Assignment 3 Computaitonal Mechanics Tools, Nonlinearity

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1. We have provided a tutorial to calculate stresses on a steel plate with a hole, which is submitted to axial tensile force. We have uploaded this tutorial as a PDF file AbaqusNonlinear.pdf in the CIMNE Virtual Center. Following this tutorial,

***a*)** Plot the distribution of Von Mises stresses in the plate.

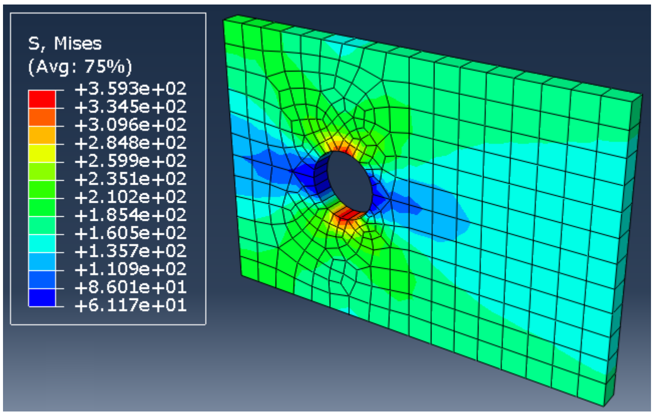


Figure 1: Distribution of Von Mises Stresses. Pure Elasticity

***b*)** Plot the Force-displacement curve at the point-set.

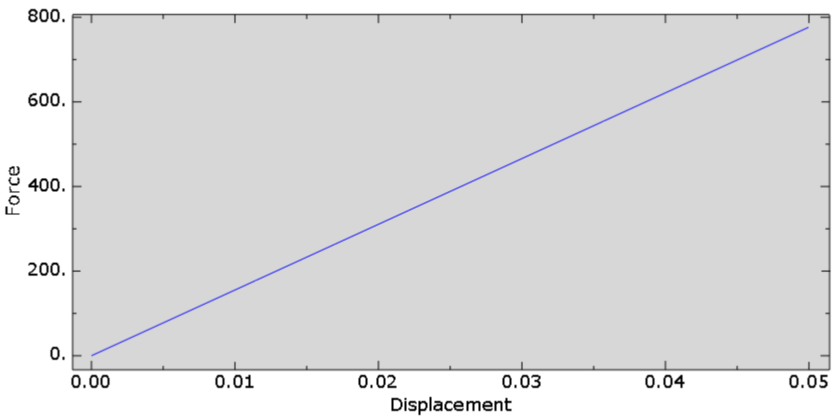


Figure 2: Force-Displacement curve for purely elastic case

***c*)** Add the plastic properties (3 different cases presented in Slide 11) and compare the results. Discuss the differences in the Force-displacement curve for the three different cases.

