Computational Mechanics Tools

Homework-4 (Nonlinearity Assignment)

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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.

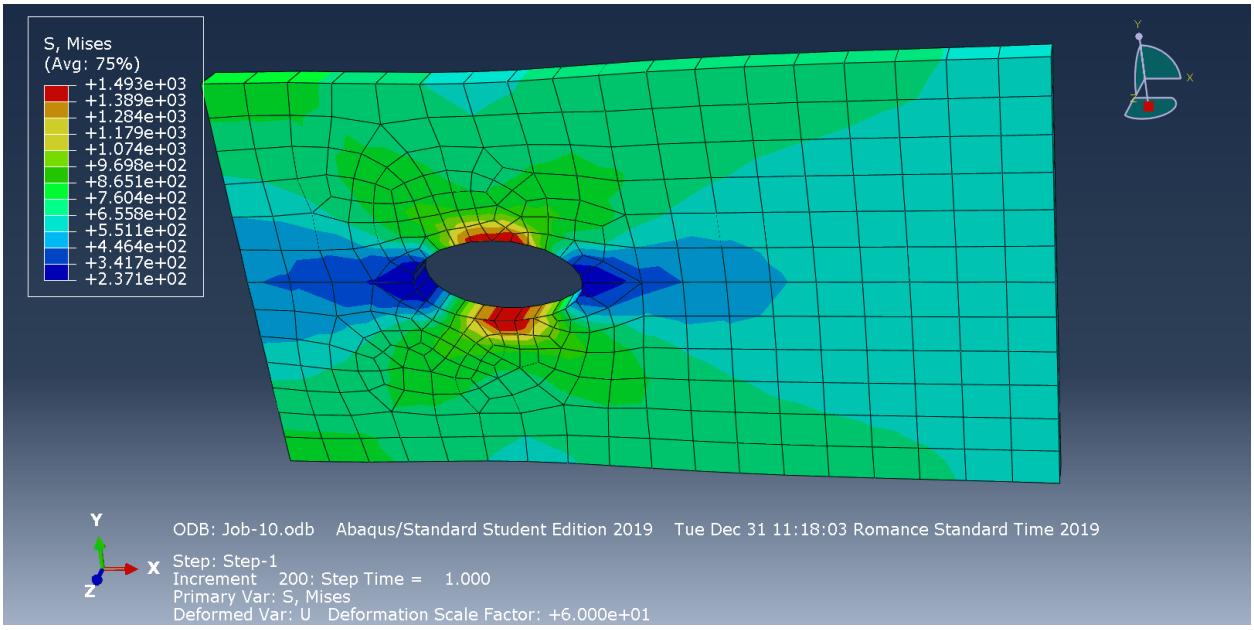


Figure 1: Von-Mises Plot for elasticity case

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

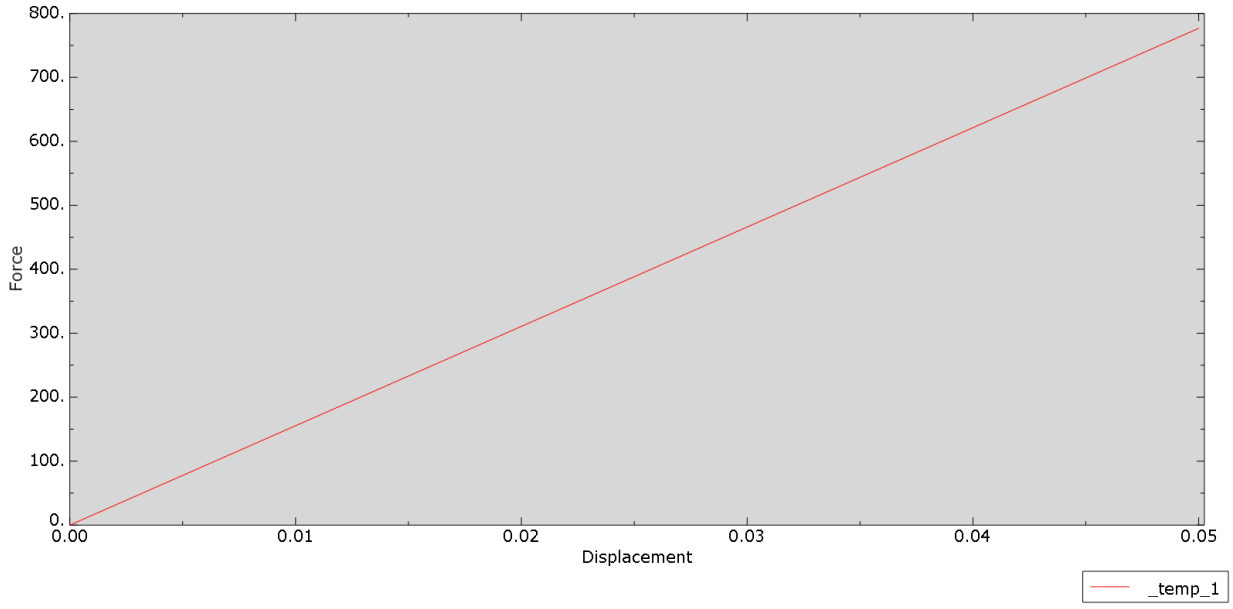
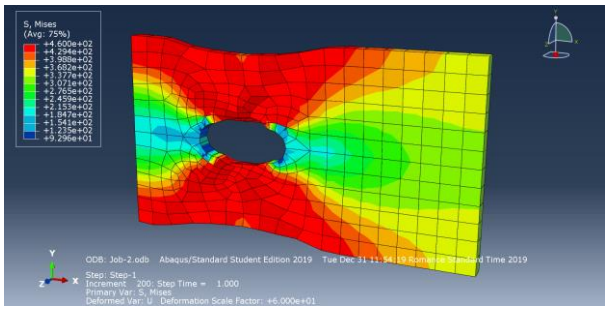
