Computational Mechanic Tools - Assignment 3

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January 11, 2019

Part 1.

The tutorial provided to calculate the stresses on a steel plate with a hole has been followed. The axial tensile force is submitted to the parts and, depending on the properties of the material a elastic or plastic response is observed.

a)

The distribution of the Von Mises stresses in the plate observe a straight line, like an elastic response as showed on the figure 1. This behavior is explained by the fact that the material has no plastic properties yet. The type of response is also observed for the following subsection.

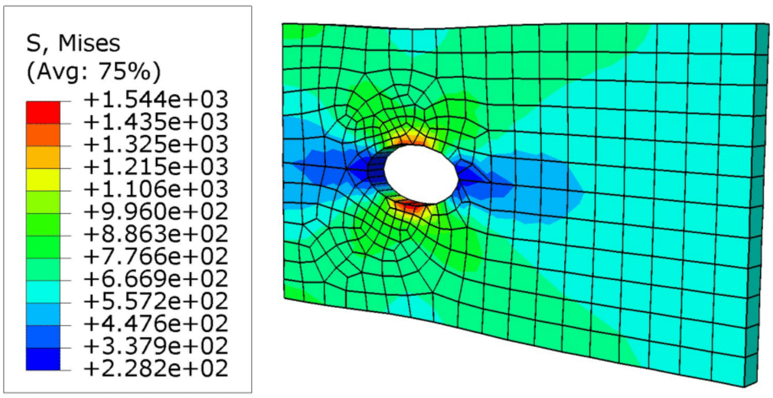

Figure 1: Distribution of Von Mises stresses in the plate

The stresses are expressed in MPa (as we used N/mm^2 for Young's modulus's unit). The limit of 460 MPa is overpassed in most of the parts on the model.

b)

The force-displacement curve at the point-set is displayed on the following figure

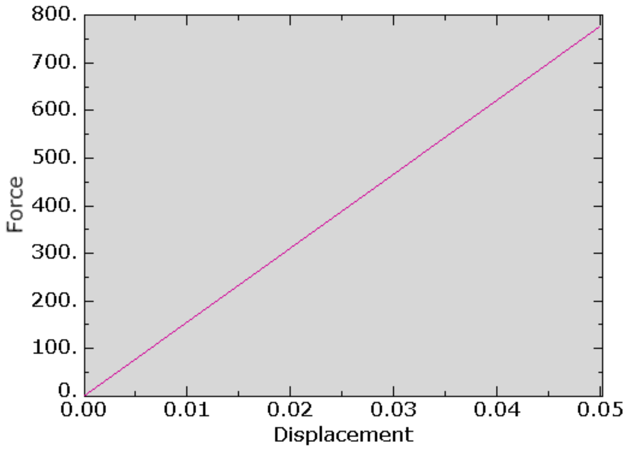

Figure 2: Force-displacement curve

The plot has a very simple linear behavior. This is explained by the fact that the material is described as simple elastic. When the force applied is removed, the material will return to its original size through the straight line defined by the young's modulus.

The following subsection takes into consideration the plastic properties of the material and a non linear response is be observed.

c)

The three following points relay the different results obtained for the three different cases

- **A)** Isotropic, perfectly plastic for $f_y = 460N/mm^2$
- **B)** Isotropic, with $f_y = 460$, plastic strain $= 0$; $f_{y2} = 520$, plastic strain $= 0.005$
- **C)** Isotropic, with $f_y = 460$, plastic strain $= 0$; $f_{y2} = 520$, plastic strain $= 0.002$

The three cases have very different results : their plot is displayed in the appendix figures 7 to 9. The reaction force plot is linear for the first part of the plot, the elastic regime, and non linear at the plastic regime.

The f_y term describe the stress at the yield point, the elastic limit of the material. Meaning that past this point (in the stress-strain curve), the material is no longer elastic. The plastic strain $\epsilon_{\text{plastic}}$ is the permanent displacement without a fracture due to plastic deformations.

The first case describe the elastic perfectly plastic : the stress held becomes a plateau after reaching a certain point: the yield point. The two last cases consider different values of the plastic strain: they are cases of hardening plasticity. It can be seen as the slope in the plastic regime is higher than zero. Meaning that the structure is harder to deform as the force increases.

