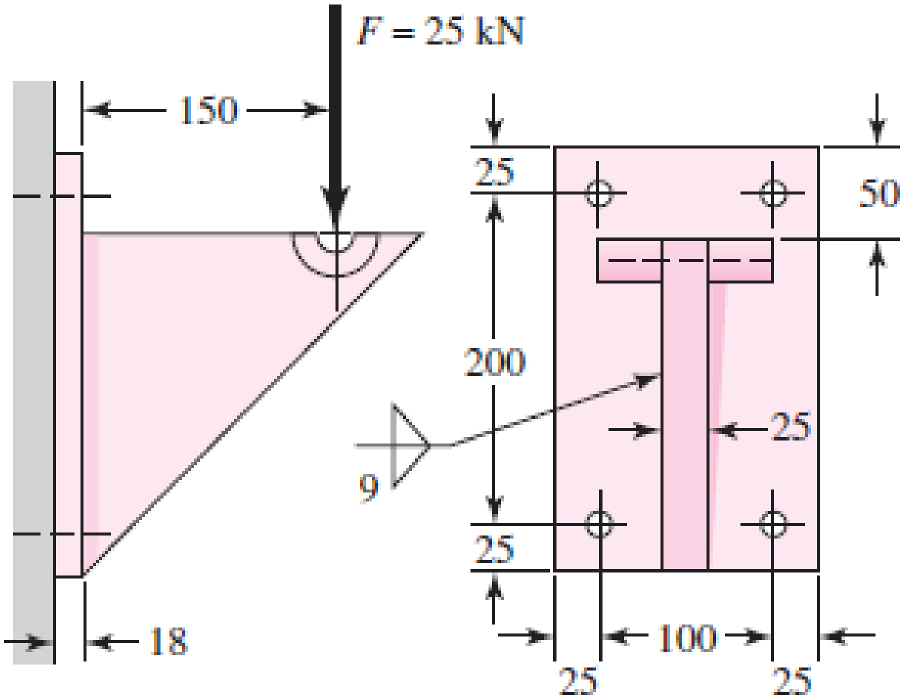
Find the maximum shear stress in the throat of the weld metal in the figure.



$h = 9 \text{ mm}, \quad d = 200 \text{ mm}, \quad b = 25 \text{ mm}$

From Table 9-2, case 2:

$$A = 1.414(9)(200) = 2.545(10^3) \text{ mm}^2$$

$$I_u = \frac{d^3}{6} = \frac{200^3}{6} = 1.333\left(10^6\right) \text{ mm}^3$$

$$I = 0.707h\, I_u = 0.707(9)(1.333)(10^6) = 8.484(10^6) \text{ mm}^4$$

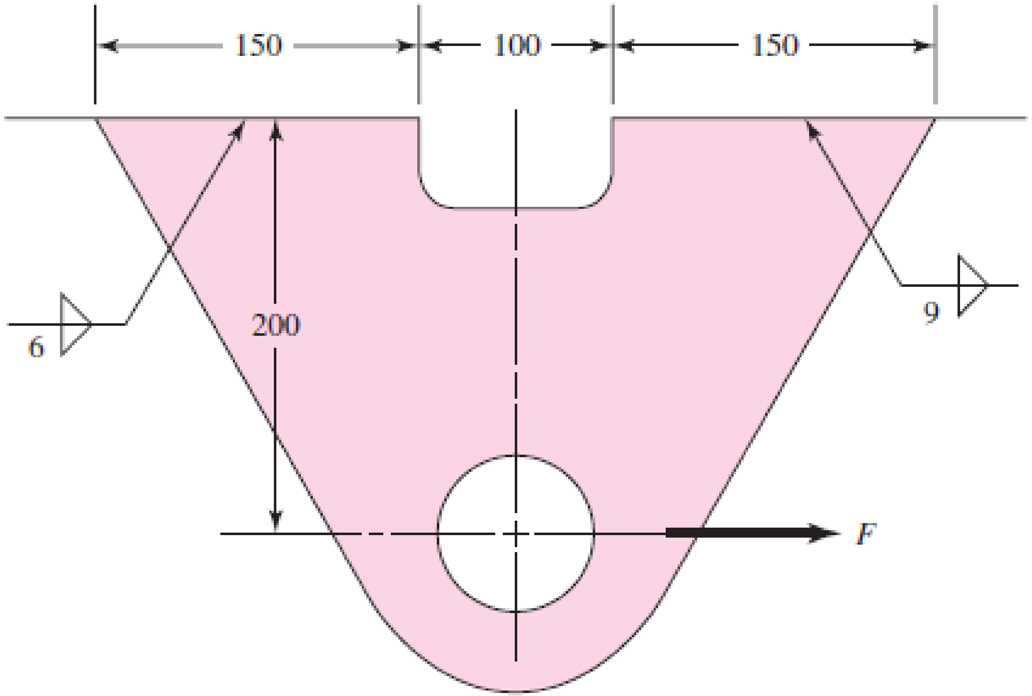
$$\tau' = \frac{F}{A} = \frac{25\left(10^3\right)}{2.545(10^3)} = 9.82 \text{ MPa}$$

