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CAE and Stress Analysis
M5X02064
Exam

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1pm

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Question 1

a) force on half cylinder = $p \times \text{projected area}$
 $= p \times d \times l$

total resistive force = $2\sigma_H \times l \times t$

$$2\sigma_H l t = p d l$$

$$\sigma_H = \frac{p d}{2t}$$

b) ~~The hoop stress within a thin cylinder is half the stress seen in a sphere, therefore a cylinder cannot hold fluid at as high a pressure fluid.~~

b) The longitudinal stress is half the hoop stress.

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

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

~~$20.00097 \text{ m}^3/\text{kg}$~~

d) $P = \rho g h$ $\rho = 1027$

$$200 \div 2.1 = 95.24$$

$$P_{\text{max}} = \frac{2\sigma_H t}{d} = \frac{1027 \times 95.24 \times 5.2 \times 10^{-3} \times 2}{5.2}$$

$$= 190480 \text{ Pa}$$

$$= 190480 \text{ Pa}$$

$$P = \rho g h$$

$$\frac{P}{\rho g} = h$$

$$\frac{190480}{1027 \times 9.81} = 18.91 \text{ m}$$

e) $190480 + 100000 = 290480 \text{ Pa}$

$$290480$$

$$\frac{290480}{1027 \times 9.81} = 28.83 \text{ m}$$

~~It is not a very good submarine~~

f) $190480 + 200,000$
 $= 390,480$

$$\frac{390,480}{1027 \times 9.81} = 38.76 \text{ m}$$

g) Our submarine is not very good, as a usual submarine can go around 200/250m, therefore the wall thickness could be increased to allow for larger depth. It also increases as pressure increases.

h) As a usual submarine can go for deeper due to more pressure and a larger wall thickness, it shows that our submarine would not be viable for a real scenario as 20-30m is nowhere near as deep as 200/250m. The pressure outside also increases as the submarine goes down therefore the pressure needs to change with h.

2m Question 2

a)

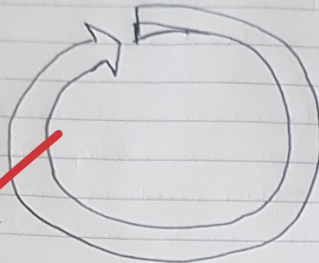
A) Define the problem

B) Gather information

C) Generate multiple solutions

D) Analyse & select a solution

E) Test or
implement
solution



The first step (defining the problem), involves identifying and establishing the need. This is essential as before the design is implemented the problem or fault must be identified. Once identified, a problem statement is required. This problem statement would lay out any targets by which the new design should achieve.

The second step (gather relevant information) is fairly self explanatory. The main information required is in terms of how to actually solve the problem and how was it being solved originally. This along with the costs is the main information required. This information comes from sources such as, scientific encyclopedias and technical handbooks, electronic catalogues, internet and publications.

The third step (generate multiple solutions) is used to deconstruct existing solutions and come up with more effective solutions. This is usually done in team brainstorming sessions, as they are an efficient method.

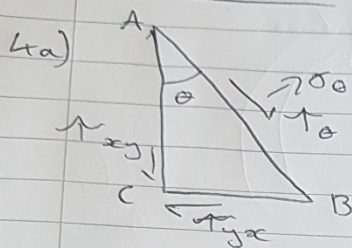
The fourth step (analyse and select an appropriate solution), usually ends up with solid solutions to the problem. This involves a functional analysis, will it work as it should? This also involves looking into ergonomics, mechanical analysis, electrical analysis, safety and reliability and economic analysis.

The last step is the decision process. After analysing solutions, a decision has to be made as to which solution is best. A method often used for this is the decision matrix system, which is a mathematical test used to generate a number that specifies and justifies the best solution.

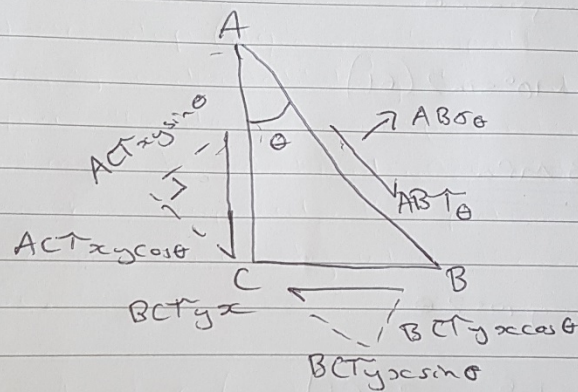
- b) The main stages influenced by FEA are the design stages as well as any analysis and information gathering stages. This is because models can be more simply produced within an FE environment. Also if CAD is used the designs produced are likely to be more efficient, delivered quicker and far less costly as many major loadpaths have been used. It also allows for the overall design phase to be

done much quicker as the CAE and CAD can be done together.

Question 4



Using forces on each face; $F = \text{area} \times \text{stress}$



For equilibrium

$$\sum \text{forces perpendicular to } AB = 0$$

$$\therefore AB \sigma_\theta = ACT_x \sin \theta + BCT_y \cos \theta$$

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

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

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

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

$$\therefore \sin \theta \cos \theta = \frac{1}{2} \sin 2\theta$$

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

$$b) \sigma_{\theta} = T_{xy} \sin 2\theta$$

$$= 86 \times 10^6 \sin 2(61)$$

$$= \underline{\underline{73 \text{ MPa}}}$$

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

$$= 86 \times 10^6 \cos 2(61)$$

$$= \underline{\underline{46 \text{ MPa}}}$$

d) an example would be a gearbox as the only interaction is between the sliding gears

e) it is unlikely as the gears are not exactly parallel to earth otherwise some direct stress would be observed.