

CAE & stress Analysis (MSX02064)

13:00pm 07/05/20

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Q 1a) The total force on half cylinder due to internal pressure =
 $p \times \text{projected area} = p d L$

$$2\sigma_H \times L t = p d L \quad \therefore \sigma_H = \frac{p d}{2t}$$

b) Hoop stress $\sigma_H = \frac{p d}{2t}$, Longitudinal stress $\sigma_L = \frac{p d}{4t}$.
 This means hoop stress is twice the longitudinal stress.
 If the hoop stress is too big the structure will burst

c) $1.0270 \text{ g/cm}^3 \rightarrow 1027 \text{ kg/m}^3$

d) $P = \rho g h$

$$\rho = 1027 \text{ kg/m}^3$$

$$g = 9.81 \text{ m/s}^2$$

$$P = \rho g h$$

$$P / \rho g = h$$

$$\sigma_H = \frac{p d}{2t} \quad \therefore \frac{\sigma_H \times 2t}{d} = p \quad \frac{200 \times 10^6 \times 2 (0.0045)}{4.5} = p$$

$$p = 400000 / (1027 \times 9.81) = 39.7$$

$$h = 39.7 \text{ m}$$

$$\times 2.1$$

$$p = 400000 \times 2.1 = 840000 / (1027 \times 9.81) = 83.38 \text{ m}$$

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Q2.

a) A - Define the problem

This step helps establish the customer needs, develop a problem statement and identify criteria for success

B - Gather relevant information

This step includes searching information sources and ^{redefining} the problem if needed.

C - Generate multiple solutions

This step involves brainstorming and combining new ideas in order to solve a ~~strong~~ design problem.

D - Analyse and select a solution

- This step considers the functional analysis, ergonomics, product safety & liability. A decision matrix can be used.

E - Test and implement solution

This step involves prototyping and testing under real conditions. Applying for patents and releasing to market.

b) FEA can be used to help benefit the Analysis and selection of solutions within the design process. It can reduce time taken to identify problems, reducing lead times. FEA can be used to reduce the amount of CAD and prototyping to reduce costs and lead times.

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Q4.

$$a) AB \cos \theta = \sigma_x AC \cos \theta + \sigma_y BC \sin \theta$$

$$AC = AB \cos \theta \quad BC = AB \sin \theta$$

$$\sigma_\theta = \sigma_x \cos^2 \theta + \sigma_y \sin^2 \theta$$

$$\sigma_\theta = \frac{\sigma_x}{2} + \frac{\sigma_x}{2} \cos 2\theta + \frac{\sigma_y}{2} - \frac{\sigma_y}{2} \cos 2\theta$$

$$\sigma_\theta = \frac{1}{2}(\sigma_x + \sigma_y) + \frac{1}{2}(\sigma_x - \sigma_y) \cos 2\theta$$

$$b) 79 \times 10^6 / \cos 54^\circ = 134.4 \text{ MPa} = \tau_\theta$$

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

$$\frac{\tau_\theta}{\cos 2\theta} = -\tau_{xy} \quad \frac{134.4 \times 10^6}{\cos (2 \times 54)} = -\tau_{xy}$$

$$\tau_{xy} = 434.93 \text{ MPa}$$

- d) Shear stress is applied parallel to the surface of an object.
 an example of a scenario where it is assumed a material
 is subjected to shear stress only could be a shelf
 glued to a wall with an even weight distributed on it.
 Shear stress would occur in the glue, holding the
 shelf to the wall.

- e) Bending could occur on the shelf if weight isn't distributed evenly
 and atmosphere conditions could affect the glue's conformity