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CAE and Stress Analysis M5X02064

07/05/2020 1PM start

Question 1

a) force on half of the cylinder due to internal pressure
 $= p \times \text{projected} = pdL$

resisting force owing to hoop stress σ_H , setup in cylinder walls $= 2\sigma_H \times Lt$

$\therefore 2\sigma_H Lt = pdL$ Thus $\sigma_H = \frac{pd}{2t}$

b) ~~then~~ The longitudinal stress is always half the hoop stress, this can be seen in the following equations:

$\sigma_{\text{Hoop}} = \frac{pd}{2t}$ $\sigma_{\text{Long}} = \frac{pd}{4t}$

c) ~~10205~~ 1.0250 g/cm^3

~~10205~~ $\rho = 1.02050 \times \frac{1000000}{1000} = 1020.5$
~~10205~~ UNITS?

d) $d = 2.1$ $t = 2.1 \times 10^{-3}$ $FOS = 1.9$

~~$P = \frac{\sigma_H \times 2t}{d}$~~ KPa

$\sigma_H = \frac{pd}{2t}$ $P = \frac{\sigma_H \times 2t}{d} = \left(\frac{1.90 \times 10^6}{1.9} \right) \times 2 \times 2.1 \times 10^{-3} = 200000 \text{ Pa}$

$P = \rho gh$

$\frac{P}{\rho g} = h = \frac{200000}{1020.5 \times 9.81} = 19.48 \text{ m}$

$$e) \frac{(200000 - 0.1 \times 10^6)}{\frac{1205 \times 9.81}{1020.5}} = \cancel{19.98} 19.99$$

$$\cancel{16 + 8.46 = 24.46m} \quad 19.98 + 9.99 = 29.97m$$

$$f) 0.1 \text{ Mpa} \times 2$$

$$0.1 \times 10^6 \times 2 = 200000$$

$$\frac{200000 + 200000}{\frac{1205 \times 9.81}{1020.5}} = 39.96m$$

~~g) The value was decided with a constant value for ρ , this in reality this value would change with depth however at 20m the change wouldn't be too significant.~~

~~h) The~~

The value for depth increases as if the internal pressure was increased

h) In reality the factor of safety value could be lower, in the aerospace industry a factor of safety of 1.25 is usually used & so could also be applied to this situation.

Question 2

Task 1 - Define the problem.

Firstly the design problem needs to have a clear & unambiguous definition of the problem, however this definition could evolve as a more complete understanding of the problem develops.

The problem needs to be identified in response to a human need.

~~A problem statement.~~

Criteria for success should also be generated here e.g.

- The design must be low cost
- The design should be aesthetically pleasing
- The design must be disposable

Task 2 - Gather Relevant Information

It is necessary to all information that relates to the problem. This can reveal facts about the problem that could necessitate the re-definition of the problem. Some of the following questions may be asked

- Is the problem real & its statement accurate?
- What are the existing solutions to the problem?
- Which companies currently manufacture the existing solutions?

Task 3- Generate Multiple Solutions

Creativity needed to begin generating new ideas that may solve the problem. It may start with de-construction of existing solutions and finding problems.

Brainstorming at this stage is often a team effort in which people from different disciplines are all involved in generating multiple solutions.

Task 4 - Analyse & Select Appropriate Solution

Once alternative designs have been generated they must all be analysed & the most suitable design chosen for implementation. Decided by results of design analysis so is subjective and should be made by a team of experienced people.

Task 5 - Test & Implement The Solution

Refers to testing, construction & manufacturing of the chosen design solution. Several methods of implementation should be considered e.g.

- Prototyping
- Concurrent Engineering
- Documentation
- Applying for patents

b) Task 2: when gathering information FEA can be used to evaluate already existing solutions & their failure points

Task 3: ~~with~~ during this stage FEA can be used to get rid of ideas that are ~~un~~ unable to be manufactured

Task 4 - Similar to stage 3 ideas that can't be manufactured will be disregarded

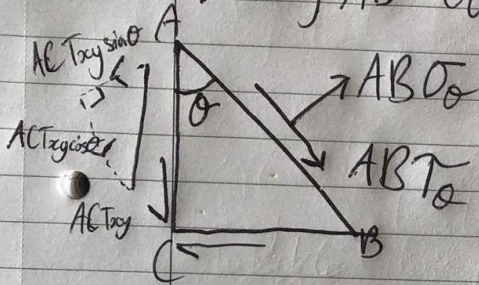
Task 5 - FEA test can be undertaken to get rid of the need for multiple prototypes.

Question 4

a) $\sum \text{forces } \perp r \text{ to } AB = 0$

$$\therefore AB \sigma_\theta = AC T_{xy} \sin \theta + BC T_{yx} \cos \theta$$

$$\text{Divide by } AB: \sigma_\theta = \frac{AC}{AB} T_{xy} \sin \theta + \frac{BC}{AB} T_{yx} \cos \theta$$



$$\text{From diagram } AB \cos \theta = AC \quad \therefore \cos \theta = \frac{AC}{AB} \quad AB \sin \theta = BC \quad \therefore \sin \theta = \frac{BC}{AB}$$

$$\begin{aligned} \sigma_\theta &= T_{xy} \sin \theta \cos \theta + T_{yx} \sin \theta \cos \theta \\ &= 2 T_{xy} \sin \theta \cos \theta \end{aligned}$$

$$\text{Remember } \sin \theta \cos \theta = \frac{1}{2} \sin 2\theta$$

$$\therefore \sigma_\theta = T_{xy} \sin 2\theta$$

$$\begin{aligned} \text{b) } 55 \times 10^6 \times \sin(2 \times 30) \\ = 47631397.21 \text{ Pa} \\ = 47.63 \text{ MPa} \end{aligned}$$

$$\begin{aligned} \text{c) } \tau_\theta &= \frac{1}{2} (55) \times \cos(2 \times 30) \\ \tau_\theta &= -27.5 \text{ MPa} \end{aligned}$$

d) Two gears meshing together in a gearbox

e) It is unlikely to happen as the planes would have to be perfectly parallel to another, which is unlikely.