HSNV136 - Degeneration of model META_LEMA_ANI out of model of Norton: simple tension in large deformations

Summarized:

This test consists in subjecting to a tension according to its axis a cylindrical bar whose behavior is viscoplastic, by modelling it in two different but equivalent ways: either with the model META_LEMA_ANI which one makes "degenerate" into a model of Norton by choosing in a judicious way the coefficients (modelization A), or with a model of Norton itself (modelization B).

The loading is done in imposed displacement and requires the reactualization of the geometry (large deformations, key word PETIT_REAC). One must then obtain the same response for the two modelizations A and B.

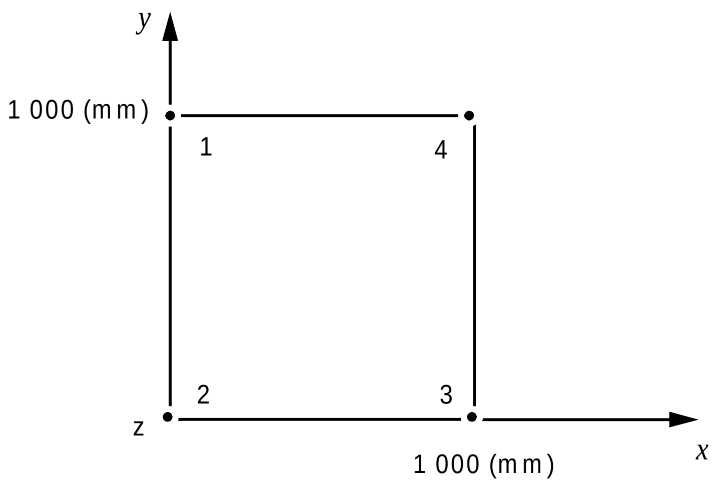
Moreover, the modelization C is introduced in order to validate the large deformations logarithmic curves (key word GDEF_LOG) for this behavior.

Lastly, the modelization D makes it possible to validate by the command the taking into account SIMU_POINT_MAT of the metallurgical data with model META_LEMA_ANI.

The bar is modelled by a quadrangular element QUAD4, into axisymmetric.

1 Problem of reference

1.1 Geometry



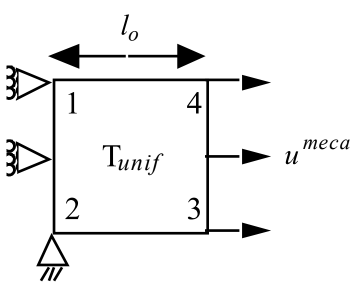
1.2 Properties of the material

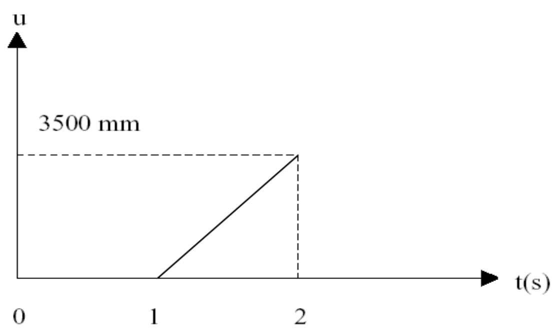
the material obeys a viscoplastic constitutive law of Norton (cas particulier of the model of Lemaître, where parameter UN_SUR_M is null, confer [R5.03.08]), whose parameters are:

Young modulus: $E=80\,000\,MPa$
Poisson's ratio: $\nu=0.35$
$n=4.39$
$K=\frac{1}{0.003944}\,MPa.s^{-1}$

1.3 Boundary conditions and loadings

the bar, initial length l_0, blocked in the direction Ox on the face $[1,2]$ is subjected to a uniform temperature T and a mechanical displacement of tension u^{meca} on the face $[3,4]$. The sequences of loading are the following ones:





Reference temperature: $T_{réf}=700°C$.

Note:

> *The uniform temperature imposed on the element, constant in the course of time and equal to the reference temperature, is only used to make function META_LEMA_ANI* `the model`*. There is no thermal thermal expansion.*

2 Reference solution

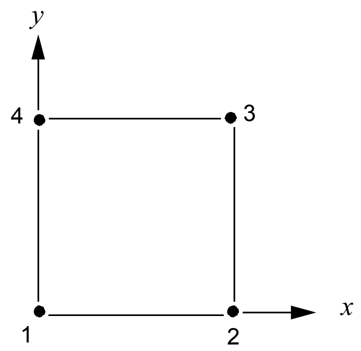
the validation of model `META_LEMA_ANI` is done by the comparison of the two modelizations A and B. Each of the two modelizations thus constitutes a reference solution for the other.

The validation of this model in large deformations logarithmic curves is done by intercomparison of the two modelizations A and C.

