



12 Pages

1. Please give the information requested in the boxes below.

2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.

3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.

4. Write your answers in ink.

5. Begin each answer on a fresh page. Do all rough work in the answer book. If you make a mistake, cross it through.

6. No part of this book is to be torn out; it must be handed in complete.

7. ^{max 15} If more books than one are used, fasten them together using the tags available from the invigilator(s).

8. Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.

**Complete, fold and seal
(see note 2 below)**

SURNAME:

Richardson

FORENAME(S):

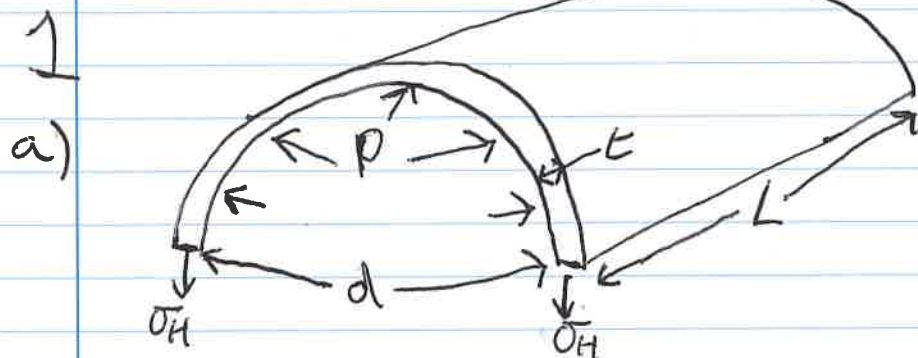
Danny

List the numbers of the questions you have attempted	Office Use
1	16
2	17
3	8
Total	41

(Gweler yr ochr arall am y fersiwn Cymraeg)

68.37





↑ = ↓ Forces are in equilibrium

$$\uparrow = P \cdot d \cdot L \quad \downarrow = 2\sigma_H \cdot L \cdot t$$

$$2\sigma_H L t = P \cdot d \cdot L$$

$$2\sigma_H = \frac{P \cdot d \cdot L}{t \cdot L}$$

$$2\sigma_H = \frac{P \cdot d}{t}$$

$$\sigma_H = \frac{P \cdot d}{2t}$$

b) $\sigma_H = 200 \text{ MPa} \quad d = 3.5 \text{ m} \quad t = 0.0005 \text{ m}$

i $P = \rho g h \quad P_{\text{atmo}} = 101 \text{ kPa at sea level}$

$$\frac{\sigma_H \cdot 2t}{d} = P$$

$$\cancel{200 \text{ MPa}} \quad \frac{200 \times 10^6 \cdot (2 \times 0.0005)}{3.5} = 57142.8571 \text{ Pa}$$

$$57.14 \text{ kPa}$$

Pressure - Cabin =

$$101 - 57.14 = 43.86 \text{ kPa @ 20'000 ft above sea}$$

6
ii

$$P = \rho gh \quad 8000 \text{ ft} - 2438 \text{ m}$$

$$\rho = 1.223 \text{ kg/m}^3$$

$$75.3 \text{ kPa at } 8000 \text{ ft}$$

$$101 - 75.3 = 25.7 \text{ kPa at } 35'000 \text{ ft}$$

C

When pressurising the cabin, it allows the aircraft to fly at higher altitudes where there is less drag resistance, in turn saving fuel for the plane.

d

$$\sigma_H = \frac{Pd}{4t}$$

$$\cancel{P} = F/A \quad P = \frac{F}{\frac{\pi d^2}{4}}$$

$$\frac{\sigma_H \cdot t}{d} = \frac{1}{4}$$

$$A = F/P$$

$$\frac{\pi d^2}{4} = \frac{\sigma_H}{P}$$

$$\uparrow = P \cdot \frac{d^2 \pi}{4}$$

$$\uparrow = \downarrow$$

$$\downarrow = \sigma_H \cdot t$$

$$\sigma_H \cdot t = \frac{P \cdot d^2 \pi}{4}$$

$$\sigma_H = \frac{P \cdot d^2 \pi}{4t}$$

- e When given a cylinder and sphere, the hoop stresses in a cylinder are double that of when in a sphere.
So if the oil is incompressible and is to be under pressure, there will be failures and ruptures.

x (0)

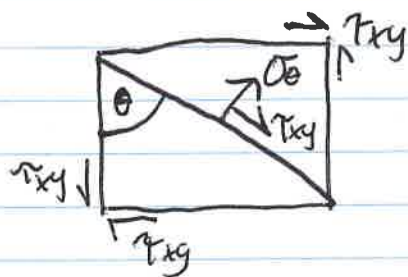
2

- a Principle stress is the maximum or minimum that a element can withstand when considering forces normal to it.

Principle stress on a plane is looking at the shear stress when at an incline from the vertical. Shear stress is 0 when principle stress is at a max or minimum value. And shear stress is at its maximum when on a 45° angle.

(3)

b



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

$$\sin^2 \theta - \cos^2 \theta = -\cos 2\theta$$

$$\sigma_H \quad C_H^A \quad T_H^A$$

Question No.

