Nonlinearity

Assignment 4

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1 Problem 1

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

1.1 Part a

Plot the distribution of Von Mises stresses in the plate.

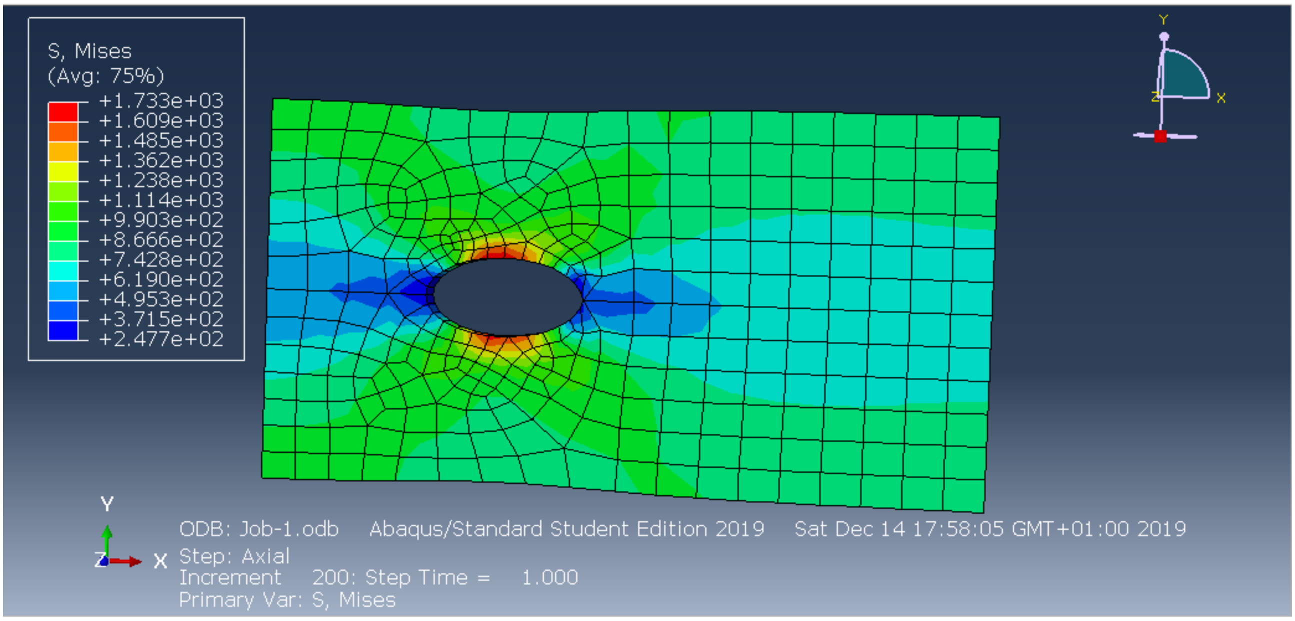

Figure 1: Von Misses Elastic

1.2 Part b

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

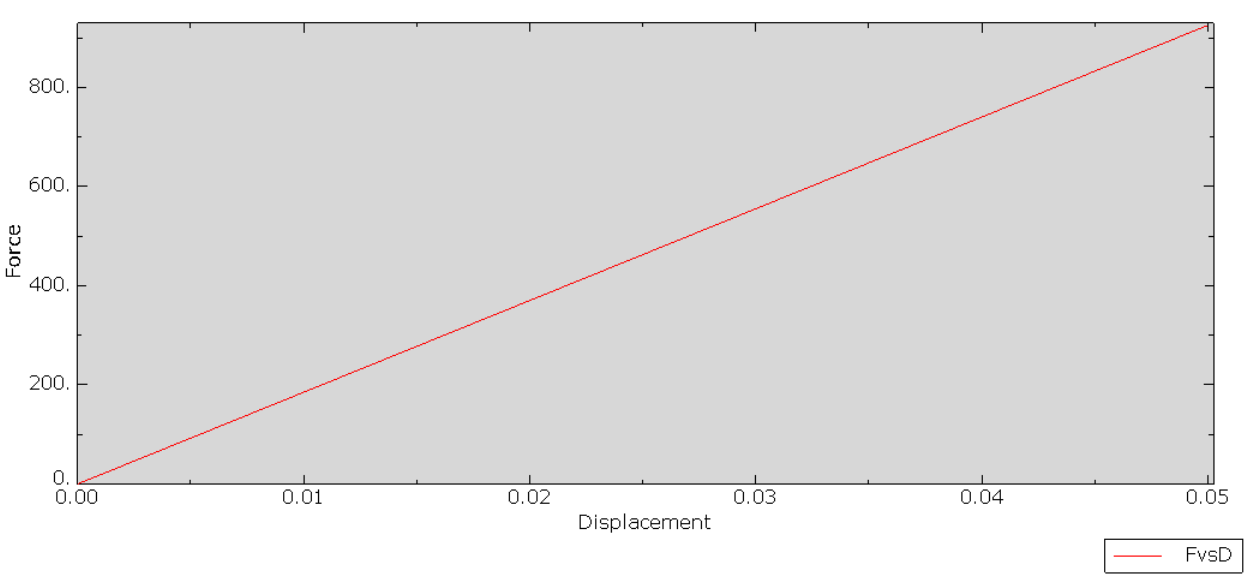

Figure 2: Force vs Displacement Elastic

1.3 Part 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.

- Isotropic, make it perfectly plastic for fy=460 N/mm2
- Isotropic, with fy=460, plastic strain=0; fy2=520, plastic strain = 5.e-3
- Isotropic, with fy=460, plastic strain=0; fy2=520, plastic strain = 2.e-3

