

Cory Allen - M6X00420
Advanced Stress Analysis & FEA
1503528

2pm 05/2/2021

Q1)

a) How can FE be used to reduce number of physical prototypes in testing phase? (10)

Due to the ability to create FE models cost and time effectively, numerous modifications can be applied such as change in geometry, thickness of material, choice of material, loading conditions.

These can be roughly split into a abbreviation of S.I.M.P.L.E to fully understand a model, and communicate with the customer/supplier.

By using FEA, ~~any~~ to its full extent, any issues with design should be discovered and addressed in the early stages of design process, CAD and CAE are completed within a feedback loop to lessen the cost and time used for tooling. and in turn will reduce the number of physical prototypes being manufactured.

FEA can also test not only the component, but also the manufacturing method through Hypermesh/Solidworks.

Numerous moulding or forging techniques can be applied to FEA to minimise prototype manufacturing defects.

Thus giving a fully validated design prior to the need to physically test prototypes.

(4) b) Physical prototypes still are required due to current legislation, or safety concern as FE models are only approximation of a physical response. The software act from user input, there still needs to be a level of physical confirmation from theory into reality.

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Cont. b) ~~Other reasons include lack of faith in the model,~~
 which correspond to the lack of faith in a model
 due to trusting a Programme/Software in with a
 depending on the outcome of failure, if the result is
 Catastrophic with a risk to life or environment, then
 physical testing is required, as opposed to a model of
 a door handle where negative impact of failure may not
 be as high (with the exception to fire doors)
 Customers may request physical testing results before the
 can approve a design due to Contracts or law or organiza-
 tions.

(6) c) To increase confidence in the FE model the user must
 Prove that the results are accurate. When meshing the
 Part the ~~Component~~ ~~may~~ Software may incorrectly mesh,
 Checks such as aspect ratios or Jacobian method, checking for
 skewness, element quality should be completed to ensure results
 are as accurate as possible. By repeating the test with
 slight deviations such as loading, condition, stiffness, linearity
 and non linearity, by changing the parameters and if the
 model still performs well then confidence will increase.
 The correlation is needed to as FEA is only an approximation
 of a physical test. There could be many external forces
 that an FEA model could overlook such as temperature,
 material variability, imperfections in design that could cause
 a failure or unexpected results in a test.

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2AM 2.1 of 6

5/2/21

Q1) C) ~~Confidence can be increased~~

Confidence can also be increased by Strain gauging, undertaking Natural Frequency comparison, dynamic response comparison and temperature and Pressure distribution comparison.

Understanding that 10-15% difference in results is considered good Correlation

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Q2) Steps during Pre-Proc stage? ~~would be~~ (10)

Introducing the SIMPLE Plan to ensure as much can be done early in Project to avoid delays.

Split - Whether 1D, 2D, 3D elements are required will affect run time and accuracy. Defining the cross section etc. Reduce degrees of freedom.

Interpolate geometry - Ask if all visible geometry is required. Can any be removed to create a lighter and more efficient solution.

Material information - ^{asses if} ~~with~~ FE model ^{will} be static or dynamic, linear or non linear, how will Young's modulus be affected? *

Loading - Check what forces will be on the component, what equations need to be used for beams etc. Will components be in compression or tension? Assess how that material will react. Load steps.

Evaluation of results - Not Pre-processing, this is Post Processing, however if results aren't as expected then Pre Process needs to run again to ensure continuity.

* Also consider Fatigue life, Ultimate (tensile) Strength, maximum deflection.

This can be run on ^{software} platforms including Hypermesh and Solidworks.

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2pm

5/12/21

Cont a)

Pre

Processing is where all possible questions need to be answered by creating a Problem Statement, what is the Solution type? Are there Constraints Set out by customer etc.

Pre Processing is the most important Part of the Process so it is extremely important to govern all possible outcomes.

b) Processing is the mathematical Solution to the input criteria in Pre-Proc. Algebraic Matrices happen at a high Speed to Process the model. This differs on whether the model needs to give results quickly or accurately.

c) Steps in Post-Proc? (5)

Once the model has been Completed and a visual representation of the results are displayed, it's important to not take these as face value as results are an approximation.

