

Stress Analysis Test: Jacob Quarry (2000885)

Stress Analysis

2000885 A=2 B/C/D=0 E=8 F=8 G=5

i) Strain $X = 25 \times 10^{-6}$ $Y = -18 \times 10^{-6}$
 Poisson 0.28 $Y_M = 170 \times 10^9 \text{ Pa}$

$$i) X \sigma = \frac{170 \times 10^9}{1 - 0.28^2} \times (25 \times 10^{-6} + 0.28 \times -18 \times 10^{-6})$$

$$= 3.682 \times 10^6$$

$$Y \sigma = \frac{170 \times 10^9}{1 - 0.28^2} \times (-18 \times 10^{-6} + 0.28 \times 25 \times 10^{-6})$$

$$= -2.029 \times 10^6$$

X is tensile Y is compressive

ii) $X \sigma_1 = 88 \times 10^6 \text{ Pa}$ $Y \sigma_2 = -45 \times 10^6 \text{ Pa}$

$$X \epsilon_1 = \frac{1}{170 \times 10^9} \times (88 \times 10^6 - 0.28 \times -45 \times 10^6)$$

$$= 4.435 \times 10^{-4} \quad 5.9176 \times 10^{-4}$$

$$Y \epsilon_2 = \frac{1}{170 \times 10^9} \times (-45 \times 10^6 - 0.28 \times 88 \times 10^6)$$

$$= -4.096 \times 10^{-4}$$

2 $\sigma_x = 108 \times 10^6 \text{ Pa}$ $\sigma_y = 208 \times 10^6 \text{ Pa}$ $\tau_{xy} = 125 \times 10^6 \text{ Pa}$

i $\sigma_1 = \left(\frac{108 \times 10^6 + 208 \times 10^6}{2} \right) + \frac{\sqrt{(108 \times 10^6 - 208 \times 10^6)^2 + 4 \times (125 \times 10^6)^2}}{2}$

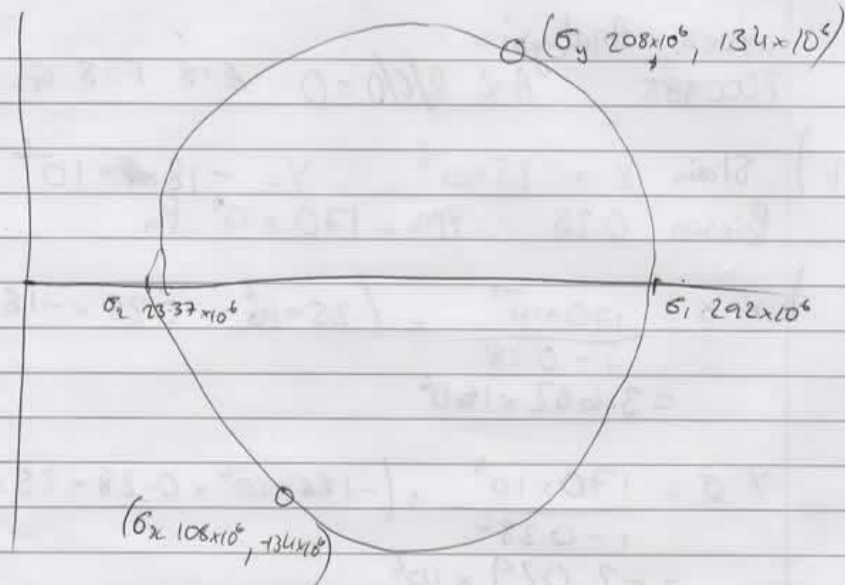
$$= 292.63 \times 10^6 \text{ Pa}$$

$$\sigma_2 = 23.37 \times 10^6 \text{ Pa}$$

ii) $\tau_{max} = 134.6 \times 10^6$
 $\tau_{min} = -134.6 \times 10^6$

①

iii)



