Assignment 2

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Finite Element Analysis I

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Abstract

This assignment shows how different modeling approaches of a corner can have an impact on the model. Different methods were discussed and implemented to show significant differences. The plots and the models are created with Abaqus, software from Dassault.

Contents

1 Introduction

We're examining the behavior of an L-beam fixed at one end and subjected to a load at the other end. the region of interest will be the inner corner where we expect the highest stresses. we will examine different setups: no fillet, 1mm fillet, and 5mm fillet.

2 Methods

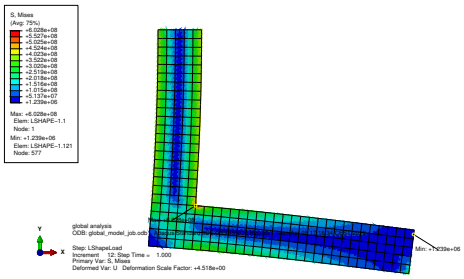
2.1 Global Modeling

We design the L-beam in Abaqus as a global model with no fillet. We then apply a coares mesh to the part and let it run. The results will serve as our baseline for the upcoming computations. The same will be done for the 1mm and 5mm fillet L-beam.

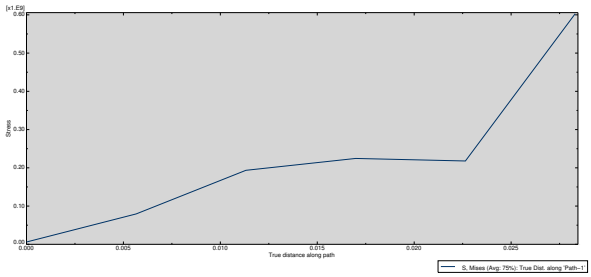
2.2 Submodeling

To each global model, we create a sub model. the submodels do only cover the region around the inner corner and will feature a finer mesh. the reason for sub modeling is the increase in accuracy whilst keeping computational effort manageable. The boundary conditions of the sub model will be taken from the calculations of our global model.

3 Results and Discussion



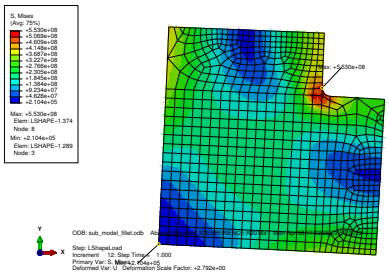
(a) maximal stress: 603 MPa
minimal stress: 1,24 MPa



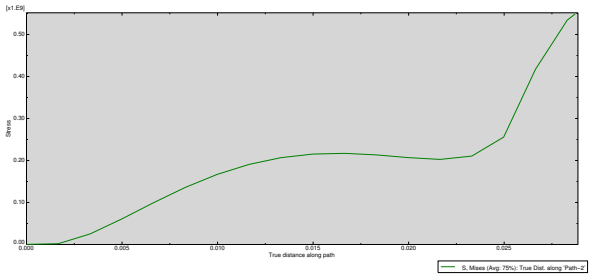
(b) Stress (Mises) in N/m^2 max. 603 N/m^2

Figure 1: Global model with no fillet

We observe, that the maximum stress value for this setup exceeds the yield stress of 500 MPa. We, therefore, expect the beam to be plastically deformed in the region of the inner corner.



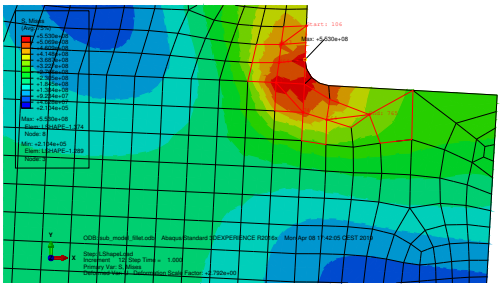
(a) maximal stress: 553 MPa
minimal stress: 0.21 MPa



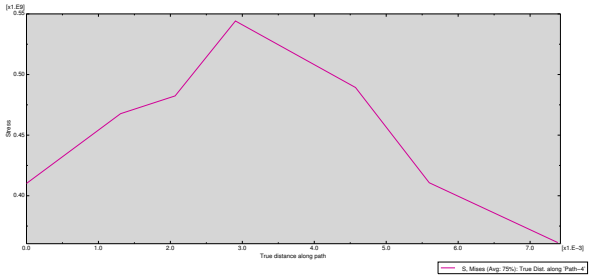
(b) Stress (Mises) in N/m^2 max. 553 N/m^2

Figure 2: Submodel with 1mm fillet

In the submodel with the 1mm fillet, we observe an evenly distributed stress pattern. Also, the maximum value for stress has decreased by about 50 MPa. From a mechanical point of view, the round corner offers a smoother distribution of internal stresses because the lines of forces in a material are not interrupted[2]. However, the maximum stress is still the yield stress of our material, we still expect it to deform.



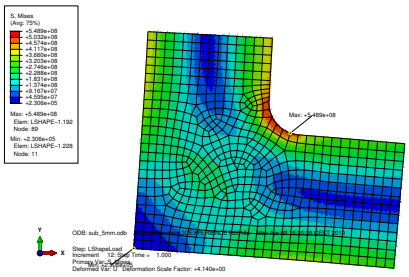
(a) Path around the inner corner



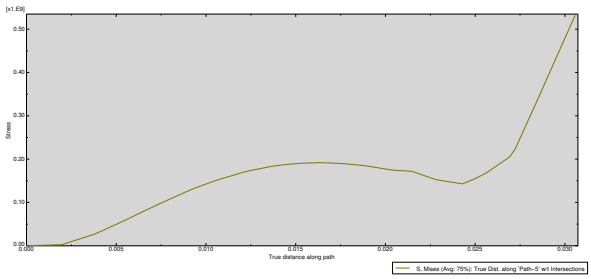
(b) Stress (Mises) in N/m^2 around the inner corner max. approx. 550 N/m^2

Figure 3: Submodel with 1mm fillet

We observe that the stresses are highest in the apex of the corner and decrease rapidly with distance. The max stress of 553 Mpa is not reached in this plot because it represents only one force line.



(a) maximal stress: 549 MPa
minimal stress: 0.23 MPa



(b) Stress (Mises) in N/m^2 around the inner corner max. approx. 500 N/m^2

Figure 4: Submodel with 5mm fillet

The 5mm fillet causes a minor decrease in maximum stress value. However, the region of high stresses is elongated and doesn't reach as deep into the beam compared to the smaller fillet.

3.1 Conclusion

The introduction of a fillet in a sharp corner offers a significant decrease in maximum stresses. Even a small fillet as a big impact on the model, respectively on the result output. Even though the yield stress of the material is still below the maximum stresses (in this exercise), we recognize the notable impact to be crucial for any construction project. In order to achieve a suitable mesh around big fillets, a repartitioning of the model can be necessary. [1]

References

[1] Michel Goossens, Frank Mittelbach, and Alexander Samarin. *The LaTeX Companion*. Addison-Wesley, Reading, Massachusetts, 1993.

[2] Barry J. Goodno, James McGere *Mechanics of Materials (2018)*. (English)

[3] Knuth: Computers and Typesetting,
`http://www-cs-faculty.stanford.edu/~uno/abcde.html`

[4] Michel Goossens, Frank Mittelbach, and Alexander Samarin. *The LaTeX Companion*. Addison-Wesley, Reading, Massachusetts, 1993.