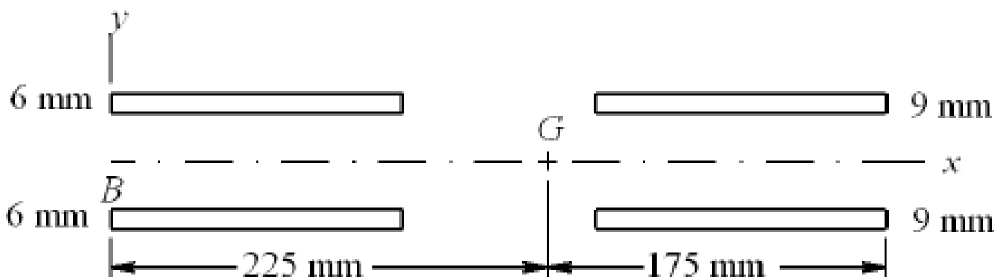
$$M = 25(150) = 3750 \text{ N}\cdot\text{m}$$

$$\tau'' = \frac{Mc}{I} = \frac{3750(100)}{8.484(10^6)}\left(10^3\right) = 44.20 \text{ MPa}$$

$$\tau_{\max} = \sqrt{\tau'^2 + \tau''^2} = \sqrt{9.82^2 + 44.20^2} = 45.3 \text{ MPa} \quad \textit{Ans.}$$

Estimate the safe static load F for the weldment shown in the figure if an E6010 electrode is used and the design factor is to be 2. The steel members are 1015 hot-rolled steel. Use conventional analysis.





For the pattern in bending shown, find the centroid G of the weld group.

$$\bar{x} = \frac{75(6)(150) + 325(9)(150)}{(6)(150) + (9)(150)} = 225 \text{ mm}$$

$$I_{6\,\text{mm}} = 2\left(I_G + A\bar{x}^2\right)_{6\,\text{mm}}$$

$$= 2\left[\frac{0.707(6)\left(150^3\right)}{12} + 0.707(6)(150)(225-75)^2\right] = 31.02\left(10^6\right) \text{ mm}^4$$

$$I_{9\,\text{mm}} = 2\left[\frac{0.707(9)\left(150^3\right)}{12} + 0.707(9)(150)(175-75)^2\right] = 22.67\left(10^6\right) \text{ mm}^4$$

$$I = I_{6\,\text{mm}} + I_{9\,\text{mm}} = (31.02 + 22.67)(10^6) = 53.69(10^6) \text{ mm}^4$$

The critical location is at B. With τ in MPa, and F in kN

$$\tau' = \frac{V}{A} = \frac{F\left(10^3\right)}{2\left[0.707(6+9)(150)\right]} = 0.3143F$$

$$\tau'' = \frac{Mc}{I} = \frac{200F\left(10^3\right)(225)}{53.69\left(10^6\right)} = 0.8381F$$

$$\tau_{\max} = \sqrt{\tau'^2 + \tau''^2} = F\sqrt{0.3143^2 + 0.8381^2} = 0.8951F$$

Materials:

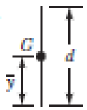
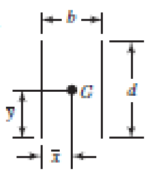
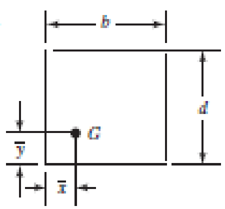
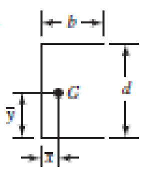
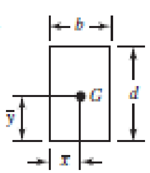
1015 HR (Table A-20): S_y = 190 MPa, E6010 Electrode(Table 9-3): S_y = 345 MPa