Part 2.

The second tutorial set the task to model a contact between a fixed pin and a plate, which is pulled at one of its ends.

a)

The distribution of the Von Mises stresses on the deformed shape with an amplification factor of 10 is displayed in the following figure. The scale of stresses is adapted as instructed.

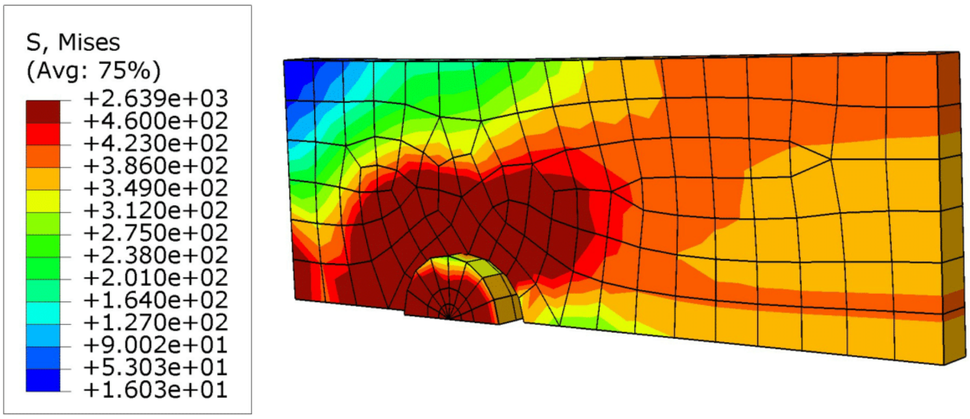

Figure 3: Caption

b)

The force-displacement curve for the horizontal reaction at the point-set is displayed on figure 4. As seen before, a linear plot is obtained as the material only yield elastic properties.

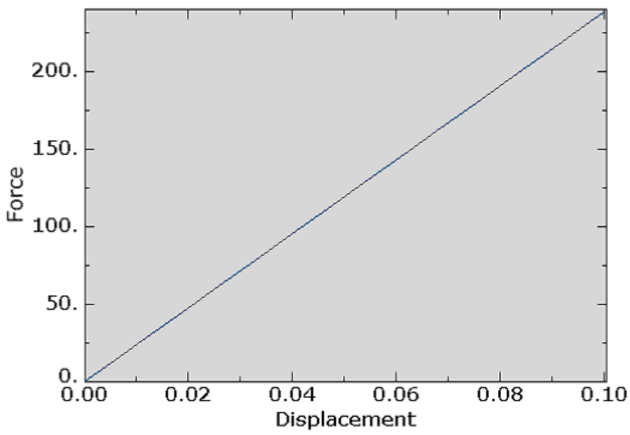

Figure 4: Plot of the force-displacement curve

c)

The plastic properties is added to the two materials according to the instructions :

- plate : Isotropic, with $f_y = 460$, plastic strain $= 0$; $f_{y2} = 520$, plastic strain $= 0.005$
- pin : 2 cases
  - Plastic, Isotropic, $f_y = 900$, $eps_p = 0$; $f_y = 1000$, $eps_p = 0.002$
  - Plastic, Isotropic, $f_y = 320$, $eps_p = 0$; $f_y = 400$, $eps_p = 0.005$

The plots are displayed in on figures 5 and 6. The case 1 exits the elastic regime later than the second case. This is caused by the fact that the value f_y of the stress at the yield point is higher for the first case.

