

Candidate's Exam Number: P144280

**Total Books
Handed In:**

Year/Level/Stage: Bery Qinet. Q

Examination Paper Title: Structural mechanics

Examination Paper Ref No.: M3x0066 Desk Letter/Number: _____

Date: 20/5 / 2017 Time: _____ am/pm Room Name or No.: _____

Summary of Marks

1. 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.
2. Commence each answer on a fresh page.
3. Do all rough work in the answer book and cross through it.
4. No part of this booklet is to be torn out.
5. Supplementary answer books if used must:-
 - (a) bear the candidate's name (concealed, where appropriate), reference number and paper title;
 - (b) be numbered consecutively;
 - (c) be fastened together by the tags available from the invigilator.
6. Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the exam room.
7. 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.

Question Numbers Answered	1st Examiner	2nd Examiner (optional)	3rd Examiner (optional)
1a	12/12.		
1b	7/8		
3a	7/10		
3b	7/10		
TOTAL	33/40		
RESULT	82.5%		

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

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

$$3.0(1 - 0.93\alpha) = 1.12 + \alpha(2.91\alpha - 0.64)$$

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

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

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

a b c

$$\alpha = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

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

$$= \frac{-2.15 \pm \sqrt{26.51}}{5.82}$$

$$= \frac{-2.15 \pm 5.149}{5.82}$$

$$\alpha = 0.515 \quad \text{or} \quad -1.254$$

↑

$$25\text{mm} = 0.025\text{m}$$

$$\alpha = \frac{a}{w}$$

$$a = \alpha w$$

$$a = 0.515 \times 0.025$$

$$a = 0.012875 \text{ m}^2 \quad \text{or} \quad 12.875 \text{ mm}^2$$

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

$$K_{Ic} = 150 \times 10^6 \times 3 \times \sqrt{\pi \times 0.012875}$$

$$K_{Ic} = 90.5 \text{ MNm}^{-2} \text{ m}^2$$

b; ~~Crack length can be measured~~

i) X-Ray - the sample could be xray, would not work on metals as metals absorb the xrays.

ii) resistivity - the sample could have two electrodes placed on it and the resistance could be measured. Not reliable as the crack ~~too~~ does not fully separate and this would give false reading due to unknown amount of contact in crack

iii) dye - adding dye to the crack, the dye ~~would~~ would go into crack through capillary action. ~~not~~ will not show the crack internally only on surface so not a true

2

2

12/12

1

1

1

representation of crack.

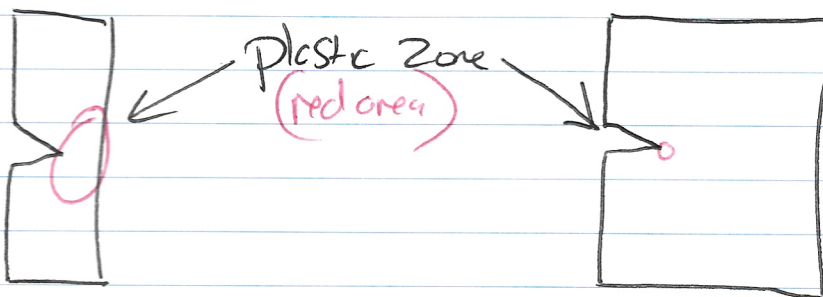
iv) Ultrasound - the piece could be tested ultrasonically, issues with ultrasound is it only represents a 2D model so crack may not be displayed fully.

bii) A crack would bow during propagation due to plain stress and plain strain.

in a thin sample the plastic zone is large and in a thick sample the plastic zone is small.