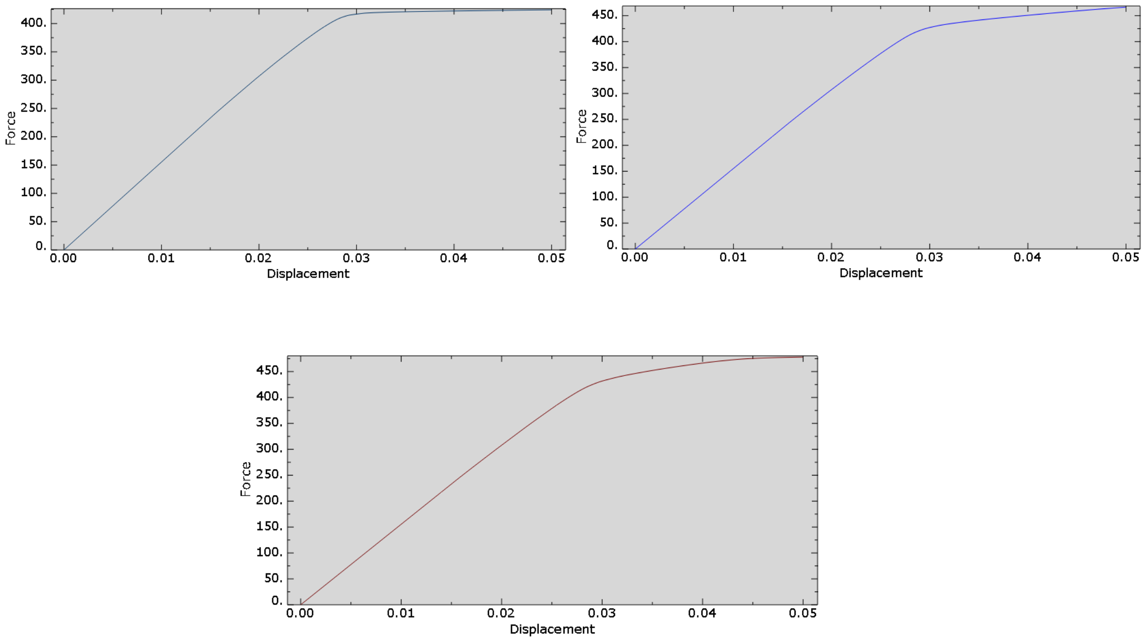


Figure 3: Force-displacement curve for plastic cases

There is an obvious difference in the Force-Displacement curve for the cases with and without plasticity. The purely elastic case keeps on increasing the stress with the same rate, independently from the strain induced.

The three cases for plasticity show a clear agreement with the expected trend. That is, for the perfectly plastic material, the yield stress is reached and the stress does not surpass this quantity, but remain at this value even though the strain continues to increase.
For the cases that include hardening, the slope is different as set for the second yield stress and the plastic strain assigned. The rate of hardening after reaching yield stress is different.

2. We have also provided another tutorial, followed by the first tutorial, to model the contact between a fixed pin and a plate, which is pulled at one of its ends. Following this tutorial,

***a*)** Plot the distribution of Von Mises stresses on the deformed shape with an amplification factor of 10. Set scale of stresses between 0-460 Mpa and make that stresses over this limit are plotted in dark red as shown in Slide 27.

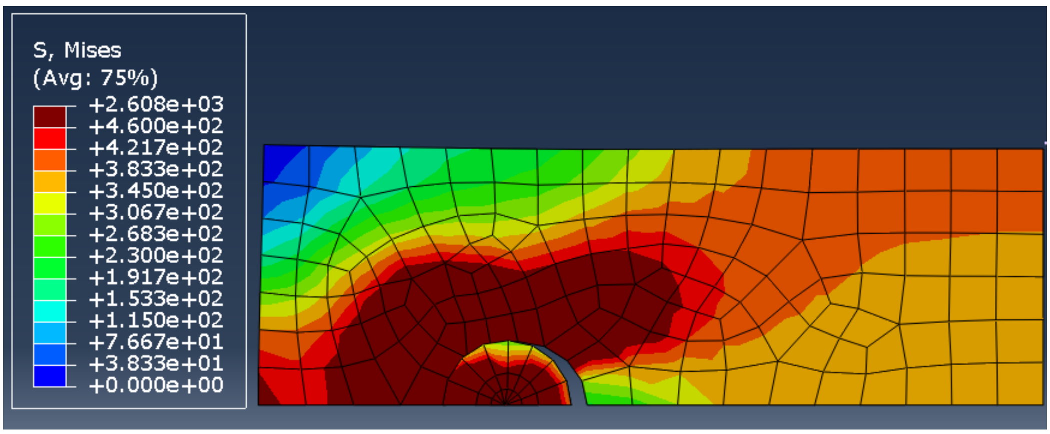


Figure 4: Von-Mises stresses over the part.