1.4 1st case

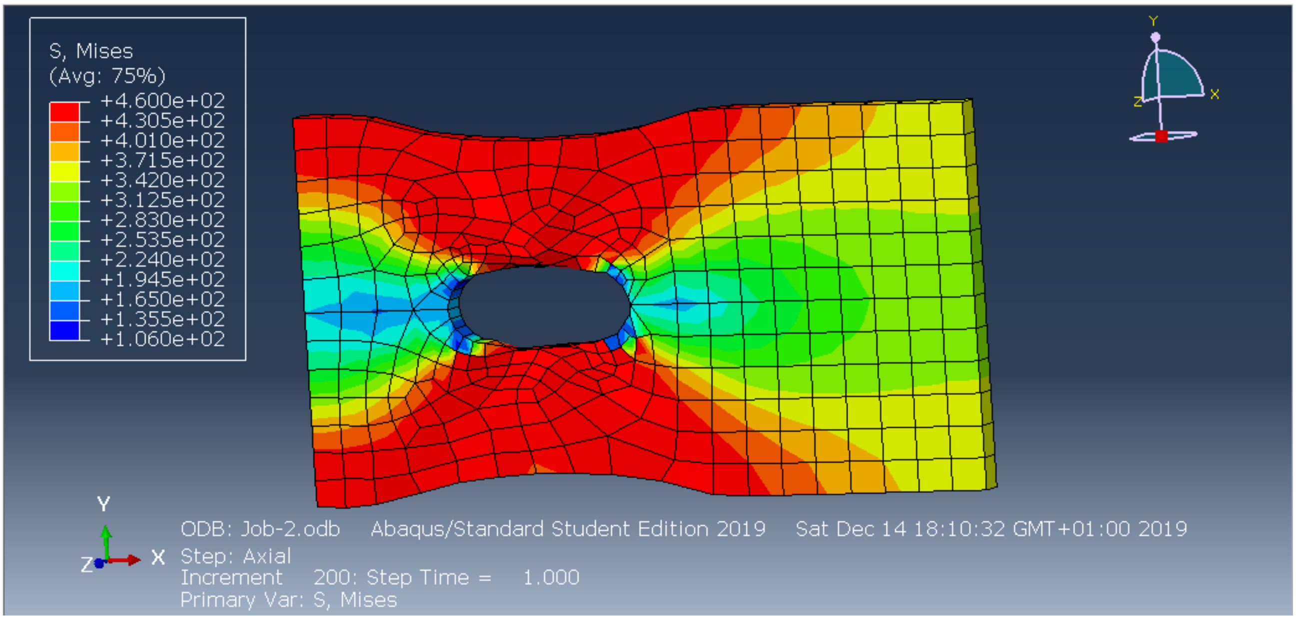

Figure 3: Von Misses 1st case

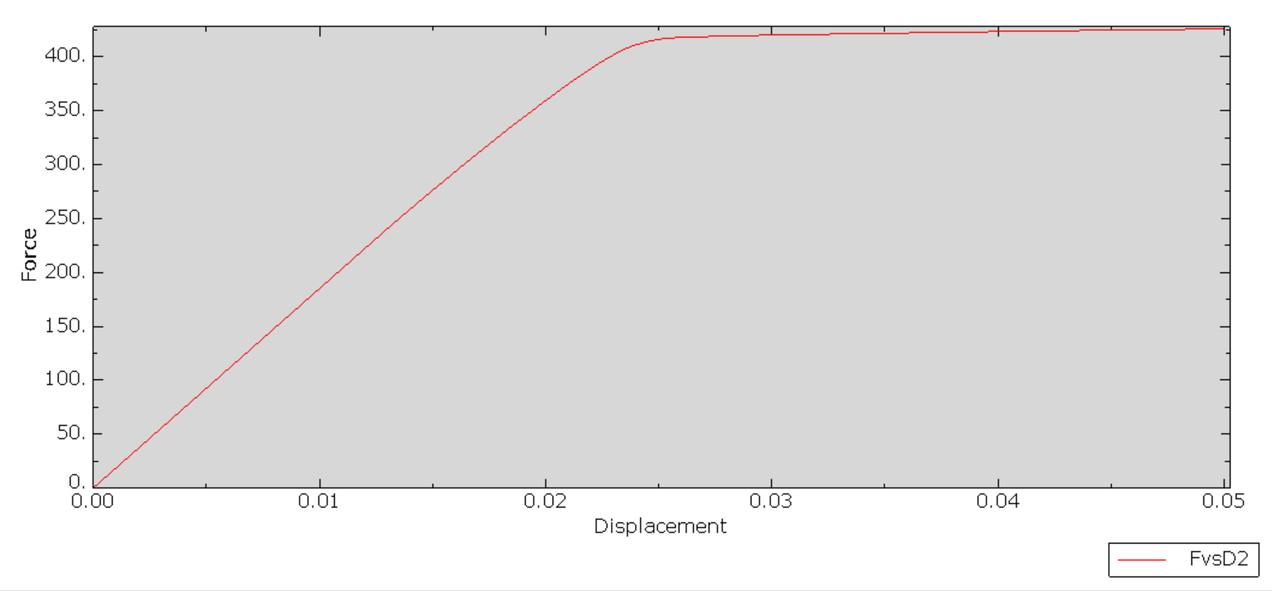

Figure 4: Force vs Displacement 1st case

1.5 2nd case

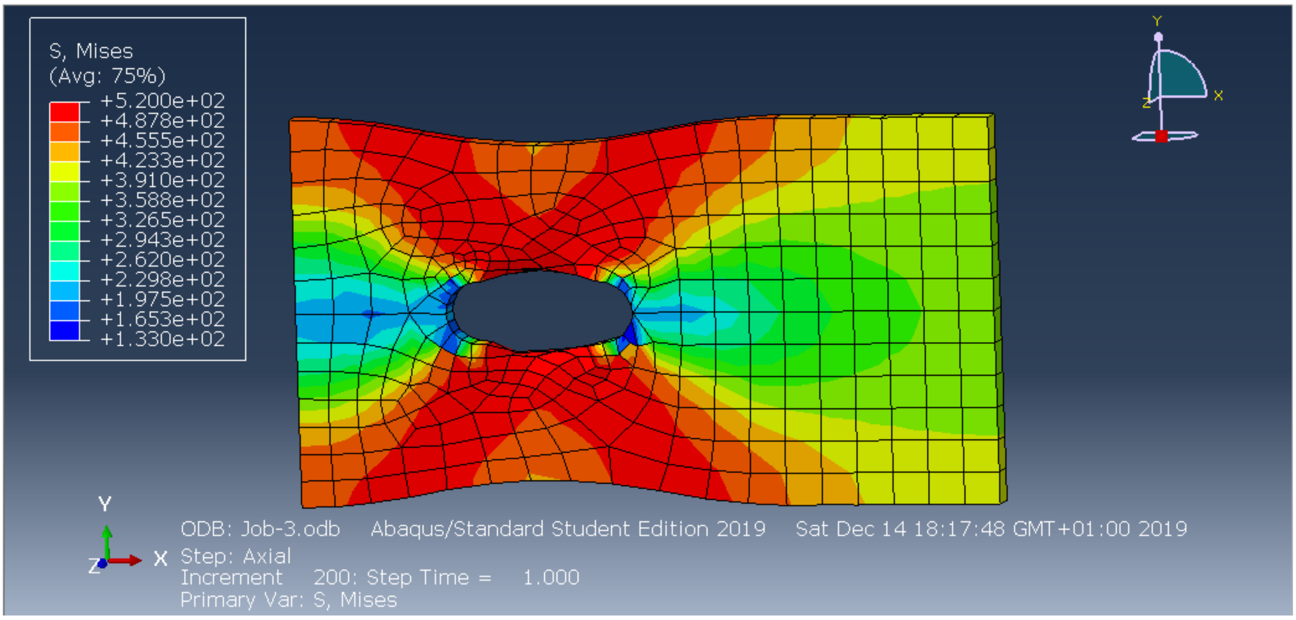

