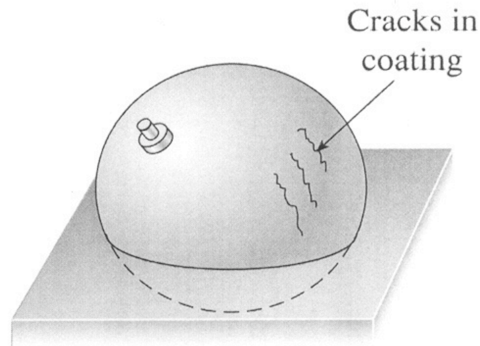
MULTIPLE CHOICE PROBLEMS (10 Points each)

1. A spherical steel pressure vessel (diameter 480 mm, thickness 8.0 mm) is coated with a brittle lacquer that cracks when the strain reaches 150×10^{-6}. The gage pressure p that will cause the lacquer to develop cracks is most nearly



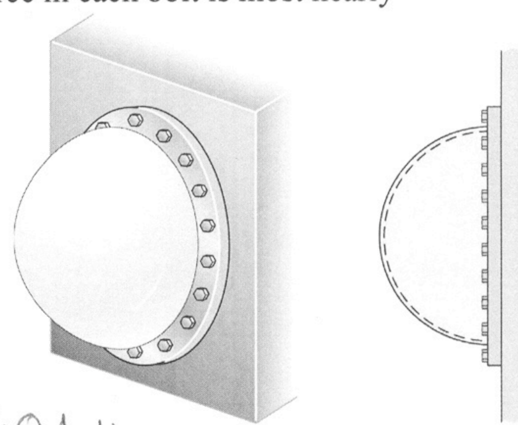
$$\sigma_1 = \sigma_2 = \frac{pr}{2t}$$

$$\varepsilon_2 = \varepsilon_1 = \frac{1}{E}\left[\sigma_1 - \nu\sigma_2\right]$$

$$= \frac{1}{E}\left[1-\nu\right]\frac{pr}{2t} = \varepsilon_{crack}$$

$$p = \frac{E\,\varepsilon_{crack}\,2t}{(1-\nu)r} = \frac{(205\,GPa)(150\times10^{-6})(2)(8\,mm)}{(1-0.3)(240\,mm)} = 2.9$$

2. A hemispherical window (or viewport) in a decompression chamber is subjected to an internal air pressure of 80 psi. The port is attached to the wall of the chamber by 18 bolts. If the radius of the hemisphere is 7.0 in. and its thickness is 1.0 in., the tensile force in each bolt is most nearly



$$F = p\,A_{projected} = p\pi r^2$$

$$= (80\,psi)(\pi)(7\,in)^2$$

$$= 12.32\text{ kips}$$

$$F_{bolt} = F/n_{bolts} = \frac{12.32\text{ kips}}{18} = \underline{\underline{684\text{ lb}}}$$

3. A beam of length L, simply-supported at each end, is subjected to a distributed load that results in an internal bending moment given by $M(x) = \frac{qLx}{2} - \frac{qx^2}{2}$ where x is the position along the length of the beam. The equation of the deflection curve for this beam is

$$EIv'' = M(x) = \frac{qLx}{2} - \frac{qx^2}{2}$$

$$EIv' = \frac{qLx^2}{4} - \frac{qx^3}{6} + C_1$$

$$EIv = \frac{qLx^3}{12} - \frac{qx^4}{24} + C_1x + C_2$$

$x = 0 \quad v = 0 \Rightarrow C_2 = 0$

$x = L \quad v = 0 \Rightarrow$

$$\frac{qL^4}{12} - \frac{qL^4}{24} + C_1 L$$

$$C_1 = -\frac{qL^3}{24}$$

$$v = \frac{1}{EI}\left[\frac{qLx^3}{12} - \frac{qx^4}{24} - \frac{qL^3x}{24}\right]$$

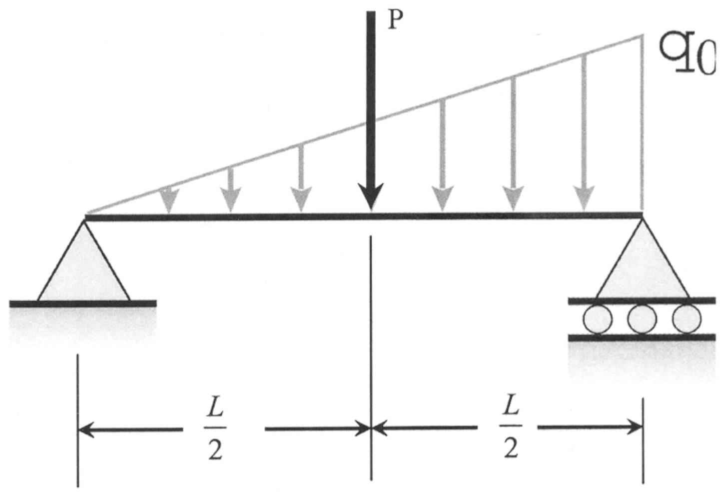
4. A simply-supported beam is subjected to the loading conditions shown below. The deflection at the midpoint C of the beam is given by

Table G-2 Case 11

$$\delta_c^{①} = \frac{5q_0L^4}{768EI}$$

Table G-2 Case 4

$$\delta_c^{②} = \frac{PL^3}{48EI}$$



$$\delta_c = \delta_c^{①} + \delta_c^{②} = \frac{5q_0L^4}{768EI} + \frac{PL^3}{48EI}$$

5. A continuous beam is subjected to the linearly varying load shown below. The reaction at the center support, R_C, is given by

