearrowleft + \Sigma M_{NA} = 0 \quad -\frac{7W_0L^2}{24} + \frac{3W_0L}{4}x - W_0x\left(\frac{x}{2}\right) - M = 0$

$M = -\frac{W_0x^2}{2} + \frac{3W_0L}{4}x - \frac{7W_0L^2}{24}$

For $L/2 < x \le L$



6-145

(a) For the square bar: $b/a = a/a = 1$

The value of α from Fig. 6-28 is: $\alpha = 0.21$

$T_{max} = \tau_{max}\alpha a^2 b = \tau_{max}(0.21)(a^2)(a) = 0.21a^3\tau_{max}$

For the circular bar: $A = a^2 = \frac{\pi}{4}(d)^2 \qquad d = 1.1284a$

$J = \frac{\pi}{32}(d)^4 = \frac{\pi}{32}(1.1284a)^4 = 0.15917a^4$

$T_{max} = \frac{\tau_{max}J}{c} = \frac{\tau_{max}(0.15917a^4)}{1.1284a/2} = 0.2821a^3\tau_{max}$

$\frac{T_{circle}}{T_{square}} = \frac{0.2821}{0.21} = 1.3433 \cong 1.342$ Ans.

(b) For the square bar: $\beta = 0.15$

$\theta = \frac{TL}{\beta a^3 bG} = \frac{TL}{0.15(a^3)(a)(G)} = \frac{6.667TL}{a^4G}$

For the circular bar:

$\theta = \frac{TL}{JG} = \frac{1.3433TL}{0.15917a^4G} = \frac{8.439TL}{a^4G}$

$\frac{\theta_{circle}}{\theta_{square}} = \frac{8.439}{6.667} = 1.2658 \cong 1.266$ Ans.