Answer Key

Simple Stress

$$S_t = \frac{F}{A}$$

$$\left(1300 \frac{kg}{cm^2}\right)\left(\frac{101.325\ kPa}{1.033\ kg/cm^2}\right) = \frac{60000\ kg\left(\frac{9.81\ m/s^2}{1000\ \frac{kg-m}{kN-s^2}}\right)}{A}$$

$$A = 4.6159 \times 10^{-3}\ m^2$$

$$\delta = kL(t_2 - t_1)$$

$$= \left(11.5 \times 10^{-6} \frac{m}{m\text{-}^\circ C}\right)(25\,m)(40-25)^\circ C$$

$$\delta = 4.3125 \times 10^{-3}\,m$$

$$\boxed{\delta = 4.3125\,mm}$$

$$\delta = \frac{FL}{AE}$$

$$15\text{mm} = \frac{(30000\ \text{N})(120000\ \text{m})}{\frac{\pi d^2}{4}\left(200000\ \frac{\text{N}}{\text{mm}^2}\right)}$$

$$d = 39.0882\ \text{mm}$$

$$S_s = (180\ MPa)\left(\frac{1000\ KPa}{1\ MPa}\right)\left(\frac{14.7\ psi}{101.325\ KPa}\right) = 26113.9896\ psi$$

Then; $S_s = \frac{F_s}{A}$

$$26113.9896\ \frac{lb}{in^2} = \frac{F_s}{\pi(2.5\ in)(0.5\ in)}$$

$$F_s = 102549.3975\ lbs$$

$$S_d = \frac{S_y}{FS} \quad ; \quad S_d = \frac{F_c}{A}$$

$$\frac{F_c}{\frac{\pi d^2}{4}} = \frac{S_y}{Fs}$$

$$\frac{220000\ N}{\frac{\pi}{4} d^2} = \frac{140\ N/mm^2}{4}$$

$$d = 89.4607\ mm$$

$$\delta = kL(t_2 - t_1)$$

$$0.0025\ m = \left(11.8 \times 10^{-6} \frac{m}{m\text{-}°C}\right)(t_2 - 20°C)$$

$$\boxed{t_2 = 231.8644\ °C}$$

$$\delta = kL(t_2 - t_1)$$

$$\text{Strain} = \epsilon = \frac{\delta}{L} = k(t_2 - t_1) = \left(11.2 \times 10^{-6} \frac{m}{m \cdot °C}\right)(65.56 - 15.56)°C$$

$$\boxed{\epsilon = 5.6 \times 10^{-4}}$$

$$\text{Strain} = \epsilon = \frac{\delta}{L}$$

$$0.0012 = \frac{\delta}{25\,m}$$

$$\delta = 0.03\,m$$

$$\boxed{\delta = 30\,mm}$$

$$\delta = \frac{FL}{AE}$$

$$0.001\ m = \frac{(250\ kg)\left(\frac{9.81\ m/s}{1000\ \frac{kg\text{-}m}{N\text{-}s^2}}\right)(5\ m)}{(0.8\ cm^2)\left(\frac{1\ m}{100\ cm}\right)^2 E}$$

$$E = 153.281\ GPa$$

$$\delta = \frac{FL}{AE}$$

$$0.010\,m = \frac{F(6m)}{\frac{\pi(0.008m)^2}{4}(180\times10^6\,kPa)}$$

$$F = 15.0796\,kN$$

$$E = \frac{\text{stress}}{\text{strain}} = \frac{400\,\text{mPa}}{0.00128}$$

$$E = 312.5\ \text{GPa}$$

$$J = \frac{\pi D^4}{32}$$

$$7.1276 \times 10^{-7}\ m^4 = \frac{\pi D^4}{32}$$

$$D = 0.05191\ m$$

for max. Torque;

$$S_s = \frac{Tc}{J} = \frac{TD}{2J}$$

$$60000\ kPa = \frac{T(0.05191\ m)}{2(7.1276 \times 10^{-7}\ m^4)}$$

$$T = 1.6477\ kN\text{-}m$$

$$S_s = \frac{16T}{\pi D^3} = \frac{16\,(4\ \text{kN-m})}{\pi\left[2.8\text{in}\left(\frac{2.54\ \text{cm}}{1\text{in}}\right)\left(\frac{1\ \text{m}}{100\ \text{cm}}\right)\right]^3}$$

