

Name - Daran Griffiths (1909143)

Date - 5th February 2021

Time - 2pm-4pm

Module- M6X00420 - Advanced Stress and FEA (PT) 2020/2021

Q1.

FEA can be used to reduce the number of prototypes used in the testing phase due to use of using virtual prototype testing, this reduces the need for building physical prototypes which can be timely and expensive, also the use of virtual prototypes not only reduces the amount of testing time and cost but also the FEA environment optimizes the structural development of the part, this structural optimisation for example could be topology, this would ~~ensure~~ ^{ensure} that no major ~~load~~ load paths are missed and the design will inevitably be a more efficient solution.

b,

Physical prototypes may still be needed as FEA is only an approximation of a real problem, a physical prototype may still be needed to verify the FEA output.

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C, Correlation is required as FEA is ~~an~~ an approximation and physical testing is still needed, this can be done by comparing the displacements in the physical test to those seen in the FEA model, this can be done using simple measuring devices, such as DTI's or Strain gauges etc. Other ways can be used to correlate ~~as~~ well, the measurement of forces in certain locations by the use of load cells or accelerometers. Also FEA models results could be compared by the simple use of mechanics of materials type hand calculations.

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Question 2.

a) Pre-processing stage is a very important step in the FEA analysis, meshing your part is particularly important step in the pre-processing stage, the quality of your mesh can significantly influence your results, some checks you should perform: -

1, Element size - this is a trade off between runtime and accuracy, generally the smaller the mesh the more accurate the results, but can take longer to analyze.

2, Element quality - The assumptions that are made from node to node across the elements are only valid if the elements ~~maintain~~ maintain the 'perfect shape'. If the elements deviate from this, then the results are questionable, checks could include Aspect ratio and jacobian

3, Element free edges ~~Element duplicate~~ - This is dependent on the quality of the cad ~~and~~ model and how well edges are butted up to each other, if this edges are butted up but not 'stitched' together, when meshed and the nodes between the two meshes are not connected then the part will behave as if the surfaces are independent of each other.

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4, Element duplicates - This can happen due to the quality of the CAD, for example, overlapping surfaces in the model when in reality there is only ~~just~~ one surface, this can cause a result of the FE model actually being stiffer than in reality

5, Element normals - The element normal is dependant on the order that the nodes are generated, this can influence contacts in non linear analysis (i.e crash analysis). This can influence any stresses etc seen if these are plotted on the top/bottom surface.

The meshing stage is one stage of the preprocessing stage of FEA, this is the Splitting stage of the S.I.M.P.L.E acronym as seen below

S - Splitting into small elements

I - Interpret the geometry

M - Material information

P - Physical properties

L - Loading

E - Evaluation of results.

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Question 2.

b, Processing stage describes the actual computer running the analysis and calculations (using matrix algebra), in order to solve the equations generated from the stiffness matrix and boundary conditions.

c, Post processing stage means the interpreting of the results, you would check whether any previous steps have been influenced, does any data need to be updated, using a computer to carry out FEA can give only approximate results. Correlation to evaluate your FE results is needed by the use of testing and hand calcs, as like any computer generated ~~results~~ information / garbage in = garbage out

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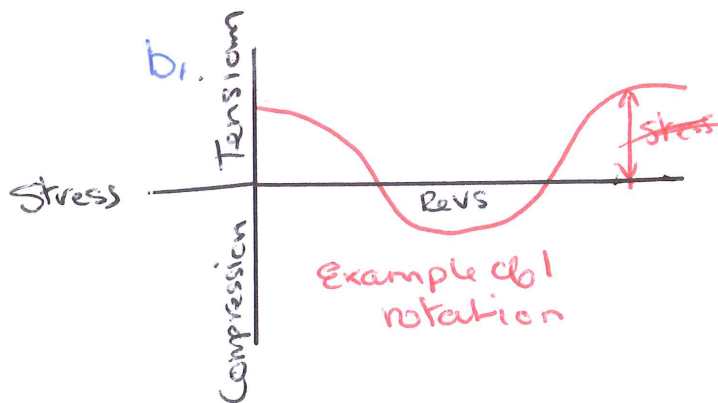
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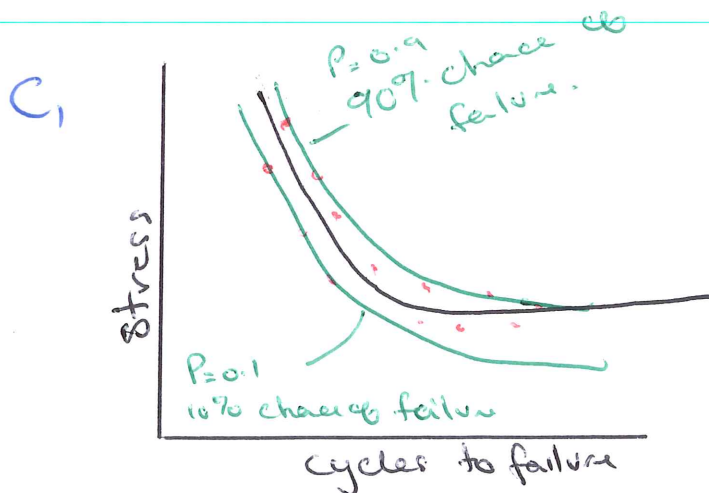
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Question 4.