Examiner Or

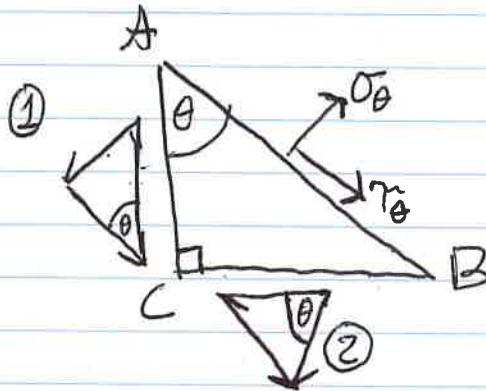
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b

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

$$\sin^2 \theta - \cos^2 \theta = -\cos 2\theta$$

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



$$\begin{aligned} & \downarrow 1 - AC \tau_{xy} \\ & \swarrow - AC \tau_{xy} \sin \theta \\ & \searrow - AC \tau_{xy} \cos \theta \end{aligned}$$

$$\begin{aligned} & \leftarrow 2 - BC \tau_{xy} \\ & \downarrow - BC \tau_{xy} \sin \theta \\ & \swarrow - BC \tau_{xy} \cos \theta \end{aligned}$$

ii

$\uparrow = \downarrow$

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

$$AB \tau_\theta = -AC \tau_{xy} \cos \theta + BC \tau_{xy} \sin \theta$$

$$\tau_\theta = \frac{AC}{AB} \tau_{xy} \cos \theta + \frac{BC}{AB} \tau_{xy} \sin \theta$$

$$\frac{AC}{AB} = \cos \theta$$

$$\frac{BC}{AB} = \sin \theta$$

$$\frac{AC}{BC} = \tan \theta$$

$$\tau_\theta = \cos \theta \tau_{xy} \cos \theta + \sin \theta \tau_{xy} \sin \theta$$

$$\tau_\theta = \tau_{xy} \cos^2 \theta + \tau_{xy} \sin^2 \theta$$

$$\tau_\theta = -\tau_{xy} \cos 2\theta \quad (\tau_{xy} \sin^2 \theta - \tau_{xy} \cos^2 \theta = -\cos 2\theta)$$

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

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

$$AB \sigma_{\theta} = AC \tau_{xy} \sin \theta + BC \tau_{xy} \cos \theta$$

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

$$\sigma_{\theta} = \cos \theta \tau_{xy} \sin \theta + \sin \theta \tau_{xy} \cos \theta$$

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

$$\sigma_{\theta} = \tau_{xy} \frac{1}{2} \sin 2\theta + \tau_{xy} \frac{1}{2} \sin 2\theta$$

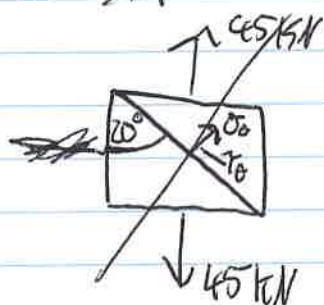
$$\sigma_{\theta} = \frac{1}{2} \tau_{xy} \sin 2\theta$$

(3)

$$P = F/A$$

$$\text{mm} \rightarrow \text{m} \times 10^{-6}$$

$$45 \text{ kN}$$

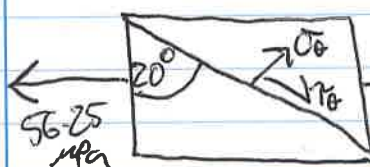


$$\text{Normal } \sigma_{\theta} = \frac{1}{2}(\sigma_x + \sigma_y) + \frac{1}{2}(\sigma_x - \sigma_y) \cos 2\theta$$

$$0.0008 \text{ m}^2$$

$$P = \frac{45000}{0.0008}$$

$$P = 56.25 \text{ MPa}$$



$$56.25 \text{ MPa}$$

$$\sigma_{\theta} = 49.67 \text{ MPa}$$

$$\tau_{\theta} = \frac{1}{2}(\sigma_x - \sigma_y) \sin 2\theta$$

$$\tau_{\theta} = 18.08 \text{ MPa}$$

$$\sigma_{\theta} = \frac{1}{2}(56.25 + 0) + \frac{1}{2}(56.25 - 0) \cos(40)$$

(4)

3

- a) With a design problem, they are to some extent continuous through the project. Because as each iteration is carried forward any problems in the design are shown, fixed and then tested again.

But with an analysis problem, it's more of a finite thing that happens when aiming for a specific answer and doesn't require multiple run throughs to progress. / (3)

- b) When facing a design ~~problem~~ problem, there is many areas that require development. Although if experienced these can be ~~cutted~~ reduced at the start. For example; material type and/or grade, strengthening aids and supports on the part, ~~and~~ aesthetics of the product and final outcome. So when an idea is thought up the design will require multiple adjustments and amendments to achieve its optimum.

With the analysis side of it, this will come into the process early once the part has been through an entire design cycle to perhaps fix an issue or demonstrate why the performance of the part wasn't as expected. / (5)

c) There is the "SIMPLE" process that is used to understand a strategic way of enhancing CTF with the use of finite element analysis.

Good logical process, but a mistake in the input data will ruin output and analysis will become difficult.

The fine design step process that outlines the key areas within an iteration that need to be ~~the~~ fulfilled.

Helping to keep the process on track and remain constant through each iteration.

X

Question No.

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ut y Cwestiwn



3. Rhaid i'r atebion fod mewn llawysgrifen gael ei theipio a chael yr ymgeisydd i dd

8. Rhaid dychwelyd pob llyfr. Ni chaniateir mynd â llyfrau atebion, wedi eu defnyddio neu heb eu defnyddio, allan o'r lleoliad arholi o dan unrhyw amgylchiadau.

[illegible]