Eq. (5-21), p. 225 $\tau_{\text{all}} = 0.577(190) = 109.6$ MPa

$$F = \frac{\tau_{\text{all}}/n}{0.8951} = \frac{109.6/2}{0.8951} = 61.2 \text{ kN} \qquad \textit{Ans.}$$

Table 9–1

Torsional Properties of Fillet Welds*

Weld	Throat Area	Location of G	Unit Second Polar Moment of Area
1. 	$A = 0.707\,hd$	$\bar{x} = 0$ $\bar{y} = d/2$	$J_u = d^3/12$
2. 	$A = 1.414\,hd$	$\bar{x} = b/2$ $\bar{y} = d/2$	$J_u = \dfrac{d(3b^2 + d^2)}{6}$
3. 	$A = 0.707h(b + d)$	$\bar{x} = \dfrac{b^2}{2(b+d)}$ $\bar{y} = \dfrac{d^2}{2(b+d)}$	$J_u = \dfrac{(b+d)^4 - 6b^2d^2}{12(b+d)}$
4. 	$A = 0.707h(2b + d)$	$\bar{x} = \dfrac{b^2}{2b+d}$ $\bar{y} = d/2$	$J_u = \dfrac{8b^3 + 6bd^2 + d^3}{12} - \dfrac{b^4}{2b+d}$
5. 	$A = 1.414h(b + d)$	$\bar{x} = b/2$ $\bar{y} = d/2$	$J_u = \dfrac{(b+d)^3}{6}$
6. 	$A = 1.414\,\pi hr$		$J_u = 2\pi r^3$

*G is centroid of weld group; h is weld size; plane of torque couple is in the plane of the paper; all welds are of unit width.

Table 9–2

Bending Properties of Fillet Welds*

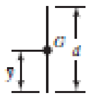
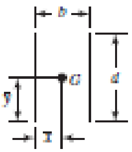
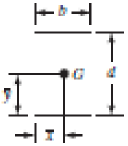
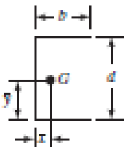
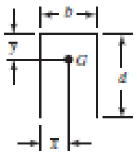
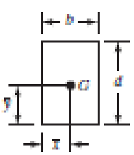
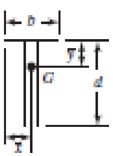
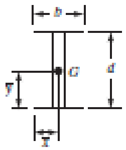
Weld	Throat Area	Location of G	Unit Second Moment of Area
1. 	$A = 0.707hd$	$\bar{x} = 0$ $\bar{y} = d/2$	$I_u = \frac{d^3}{12}$
2. 	$A = 1.414hd$	$\bar{x} = b/2$ $\bar{y} = d/2$	$I_u = \frac{d^3}{6}$
3. 	$A = 1.414hb$	$\bar{x} = b/2$ $\bar{y} = d/2$	$I_u = \frac{bd^2}{2}$
4. 	$A = 0.707h(2b + d)$	$\bar{x} = \frac{b^2}{2b+d}$ $\bar{y} = d/2$	$I_u = \frac{d^2}{12}(6b+d)$
5. 	$A = 0.707h(b + 2d)$	$\bar{x} = b/2$ $\bar{y} = \frac{d^2}{b+2d}$	$I_u = \frac{2d^3}{3} - 2d^2\bar{y} + (b+2d)\bar{y}^2$
6. 	$A = 1.414h(b + d)$	$\bar{x} = b/2$ $\bar{y} = d/2$	$I_u = \frac{d^2}{6}(3b+d)$
7. 	$A = 0.707h(b + 2d)$	$\bar{x} = b/2$ $\bar{y} = \frac{d^2}{b+2d}$	$I_u = \frac{2d^3}{3} - 2d^2\bar{y} + (b+2d)\bar{y}^2$

Table 9–2

Continued

Weld	Throat Area	Location of G	Unit Second Moment of Area
8. 	$A = 1.414h(b + d)$	$\bar{x} = b/2$ $\bar{y} = d/2$	$I_u = \frac{d^2}{6}(3b + d)$
9. 	$A = 1.414\pi hr$		$I_u = \pi r^3$