thin sample

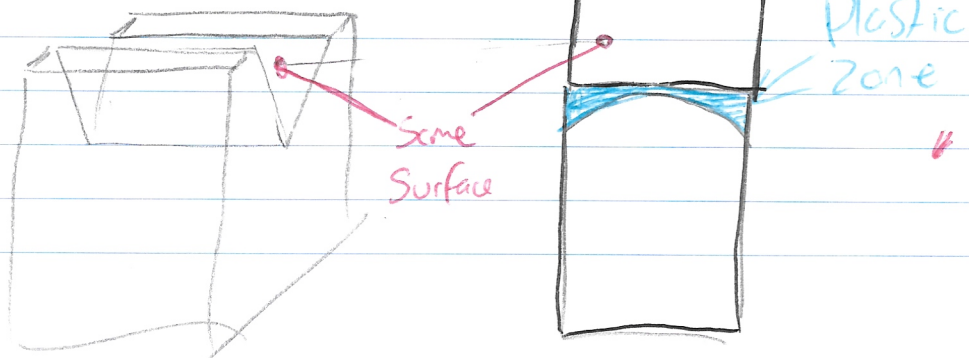
thick sample



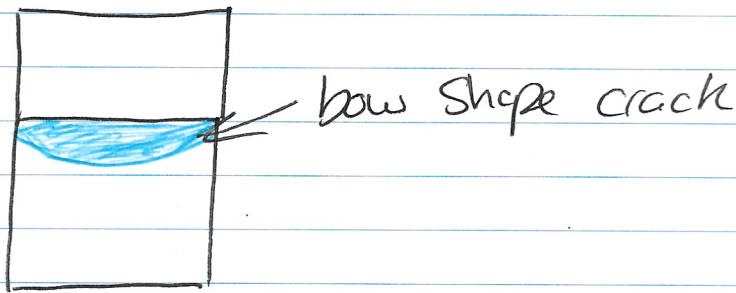
If you take the sample and look along the pre-made crack the plastic zone would vary in size.

3d model

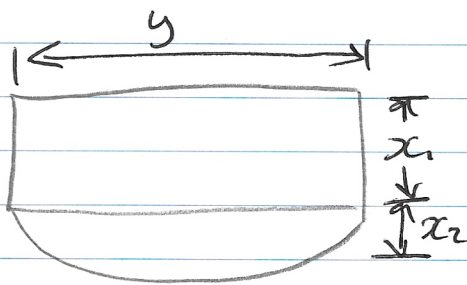
2d model



The Plastic Zone on the outer edges of Sample are larger than the centre, so this means that the outer edges ~~can take more energy~~ can absorb more energy through plasticity than the centre. as the centre takes less energy it cracks first, as the energy increases then the sample cracks grow to the outside of the sample, but the crack also develops down the centre too, causing the bow shape.



The average crack length can be calculated by the following method



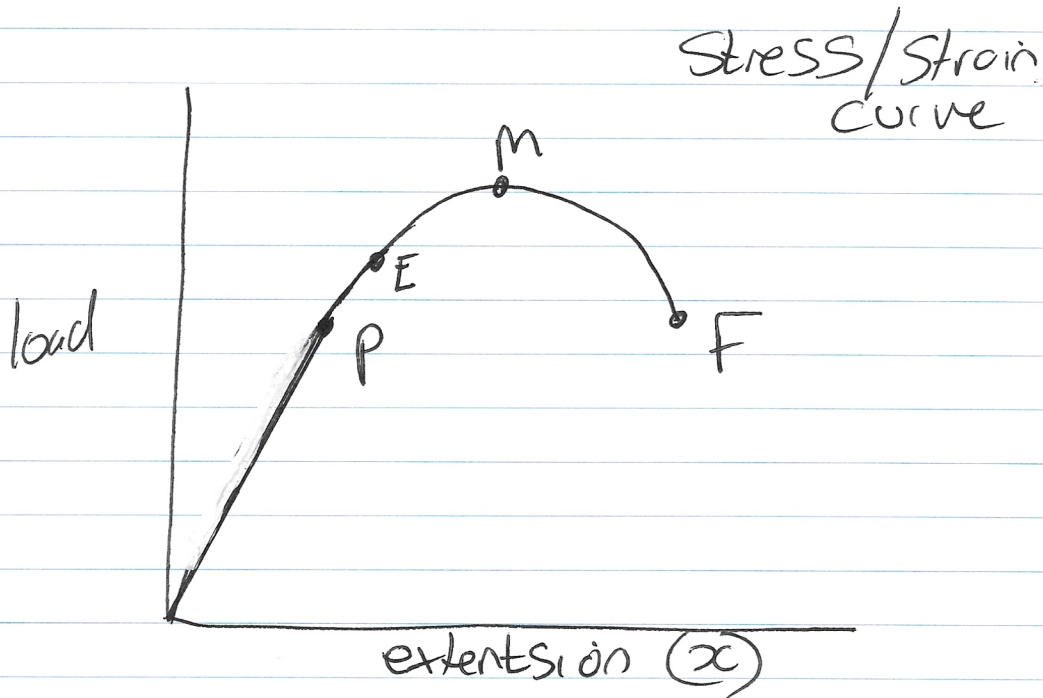
area calculated for rectangle
 $= x_1 \times y$