Figure 5: Von Misses 2nd case

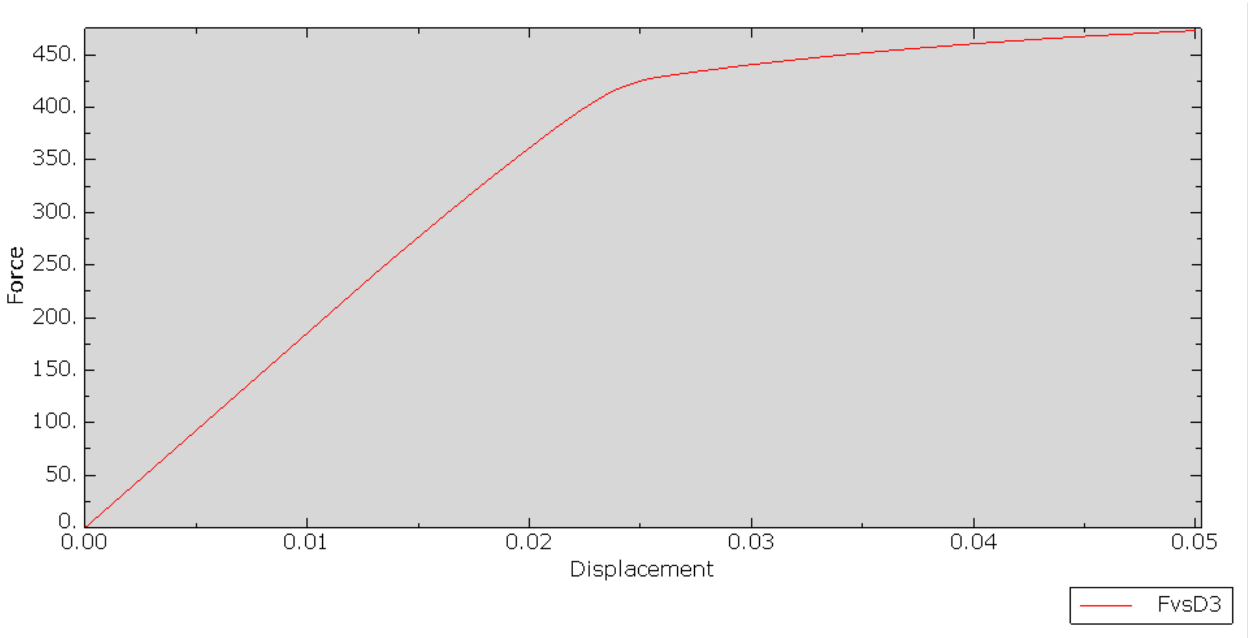

Figure 6: Force vs Displacement 2nd case

1.6 3th case

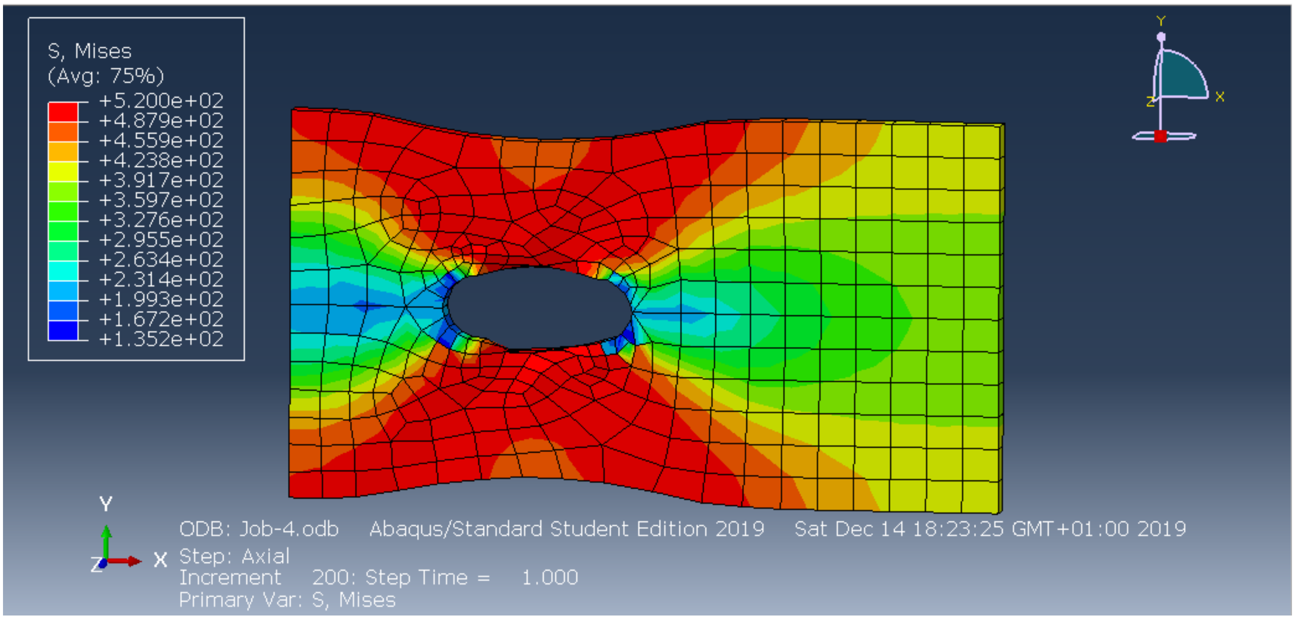

Figure 7: Von Misses 3th case

