



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 and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. 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.**

SURNAME: Cheeseman

FORENAME(S): Michael

1	Student Number	1707473
2	Title of Examination Paper	Advanced Stress & FEA
3	Module Code	MGX00420
4	Date and Time of Examination	31-1-20 1:30
5	Examination Venue	IQ 002
6	Seat Number	
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
1	10
2	14
4	9
Total	33

(Gweler yr ochr arall am y fersiwn Cymraeg)

55%

Q1

- a. Strain energy is the energy caused by placing a load onto an object and deforming. It can be the integral area under the Curve of the Load extension Graph.

/ 2

b. $E = \frac{\sigma}{\epsilon}$ $E = \frac{\sigma}{\frac{\delta L}{L}}$

$$E = \frac{\sigma \cdot L}{\delta L}$$

$$\delta L = \frac{\sigma L}{E}$$

$$\sigma = \frac{P}{A}$$

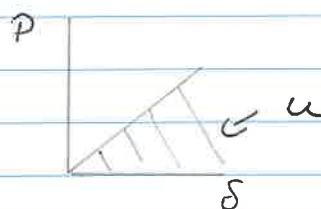
$$\delta L = \frac{PL}{AE} \quad // \text{sub values for } L$$

$$\therefore \delta = \frac{P \delta b}{AE}$$

/

2

c. $\frac{\delta \cdot P \delta b}{AE}$



$$u = \frac{1}{2} P \delta$$

$$u = \frac{1}{2} P \frac{P \delta b}{AE}$$

$$\therefore u = \frac{P^2 \delta b}{2AE}$$

X 0

d the term resilience is the strain energy per unit volume.

$$E. \quad U = \frac{P^2 L}{2AE} \quad \text{or } P = \sigma A$$

$$U = \frac{P(\sigma A)^2 L}{2AE}$$

$$U = \frac{\sigma^2 A^3 L}{2AE}$$

$$U = \frac{\sigma^2}{2E} \cdot AL$$

$$U = \frac{\sigma^2}{2E} \times V$$

$$\frac{U}{V} = \frac{\sigma^2}{2E} = \text{Resilience}$$

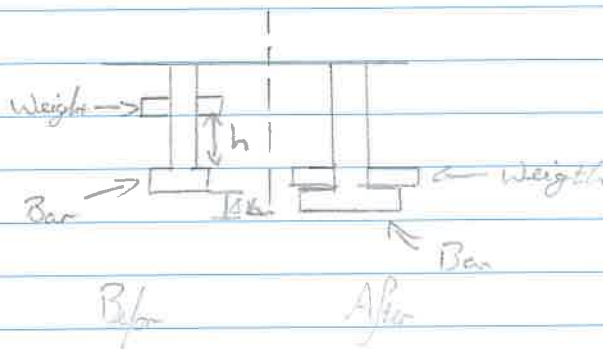
f. $U = \frac{P^2 L}{2AE}$ $P = 200 \text{ MPa}$
 $A = 15 \times 10^{-3} \times 15 \times 10^{-3} = 2.25 \times 10^{-4} \text{ m}^2$
 $L = 1 \text{ m}$
 $E = ? \quad \therefore \text{Assumed } 200 \text{ GPa}$
 $U = ?$

$$U = \frac{(200 \times 10^6)^2 \times 1}{2 \times (2.25 \times 10^{-4}) \times (200 \times 10^9)}$$

$$U = \frac{(200 \times 10^6)^2}{90 \times 10^6}$$

$$U = 444.4 \times 10^6 \text{ J}$$

- 6 If there was a sudden load placed onto it the energy transfer from the P.E. ~~into~~ of the Load to the strain energy would be close to 1 to 1 transfer.



When designing a part this should be taken into consideration to ensure that the ~~strain energy is able move through~~ part is able to take the force of the object if suddenly Applied.

X

Q2a A crack might be initiated due to :

- ① Cyclic Loading on the part
- ② Deformities within the material structures such as voids
- ③ Area Conto Damaged through contact force
- ④ Corrosion to the Material.

2

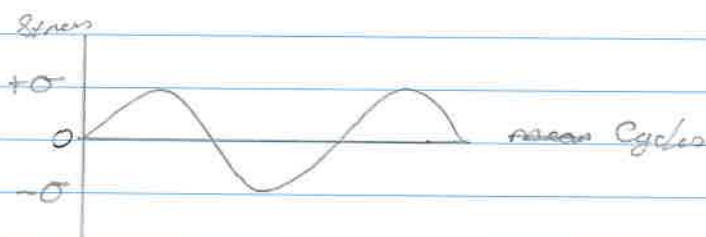
b Three Areas are

Point of initiation
"Arrest lines"

Crystalline structure of the material

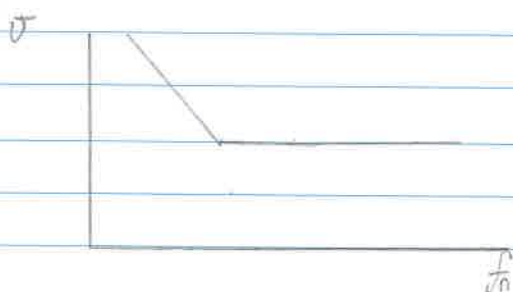
3

c.



