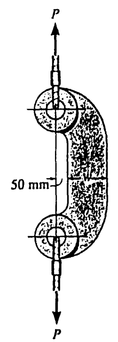
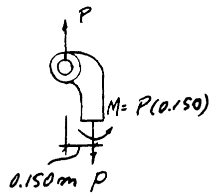
8-21. The offset link has a width of $w = 200$ mm and a thickness of 40 mm. If the allowable normal stress is $\sigma_{allow} = 75$ MPa, determine the maximum load P that can be applied to the cables.





$$A = 0.2(0.04) = 0.008 \text{ m}^2$$

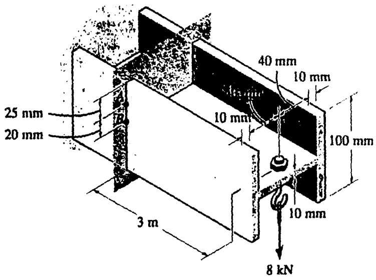
$$I = \frac{1}{12}(0.04)(0.2)^3 = 26.6667(10^{-6}) \text{ m}^4$$

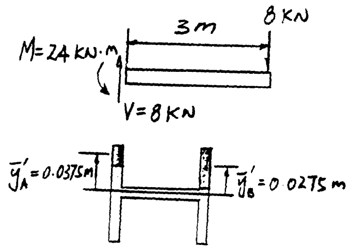
$$\sigma = \frac{P}{A} + \frac{Mc}{I}$$

$$75(10^6) = \frac{P}{0.008} + \frac{0.150\,P(0.1)}{26.6667(10^{-6})}$$

$P = 109$ kN **Ans**

8–35 The cantilevered beam is used to support the load of 8 kN. Determine the state of stress at points A and B, and sketch the results on differential elements located at each of these points.





$$I = 2[\frac{1}{12}(0.01)(0.1^3)] + \frac{1}{12}(0.08)(0.01^3) = 1.6733(10^{-6})\ \text{m}^4$$

$$A = 2[0.01(0.1)] + 0.08(0.01) = 0.0028\ \text{m}^2$$

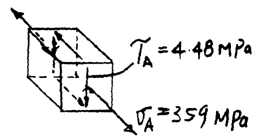
$$Q_A = \bar{y}'_A A = 0.0375(0.025)(0.01) = 9.375(10^{-6})\ \text{m}^3$$

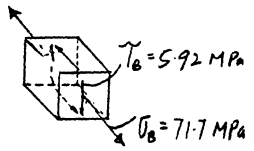
$$Q_B = \bar{y}'_B A = 0.0275(0.045)(0.01) = 12.375(10^{-6})\ \text{m}^3$$

$$\sigma = \frac{M\,y}{I}$$

$$\sigma_A = \frac{24(10^3)(0.025)}{1.6733(10^{-6})} = 359\ \text{MPa (T)}$$ **Ans**

$$\sigma_B = \frac{24(10^3)(0.005)}{1.6733(10^{-6})} = 71.7\ \text{MPa(T)}$$ **Ans**



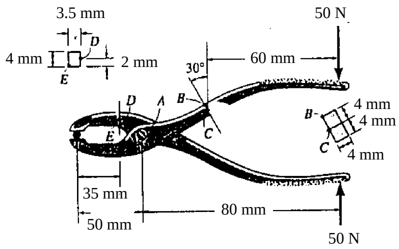


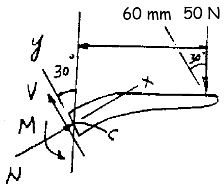
$$\tau = \frac{VQ}{I\,t}$$

$$\tau_A = \frac{8(10^3)(9.375)(10^{-6})}{1.6733(10^{-6})(0.01)} = 4.48\ \text{MPa}$$ **Ans**

$$\tau_B = \frac{8(10^3)(12.375)(10^{-6})}{1.6733(10^{-6})(0.01)} = 5.92\ \text{MPa}$$ **Ans**

8-45 The pliers are made from two steel parts pinned together at *A*. If a smooth bolt is held in the jaws and a gripping force of 50 N is applied at the handles, determine the state of stress developed in the pliers at points *B* and *C*. Here the cross section is rectangular, having the dimensions shown in the figure.