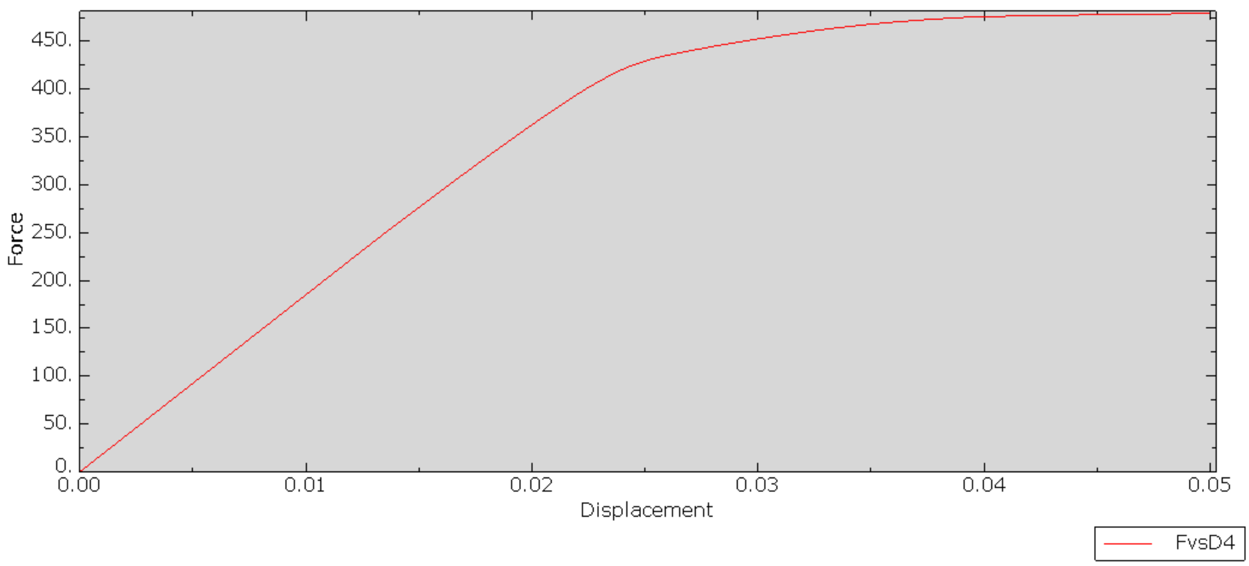

Figure 8: Force vs Displacement 3th case

The force vs displacement graphs behaved as expected, it can be noticed in figure 2 that it has a linear behavior due to elasticity, and for the perfect plastic case, stresses are up to 460 MPa which is how it is expected to be. For the 2nd and 3rd cases, a similar behavior was expected since only a change in plastic strain from above 520 MPa occurred.

