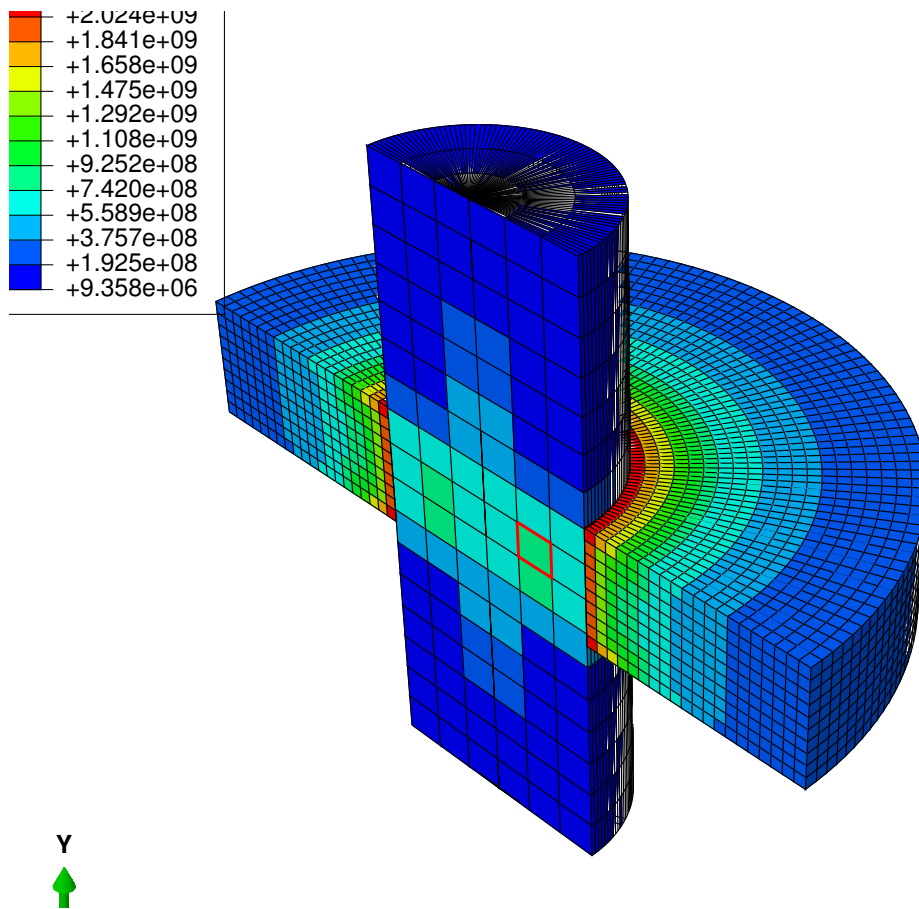


Assignment 7

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Finite Element Analysis I

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Abstract

In this assignment we investigate a cooling disc which is mounted on a shaft. The occurring stresses after cooling are then assessed.

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1 Introduction

The disc is heated up to increase its diameter, then cooled down to form an interference fit. This is a common procedure in mechanics to fit parts together (e.g. bearings on shafts). It is therefore interesting to know, by how much the disc has to be heated in order to get an inside diameter which fits over the shaft. In a practical application, this could be used to specify manufacturing tolerances.

2 Methods

2.1 Diameter as Function of Temperature

The inside diameter of the disc changes with temperature. The rate of change depends on the thermal heat expansion coefficient.

2.2 Modelling

It is important to sequence the model into different steps. Contacts are only activated after both instances are clear of each other (after heating up the disc).

3 Results and Discussion

The results vary greatly with different mesh sizes. Especially when using quilt plots, results may differ quite heavily from one mesh to another, as there is no averaging between elements. Quilt plots are good for evaluation on an element-by-element basis. We reach a maximum mises sstress of around 1.2GPa, which is way below the plasic deformation threshold for the shaft material, which lies at 200GPa. However, it is also possible that this maximum value of 1.2GPa comes from the thermal deformation of the part itself during heating up. When thinkin about the real world application, it seems reasonable that the maximum stresses stay in the elastic region of the materials, because the shaft could not be reused after the diss (or bearing) would be removed. The simulation with a smaller overlap of the parts shows no smaller stress value at the surface. This is qulitatively a questionable result. We would assume, that by having a smaller overclosure, lower stress values would result. From a practical perspective, by dimensioning the overclosure to a certain value (during manufacturing of the parts), engineers can influence the behaviour of the assembly, mainly its ability to withstand axial loads. We assume that there might be errors in the selection of the respective nodes for plotting, or possibly in the material characteristics. However, due to lack of time we were not able to fully investigate further. Corrected results may follow in an appendix to this report.

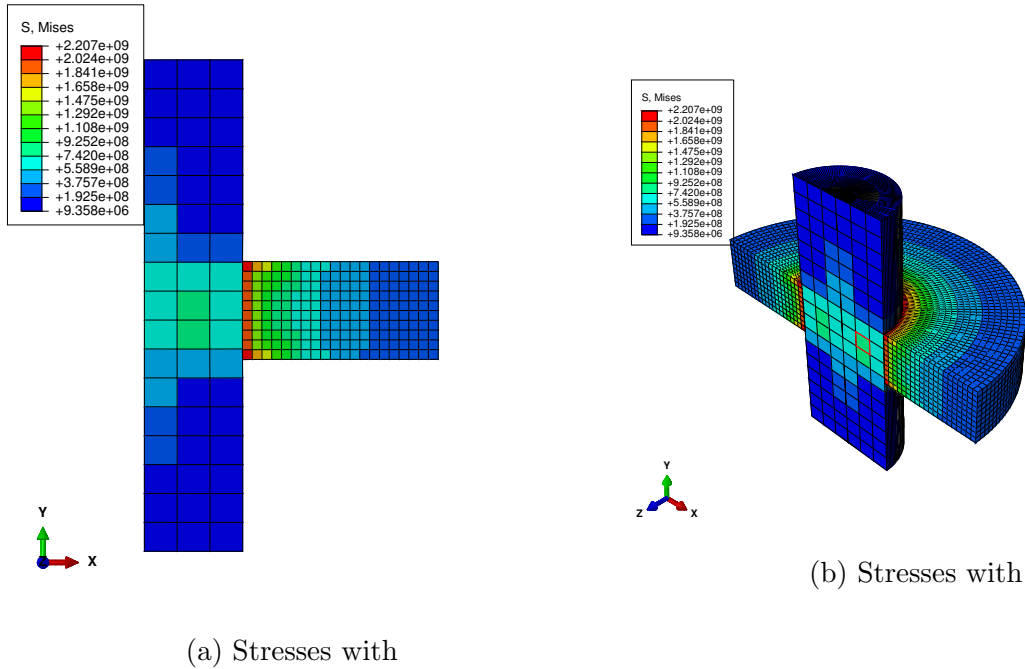


Figure 1: Stresses on Sample

References

- [1] Michel Goossens, Frank Mittelbach, and Alexander Samarin. *The L^AT_EX Companion*. Addison-Wesley, Reading, Massachusetts, 1993.
- [2] Michel Goossens, Frank Mittelbach, and Alexander Samarin. *On the Use of Biaxial Properties in Modeling Annulus as a Holzapfel–Gasser–Ogden Material*. Sharaki et al., University of Toledo, Toledo, OH, USA, 2015.