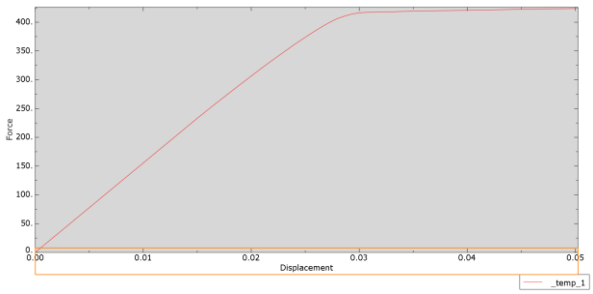


Figure 2: F-x Plot for elasticity cas

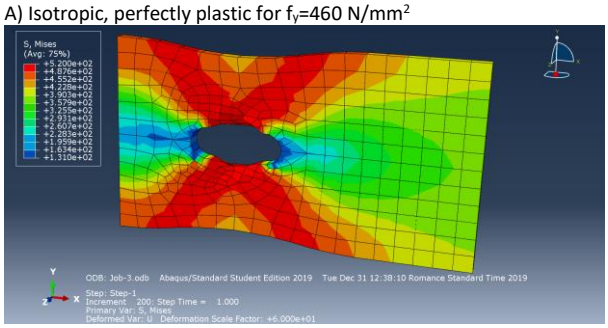
c) Add the plastic properties (3 different cases presented in Slide 11) and compare the results. Discuss the differences in the Force-displacement curve for the three different cases.



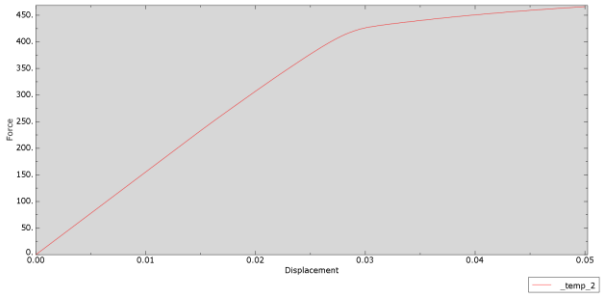
A) Isotropic, perfectly plastic for f_y=460 N/mm^2