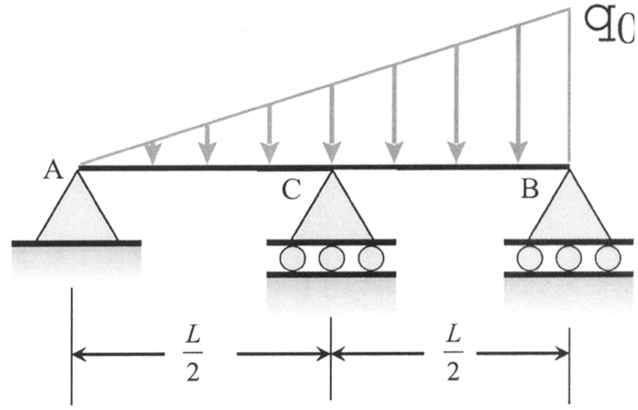
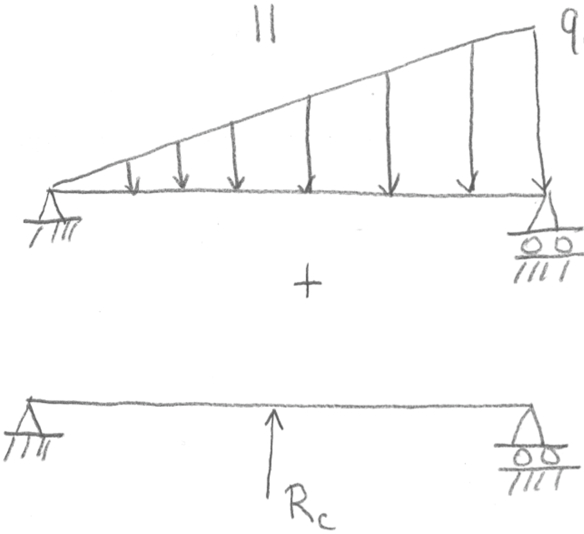


Table G-2 Case 11

$$\delta_c^{①} = \frac{5 q_0 L^4}{768 EI}$$

Table G-2 Case 4

$$\delta_c^{②} = -\frac{R_c L^3}{48 EI}$$

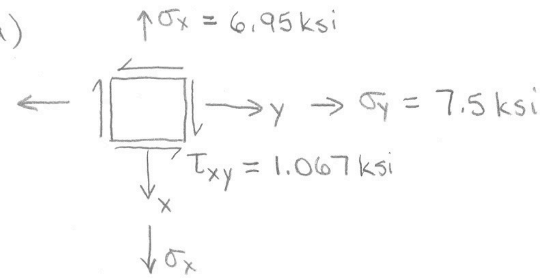


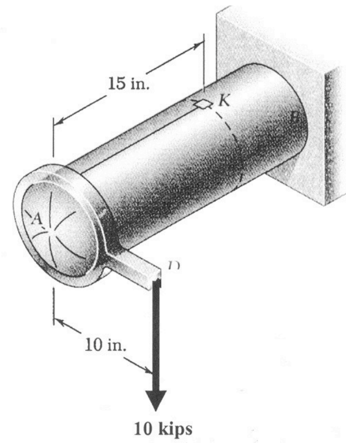
$$\delta_c = \delta_c^{①} + \delta_c^{②} = 0$$

$$\frac{5 q_0 L^4}{768 EI} - \frac{R_c L^3}{48 EI} = 0$$

$$\boxed{R_c = \frac{5}{16} q_0 L}$$

(a)



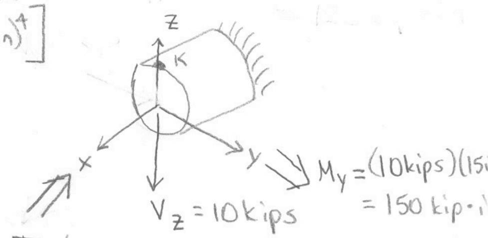


$$\sigma_x = \frac{pr}{2t} + \frac{M_y c}{I_y}$$

$$= \frac{(500\text{ psi})(6\text{ in})}{2(0.4\text{ in})} + \frac{(150\text{ kip}\cdot\text{in})(6+0.4\text{ in})}{\frac{\pi}{4}\left[(6.4\text{ in})^4 - (6.0\text{ in})^4\right]}$$

$$= 3750\text{ psi} + 3202\text{ psi}$$

$$= \underline{\underline{6.95\text{ ksi}}}$$



$T = (10\text{kips})(10\text{in}) = 100\text{ kip}\cdot\text{in}$

$$\sigma_y = \frac{pr}{t} = \frac{(500\text{psi})(6\text{in})}{0.4\text{in}} = \underline{\underline{7.5\text{ ksi}}}$$

$$\tau_{xy} = \frac{Tc}{J} = \frac{(100\text{ kip}\cdot\text{in})(6+0.4\text{in})}{\frac{\pi}{2}\left[(6.4\text{in})^4 - (6.0\text{in})^4\right]} = 1067\text{ psi} = \underline{\underline{1.067\text{ ksi}}}$$

(b)

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$= 7.23\text{ ksi} \pm 1.101\text{ ksi} \Rightarrow \boxed{\begin{aligned}\sigma_1 &= 8.33\text{ ksi}\\ \sigma_2 &= 6.12\text{ ksi}\\ \sigma_3 &\approx 0\end{aligned}}$$

(c) $\tau_{max} = \frac{1}{2}\left|\sigma_1 - \sigma_3\right| = \underline{4.16\text{ ksi}}$