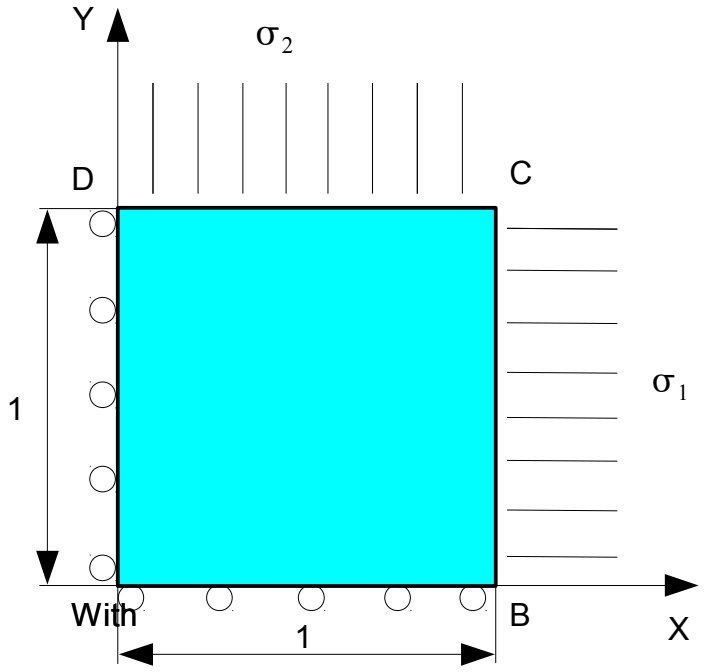
SSNP02 - Element of plate in plane deformations and biaxial traction (law of Norton)

Summary:

This CAS-test makes it possible to test the law of NORTON by using the relation of behavior of LEMAITRE in the case of a plate in plane deformations in biaxial traction. One is interested in the plastic deformations.

1 Problem of reference

1.1 Geometry



Coordinates of the points (m) :

- $A(0.,0.)$
- $B(1.,0.)$
- $C(1.,1.)$
- $D(0.,1.)$

1.2 Properties of material

Rubber band

- $E=178\,000\,MPa$ Young modulus
- $\nu=0.3$ Poisson's ratio

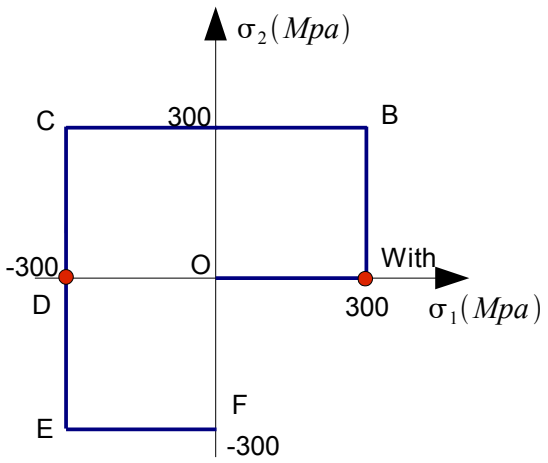
LEMAITRE

- $n=9.7$
- $K=1\,920.$
- $\frac{1}{m}=0.$

1.3 Boundary conditions and loadings

Imposed displacement (m) :
- AB : $DY=0$
- AD : $DX=0$

Loading
- Uniform pressure on BC : σ_1
- Uniform pressure on CD : σ_2
- Ways OA, AB, CD, DE and EF from duration 30 seconds
- Way BC from duration 60 seconds
- Time of maintenance in A, B and D from 3600 seconds



2 Reference solution

2.1 Method of calculating used for the reference solution

The reference solution was obtained with various codes calculations finite elements using various explicit, semi-implicit or implicit algorithms [2]

2.2 Reference variables

$EPXX$: plastic deformation according to X
$EPYY$: plastic deformation according to Y

2.3 Size and result of reference

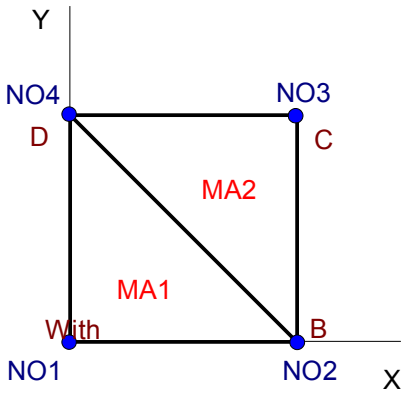
Moment (s)	Component	Reference
30.	$EPXX$	6.125×10^{-7}
	$EPYY$	-4.684×10^{-7}
3630.	$EPXX$	7.056×10^{-4}
	$EPYY$	-5.720×10^{-4}
3660.	$EPXX$	7.061×10^{-4}
	$EPYY$	-5.724×10^{-4}
7260.	$EPXX$	7.061×10^{-4}
	$EPYY$	-5.724×10^{-4}
7320.	$EPXX$	-2.443×10^{-5}
	$EPYY$	1.377×10^{-4}
7350.	$EPXX$	-7.788×10^{-4}
	$EPYY$	8.423×10^{-4}
11010.	$EPXX$	-1.534×10^{-3}
	$EPYY$	1.432×10^{-3}