They need to be evaluated by either Correlating to the test or, hand calculations or Physical testing such as drop tests, Photo elastic techniques, and using accelerometers.

The visual representation can be seen as Stress maps, Contour Plots and heat maps.

By questioning the results it shows a deeper understanding to if they results are as expected. Personal judgement can be used to evaluate the accuracy of results.

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2pm

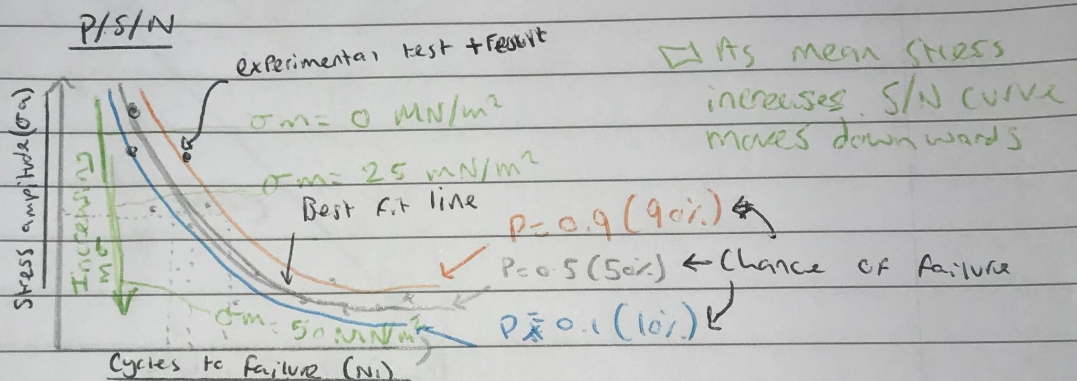
5/2/21

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1503528

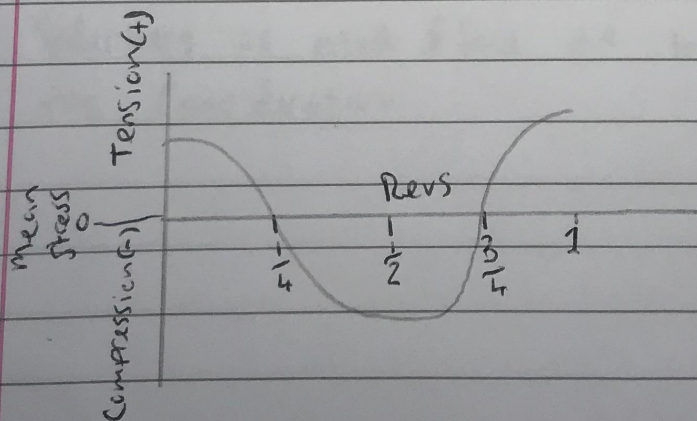
Q4) The Specimen Under goes a sin wave of Compressive and tensile loading, which rotates the Specimen to ensure loading is Symmetrical. The top Surface is in tension, whilst bottom is compressive. ~~The weight~~ The weight is applied as a stress, the more weight is used, the less cyclic loading will occur. The less weight/stress then the number of cyclic loading increases.

Q5)



A P/S/N curve includes the acceptance of the exact Specimen will give vastly varying results. A number of samples are tested at the same stress and thus a more diverse number of cycles is recorded. This can be used in different applications and industries. P stand for Probability.

b)