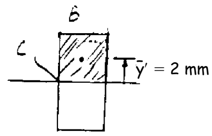




$+\Sigma F_x = 0; \quad N - 50 \sin 30° = 0; \quad N = 25 \text{ N}$

$+\Sigma F_y = 0; \quad V - 50 \cos 30° = 0; \quad V = 43.3 \text{ N}$

$\circlearrowleft + \Sigma M_C = 0; \quad M - 50(60) = 0; \quad M = 3000 \text{ N} \cdot \text{mm}$



$A = 4 \times 8 = 32 \text{ mm}^2$

$I = \frac{1}{12}(4)(8^3) = 170.67 \text{ mm}^4$

$Q_B = 0$

$Q_C = \bar{y}'A' = (2)(4)(4) = 32 \text{ mm}^3$

Point B:

$\sigma_B = \frac{N}{A} + \frac{My}{I} = \frac{-25}{32} + \frac{3000(4)}{170.67} = 69.53 \text{ MPa (T)}$ **Ans**

$\tau_B = \frac{VQ}{It} = 0$ **Ans**

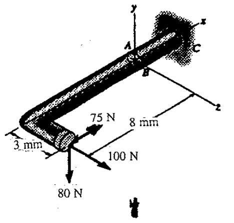
Point C:

$\sigma_C = \frac{N}{A} + \frac{My}{I} = \frac{-25}{32} + 0 = -0.78 \text{ MPa} = 0.78 \text{ MPa (C)}$ **Ans**

Shear Stress:

$\tau_C = \frac{VQ}{It} = \frac{43.3(32)}{170.67(4)} = 2.03 \text{ MPa}$ **Ans**

8-57 The 1-mm-diameter rod is subjected to the loads shown. Determine the state of stress at point B, and show the results on a differential element located at this point.



$\Sigma F_z = 0; \quad V_z + 100 = 0; \quad V_z = -100\text{ N}$

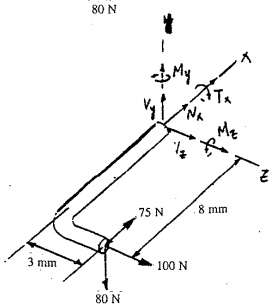
$\Sigma F_x = 0; \quad N_x - 75 = 0; \quad N_x = 75.0\text{ N}$

$\Sigma F_y = 0; \quad V_y - 80 = 0; \quad V_y = 80\text{ N}$

$\Sigma M_z = 0; \quad M_z + 80(8) = 0; \quad M_z = -640\text{ N}\cdot\text{mm}$

$\Sigma M_x = 0; \quad T_x + 80(3) = 0; \quad T_x = -240\text{ N}\cdot\text{mm}$

$\Sigma M_y = 0; \quad M_y + 1000(8) - 75(3) = 0; \quad M_y = -575\text{ N}\cdot\text{mm}$

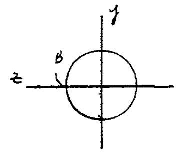


$$A = \frac{\pi}{4}d^2 = \frac{\pi}{4}(1^2) = \frac{\pi}{4}\text{ mm}^2$$

$$J = \frac{\pi}{2}c^4 = \frac{\pi}{2}(0.5^4) = 0.03125\pi\text{ mm}^4$$

$$(Q_y)_B = \frac{4(0.5)}{3\pi}\frac{1}{2}\left(\frac{\pi}{4}\right)(1^2) = 0.08333\text{ mm}^3$$

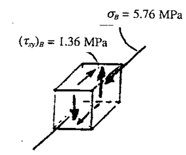
$$I_y = I_z = \frac{\pi}{4}r^4 = \frac{\pi}{4}(0.5^4) = 0.015625\pi\text{ mm}^4$$



Normal stress :

$$\sigma = \frac{P}{A} + \frac{M_z y}{I_z} + \frac{M_y z}{I_y}$$

$$\sigma_B = \frac{75}{\frac{\pi}{4}} + 0 - \frac{575(0.5)}{0.015625\pi} = -5.76\text{ MPa} = 5.76\text{ MPa (C)}$$ **Ans**



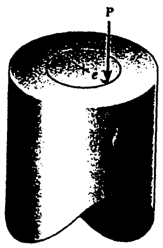
Shear stress :

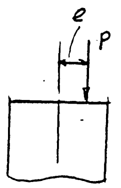
$$\tau = \frac{VQ}{It} \text{ and } \tau = \frac{Tc}{J}$$

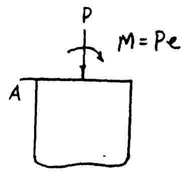
$$(\tau_{xy})_B = \frac{Tc}{J} - \frac{VQ}{It} = \frac{240(0.5)}{0.03125\pi} + \frac{80(0.0833)}{0.015625\pi(1)} = 1.36\text{ MPa}$$ **Ans**

$(\tau_{xz})_B = 0$ **Ans**

8-58 The post has a circular cross section of radius c. Determine the maximum radius e at which the load can be applied so that no part of the post experiences a tensile stress. Neglect the weight of the post.







Require $\sigma_A = 0$

$$\sigma_A = 0 = \frac{P}{A} + \frac{Mc}{I}; \quad 0 = \frac{-P}{\pi c^2} + \frac{(Pe)c}{\frac{\pi}{4}c^4}$$

$$e = \frac{c}{4}$$ **Ans**