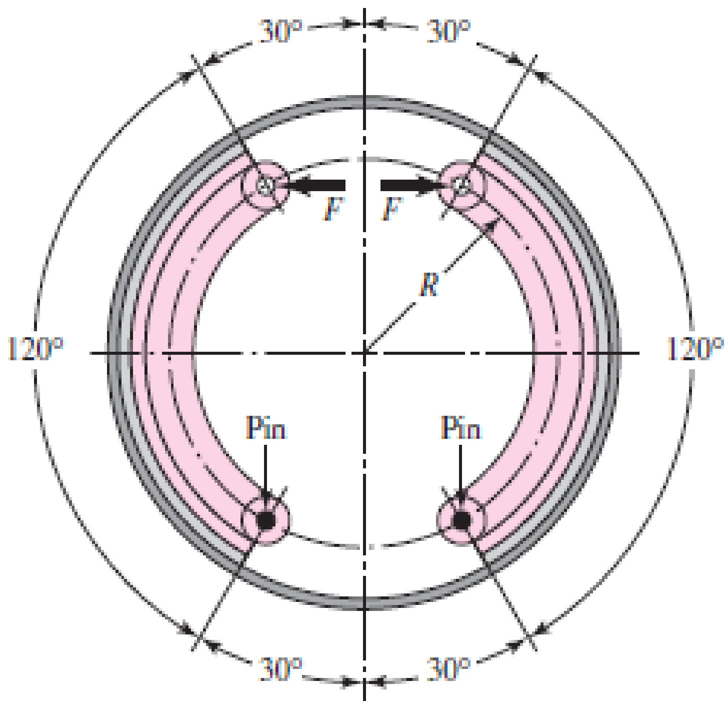
*I_u, unit second moment of area, is taken about a horizontal axis through G, the centroid of the weld group, h is weld size; the plane of the bending couple is normal to the plane of the paper and parallel to the y-axis; all welds are of the same size.

The figure shows an internal rim-type brake having an inside rim diameter of 300 mm and a dimension $R = 125$ mm. The shoes have a face width of 40 mm and are both actuated by a force of 2.2 kN. The mean coefficient of friction is 0.28.

(*a*) Find the maximum pressure and indicate the shoe on which it occurs.

(*b*) Estimate the braking torque effected by each shoe, and find the total braking torque.

(*c*) Estimate the resulting hinge-pin reactions.



Given: $r = 300/2 = 150$ mm, $a = R = 125$ mm, $b = 40$ mm, $f = 0.28$, $F = 2.2$ kN, $\theta_1 = 0°$, $\theta_2 = 120°$, and $\theta_a = 90°$. From which, $\sin\theta_a = \sin 90° = 1$.

Eq. (16-2):

$$M_f = \frac{0.28 p_a (0.040)(0.150)}{1} \int_{0°}^{120°} \sin\theta (0.150 - 0.125\cos\theta)\, d\theta$$
$$= 2.993(10^{-4}) p_a \ \text{N} \cdot \text{m}$$

Eq. (16-3): $$M_N = \frac{p_a (0.040)(0.150)(0.125)}{1} \int_{0°}^{120°} \sin^2\theta \, d\theta = 9.478(10^{-4}) p_a \ \text{N} \cdot \text{m}$$

$$c = 2(0.125 \cos 30°) = 0.2165 \text{ m}$$

Eq. (16-4): $$F = \frac{9.478(10^{-4}) p_a - 2.993(10^{-4}) p_a}{0.2165} = 2.995(10^{-3}) p_a$$

$$p_a = F/[2.995(10^{-3})] = 2200/[2.995(10^{-3})]$$
$$= 734.5(10^3) \text{ Pa} \quad \text{for cw rotation}$$

Eq. (16-7): $$2200 = \frac{9.478(10^{-4}) p_a + 2.993(10^{-4}) p_a}{0.2165}$$

$$p_a = 381.9(10^3) \text{ Pa for ccw rotation}$$

A maximum pressure of 734.5 kPa occurs on the RH shoe for cw rotation. *Ans.*

(b) *RH shoe*:

Eq. (16-6):

