Lab 1 Report ME 371

Jiajun Hu
October 9, 2023

Question 1

a) ***Find the theoretical deflection of the beam analyzed in the solid model and compare with the maximum deflection predicted by the FEA model.***

We get the elastic modulus for ASTM A36 is $E = 200\ GPa$ From Wiki

By using deflection equation we get

$$\boldsymbol{\delta_{Max,Cal}} = \frac{FL^3}{3EI} = \frac{1000N \times 500mm}{3 \times 200GPa \times \frac{(50mm)^4}{12}} = \mathbf{0.3999\ mm}$$

By performing FEA test on FUSION 360 we get

$$\boldsymbol{\delta_{Max,FEA}} = \mathbf{0.3961\ mm}$$

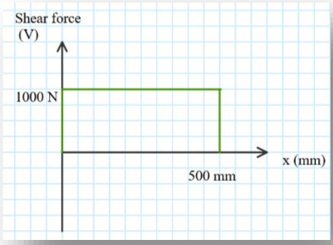
Therefore, we can see the theoretical value is very close to the FEA value.

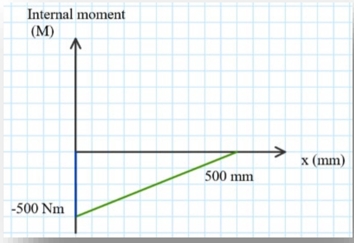
b) ***How does the theoretical deflection compared to the deflection predicted in the model? Does this give you confidence that you set up the model correctly?***

From comparison between calculation and experiment, we see there only exert small error. Therefore we can say the deflection model predicts pretty well. And this gives me confidence that my model setting is correct.

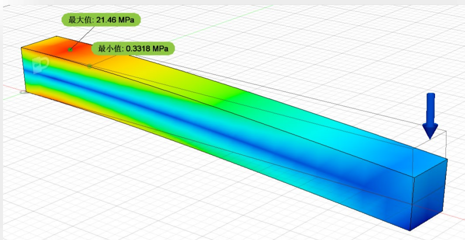
Question 2

a) What is the theoretical maximum stress in the beam from the solid model? Where exactly does it occur?

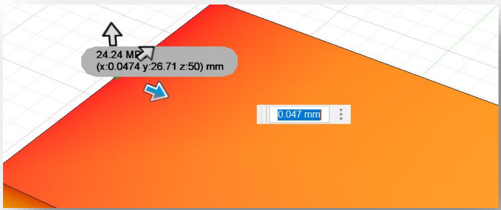




Based on the M-x diagram, the theoretical maximum stress could be calculated as follows



b) What is the FEA-predicted maximum bending stress in the model? Where exactly does it occur? How does it compare to the theoretical prediction?



c) FEA has a tendency to over-predict stresses at sharp corners (perfect 90 degree sharp corners never exist in real world geometry) and at unrealistically stiff supports. While in "Results" mode, use the "Create point probe" button on the top ribbon to hover your mouse around the model and view the stresses at any point. Is the maximum bending stress closer to the theoretical value away from sharp corners? Comment on your findings.

Question 3 (Case 1)

What is the magnitude of the largest strain component? Do the same for the largest stress component (i.e."1st Principal" stress) – how does it compare to the material's yield stress? Recall that we are performing this FEA analysis assuming that the material behaves in a linear elastic manner – are the stresses and strains small enough for this assumption, and therefore the FEA results, to be valid? You do not need to include a screenshot as part of your answer.

$$\sigma_{yield} = 250\ MPa$$

$$\boldsymbol{\varepsilon_{Max,FEA} = 9.511 \times 10^{-5}}$$

$$\boldsymbol{\sigma_{Max,FEA} = 21.46\ MPa \ll \sigma_{yield}}$$

Yes, the maximum strain and the maximum stress are small enough for linear elastic region assumption.

Question 4 (Case 2)

Based on the theoretical load-deflection relation for the cantilever beam, how does the reaction force in the z direction compare to theory? Comment on the result and whether this gives you confidence that the model has been set up correctly.

$$\boldsymbol{F_{React,FEA,z} = 633.343\ N}$$

$$\boldsymbol{F_{React,Cal,z} = \frac{3EI\delta}{L^3} = 625N \approx F_{React,FEA,z}}$$

The theoretical matches the simulation value quite well. So I'm quite confident in my model setting.