Nathaniel Allcock

P1506639

07/05/2020

13:00 HRS

CAE + Stress Analysis

M5X02064

Q1)a) $\sigma_h = \frac{Pd}{2t}$

Thin cylinder:

Σ forces up = Σ forces down

$F = PA$

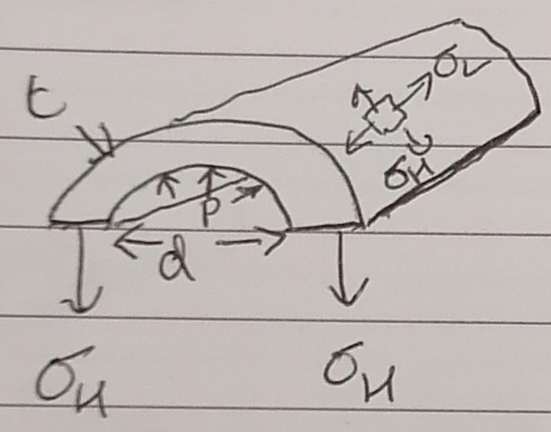
$F = PdL$

$F = 2\sigma_H \times tL$

$\therefore F = 2\sigma_H + tL = PdL$

$2\sigma_H t = Pd$

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



b) Hoop stress is twice as large as the longitudinal stress for a thin cylinder. Hence, why sausages split horizontally and nor in half.

c) From graph; salinity = 35.5psu

temperature = 20°C

density = 1.0255 g/cm³

g/cm³ to kg/m³ = 1 to 1000

$$1025.5 \text{ kg/m}^3$$

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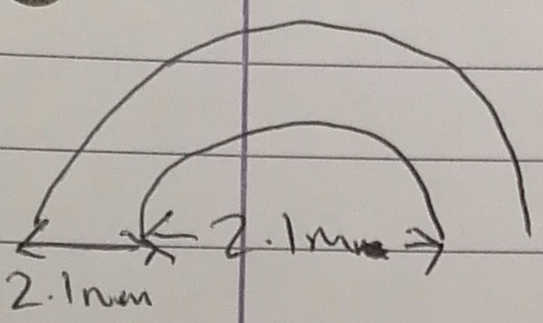
Q1) d) $P = \rho g h$

Submarine = thin cylinder

diameter = 2.1m

Wall Thickness = 2.1mm = 0.0021m

Y = ? without exceeding 190MPa Yield Stress



Max Pressure Sub can withstand

$$P_{max} = \frac{2\sigma_H t}{d} = \frac{2 \times 190 \times 10^6 \times 0.0021}{2.1} = 38{,}000\,Pa$$

$$= \underline{38\,Kpa}$~~$P_{max} = \frac{2\sigma_H t}{d}$~~

$P = \rho g h$

$P = 1025.5 \times 9.81 \times h$

If $P = 38\,kpa$, $\frac{38{,}000}{1025.5 \times 9.81} = h$

$$\boxed{3.78\,m = h}$$

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Q1)E) Pressure inside Sub = 0.1MPa = 100,000 Pa

$$\frac{100,000}{1025.5 \times 9.81} = h$$

$$9.94m = h$$ ✓

Q1) f) $$\frac{200\,000}{1025.5 \times 9.81} = 19.88m$$ ECF

Q1) g) It can be seen, if the ~~e~~ riside of the submarine can be pressurised at a higher pressure, it will be able to reach ~~l~~ depths greater than if it was pressurised with less of a pressure difference ~~.~~. This enables the submarines ability to reach greater depths in the sea, before exceeding max hoop stress due to pressure differences.

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h) Results may differ due to;

- pressure differences being slightly different
- yield Shrength of material may not be uniform
- there may have been construction issues
- pressure of sea may vary due to density changes
- temperature changes could also affect results.

