

DATE: 07/05/2020

TIME: 1 pm

MODULE TITLE: CAE and stress analysis

MODULE CODE: MSX02067

NAME: Alexander Baldwin

STUDENT NUMBER: 1801714

a) Force of half cylinder = $p \cdot \text{projected area}$
 $= p \cdot dL$

$$\text{Force} = 2\sigma_H L t$$

$$pdL = 2\sigma_H L t$$

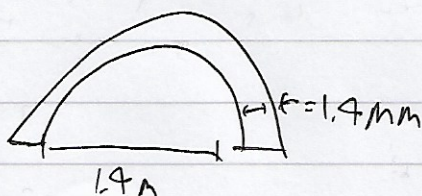
$$\frac{pd}{2t} = \sigma_H$$

$$\sigma_H = \frac{pd}{2t}$$

b) This is because the circumferential stress is always double the longitudinal stress therefore making σ_H the limiting factor

c) ~~$1.02875 \text{ m}^3 \text{ kg}^{-1}$~~ $1.02875 \text{ g/cm}^3 = 1028.75 \text{ kg m}^{-3}$

d)



$$d = 1.4 \text{ m}$$

$$\sigma_H = 190 \times 10^6 \text{ Pa}$$

$$t = 1.4 \text{ mm}$$

$$t = 0.0014 \text{ m}$$

~~$p = 1.02875 \text{ Pa}$~~

$$p = 1028.75 \text{ Pa}$$

~~$p = 1.02875 (4.01) ($~~ $p_{\text{inside}} = 0$

~~At~~ pressure outside = $1 \times 10^5 \text{ Pa}$

$$\text{Net pressure outside} = 1 \times 10^5 \text{ Pa} \text{ vs}$$

$$= 1 \times 10^5 \text{ Pa}$$

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$$p = \rho g h$$

$$1 \times 10^5 = (1028.75)(9.81)(h)$$

$$\frac{1 \times 10^5}{(1028.75)(9.81)} = h$$

$$h = 9908.8 \text{ m}$$

$$\boxed{h = 9.91 \text{ m}}$$

e) Max pressure inside = $1 \times 10^5 + 9.1 \times 10^5$
 $\approx 200 \times 10^5$
 $= 0.2 \times 10^6 \text{ Pa}$

$$0.2 \times 10^6 = (1028.75)(9.81)(h)$$

$$\frac{0.2 \times 10^6}{(1028.75)(9.81)} = h$$

$$\boxed{h = 19.82 \text{ m}}$$

f) max ρ inside = $1 \times 10^5 + 0.2 \times 10^6$
 $= 0.3 \times 10^6$

$$\frac{0.3 \times 10^6}{(1028.75)(9.81)} = h$$

$$\boxed{h = 29.73 \text{ m}}$$

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- g) As the atmospheric pressure inside the submarine increases, the depth ~~at~~ that the submarine can dive also increases. This is due to the inner walls managing to battle the pressure from outside the walls.
- h) This is because assumptions were made in the calculations. These assumptions were: thin cylinders used, no joints, ~~on~~ cylinder, no material inconsistencies, and no tolerances to thickness of the walls.

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$$3a) \quad M_{xx} = EI \frac{d^2 y}{dx^2}$$

$$M_{xx} = \frac{w}{2} \left(\frac{L}{2} - x \right)$$

$$M_{xx} = \frac{wL}{4} - \frac{wx}{2}$$

$$EI \frac{d^2 y}{dx^2} = \frac{wL}{4} - \frac{wx}{2}$$

$$EI \frac{dy}{dx} = \frac{wLx}{4} - \frac{wx^2}{4} + A$$

$$EI y = \frac{wLx^2}{8} - \frac{wx^3}{12} + Ax + B$$

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

$$0 = \frac{wL(0)}{4} - \frac{w(0)^2}{4} + A$$

$$A = 0$$

$$\text{When } x = \frac{L}{2} \quad y = 0$$

$$0 = \frac{wL \left(\frac{L}{2} \right)^2}{8} - \frac{w \left(\frac{L}{2} \right)^3}{12} + \left(\frac{L}{2} \right) + B$$

