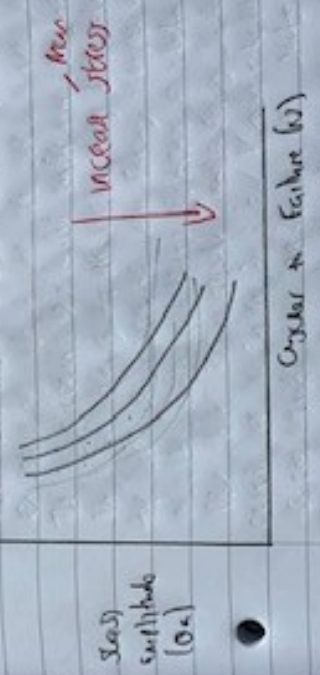


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ADVANCED STRESS + FEA M6X05470

c)



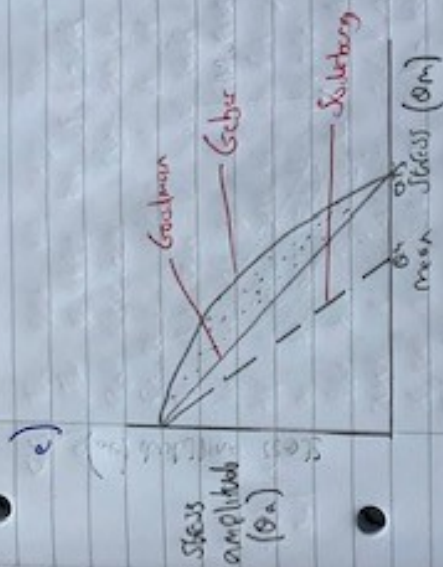
A PSN Curve is the ~~the~~ Probability of Failure of a specimen from a large number of samples. With a degree of variation, this enables the degree of failure probability to be determined. This can influence the design of the product or choice of material.

d) Increase in mean stress results in less number of cycles to failure.

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Most test results fall between the Goodman and Gerber curves. However, with Soderberg giving a margin of safety this is often used.

For example, the stress experienced on an aircraft wing the use of Soderberg with the additional factor of safety, although the likelihood is the wing would be subjected to greater stress. The use of Soderberg would cause failure of the material is not experienced.

Q1 Product development is a fundamental concept for

a) any process. FEA can be utilised to evaluate the performance of a design concept without the

costs of producing 3D CAD within the CAD

Software. Unlike the traditional approach to product

development, whereby each proposed design change would

have resulted in a new prototype being generated, FEA

allows for these design concepts to be altered before

the design has been made and primary CAD model

altered. Additionally, the manufacture of various prototypes

to achieve the optimum design is not only costly

but also time consuming. Although consideration to the

variables during FE modelling such as element type and

element size, even so the time taken to generate an

accurate FEA outweighs that of generating numerous

prototypes to achieve the same outcome. The design

phase for product development is highly dependent on

customer / supplier relations, however customer led

design changes are a common occurrence. This can

be challenging during the design phase with multiple of

revision amendments, however FEA allows for a fast

answer on the success or failure of the change.

FEA also allows for changes to the condition of

the process such as stresses exposed on certain

features, allowing for changes virtual changes as

compared to physical ones and additional prototyping

manufacture.

FEA also enables optimisation of product using

tools such as topology, effectively designing

a solution with greater efficiency.

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b) Although the implementation of FEA has streamlined the design process, the use of physical prototypes can still be of benefit. Ideally, all prototypes would be as accurate as possible. However, a physical prototype is more to be used in a final sign off of the design before mass production can begin. Many customers, such as automotive, may require final sign off due to international standards or accreditation requirements.

c) FEA, although used widely, is still an approximation, (albeit accurate) of the physical design and context. The FEA analysis is governed by the inputs entered by the user during the pre-processing stage. Failure to accurately constrain a feature, or enter incorrect material properties, would influence the stress as high stress concentrations or levels of displacement are noted. Therefore, correlation between test and FEA can give confidence that the physical results achieved, correlate to the virtual results.

Additionally, correlation of the model can be achieved using measuring device such as accelerometers measuring the force experienced at certain critical areas of the model. These can be verified using traditional hand collection.

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Q2

a) The pre processing stage of designing in FEA model is fundamental to the accuracy and success of the finished design. There are many process steps to consider to achieve the desired outcome. Prior to consideration is required to what the outcome is to achieve with the analysis and also what type of analysis will be undertaken. For example is the purpose of the FEA to identify the stresses under load of certain features or optimisation of the overall model.

Selection of the element type within your model will impact the number of nodes and dof's within your model. Although, historically computing power would impact the choice of element used, therefore the use of 1D elements would be time saving, however as we as accurate. However, this isn't the situation with modern computer capabilities today. However, this method can still be employed when evaluating the design. Such as using 3D elements for critical features only to reduce unnecessary ~~analysis~~ additional running time. Additionally, review of the critical features and reduced areas of high stress for example, therefore reducing the number of ~~elements~~ consideration to the number of elements required per feature, i.e. critical or not.

The size of the element must also be considered. With smaller elements generating greater accuracy. However, the complete use of small elements would be unnecessary if the objective was to analyse certain features. However, checks for ~~excessive~~ large difference in stress with neighbouring elements must be considered. (post 8)

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To ensure no errors have been generated during meshing, there are many checks that can be made. These include having the model size checked by an experienced engineer to checking for the number of the edges to duplicate surfaces. Errors such as duplicates or overlapping surfaces can be noticed when the model processor is called, i.e. it double the amount of elements has been entered then material will weight twice as much as expected. Once the material properties have been added, the loading and boundary conditions can then be entered.

b) ~~The pre processing stage is fundamentally seen as the setting up stage of the FE model. This stage is capable of assisting up to the processing of the FE model.~~

The processing stage is fundamentally when the FE model is prepared for assembly and solving the mathematical linear equations. This process is generally all undertaken by the software. However, failure to adequately complete the pre processing phase could result in assembly issues and errors being generated. This could be as a result of poor element quality, such as skewed or issues with aspect ratios. Additionally, an insufficient constrained model could generate an error, demonstrating rigid body motion as a result of external loads.

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- C) The post processing stage is when the overall model is evaluated to see if the cloud results have been achieved. This stage can include checks such as a visual check of the stress concentrations generated, large distances in stress concentration or neighbouring elements suggest the need for remeshing to increase the quality of the results. Evaluation of the FEA and physical results achieved to establish correlation. If the results do not correlate as expected, then review of inputs at the processing i.e. boundary conditions or material properties.

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Q4

a) The washer test subjects the specimen to both tension and compression, demonstrated graphically as a sinusoidal curve.

The specimen is loaded with a weight whilst being held in a bearing, powered by a belt drive. When the top of the specimen is being upwards it is subjected to tension, whilst compression when the same area of the bar is rotated and facing downwards. The combined cycle of compression and tension will generate an S-N curve until the specimen is subjected to fatigue failure. The specimen is at zero stress when it is not in tension or compression.

