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Examination Answer Books

Candidate's Exam Number: _____

Book No.

Total Books
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Complete, fold and seal
(see note 1 below)

SURNAME: HOLLOWAY

FORENAME(S): CRAIG

Programme Title: TEST RANGE ENGINEERING

Year/Level/Stage: _____

Examination Paper Title: STRUCTURAL MECHANICS

Examination Paper Ref No.: M3X0066

Desk Letter/Number: _____

Date: 20/5/2017

Time: 9.00 am/pm

Room Name or No.: MT 202

Instructions to Candidates:

- Please give the information requested above and enter your name in the space provided at the top right of this page. If your answers are to be marked under a scheme whereby the examiners will not know your identity, fold over and seal down the top right-hand corner of the page (using the gummed label provided) in order to conceal your name.
- Commence each answer on a fresh page.
- Do all rough work in the answer book and cross through it.
- No part of this booklet is to be torn out.
- Supplementary answer books if used must:-
 - bear the candidate's name (concealed, where appropriate), reference number and paper title;
 - be numbered consecutively;
 - be fastened together by the tags available from the invigilator.
- Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the exam room.
- Your answers must be legibly written **IN INK**. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.

Summary of Marks

Question Numbers Answered	1st Examiner	2nd Examiner (optional)	3rd Examiner (optional)
1a	6/12		
1b	5/8		
2a	6/12		
2b	5/8		
TOTAL	22/40		
RESULT	55%		

$$1a \quad Y = \frac{(1.12 + \alpha(2.91\alpha - 0.64))}{(1 - 0.93\alpha)} \quad (Y=3.0)$$

$$3(1 - 0.93\alpha) = (1.12 + \alpha(2.91\alpha - 0.64))$$

$$3 - 2.79\alpha = 1.12 + 2.91\alpha^2 - 0.64\alpha$$

$$0 = 2.91\alpha^2 + 2.15\alpha - 1.88$$

$$\text{Quadratic equation} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{-2.15 \pm \sqrt{2.15^2 - (4 \times 2.91 \times -1.88)}}{(2 \times 2.91)}$$

$$= \frac{41968}{0.41678} \text{ or } 0.420 \text{ to 3 pp}$$

Equation with '-' sign = -1.159 so is discarded.

$$d = \frac{a}{w} \quad d \times w = a \quad (w = 20 \text{ mm})$$

$$? \quad 0.42 \times 25 \times 10^{-3} = a$$

$$0.0105 \text{ m}$$

$$= 10.5 \text{ mm}$$

$$\text{or } 10.5 \text{ mm}$$

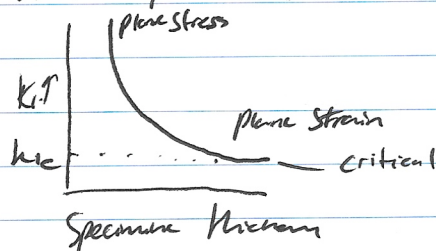
$$K_{Ic} = \sigma \gamma \sqrt{\pi a}$$

$$= 150 \times 3 \sqrt{\pi \times (10.5 \times 10^{-3})}$$

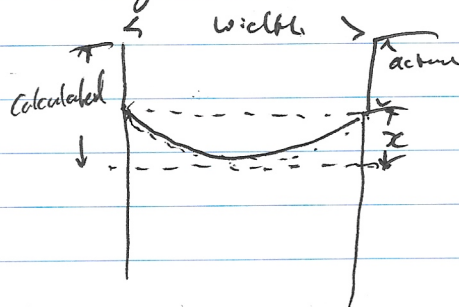
$$= 81.73 \text{ MN}$$

1 b) Methods of measuring crack length are; ~~Visual~~ - simple to use		
	~~Advantage~~	~~Disadvantage~~
Visual	Simplistic	hard to monitor and gauge
Potential drop	good Accurate to measure	can be inaccurate due to arcing at tip due to arcing
Ultrasonic	good flaw detection	hard to define tip
~~Photo~~ Acoustic	good flaw detection	hard to calibrate

A crack would normally bow due to the differing plastic zone sizes. At the surface the material will be in a state of plane stress, the plastic zone size will be larger, the material around the crack will have past its yield point and will deform more. Further in the material, the plastic zone size will be smaller due to plane strain and it will be harder for the crack to propagate.