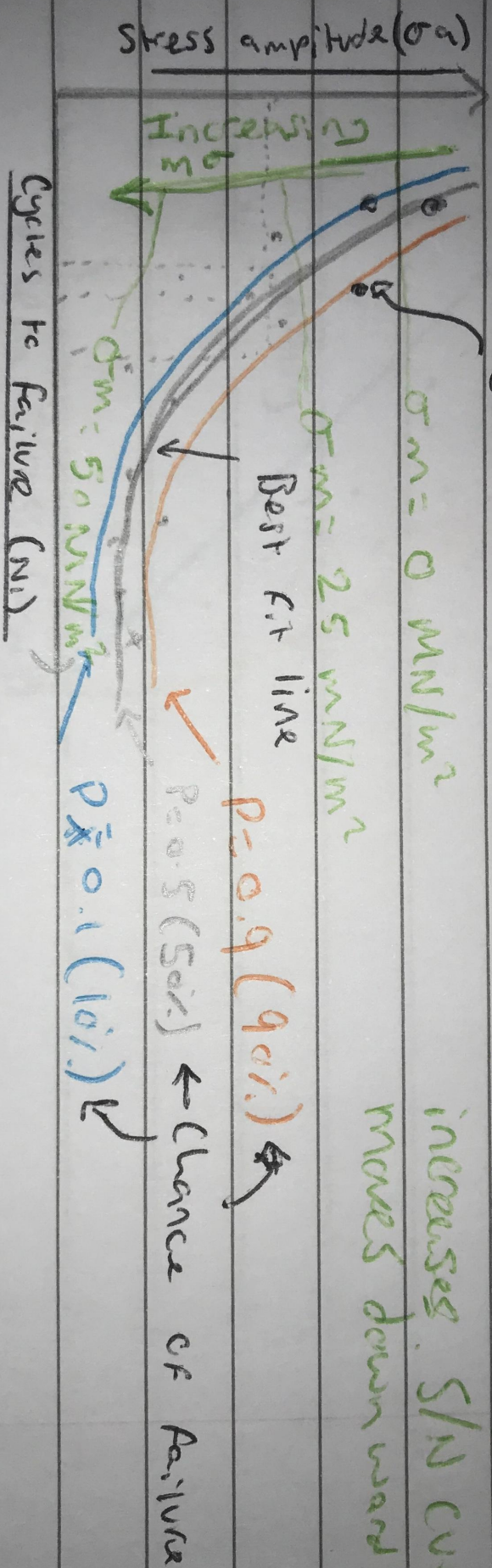
compression is compressive. The weight is affected by a stress, the more weight is used, the less cyclic loading will occur. The less weight/stress then the number of cycles leading increases.