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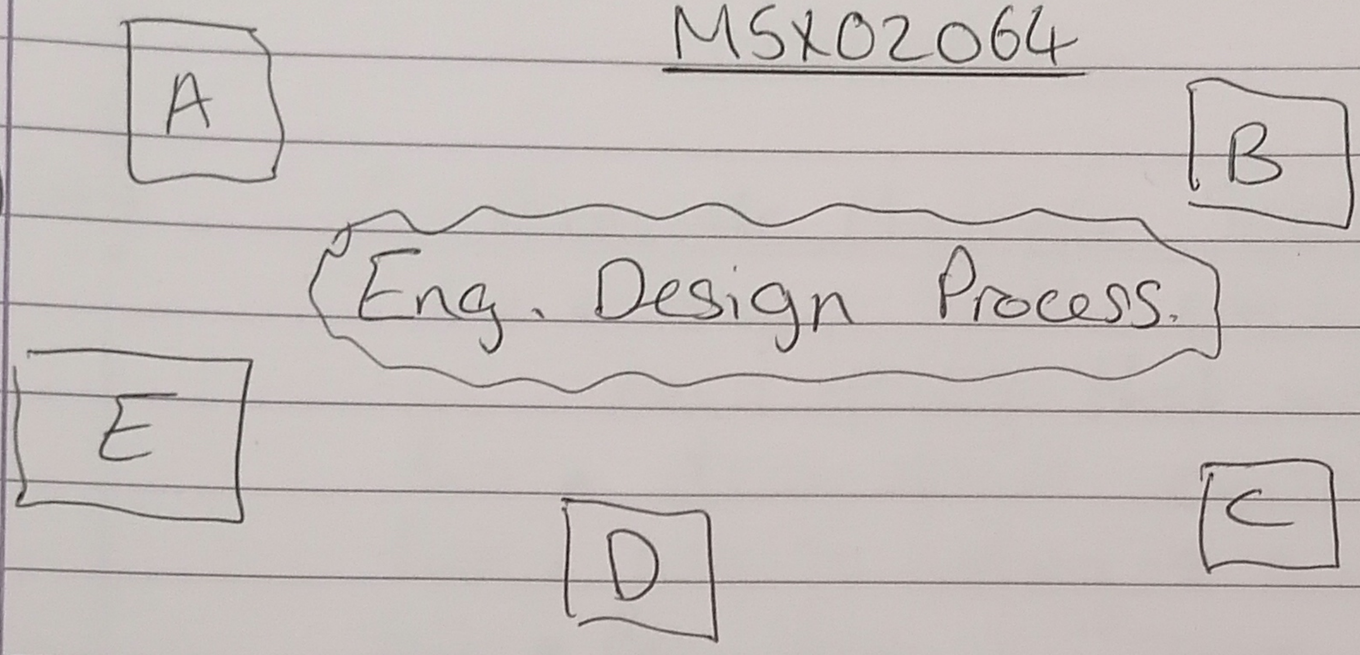
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Q2) a)



A = Define the Problem
B = Gather Information
C = Generate Multiple Solutions
D = Analyze and Select a Solution
E = Test and Implement Solution

A = Define → • contains a listing of product / customer requirements / needs
→ • contains specific information regarding product functions + features
→ • Availability of products similar + criteria for success

B = Gather
↳ • gather info that relates to problem
↳ • existing solutions?
↳ • other important factors eg. cost, availability etc.

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Q2) a) (cont.)

C = Generate Multiple ~~Scenarios~~ Solutions

↳ • begins with creativity in generating new ideas that may solve problem

↳ • deconstruct existing solutions

↳ • what's wrong → how to improve?

↳ • Brainstorm + share ideas (synthesis)

D = Analyse

↳ Analyse solutions + decide upon which solution is best suited for implementation.

↳ functional analysis

↳ does it work how it should do?

↳ ergonomics

↳ how do people interact with machines.

↳ Safety + Liability

↳ Economic + Market Analysis

↳ design evaluated against criteria such as Sales, costs etc.

↳ Mechanical Strength

↳ heat produced

↳ longevity of product

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(Q2) a) (cont.) ↳ decision process

↳ which solution is best?

↳ ranking order of solutions.

E = Test + Implement Solution

↳ final phase → Prototyping

↳ build first fully operational production of the complete design soln.

↳ Concurrent Engineering

↳ Ability to implement parallel design analysis in which safety, manufacturability, serviceability, marketability and regulatory compliance.