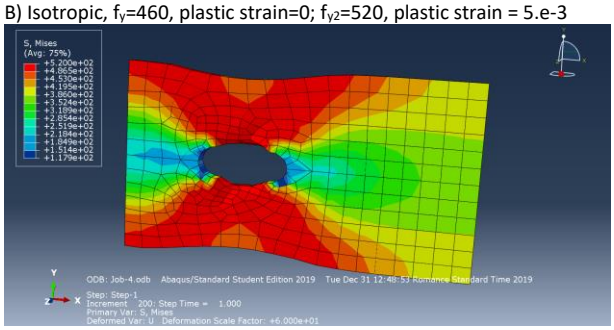
F-t plot for case A



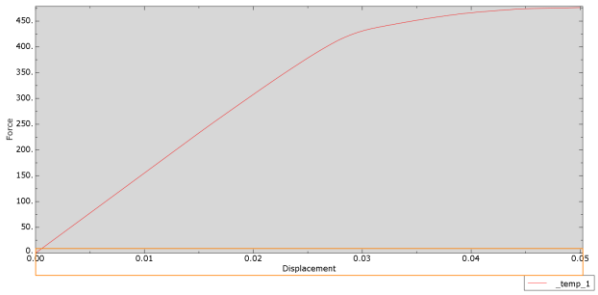
B) Isotropic, f_y=460, plastic strain=0; f_{y2}=520, plastic strain = 5.e-3



F-t plot for case B



C) Isotropic, f_y=460, plastic strain=0; f_{y2}=520, plastic strain = 2.e-3



F-t plot for case C

Figure 3: Plasticity Plots for Plate

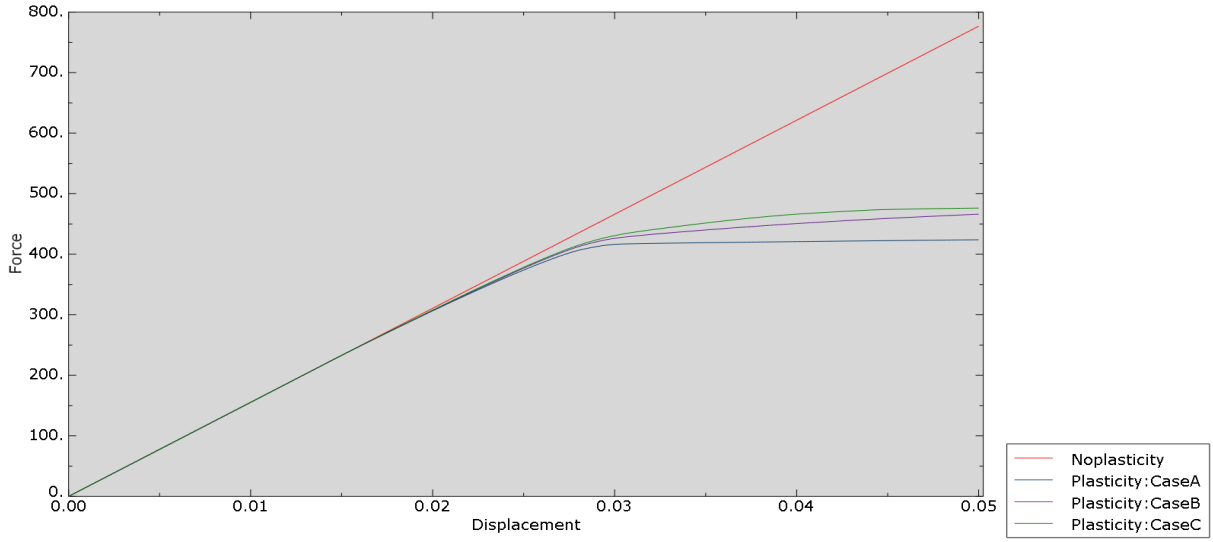


Figure 4: Comparison of F-x plots for elasticity and plasticity cases

For Case A (Isotropic, perfectly plastic for f_y=460 N/mm^2), the force first increases with displacement linearly, then becomes horizontal to x-axis indicating the perfectly plastic behaviour.