area in curved area =
 $\frac{2}{3} \times x_2 \times y$

average
 so ~~total~~ crack length =

$$x_1 y + \frac{2}{3} x_2 y$$

3a



P - limit of proportionality

This is where the sample increases in length in proportion to the load up to the limit where after that the sample will increase in length with no relationship to the load.

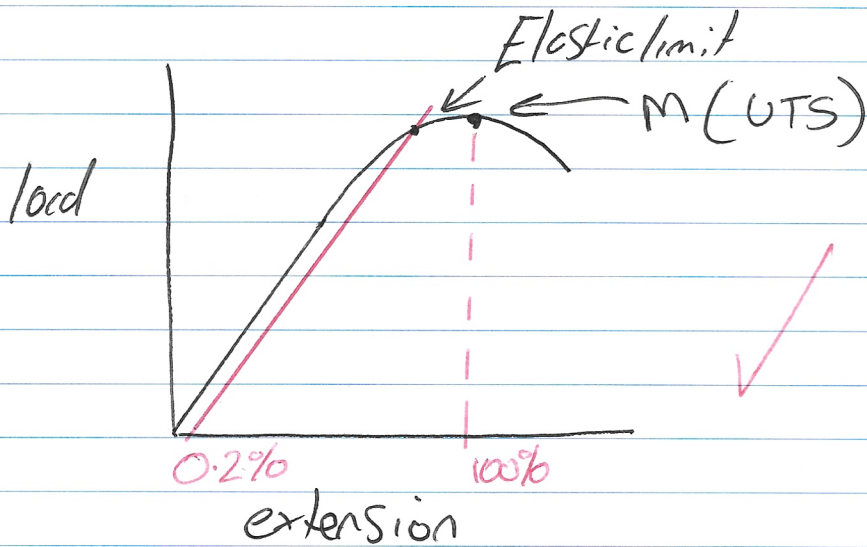
E - Elastic limit

This is the point where after this the sample will not return to the original shape and size when the load is removed and experience permanent deformation.

This can only be given as a theoretical figure, and is worked out in the following way.

A point on the graph which is 0.2% extension of the ultimate tensile strength. A line is drawn perpendicular to the line of the proportionality line.

where this line crosses the line on the graph is the theoretical elastic limit



M - Ultimate Tensile Strength

This is the point in the sample where the maximum load on the sample has been reached and the sample continues to deform with less force applied.

This point is considered the maximum force or ultimate tensile strength of the material.

F - Failure point

This is where sample fails and fractures.

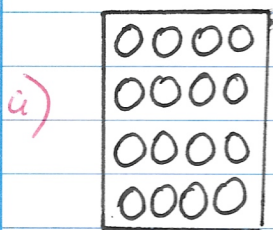
Other results that can be seen from this test is how much energy can the sample take by calculating the area under the graph.

The CSA of the sample can be measured to see how much necking has occurred before failure.