3 Modelization A

3.1 Characteristic of the axisymmetric

modelization $2D$ Modelization, AXIS :



Boundary conditions:

$N1 : u_y=0$

$N2 : u_y=0$

Loading:

Tension on the face $[3\,4]$ (mesh SEG2)
Assignment of the same temperature on all the nodes
the nombre total of increments is of 501 (1 increment enters $t=0\text{s}$ and $t=1\text{s}$, 500 increments enters $t=1\text{s}$ and $t=2\text{s}$)

convergence is carried out if residue RESI_GLOB_RELA is lower or equal to 10^{-6} .

Behavior:

One carries out a metallurgical computation on the first increment (which gives 100% cold phase).

For mechanical computation, one uses key words ELAS_META and META_LEMA_ANI, with the following parameters (see [R4.04.05]):

$E=80\,000\ MPa$
$\nu=0.35$
$\alpha_f=0.$
$\alpha_c=0.$
$a_1=2.40\ MPa$
$m_1=0.$
$n_1=4.40$
$Q_1=19900.K$
$M^1_{rrrr}=1.$
$M^1_{\theta\theta\theta\theta}=1.$
$M^1_{zzzz}=1.$
$M^1_{r\theta r\theta}=0.75$
$M^1_{rzrz}=0.75$

$M^1_{\theta z \theta z}=0.75$

The parameters corresponding to phases 2 and 3 (respectively mixture $\alpha\beta$ and hot phase) do not play of role and are taken unspecified.

3.2 Characteristics of the mesh

Many nodes: 4
Number of meshes: 2
1 QUAD4
1 SEG2

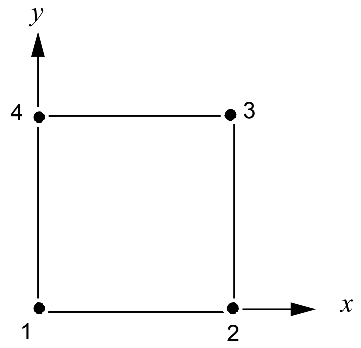
3.3 Quantities tested and results

Identification	Reference
$t=2$ Displacement DX ($N3$)	-527.4259
$t=2$ Stresses $SIGYY$ ($PG1$)	236.6860
$t=2$ Variable p $VARI$ ($PG1$)	1.4984

4 Modelization B

4.1 Characteristic of the axisymmetric

modelization $2D$ Modelization, AXIS :



Boundary conditions:

$N1 \; : \; u_y = 0$

$N2 \; : \; u_y = 0$

Loading:

Tension on the face $[3\;4]$ (mesh SEG2)
Assignment of the same temperature on all the nodes
the nombre total of increments is of 501 (1 increment enters $t = 0\text{s}$ and $t = 1\text{s}$, 500 increments enters $t = 1\text{s}$ and $t = 2\text{s}$)

convergence is carried out if residue RESI_GLOB_RELA is lower or equal to 10^{-6} .

Behavior:

One uses key words ELAS and LEMAITRE, with the following parameters:

$$E = 80\,000\; MPa$$
$$\nu = 0.35$$
$$n = 4.39$$
$$\frac{1}{K} = 0.003944$$
$$\text{UN\_SUR\_M} = 0.$$

4.2 Characteristics of the mesh

Many nodes: 4
Number of meshes: 2
1 QUAD4
1 SEG2

4.3 Quantities tested and results

Identification	Reference	Tolerance
$t = 2$ Displacement DX ($N3$)	-527.4259	1.0%
$t = 2$ Stresses $SIGYY$ ($PG1$)	236.6860	1.0%
$t = 2$ Variable p $VARI$ ($PG1$)	1.4984	1.5%

5 Modelization C

5.1 Characteristic of the modelization

Modelization $2D$ axisymmetric, AXIS , identical to modelization A. Seul changes large deformations the model: one uses here GDEF_LOG

5.2 Characteristics of the mesh

As for modelization A.

5.3 Grandeurs tested and results

Identification	Reference	Tolerance
$t=2$ Displacement DX ($N3$)	-527.4259	1.0%
$t=2$ Stresses $SIGYY$ ($PG1$)	236.6860	1.0%
$t=2$ Variable p $VARI$ ($PG1$)	1.4984	1.5%

6 Modelization D

6.1 Characteristic of the modelization

Modelization $2D$ axisymmetric, AXIS , identical to modelization A. Seuls change the command used and the time of end: one uses here SIMU_POINT_MAT and one stops with $t=1.03$.

6.2 Characteristics of the mesh

As for modelization A.

6.3 Grandeurs tested and results

Identification	Reference
$t=1.03$ Strain $EPYY$ ($PG1$)	0.105
$t=1.03$ Stresses $SIGYY$ ($PG1$)	337.24
$t=1.03$ Variable p $VARI$ ($PG1$)	0.10078

7 Summary of the results

the results found with these three modelizations are very close, the relative error being lower than 0.02% .