$$S_s = 56631.0817\ \text{kPa}$$

$$\boxed{S_s = 56.6311\ \text{MPa}}$$

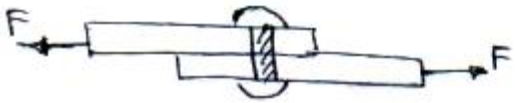
$$S_s = \frac{F}{A}$$

$$420\ \frac{N}{mm^2} = \frac{F}{\pi(28\ mm)(25\ mm)}$$

$$F = 923.628\ kN$$

$$S_b = \frac{F}{A} = \frac{60\ kN}{2(0.025\ m)(0.032\ m)}$$

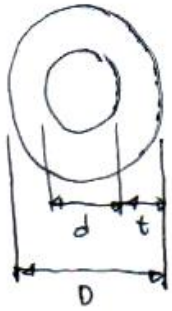
$$S_b = 37500\ \frac{kN}{m^2}$$



$$S_s = \frac{F}{A} = \frac{F}{\frac{\pi D^2}{4}}$$

$$75000\,kPa = \frac{F}{\frac{\pi}{4}(0.018\,m)^2}$$

$$F = 19.0852\,kN$$



$D = d + 2t$

$d = D - 2t$

$d = 10t - 2t$

$d = 8t$

$$S_t = \frac{F}{A}$$

$$145 \frac{N}{mm^2} = \frac{600\,000\ N}{A}$$

$$A = 4137.9310\ mm^2$$

and;

$$A = \frac{\pi}{4}(D^2 - d^2)$$

$$4137.9310\ mm^2 = \frac{\pi}{4}\left[(10t)^2 - (8t)^2\right]$$

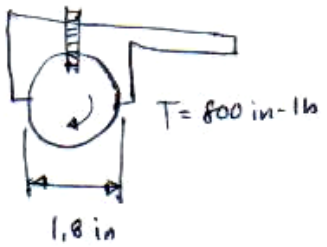
$$t = 12.0975\ mm$$

$$S_c = \frac{F}{\frac{\pi}{4}(D^2 - d^2)}$$

$$60 \times 10^6 \frac{N}{m^2} = \frac{260000\ N}{\frac{\pi}{4}(D^2 - 0.180^2)\ m^2}$$

$$D = 0.1947\ m$$

$$\boxed{D = 194.7\ mm}$$



$$S = \frac{F}{A} \; ; \; T = Fr$$

$$800 \text{ in-lb} = F\left(\frac{1.8 \text{ in}}{2}\right)$$

$$F = 888.8889 \text{ lbs}$$

then;

$$22\,000 \frac{\text{lb}}{\text{in}^2} = \frac{888.8889 \text{ lbs}}{\frac{\pi d^2}{4}}$$

$$d = 0.2268 \text{ in}$$

$$S_s = \frac{F}{A} = \frac{F}{\pi D t}$$

$$58000 \frac{lb}{in^2} = \frac{(80 \text{ tons})\left(\frac{2000 lbs}{1 ton}\right)}{\pi D (1/8 \text{ in})}$$

$$D = 7.0248 \text{ in}$$

Hence;

$$n = \#\text{ of holes} = \frac{7.0248 \text{ in}}{1/2 \text{ in}}$$

$$n = 14.0495 \text{ holes}$$

$$n = 14 \text{ holes}$$

$$S_a = \frac{S_{max} - S_{min}}{2}$$

$$S_{max} = \frac{16\,T_{max}}{\pi D^3} = \frac{16(6500\ in\text{-}lb)}{\pi(1.25\ in)^3} = 16949.3648\ psi$$

$$S_{min} = \frac{16\,T_{min}}{\pi D^3} = \frac{16(2000\ in\text{-}lb)}{\pi(1.25\ in)^3} = 5215.1892\ psi$$

Hence;

$$S_a = \frac{(16949.3648 - 5215.1892)\,psi}{2}$$

$$S_a = 5867.0878\ psi$$

$$\delta = \frac{FL}{AE} = S_t\left(\frac{L}{E}\right)$$

$$(4\text{cm})\left(\frac{1\text{in}}{2.54\text{cm}}\right) = \left(60\frac{\text{lb}}{\text{in}^2}\right)\frac{\left[(150\text{m})\left(\frac{3.28\text{ ft}}{1\text{m}}\right)\left(\frac{12\text{ in}}{1\text{ ft}}\right)\right]}{E}$$

$$E = 224942.4\ \text{psi}$$

$$\frac{L}{D} = 2.5 \; ; \quad A = DL = D(2.5D) = 2.5D^2$$

$$= 2.5\,(9\text{cm})^2\left(\frac{10\text{mm}}{1\text{cm}}\right)^2$$

$$A = 20250\ \text{mm}^2$$

$$S_b = \frac{\pm}{A} = \frac{4800\ lbs}{(3.0\ in)(1.7in)}$$

$$S_b = 941.1765\ psi$$

$$S_s = \frac{F}{A} = \frac{F}{\pi D t}$$

$$46000 \frac{lb}{in^2} = \frac{F}{\pi (1.0\,in)(3/4\,in)}$$

$$F = 108384.9465\ lbs$$