3.) $R_A = 1969.4$ $R_B = 2580.6$

$$EI \frac{d^2 y}{dx^2} = 1969.4 \times x - \frac{450}{2} \times [x-0.5]^2 + \frac{450}{2} [x-1.5]^2 - 2300 [x-1.5] - \frac{800}{2} [x-2.5]^2 + \frac{800}{2} [x-2.5]^2 - 1000 \times [x-2.5] - 2580.6 \times [x-2.5]$$

$$EI \frac{dy}{dx} = \frac{1969.4}{2} \times x^2 - \frac{450}{6} \times [x-0.5]^3 + \frac{450}{6} [x-1.5]^3 - \frac{2300}{2} [x-1.5]^2 - \frac{800}{6} [x-2.5]^3 + \frac{800}{6} [x-2.5]^3 - \frac{1000}{2} \times [x-2.5]^2 + \frac{2580.6}{2} \times [x-2.5]^2 + A$$

$$EI y = \frac{1969.4}{6} \times x^3 + \frac{450}{24} \times [x-0.5]^4 + \frac{450}{24} [x-1.5]^4 - \frac{2300}{6} [x-1.5]^3 - \frac{800}{24} [x-2.5]^4 + \frac{800}{24} [x-2.5]^4 - \frac{1000}{6} \times [x-2.5]^3 + \frac{2580.6}{6} \times [x-2.5]^3 + Ax + B$$

iv) ~~At $x=0$, $y=0 \therefore A=B=0$~~

v) $EI = 1.88 \times 10^6$

$$1.88 \times 10^6 y = \frac{1969.4}{6} \times 1.55^3 - \frac{450}{24} \times [1.55-0.5]^4 + \frac{450}{24} [1.55-1.5]^4 - \frac{2300}{6} [1.55-1.5]^3 - \frac{800}{24} [1.55-2.5]^4 + \frac{800}{24} [1.55-2.5]^4 - \frac{1000}{6} \times [1.55-2.5]^3 + 0 \times 1.55 + 0$$

$$1.88 \times 10^6 \times y = 1199.4611$$

(2)

See Corrections Below

correction
3 fiv) $x=0 \quad y=0$

$$0 = 0 + \frac{450}{24} \times (-0.5)^4 + \frac{450}{24} (-1.5)^4 - \frac{2300}{6} (-1.5)^3 - \frac{800}{24} (-1.5)^4$$

$$+ \frac{800}{24} (-1.5)^4 - \frac{1000}{6} (-2.5)^3 + A(0) + B$$

$$0 = 3991.67 + B$$

$$B = -3991.67$$

$x=0 \quad \frac{dy}{dx} = 0$

$$0 = 0 - \frac{450}{6} \times (-0.5)^3 + \frac{450}{6} (-1.5)^3 - \frac{2300}{2} (-1.5)^2 - \frac{800}{6} (-1.5)^3$$

$$+ \frac{800}{6} (-2.5)^3 - \frac{1000}{2} \times (-2.5)^2 + A$$

$$0 = -7589.5833 + A$$

$$A = 7589.5833$$

correction
3v)

$$E1 = 1.88 \times 10^6$$

$$1.88 \times 10^6 \times y = \frac{1969.4}{8}$$

$$1.88 \times 10^6 \times y = 246.175 \quad 1199.4611 \text{ (from previous working)} + 7589.5833 \times 1.55 = 3991.67$$

$$y = \frac{8971.645}{1.88 \times 10^6}$$

$$= 4.772 \times 10^{-3} \text{ m}$$

4) Press $14.8 \text{ Bar} = 14.8 \times 10^5 \text{ Pa}$ Long = 58% Circ = 65%

i) ~~62~~ ~~185~~ $\frac{14.8 \times 10^5 \times 0.28}{2 \times 0.858 \times 150 \times 10^6} = 2.38 \text{ mm}$

ii) $\frac{14.8 \times 10^5 \times 0.28}{4 \times 0.65 \times 150 \times 10^6} = 1.06 \text{ mm}$

iii) Minimum thickness is highest value, 2.38 mm

5) length 1.38 m OD = 19.05 mm ID = 16.65 mm

i) $I_{xx} = \frac{\pi}{64} ((19.05 \times 10^{-3})^4 - (16.65 \times 10^{-3})^4) = 2.69 \times 10^{-9} \text{ m}^4$

ii) Restrained Bottom Unrestrained Top $n = 0.25$

iii) $F = \frac{0.25 \times \pi^2 \times 200 \times 10^9 \times 2.69 \times 10^{-9}}{1.38} = 962.73 \text{ N}$

iv) $K = \frac{2.69 \times 10^{-9}}{\sqrt{\pi/4 \times ((19.05 \times 10^{-3})^2 - (16.65 \times 10^{-3})^2)}} = \frac{4.06 \times 10^{-5}}{6.325 \times 10^{-3}}$

SR = $\frac{1.38}{\frac{4.06 \times 10^{-5}}{6.325 \times 10^{-3}}} = \frac{34.49 \times 10^3}{218.176}$

Given the slenderness Ratio of ≈ 220 this does count as a strut which would require an S.R. of 120 for steel.