For Case B (Isotropic, f_y=460, plastic strain=0; f_{y2}=520, plastic strain = 5.e-3), the value of stress induced as compared to case A is more and the slope of F-x plot is slightly more than perfectly plastic case. Further, after entering plastic region the slope decreases drastically then again becomes almost constant. Also, the reaction force value is more than perfectly plastic case.

For Case C (Isotropic, f_y=460, plastic strain=0; f_{y2}=520, plastic strain = 2.e-3), it is observed than the reaction force value after which the graph enters the plastic region is greater as compared to previous two cases for plastic deformation. Moreover, the slope decreases gradually to approach zero.

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.

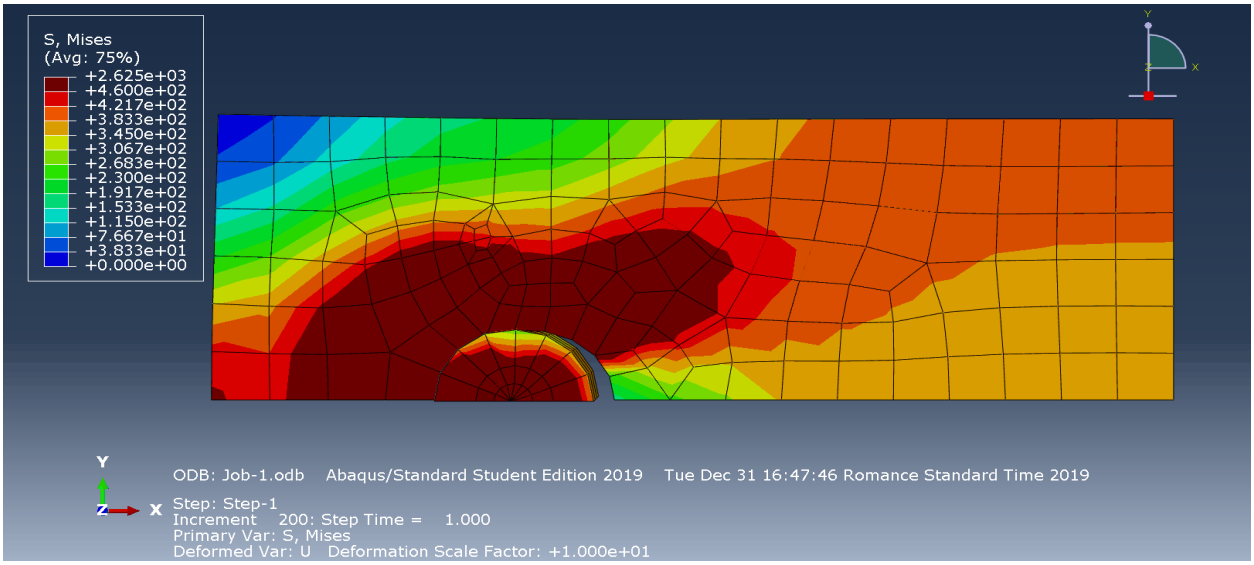


Figure 5: Von-Mises Plot for Pin-Plate elasticity case

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

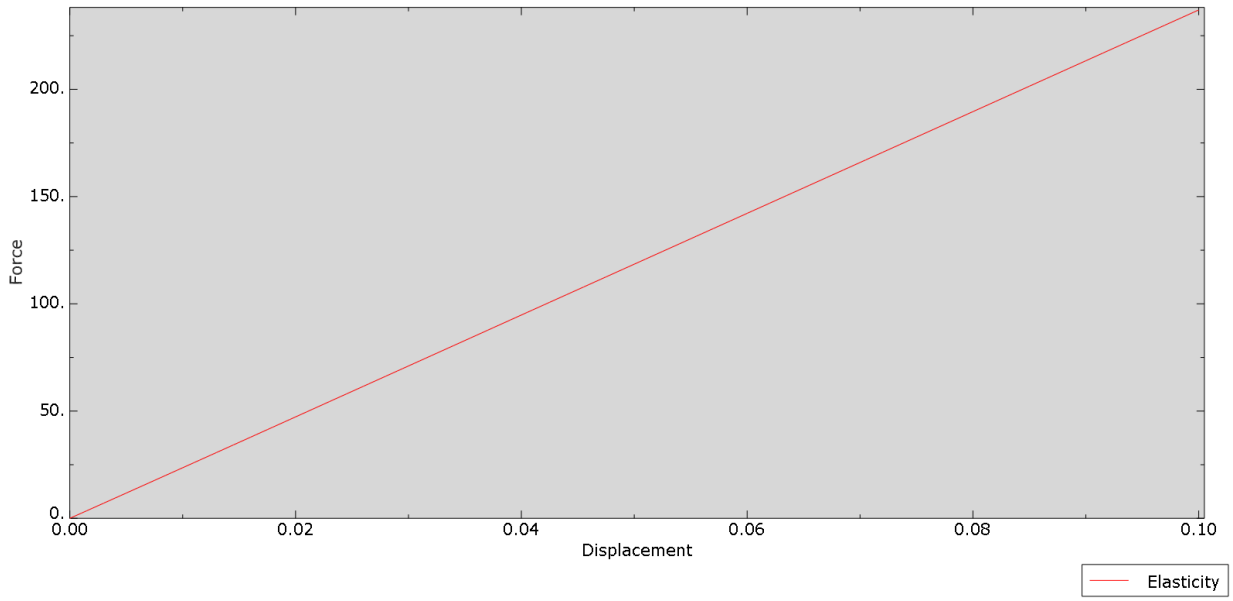
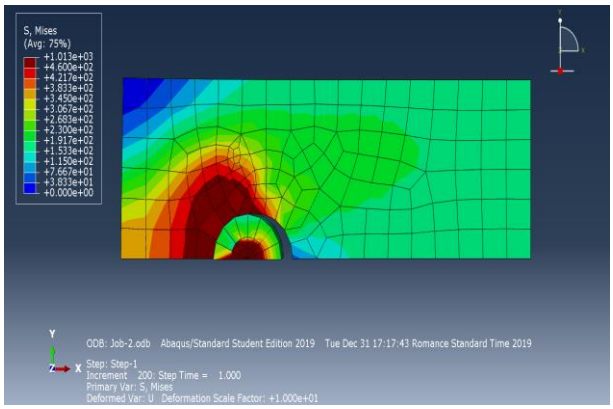
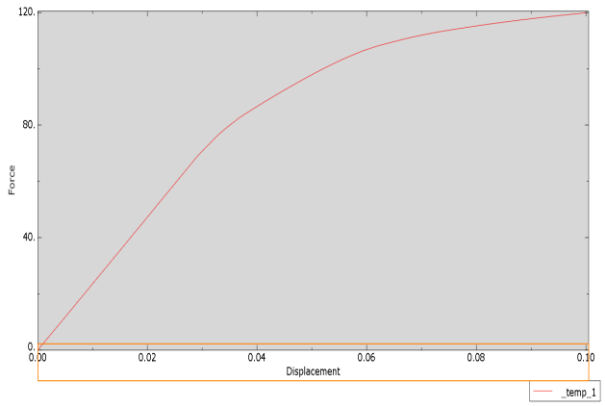


Figure 6: F-x Plot for elasticity case (plate-pin)

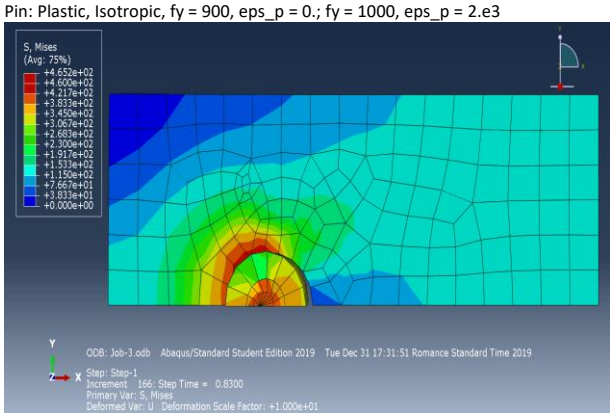
c) Add the plastic properties to the two materials, one for the plate, and another one for the pin according to Slide 28 and compare the results with the elastic case.