S/N

Experimental Test + Result

Its mean stress

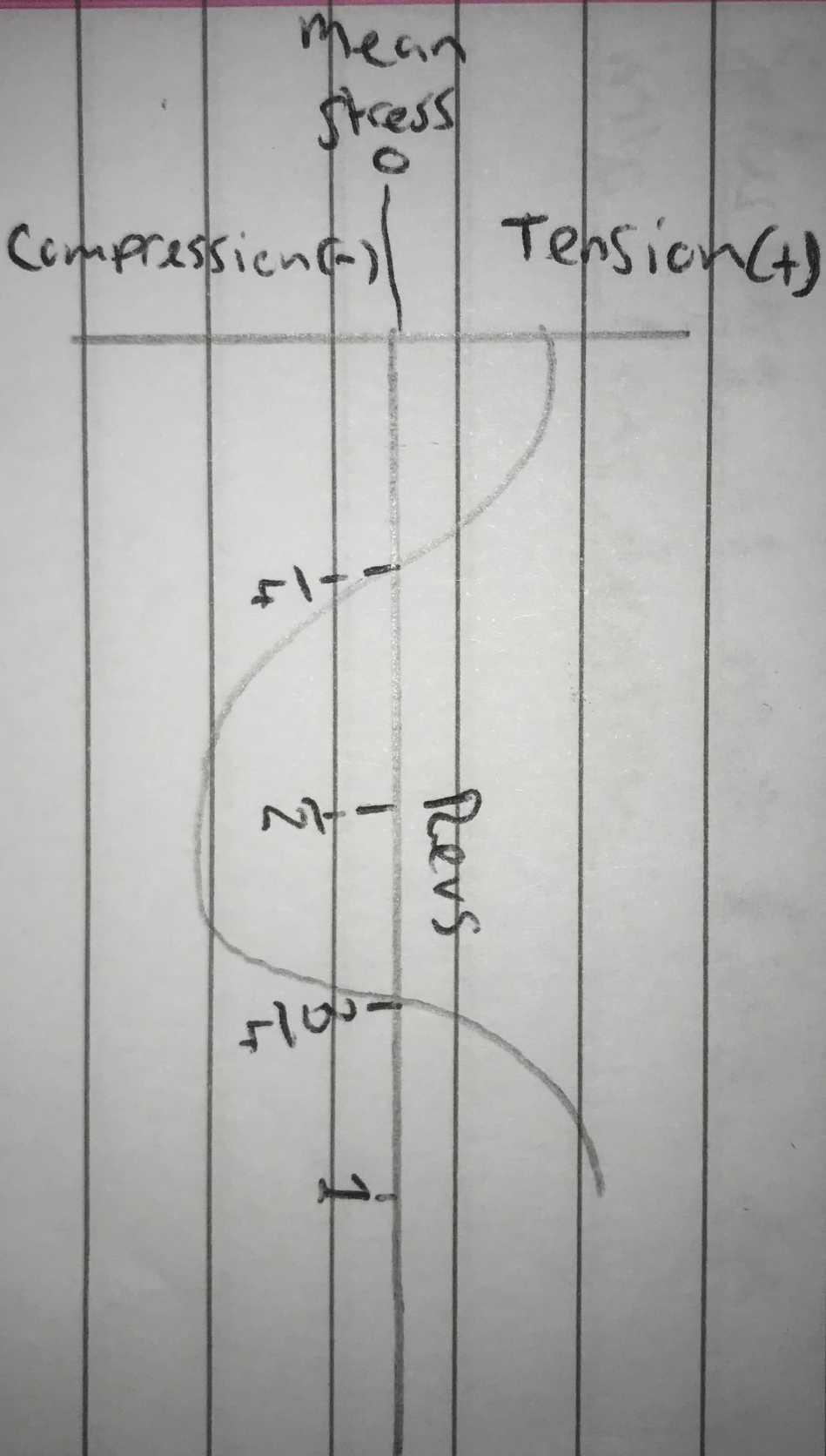
increases. S/N curve moves downwards



S/N curve includes the acceptance of the exact specimen give vastly varying results. A number of samples are tested at the same stress and thus a more diverse

Number of cycles is recorded. The different applications and industries.

(b)

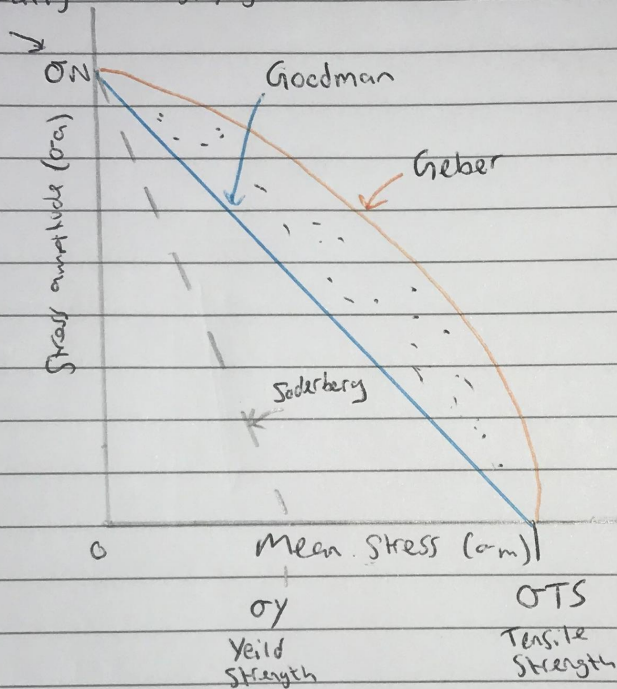


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- e) as stress amplitude increases the less mean stress
 If component tested with higher mean stress stress amplitude must be reduced to see a similar fatigue life.
 Fatigue Strength/cycles under zero