Using a rotating - bending with a zero mean stress will aid in helping producing an S-N Curve as it can plot the mean stress ~~off~~ over the ^{fatigue life} number of cycles. if the mean stress were to increase the fatigue life would decrease.

X



$$d. \sigma_r^a N_f = K$$

$$N_f = 10^9 \text{ where } \sigma_r = 100 \text{ MPa}$$

$$N_f = 10^6 \text{ where } \sigma_r = 200 \text{ MPa}$$

$$N_f = ? \text{ where } 150 \text{ MPa}$$

$$\sigma_r^a \times N_f = K$$

$$① (100 \times 10^6)^a \times 10^9 = K$$

$$② (200 \times 10^6)^a \times 10^6 = K \quad \text{Divide by } \sigma_r^3$$

$$100 \times 10^6 \times 10^9 = K$$

$$(200 \times 10^6)^a \times 10^6 = K \times 10^3$$

$$0 = 100 \times 10^6 \times 10^9$$

$$0 = 200 \times 10^6 \times 10^6$$

$$0 = 100 \times 10^6 \times 10^9$$

$$0 = 200 \times 10^6 \times 10^6$$

$$= -100 \times 10^6 \times 10^3$$

$$100 \times 10^6 = 10^3$$

$$a \ln 100 \times 10^6 \times 9 \ln 10 = \ln K$$

$$a \ln 200 \times 10^6 \times 6 \ln 10 = \ln K$$

$$(100 \times 10^6)^a = 10^3$$

$$a \ln 100 \times 10^6 = 3 \ln 10$$

$$a = \frac{3 \ln 10}{\ln 100 \times 10^6}$$

$$\ln 100 \times 10^6$$

$$a = 0.375$$

$$K = 100 \times 10^6 \times 10^9$$

$$K = (100 \times 10^6)^{0.375} \times 10^9$$

$$K = 1 \times 10^{12}$$

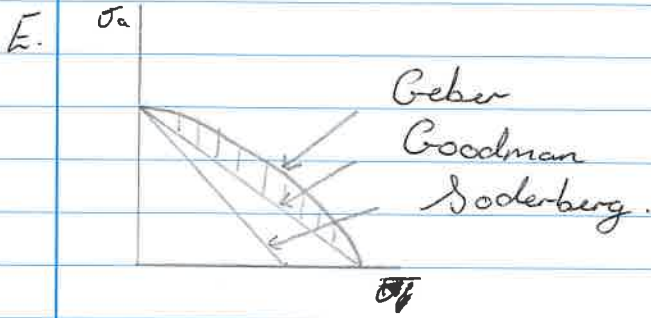
$$\therefore \sigma_r^a \times N_f = K$$

$$N_f = \frac{K}{\sigma_r^a}$$

$$N_f = \frac{1 \times 10^{12}}{(150 \times 10^6)^{0.375}}$$

$$= 858.95 \times 10^6 \text{ Cycles.}$$

15



On the diagram above shows the relationship between the three theories. Most of the failures occur within the shaded region between Geber & Goodman. Most people use Soderberg as it is more conservative.

4

a. Pre-Processing

~~What~~ ~~What~~

Within pre-processing the part will be split down into Elements and nodes depending on the meshing criteria eg if 1D, 2D or 3D is required. Material properties ~~also~~ should be added at this stage as well as any Physical Properties such as second moment of Area for 1D Elements, 2D Element needs the Depth of material. Loadcase is ~~the~~ ^{next} ~~last~~ thing to be added at this time for the boundary Conditions and the Physical load.

Processing.

Here all the calculations are performed to ensure ~~all~~ that the ~~stiffness~~ each node has been calculated for stress, strain and displacement. If the an attached meshing was used either h or P adapted the nodes would increase around the highly stressed areas.

Post Processing.

This is when the results have be calculated and the evaluation can begin. here is were the elements should be looked at to see how reliable the results actually ~~are~~ are.

6

- b. From the statement given it is shown that known that upto date software is more powerfull an quicker at producing results ~~did~~ depending on how powerful the computers are. The higher spect computers are able to calculate more nodes at a quicker ~~time~~ rate than slower ones. This interrr has lead to not needing to reduce the or simplify the geometry to work out these nodes and elements.

3

Question No.

Examiner Only

Question No.