***b*)** Plot the Force-displacement curve for the horizontal reaction at the point-set.

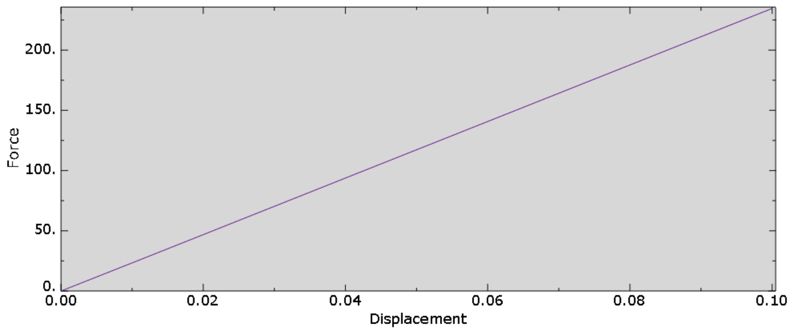
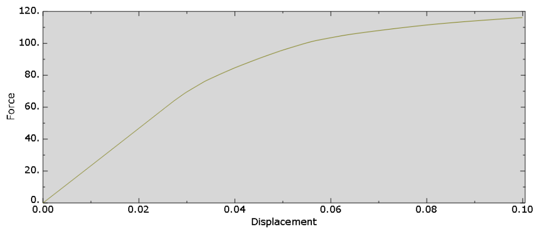
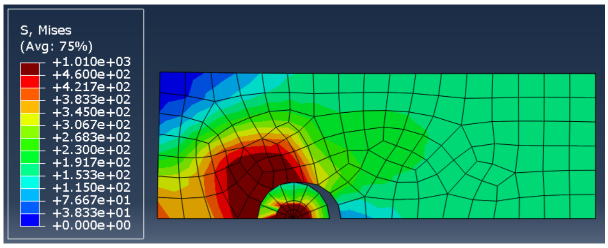
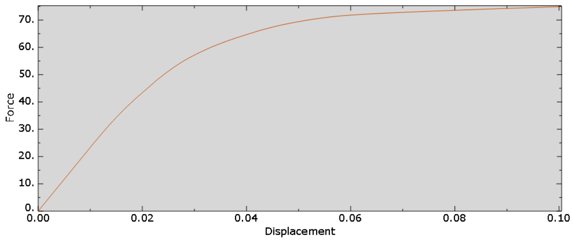


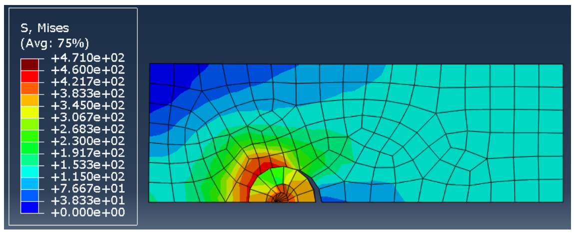
Figure 5: Force-Displacement curve for purely elastic case

***c*)** Add the plastic properties to the two materials, one for the plate, and another one for the pin according to Slide 28 and compare the results with the elastic case.









Once again the main difference between the purely elastic case and the ones that do take into account plasticity is that the rate of stress-strain remains constant.

When taking into account plasticity, the plastic characteristics of the material for the plate remain the same for both simulations, while the material for the pin is changed from one with large yield stress (900), to another one with a lower yield stress (320). The result in the plot for the Von Mises stress shows agreement on this, since values for the stress on the pin decrease for the second material.

One can observe that the combined effect of the plastic properties of the two materials produces softer plots, compared to those of exercise 1 (without contact). Moreover the yield stress of each material is not immediately identifiable in the Force-displacement curve, but one can see a difference in the maximum value of stress reached.

The plot of distribution of Von Mises stresses for the purely elastic case (figure 4), shows a large portion of the piece being colored in brown; meaning high stresses. When taking into account plasticity, one can easily observe that the Von Mises distribution is not reaching that large portions of the pieces. Even more, one can observe how the pin element suffers a great deal of deformation near its centerline, as this was the part used to prescribed the constrain.