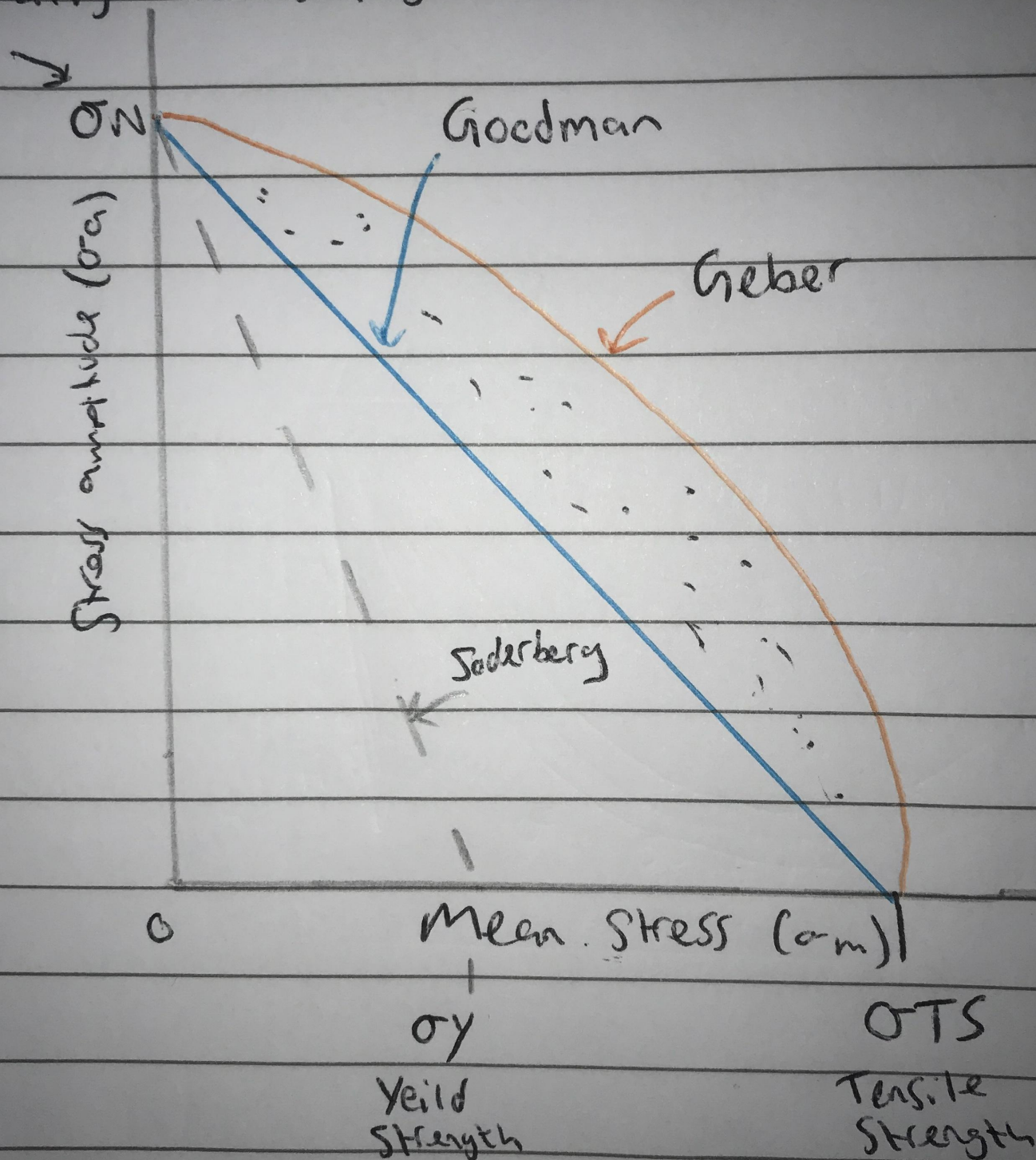
Gerber is the most optimistic of theories as it includes the most stress amplitude and mean stress

Goodman is realistic as the theory goes beyond Yield Strength.

Soderberg is most safe due to taking Factor of Safety into consideration

If component tested with higher
 life must be reduced to see

Fatigue strength / cycles under zero



Gerber is the most optimistic of
 the most stress