2 Problem 2

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

2.1 Part 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.

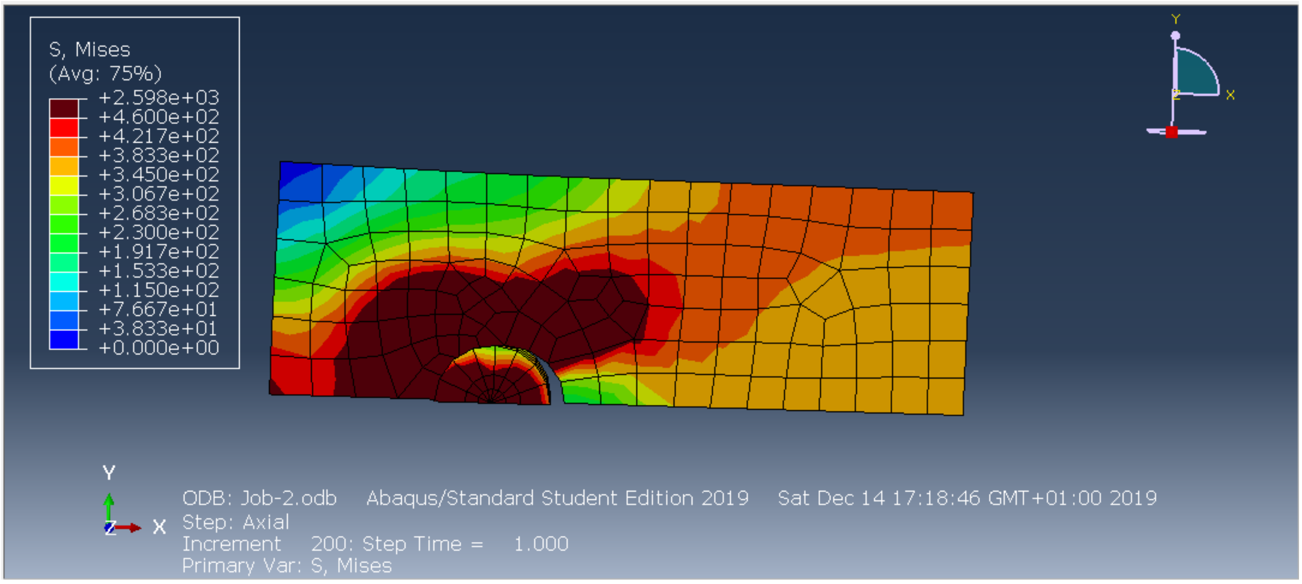

Figure 9: Von Misses Elastic

2.2 Part b

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

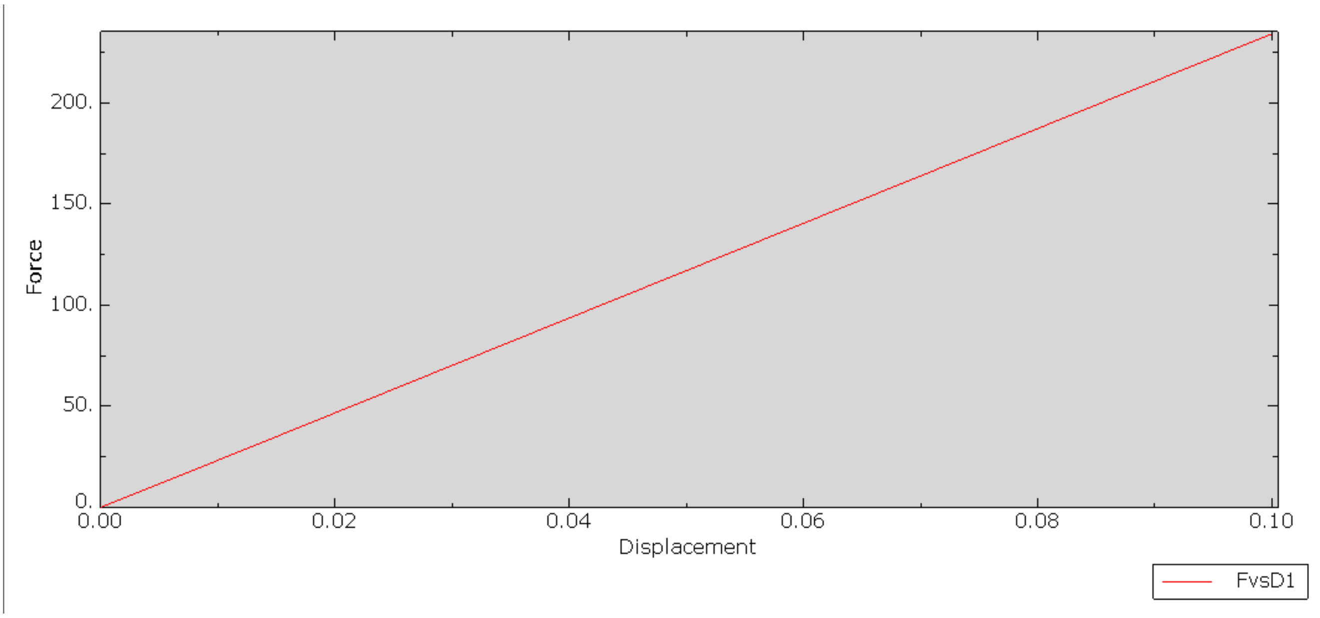

Figure 10: Force vs Displacement Elastic

2.3 Part 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.

- Plastic, Isotropic, fy = 900, $epsp$ = 0.; fy = 1000, eps_p = 2.e-3
- Plastic, Isotropic, fy = 320, $epsp$ = 0.; fy = 400, eps_p = 5.e-3

