SSNA113 – Notched sample in viscoplasticity

Summary:

This test models a notched sample into axisymmetric. The law of behavior used is the law VISC_ISOT_TRAC. Two loading rates are simulated:

- slow: \( T = 1000\, \text{s} \) That is to say \( \dot{\varepsilon} = 10^{-3}\, \text{s}^{-1} \)
- rapid: \( T = 0.001\, \text{s} \) That is to say \( \dot{\varepsilon} = 10^{-3}\, \text{s}^{-1} \)

The results (effort resulting and contraction from the ligament) are compared with the calculations carried out with the model of viscous Rousselier (ROUSS_VISC) degenerated so that the evolution of porosity is negligible.
1 Problem of reference

1.1 Geometry

The test-tube is axisymmetric, and only half of the test-tube is represented. Dimensions are given in millimetres.
1.2 Properties of material

Isotropic elasticity

Young modulus: $E = 215000 \text{MPa}$

Poisson's ratio: $\nu = 0.3$

Traction diagram

Coefficient for viscous law $VISC\_SINH$

$\sigma_0 = 6176 \text{MPa}$

$\epsilon_0 = 3.31131121483 \times 10^{13}$

$m = 6.76$

$\sigma_1 = 1575 \text{MPa}$

1.3 Boundary conditions and loadings

Because of symmetry, vertical displacements are blocked for the side $P0P1$ that is to say $DY = 0$.

The side $P8P9$ is subjected to an imposed displacement $U_d = 1 \text{mm}$.

The loading is imposed using 500 pas de time in $T = 1000 \text{s}$ for the slow case and $T = 0.001 \text{s}$ for the fast case.

2 Reference solution

2.1 Results of reference

The reference solution is obtained by carrying out same calculation with the model of Rousselier in viscous version ($BEHAVIOR = 'ROUSS\_VISC', DEFORMATION = 'PETIT\_REAC'$) whose parameters were selected in order to return the effect of negligible porosity.

One compares the contraction of the ligament, i.e. following displacement $x$ node $P1$ as well as the resulting effort ($REAC\_NODA$) on the face $P8P9$.

One is interested in 3 values of displacement $U_d$:

- $0.05 \text{mm}$
- $0.5 \text{mm}$
- $1 \text{mm}$
3 Modeling A

3.1 Characteristics of modeling

- Modeling AXIS_SI

3.2 Characteristics of the grid

The grid is obtained by GIBI.

Many nodes: 1440
Many meshes: 445 QUAD8

3.3 Sizes tested and results

Fast speed

<table>
<thead>
<tr>
<th>Displacement</th>
<th>Identification</th>
<th>Reference</th>
<th>% tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(U = 0.05 \text{ mm})</td>
<td>REAC_NODA on P8P9 (U_y ) in P1</td>
<td>(3.43132 \times 10^3)</td>
<td>0.12</td>
</tr>
<tr>
<td>(U = 0.5 \text{ mm})</td>
<td>REAC_NODA on P8P9 (U_y ) in P1</td>
<td>(3.93495 \times 10^3)</td>
<td>0.22</td>
</tr>
<tr>
<td>(U = 1 \text{ mm})</td>
<td>REAC_NODA on P8P9 (U_y ) in P1</td>
<td>(3.17328 \times 10^3)</td>
<td>0.28</td>
</tr>
</tbody>
</table>

Slow speed

<table>
<thead>
<tr>
<th>Displacement</th>
<th>Identification</th>
<th>Reference</th>
<th>% tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(U = 0.05 \text{ mm})</td>
<td>REAC_NODA on P8P9 (U_y ) in P1</td>
<td>(2.86423 \times 10^3)</td>
<td>0.12</td>
</tr>
<tr>
<td>(U = 0.5 \text{ mm})</td>
<td>REAC_NODA on P8P9 (U_y ) in P1</td>
<td>(3.36223 \times 10^3)</td>
<td>0.19</td>
</tr>
<tr>
<td>(U = 1 \text{ mm})</td>
<td>REAC_NODA on P8P9 (U_y ) in P1</td>
<td>(2.73903 \times 10^3)</td>
<td>0.26</td>
</tr>
</tbody>
</table>
4 Summary of the results

One obtains a good agreement of the results between the 2 models with lower deviations than 1%.

At the total level, one notes that to the maximum 4 iterations are necessary to obtain convergence. On the level of the integration of the law of behavior, less than 10 iterations are necessary to obtain an accuracy of $10^{-9}$. 