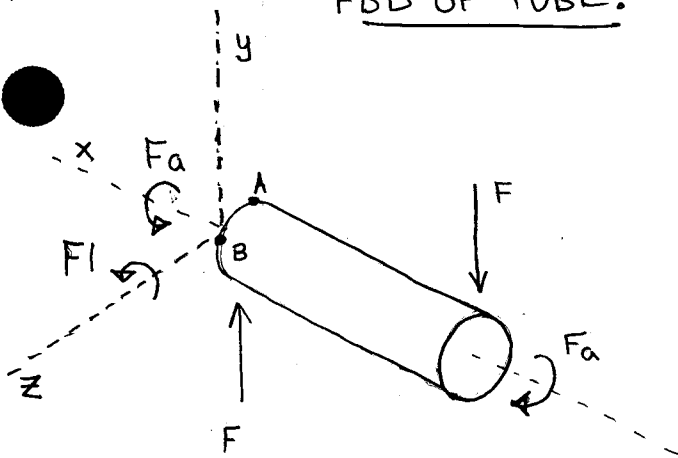


FBD OF TUBE:

FIND VON MISES AT POINTS A & B

POINT A

$$\sigma_x = \frac{Mc}{I}$$

$$M = Fl$$

$$c = \frac{od}{2}$$

$$I = \frac{\pi}{64}(od^4 - id^4)$$

BENDING

$$\tau_{xz} = \frac{T_r}{J}$$

$$T = Fa$$

$$r = \frac{od}{2}$$

$$J = \frac{\pi}{32}(od^4 - id^4)$$

TORSION

VON MISES

$$\sigma_{eq} = \sqrt{\sigma_x^2 + 3\tau_{xz}^2}$$

POINT B

$$\sigma_x = 0$$

BENDING

$$\tau_{xy} = \frac{T_r}{J} + \frac{4V}{3A}$$

$$T = Fa$$

$$r = \frac{od}{2}$$

$$J = \frac{\pi}{32}(od^4 - id^4)$$

$$V = F$$

$$A = \frac{\pi}{4}(od^2 - id^2)$$

TORSION
AND
BENDING SHEAR(SHEAR CAN BE
NEGLECTED)VON MISES

$$\sigma_{eq} = \sqrt{3}\tau_{xy}$$

HANDCALCS FOR ROW(a)

POINT A

$$\sigma_x = \frac{50\text{N}(.100\text{m})(.010\text{m})64}{\pi (.020^4 - .014^4)\text{m}^4} = 8.378 \text{ MPa}$$

$$\tau_{xz} = \frac{50\text{N}(.400\text{m})(.010\text{m})32}{\pi (.020^4 - .014^4)\text{m}^4} = 16.76 \text{ MPa}$$

$$\sigma_{eq} = \sqrt{8.378^2 + 3(16.76)^2} = 30.21 \text{ MPa}$$

POINT B

$$\sigma_x = 0$$

$$\tau_{xy} = 16.76 \text{ MPa} + \frac{4(.50\text{N})}{3\pi (.010^2 - .007^2)} = 17.2 \text{ MPa}$$

$$\sigma_{eq} = \sqrt{3}(17.2 \text{ MPa}) = 29.7 \text{ MPa}$$

SEE SPREADSHEET (PG 3) FOR ADDITIONAL ROWS

Data from Table P5-3							Prob. 5-33						
ROW	l (m)	a (m)	F (N)	od (m)	id (m)		Stresses at Point A (Mpa)				Stresses at Point B (Mpa)		
							Sigma	Tau-torsion	Tau-bending	von mises	Sigma	Tau-torsion	Tau-bending
a	0.100	0.400	50	0.020	0.014		8.38	16.76	0	30.2	0	16.76	0.42
b	0.070	0.200	85	0.020	0.006		7.64	10.92	0	20.4	0	10.92	0.40
c	0.300	0.100	95	0.025	0.017		23.64	3.94	0	24.6	0	3.94	0.48
d	0.800	0.500	160	0.046	0.022		14.14	4.42	0	16.1	0	4.42	0.17
e	0.085	0.350	900	0.055	0.024		4.86	10.01	0	18.0	0	10.01	0.62
f	0.050	0.180	950	0.050	0.030		4.45	8.01	0	14.6	0	8.01	1.01
g	0.160	0.280	850	0.045	0.019		15.71	13.75	0	28.5	0	13.75	0.87
h	0.200	0.100	800	0.040	0.024		29.27	7.32	0	31.9	0	7.32	1.33
i	0.400	0.150	950	0.065	0.037		15.76	2.95	0	16.6	0	2.95	0.56
j	0.200	0.100	600	0.045	0.032		18.03	4.51	0	19.6	0	4.51	1.02
k	0.120	0.180	880	0.060	0.047		7.99	5.99	0	13.1	0	5.99	1.07
l	0.150	0.250	750	0.052	0.028		8.90	7.42	0	15.6	0	7.42	0.66
m	0.070	0.100	500	0.036	0.030		14.77	10.55	0	23.5	0	10.55	2.14
n	0.085	0.150	820	0.040	0.015		11.32	9.99	0	20.7	0	9.99	1.01