- a, The Wohler machine can be used to carry out a fatigue test, fatigue tests are usually carried out under conditions of rotating-bending and with a zero mean stress.



The Wohler machine puts the top surface in tension, bottom surface in compression



Repeated tests plotted with varying stress amplitude could be completed and a line of 'best fit' could be drawn, this line would be fitted to these experiments as probability of failure.

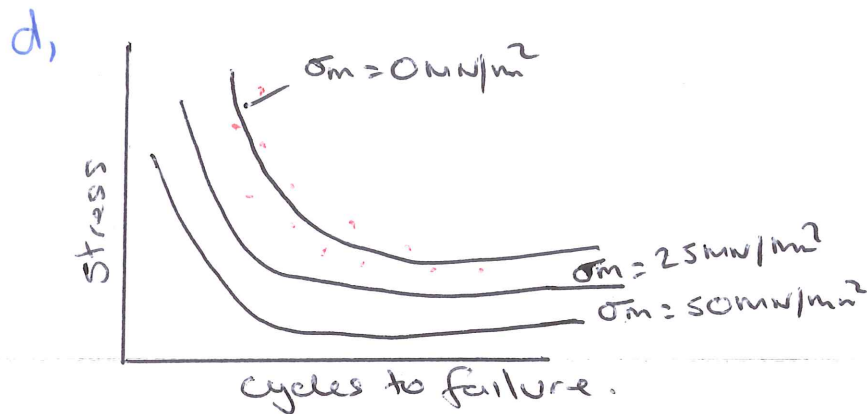
- a P/S/N curve is a probability S/N curve, to overcome the use of multiple tests needed, multiple tests of the same stress are done and the probability of failure can be calculated.

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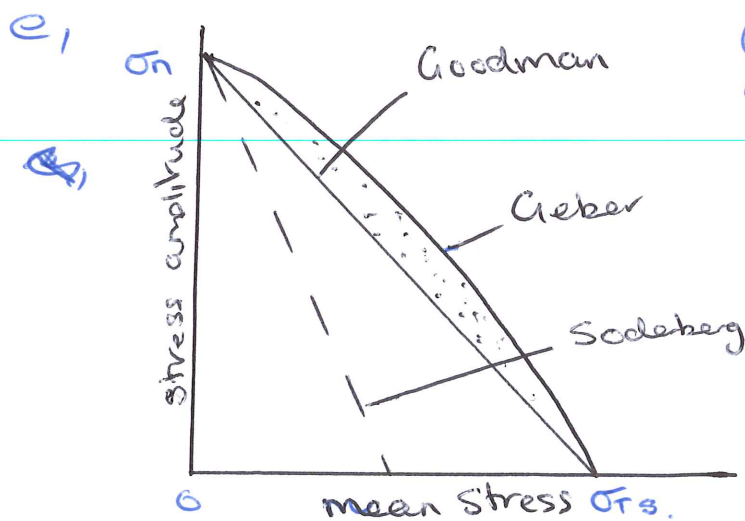
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As mean stress on a specimen is increased,
then the fatigue life is reduced.



Goodman, Gerber and Soderberg created relationship linking the stress amplitude and the mean stress for a certain sample subject to a certain N^o of cycles.

Soderberg is the most conservative and is often used but in reality most fall inside the shaded area between Gerber and Goodman.