$$0 = \frac{wL^3}{32} - \frac{wL^3}{96} + B$$

$$0 = \frac{3wL^3}{96} - \frac{wL^3}{96} + B$$

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$$0 = \frac{3wL^3}{96} - \frac{wL^3}{96} + B$$

$$B = \frac{-2wL^3}{96}$$

$$B = -\frac{wL^3}{48}$$

$$EIy = \frac{wx^3}{6} - \frac{wx^3}{12} - \frac{wL^3}{48}$$

$$y = \frac{1}{EI} \left[\frac{wx^3}{6} - \frac{wx^3}{12} - \frac{wL^3}{48} \right]$$

b) at max deflection $x=0$

$$y_{max} = \frac{1}{EI} \left[\frac{w(0)^3}{6} - \frac{w(0)^3}{12} - \frac{wL^3}{48} \right]$$

$$y_{max} = \frac{1}{EI} \left(-\frac{wL^3}{48} \right)$$

$$y_{max} = -\frac{wL^3}{48EI}$$

c) $w = 48 \times 10^3 \text{ N}$

$y_{max} = 9 \text{ mm}$

$E = 193 \times 10^6 \text{ Pa}$

$y_{max} = 0.009 \text{ m}$

$I = 38 \times 10^{-6} \text{ m}^4$

$L = ?$

$$EI = (193 \times 10^6) (38 \times 10^{-6})$$

$$= 7334 \text{ kg m}$$

$$= 7334 \text{ Pa}$$

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$$9 \times 10^{-3} = - \frac{(48 \times 10^3) L^3}{48(7334)}$$

$$\frac{(9 \times 10^{-3})(48)(7334)}{48 \times 10^3} = L^3$$

$$\sqrt[3]{\frac{3168.288}{48 \times 10^3}} = L$$

$$L = 0.40 \text{ m}$$

- d) This is because assumptions were made. These assumptions were no joints on the rail, no material inconsistencies, no tolerances to thickness of the track, the mass will not be on ~~at~~ a specific point but more spread out.
- e) The train will move across the track therefore the mass won't always be in the centre.

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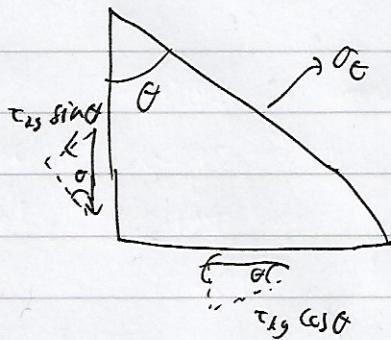
$$4a) \quad \sigma_\theta = \frac{1}{2}(\sigma_x + \sigma_y) + \frac{1}{2}(\sigma_x - \sigma_y)\cos 2\theta + \tau_{xy}\cos 2\theta$$

$$\text{as } \sigma_x \text{ and } \sigma_y = 0$$

$$\sigma_\theta = \frac{1}{2}(\sigma + \sigma) + \frac{1}{2}(\sigma - \sigma)\cos 2\theta + \tau_{xy}\cos 2\theta$$

$$\sigma_\theta = \tau_{xy}\cos 2\theta$$

$$\sigma_\theta = \tau_{xy}\sin 2\theta$$



$$\sigma_\theta = 2\tau_{xy}(\sin\theta \cos\theta)$$

$$\sigma_\theta = 2\tau_{xy}\left(\frac{1}{2}\sin 2\theta\right)$$

$$\sigma_\theta = \tau_{xy}\sin 2\theta$$

$$b) \quad \tau_{xy} = -48 \times 10^6 \text{ Pa}$$

$$\sigma_\theta = (-48 \times 10^6) \sin(2(23))$$

$$\sigma_\theta = -34.53 \quad \boxed{\sigma_\theta = -34.53 \text{ MPa}}$$

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c) $\tau_\theta = -\tau_{xy} \cos 2\theta$

$$\tau_\theta = -(-40 \times 10^6) \cos(2(29))$$

$$\tau_\theta = 33.34 \text{ MPa}$$

d) A thin material which is getting ripped.
For example a piece of paper.

e) There is always ~~at least~~ going to be a direct stress acting on a material, even if its very small. If you take a material in air, there will be a pressure applied to the walls ~~as~~ and cause direct stress to the material even though it is ~~neglected~~ neglected in calculations.