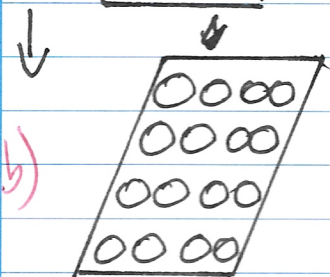
The ductility of the material can be ~~calculated~~ calculated by the % elongation this is calculated by ~~measuring~~ measuring the sample's length at failure and the original length.

7/10

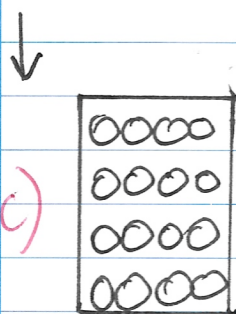
3b) when a material is subjected to a tensile test, the following happens



Sample in original state
molecules packed together.



when a load is placed on the sample then it deforms. If the force is only within the elastic limits of the material then the sample will return back to its original state.



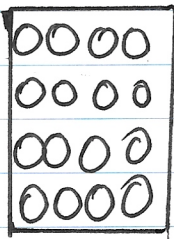
a) original state

b) sample under load

c) original state

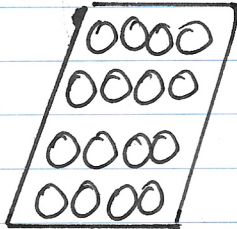
3b)

a



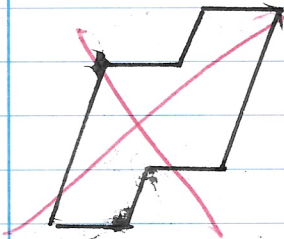
If the load placed on the sample is greater than elastic limit ~~th~~ then the molecules slip and cause permanent ~~defor~~ deformation

b

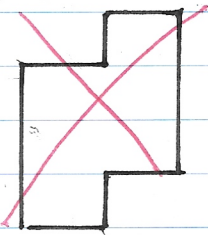


a) Sample in original state

b) Sample deforms but still in elastic limit

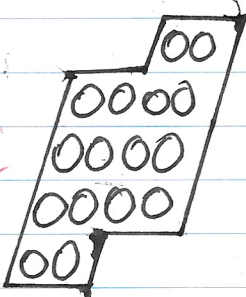


c) as the load is increased past the elastic limit then the molecules slip.

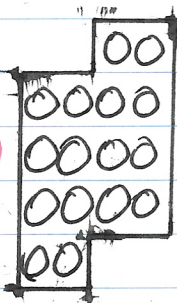


d) when the load is removed from sample, the sample returns to ~~an~~ ~~for~~ state ~~to~~ to a state similar to the original shape but with permanent deformation.

c



d



The difference between metals and polymers is the way the molecules are packed together.

metals ~~are~~ molecules are stacked together in a centre cubic structure ~~with~~, ~~which~~ which can be classed as Austenite.

Polymer molecules are stacked together in a face cubic structure, which is classed as Martensite.

there is a greater amount of molecules in the polymer structure than the metal structure. of the same size.

This means that the metal molecules are more prone to slipping than the polymers molecules. Hence why metals are able to be deformed before cracking ~~but~~ ~~polymers~~ (ductile) but the polymers crack with a much deformation occurring (fragile)

When conducting the tensile test there are certain considerations to be taken into account

firstly the samples ~~all~~ are all manufactured to the same specification, the length of the specimen ~~is~~ has a relationship to the diameter

$$\therefore \text{gauge length} = 5.65 \sqrt{\pi r^2}$$

The sample needs to be mounted in the test set in the correct alignment otherwise it will be subjected to other forces not intended for this specific test.

The results obtained are based on a specimen that is manufactured in a near perfect state, so any anomalies are ruled out.

This means the test is not a good example of real world forces on the material, but does give a good comparison of other materials tensile strengths based on the exact manufactured design piece.
test

7/10