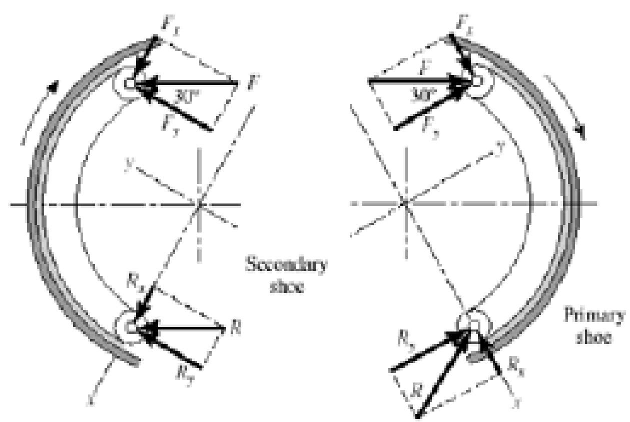
$$T_R = \frac{0.28(734.5)10^3(0.040)0.150^2(\cos 0° - \cos 120°)}{1} = 277.6 \ \text{N} \cdot \text{m} \quad \textit{Ans.}$$

LH shoe:

$$T_L = 277.6 \frac{381.9}{734.5} = 144.4 \ \text{N} \cdot \text{m} \quad \textit{Ans.}$$

$$T_{total} = 277.6 + 144.4 = 422 \ \text{N} \cdot \text{m} \quad \textit{Ans.}$$

(c)



RH shoe: $F_x = 2200 \sin 30° = 1100$ N, $F_y = 2200 \cos 30° = 1905$ N

Eqs. (16-8): $A = \left(\frac{1}{2}\sin^2\theta\right)_{0°}^{120°} = 0.375$, $B = \left(\frac{\theta}{2} - \frac{1}{4}\sin 2\theta\right)_{0}^{2\pi/3 \text{ rad}} = 1.264$

Eqs. (16-9):

$$R_x = \frac{734.5(10^3)0.040(0.150)}{1}[0.375 - 0.28(1.264)] - 1100 = -1007 \text{ N}$$

$$R_y = \frac{734.5(10^3)0.04(0.150)}{1}[1.264 + 0.28(0.375)] - 1905 = 4128 \text{ N}$$

$$R = [(-1007)^2 + 4128^2]^{1/2} = 4249 \text{ N} \quad \textit{Ans.}$$

LH shoe: $F_x = 1100$ N, $F_y = 1905$ N

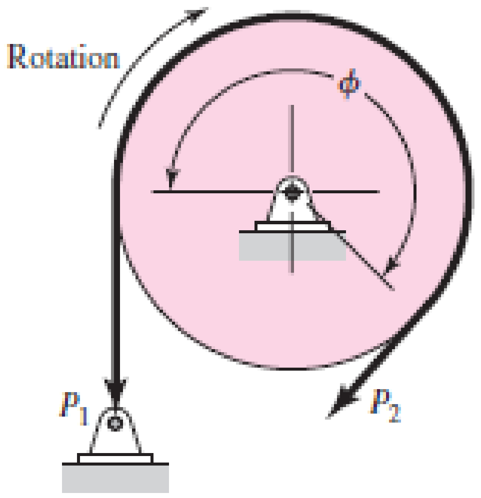
Eqs. (16-10):

$$R_x = \frac{381.9(10^3)0.040(0.150)}{1}[0.375 + 0.28(1.264)] - 1100 = 570 \text{ N}$$

$$R_y = \frac{381.9(10^3)0.040(0.150)}{1}[1.264 - 0.28(0.375)] - 1905 = 751 \text{ N}$$

$$R = \left(597^2 + 751^2\right)^{1/2} = 959 \text{ N} \quad \textit{Ans.}$$

The maximum band interface pressure on the brake shown in the figure is 620 kPa. Use a 350 mm-diameter drum, a band width of 25 mm, a coefficient of friction of 0.30, and an angle-of-wrap of 270°. Find the band tensions and the torque capacity.



Given: $D = 350$ mm, $b = 100$ mm, $p_a = 620$ kPa, $f = 0.30$, $\phi = 270°$.

Eq. (16-22):

$$P_1 = \frac{p_a bD}{2} = \frac{620(0.100)0.350}{2} = 10.85 \text{ kN} \quad \textit{Ans.}$$

$$f\phi = 0.30(270°)(\pi / 180°) = 1.414$$

Eq. (16-19): $P_2 = P_1 \exp(-f\phi) = 10.85 \exp(-1.414) = 2.64 \text{ kN}$ *Ans.*

$$T = (P_1 - P_2)(D / 2) = (10.85 - 2.64)(0.350 / 2) = 1.437 \text{ kN} \cdot \text{m} \quad \textit{Ans.}$$