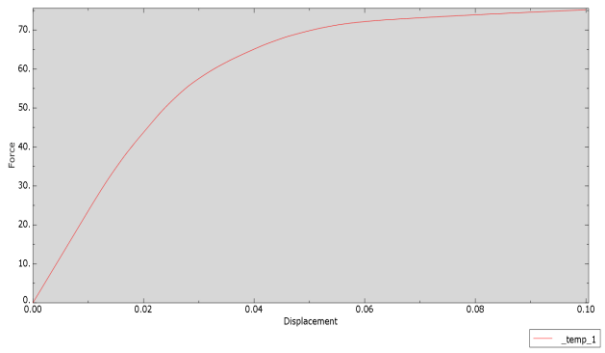
Case1: Plate: Isotropic, f_y=460, plastic strain=0; f_{y2}=520, plastic strain = 5.e-3
Pin: Plastic, Isotropic, fy = 900, eps_p = 0.; fy = 1000, eps_p = 2.e3



F-x plot for case 1



Case2: Isotropic, f_y=460, plastic strain=0; f_{y2}=520, plastic strain = 5.e-3
Pin: Plastic, Isotropic, fy = 320, eps_p = 0.; fy = 400, eps_p = 5.e-3



F-x plot for case 2

Figure 7: Von-mises Plots for plasticity cases (plate-pin)

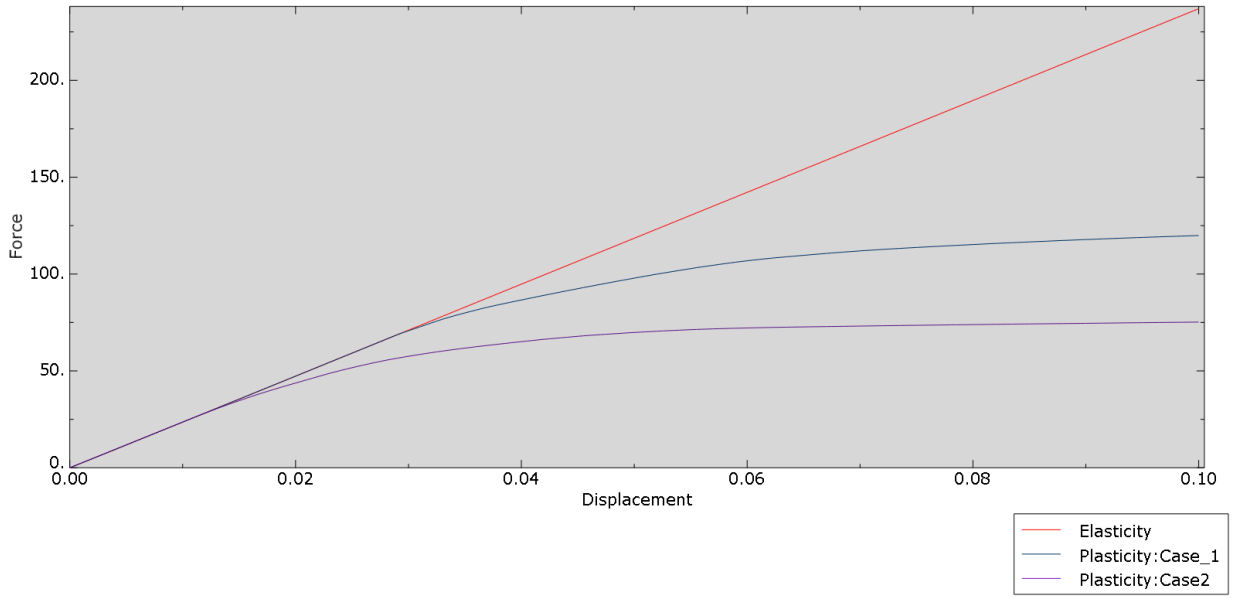


Figure 8: Comparison of F-x Plot for elasticity and plasticity cases

Comparing the results, the slope for elastic case is the greater than other plastic cases, indicating maximum value of reaction force. For case 2, the graph becomes almost horizontal after sometime as it enters the plastic region. Further, it is clear from the graph that pin starts yielding at much less stress value for plasticity cases.