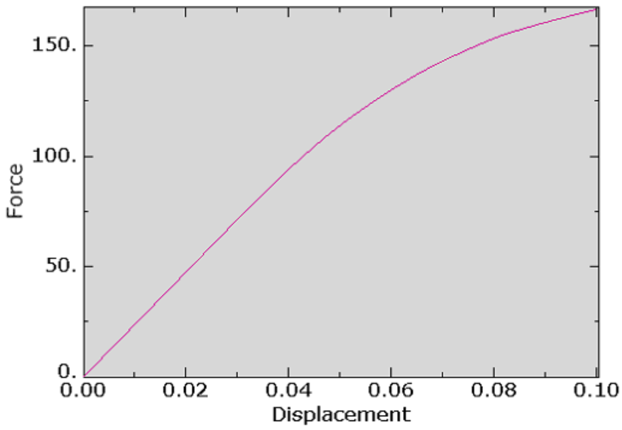

Figure 5: Plot of the force-displacement curve of case 1

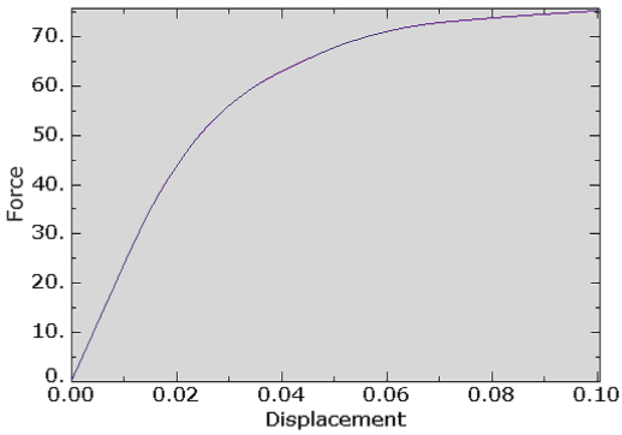

Figure 6: Plot of the force-displacement curve of case 2

Appendix

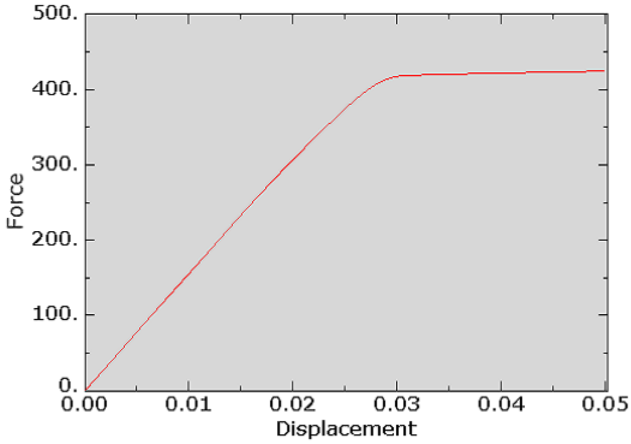

Figure 7: Plot of force-displacement curve of case 1

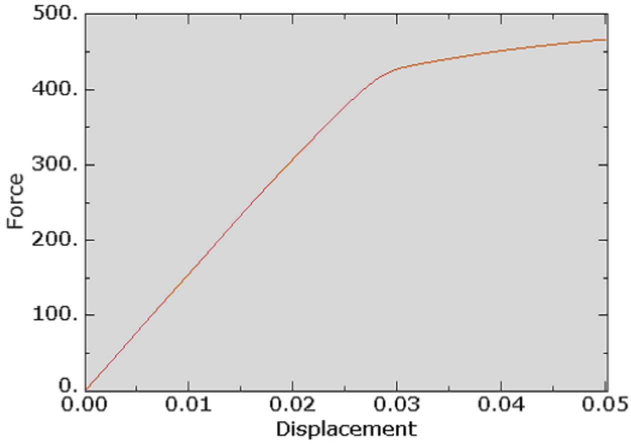

Figure 8: Plot of force-displacement curve of case 2

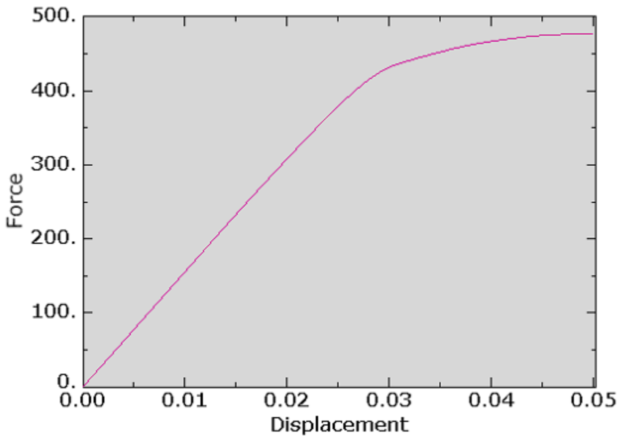

Figure 9: Plot of force-displacement curve of case 3