2.4 1st case

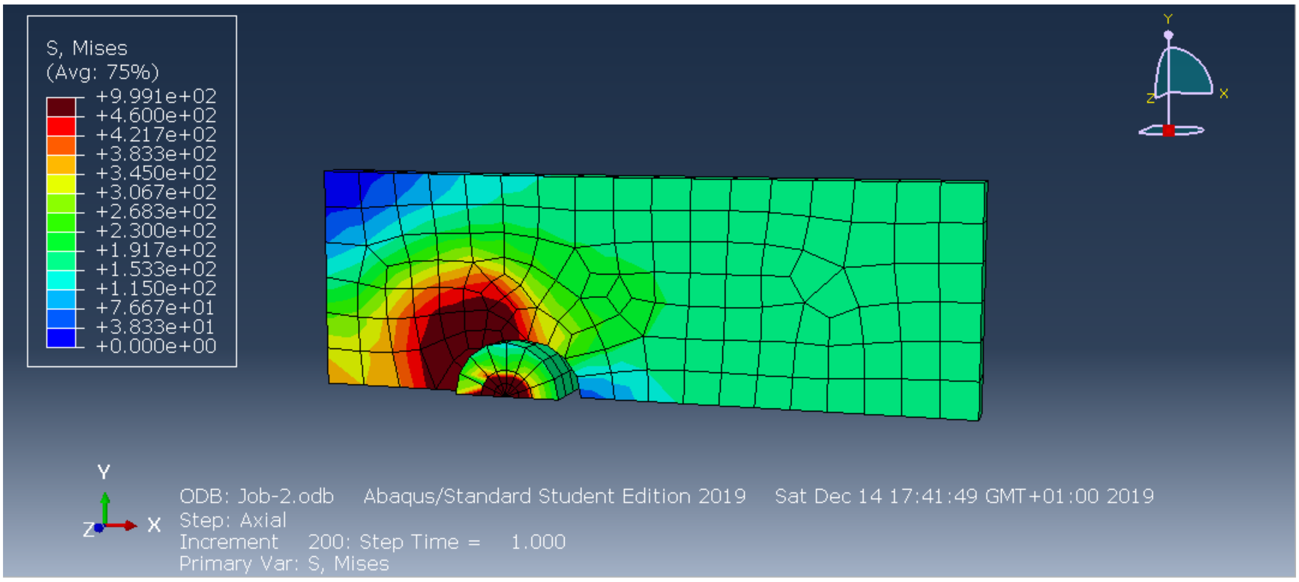

Figure 11: Von Misses 1st case

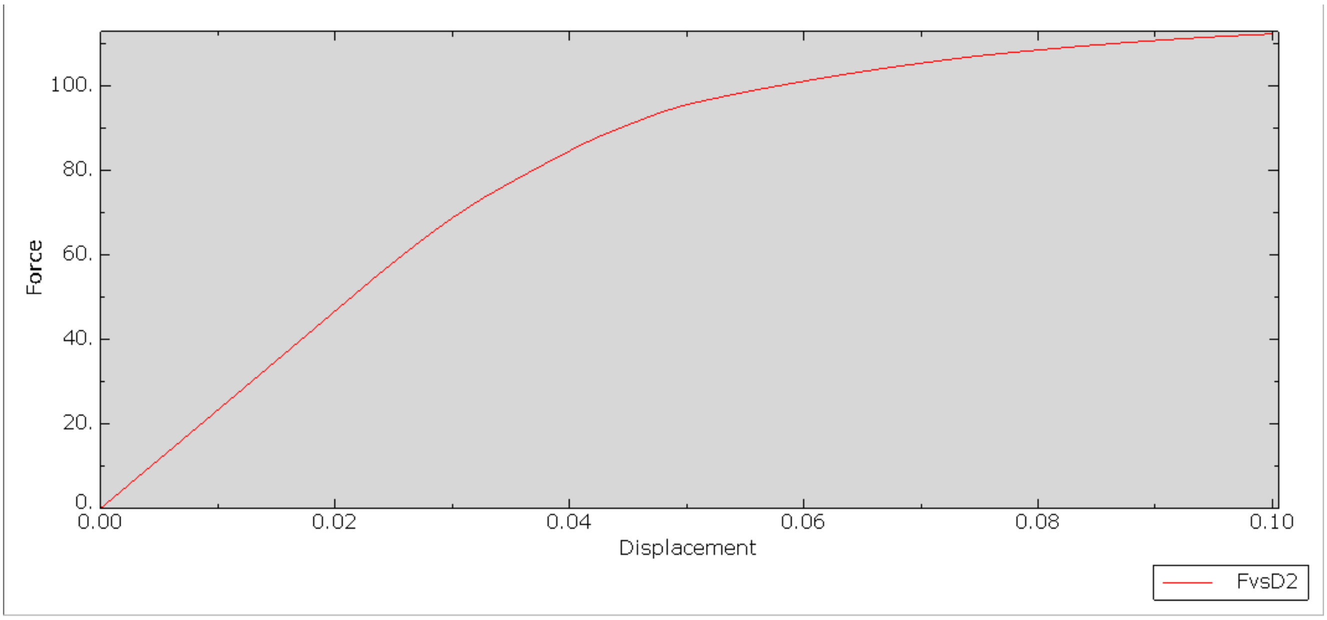

Figure 12: Force vs Displacement 1st case

2.5 2nd case

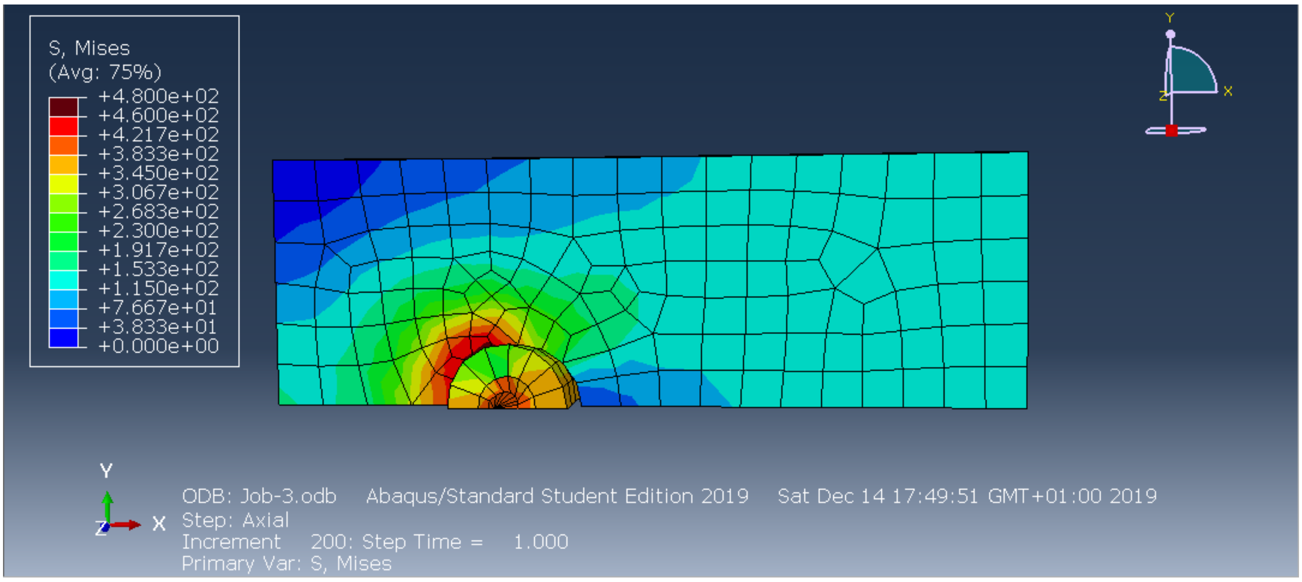

Figure 13: Von Misses 2nd case

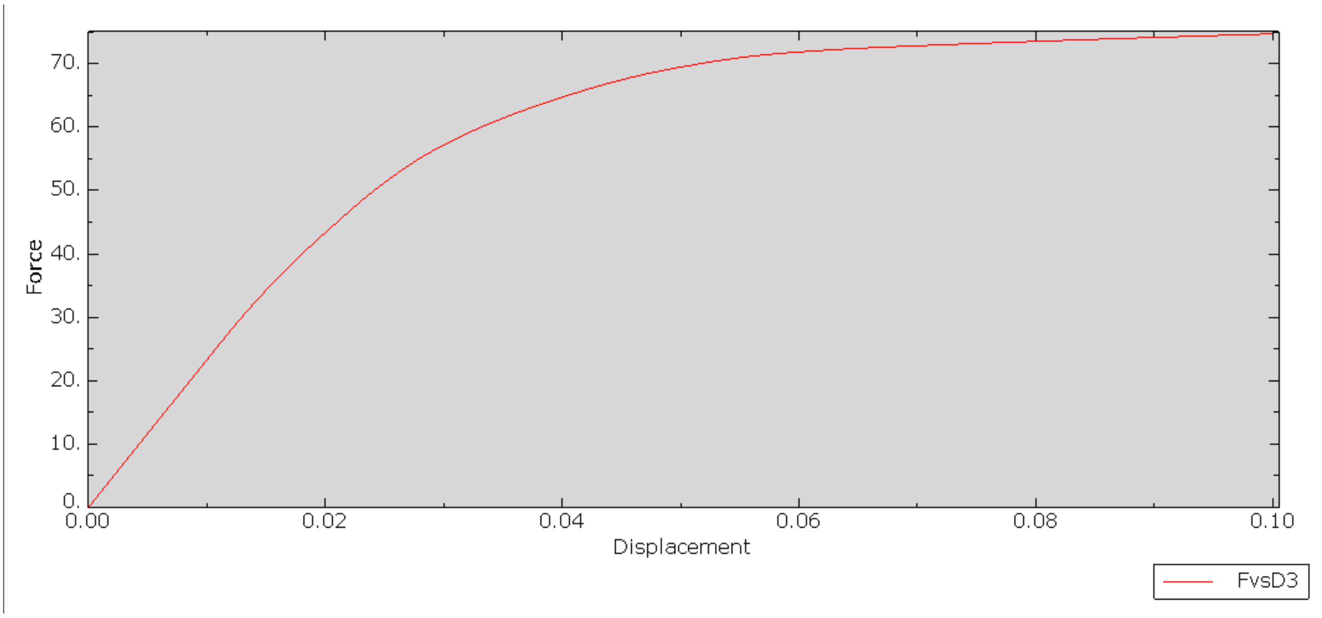

Figure 14: Force vs Displacement 2nd case

As in the first exercise, the force vs displacement graph for the elastic case behaved as expected (linearly). It can be noticed that a change in stresses occurred for the 1st and 2nd cases for plasticity, as expected, the 1st case will require more force to displace the system than the second case due to the change in yield stress, therefore bigger stresses were expected.