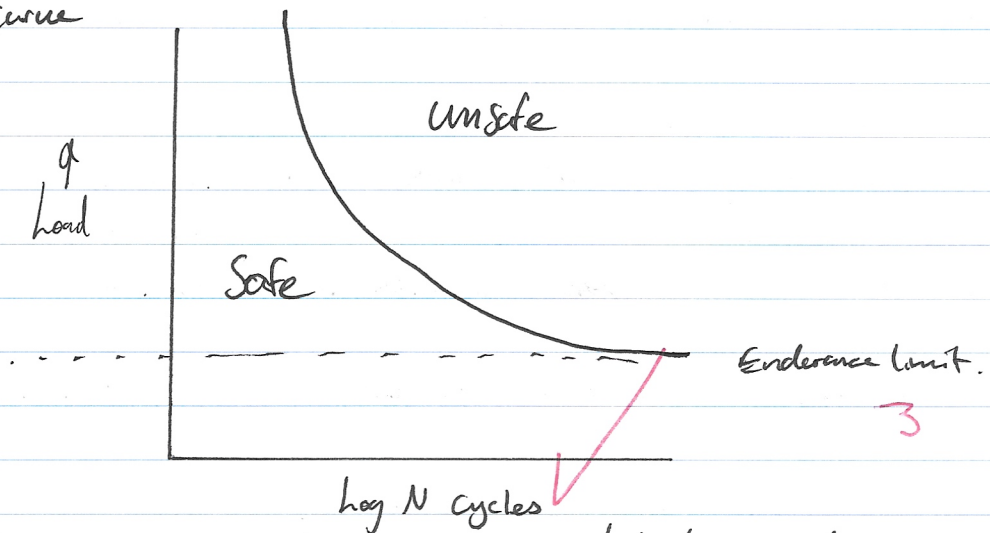


Average crack length can be calculated = $\frac{2}{3}$ Calculated + actual

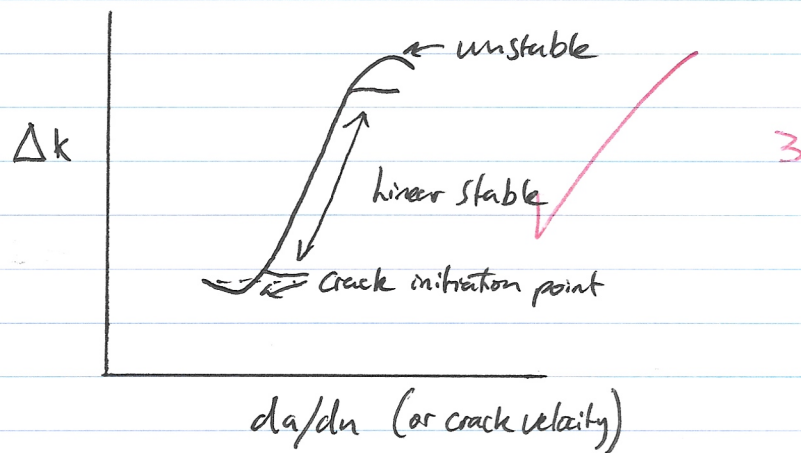


$$\text{average} = \frac{2}{3} x \times \text{width}$$

2a) SN curve



In theory this means if you keep a specimen below the endurance limit, it would last indefinitely but this test (normally a cantilever) uses a prepared specimen that is polished and blended to remove stress concentration points and isn't affected by environmental factors. so As such, it is unrealistic but it is useful for compare materials.

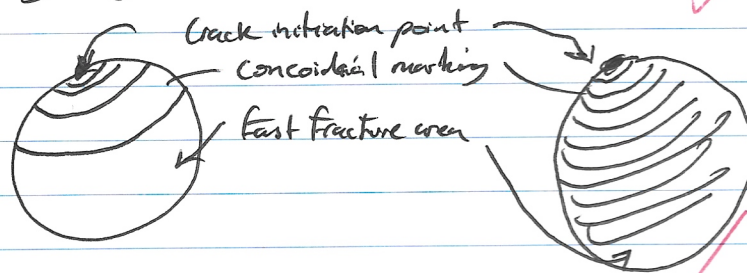


This can differ due to voids or imperfections in the material. They both use a logarithmic scale so can be visually misleading to real world applications.

6/12

2b) Minimising fatigue can be done by the following.

- Having a good surface finish, polishing and blending out sharp changes in ~~and~~ angles; removing stress concentration points.
- Placing the surface in a state of compression by shot peening or nitriding. ~~Also~~ Strengthening the surface against cracks
- Changing work procedures to have slow startup and stop cycles, Minimising vibration and sinusoidal loading cycles.
- Reducing any load to reduce fatigue. eg.



high load

low load

fatigue is still happening but at a slower rate with a lower load.

5/8