↳ Possible through CAE tools + software

↳ documentation → communication of design to be easily interpreted by those lacking knowledge of technical details.

↳ Patent Application.

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Q2) b) FEA = Finite Element Analysis

↳ Taking a complex problem and splitting into smaller pieces which can be approximated and solved to get a solution.

FEA helps with most steps during the engineering design process, especially for data evaluation and generating multiple solutions, and also during the analyse and select Stage as the use of computer aided design can speed up the process of FEA when determining ~~constraints~~ constraints.

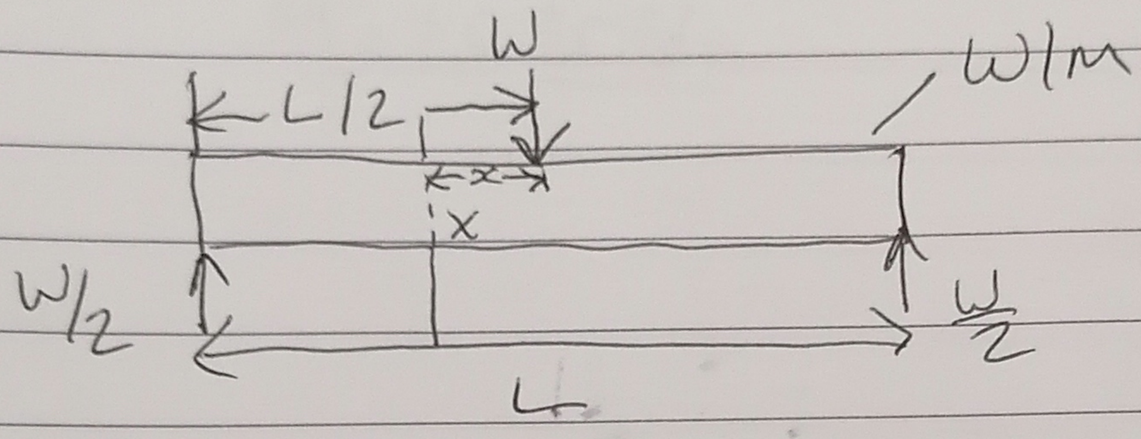
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Q3) a)



$$y = \frac{1}{EI}\left[\frac{WLx^2}{8} - \frac{Wx^3}{12} - \frac{WL^3}{48}\right]$$

$$Mxx = \frac{EI\,d^2y}{dx^2}$$

$$Mxx = \frac{WLx}{2} - \frac{Wx^2}{2}$$

$$\therefore EI\frac{d^2y}{dx^2} = \frac{WLx}{2} - \frac{Wx^2}{2}$$

$$\therefore EI\frac{dy}{dx} = \frac{WLx^2}{4} - \frac{Wx^3}{6} + A$$

$$\therefore EIy = \frac{WLx^3}{12} - \frac{Wx^4}{24} + Ax + B$$

$$y = \frac{1}{EI}\left[\frac{WLx^3}{12} - \frac{Wx^4}{24} - \frac{WL^3x}{24}\right]$$

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Q3) a) Cont.

Q3) b) Max deflection $Y_{max} = \frac{-WL^3}{48EI}$

Y_{max} when ~~[illegible]~~ $x = \frac{L}{2}$

$$Y_{max} = \frac{1}{EI}\left[\frac{WLx^2}{8} - \frac{Wx^3}{12} - \frac{WL^3}{48}\right]$$

$$Y_{max} = \frac{1}{EI}\left[\frac{WL\,\frac{L}{2}^2}{8} - \frac{W\frac{L}{2}^3}{12} - \frac{WL^3}{48}\right]$$

$Y_{max} = \frac{1}{EI}$ [illegible]

Q3) c)

Q3) d) → temperature can expand metal giving x different value, Youngs Modulus may be slightly different, metal may be slightly thinner than expected, Wheel may not be round.

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23) d) Cont. Atmospheric pressure + conditions may also affect results.

23) e) The train i.e. weight, friction, material used as would wear track or expand differently.