Examiner On

Arholwr yn unig

hif y Cwestiwn

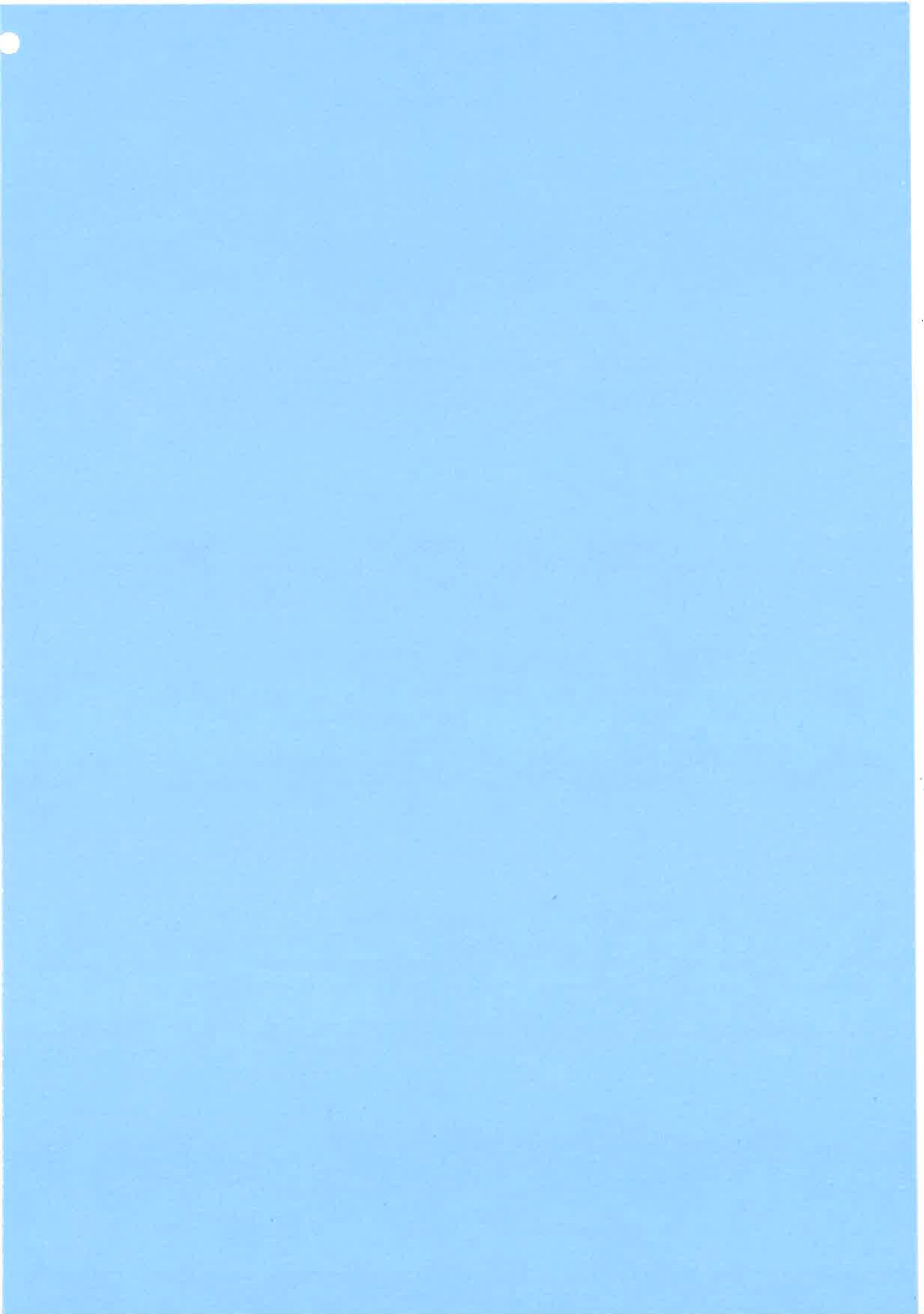
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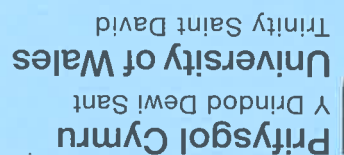
Examiner Only

Arholwr yn unig

Rhif y Cwestiwn

Split
Implant
Material
Physical Properties
Loading
Evaluate.





12 Tudalen

1. Rhwch yr holl wybodaeth y gofynnir amdani yn y blychau isod.
2. Rhwch eich enw yn lle a ddarparwyd ar y dde, plygwch ef at i seilio i lawr (gan ddefnyddio'r label a ddarparwyd) i guddio'ch enw.

3. Rhaid i'r atebion fod mewn llawysgriften ddarlennadwy. Gall yr Arholwyr naill ai anwybyddu sgript annarllennadwy, neu drefnu iddi gael ei theipio a chael yr ymgeisydd i dalu.
4. Ysgrifennwch eich atebion mewn inc.
5. Dechreuwch bob ateb ar dudalen newydd. Gwnewch unrhyw fras nodiadau yn y llyfr atebion a thynnu llinell drwyddynt.
6. Ni ddylid rhwngo unrhyw ran o'r llyfr hwn; rhaid ei gyflwyno yn gyfan.
7. Os defnyddir mwy nag un llyfr, rhwymwch hwy gyda'i gilydd gan ddefnyddio'r tagiau sydd ar gael oddi wrth y gwyllwyr/gwylwyr.
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.

CYFENW:

ENW(AU) CYNTAF:

7	Nifer y Llyfrau Atebion a gyflwynwyd	
6	Rhif Sedd	
5	Lleoliad yr Arholiad	
4	Dyddiad ac Amser yr Archoliad	
3	Cod y Modwl	
2	Teitl y Papur Arholiad	
1	Rhif Myfyrwr	

[illegible]

(See the other side for English version)