SSNA303: Elastoplastic notched sample in great deformations

Summary:

This test models a notched sample in axi-symmetry. The behavior is elastoplastic with linear isotropic work hardening of type von Mises (VMIS_ISOT_LINE).

In modeling A, two modelings of the great deformations are compared:
- SIMO-MIEHE, very-rubber band and catch here like reference
- GDEF-HYPO-ELAS, hypo-rubber band and tested here.

In modeling B two modelings of the great deformations are compared:
- SIMO-MIEHE, very-rubber band and catch here like reference
- GDEF-LOG, hypo-rubber band and tested here.

The compared data are the effort resulting and the contraction from the ligament.

1 Problem of reference

1.1 Geometry

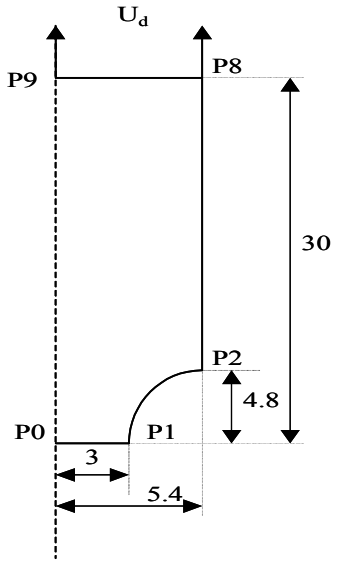

Figure1: Problem of reference

The test-tube is axisymmetric, and only half of the test-tube is modelled by elements. Dimensions are given here in millimetres.

1.2 Data of material

The material considered is elastoplastic with linear isotropic work hardening of type von Mises (VMIS_ISOT_LINE).
The data material used are the following ones:

Young modulus:	$200\,000\ MPa$
Poisson's ratio	$0{,}3$
Elastic limit	$200\ MPa$
Linear module of work hardening	$20\,000\ MPa$

1.3 Boundary conditions and loadings

Because of symmetry, vertical displacements are blocked on the line $P0-P1$ and horizontal displacements are blocked on the axis $P0-P9$; the loading consists of a vertical displacement imposed on the side $P8-P9$:

axis $P0-P9$	$DX=0$
axis $P0-P1$	$DY=0$
axis $P8-P9$	$DY=6\,mm$

The loading is imposed in 50 increments of $0.12\,mm$.

2 Results of reference

The results of reference are got by carrying out same calculation with the model of great deformations of Simo-Miehe (DEFORMATION = 'SIMO-MIEHE'). 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 $P8-P9$.

Values of imposed displacement $Ud=0,6\,mm$, $Ud=3\,mm$ and $Ud=6\mathrm{mm}$ are considered.

The final deformations obtained are to the maximum of 70%.

3 Modeling A

3.1 Characteristic of modeling

Modeling tests GDEF_HYPO_ELAS in AXIS

3.2 Characteristics of the grid

The grid is carried out under GIBI. It is represented on Figure 2. It contains 1440 nodes for 445 quadratic quadrangular elements (QUAD8).

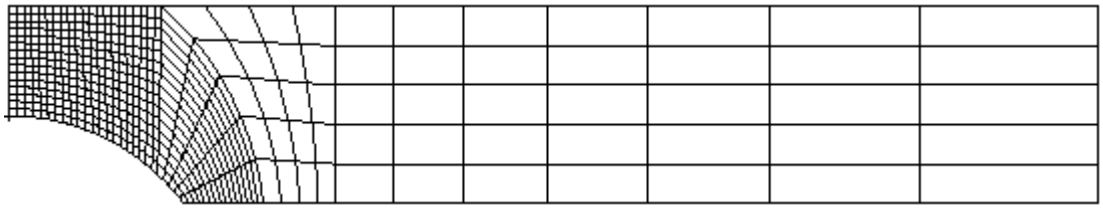

Figure 2: Grid GIBI used

3.3 Sizes tested and results

Imposed displacement	Sizes tested	Reference	Tolerance (%)
$U=0,6\,mm$	REAC_NODA on $P8P9$	$6616,59\,N$	1
	Ux in $P1$	$-0,0845\,mm$	1
$U=3\,mm$	REAC_NODA on $P8P9$	$21541\,N$	1
	Ux in $P1$	$-0,3766\,mm$	1
$U=6\,mm$	REAC_NODA on $P8P9$	$33821\,N$	1
	Ux in $P1$	$-0,826\,mm$	1

4 Modeling B

4.1 Characteristic of modeling

Modeling tests GDEF_LOG, in AXIS.

4.2 Characteristics of the grid

The grid is identical to that of modeling A.

4.3 Sizes tested and results

Imposed displacement	Sizes tested	Reference	Tolerance (%)
$U=0,6\,mm$	REAC_NODA on $P8P9$	$6616,59\,N$	1
	Ux in $P1$	$-0,0845\,mm$	1
$U=3\,mm$	REAC_NODA on $P8P9$	$21541\,N$	1
	Ux in $P1$	$-0,3766\,mm$	2
$U=6\,mm$	REAC_NODA on $P8P9$	$33821\,N$	3
	Ux in $P1$	$-0,826\,mm$	1

5 Summary of the results

The results got with the formulation great deformations hypoelastic agree with those obtained with SIMO_MIEHE with a maximum change of $0,36\%$ for the displacement of $P1$ and $0,81\%$ for the forces on the face $P8P9$.

The formulation GDEF_LOG conduit with a maximum difference of 4%, which is explained by the difference in measurement of deformation.

Convergence is obtained in 108 iterations on the whole with SIMO_MIEHE, in 165 iterations with GDEF_LOG, and in 500 iterations with GDEF_HYPO_ELAS.