2.4 Bibliographical references

[1] Guide of Validation of the Software packages of Calculations of the Structures: SFM, technical AFNOR, ISBN: 2-12-486611-7
[2] Validation of computer codes in viscoplasticity: Report of a scientific interest group. (GIS), ONERA France, 1989

3 Modeling A

3.1 Characteristics of modeling A



Modeling D_PLAN :

Many nodes 4

Many meshs 4 That is to say:

SEG2 2

TRIA3 2

Group of meshs:

- $DROITE$: segment BC
- $HAUT$: segment CD

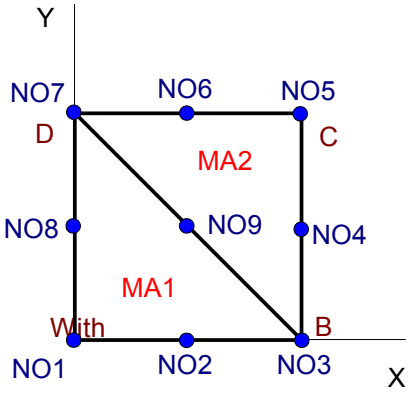
3.2 Sizes tested and results

Mesh	Not	Moment (s)	Component	Reference	Tolerance (%)
$MA1$	1	30.	$EPXX$	6.125×10^{-7}	0.2
			$EPYY$	-4.684×10^{-7}	0.2
$MA1$	1	3630.	$EPXX$	7.056×10^{-4}	0.2
			$EPYY$	-5.720×10^{-4}	0.2
$MA1$	1	3660.	$EPXX$	7.061×10^{-4}	0.2
			$EPYY$	-5.724×10^{-4}	0.2
$MA1$	1	7260.	$EPXX$	7.061×10^{-4}	0.2
			$EPYY$	-5.724×10^{-4}	0.2
$MA1$	1	7320.	$EPXX$	-2.443×10^{-5}	0.2
			$EPYY$	1.377×10^{-4}	0.2
$MA1$	1	7350.	$EPXX$	-7.788×10^{-4}	0.2
			$EPYY$	8.423×10^{-4}	0.2

MA1	1	11010.	EPXX	-1.534×10^{-3}	0.2
			EPYY	1.432×10^{-3}	0.2

4 Modeling B

4.1 Characteristics of modeling B



Modeling D_PLAN:

Many nodes 9

Many meshs 4 That is to say:

SEG3 2

TRIA6 2

Group of meshs:

- *DROITE* : segment *BC*
- *HAUT* : segment *CD*

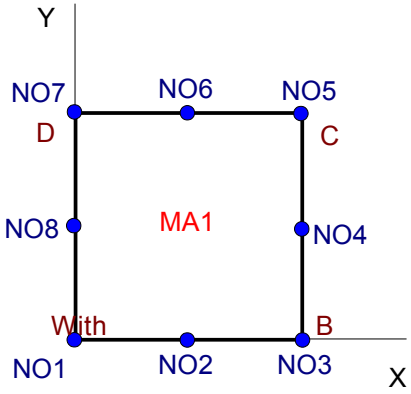
4.2 Sizes tested and results

Mesh	Not	Moment (s)	Component	Reference	Tolerance (%)
MA1	1	30.	EPXX	6.125×10^{-7}	0.2
			EPYY	-4.684×10^{-7}	0.2
MA1	1	3630.	EPXX	7.056×10^{-4}	0.2
			EPYY	-5.720×10^{-4}	0.2
MA1	1	3660.	EPXX	7.061×10^{-4}	0.2
			EPYY	-5.724×10^{-4}	0.2
MA1	1	7260.	EPXX	7.061×10^{-4}	0.2
			EPYY	-5.724×10^{-4}	0.2
MA1	1	7320.	EPXX	-2.443×10^{-5}	0.2
			EPYY	1.377×10^{-4}	0.2

MA1	1	7350.	EPXX	-7.788×10^{-4}	0.2
			EPYY	8.423×10^{-4}	0.2
MA1	1	11010.	EPXX	-1.534×10^{-3}	0.2
			EPYY	1.432×10^{-3}	0.2

5 Modeling C

5.1 Characteristics of modeling C



Modeling D_PLAN :

Many nodes 8

Many meshs 3 That is to say:

SEG3 2
QUAD8 1

Group of meshs:
- *DROITE* : segment *BC*
- *HAUT* : segment *CD*

5.2 Sizes tested and results

Mesh	Not	Moment (s)	Component	Reference	Tolerance (%)
MA1	1	30.	EPXX	6.125×10^{-7}	0.2
			EPYY	-4.684×10^{-7}	0.2
MA1	1	3630.	EPXX	7.056×10^{-4}	0.2
			EPYY	-5.720×10^{-4}	0.2
MA1	1	3660.	EPXX	7.061×10^{-4}	0.2
			EPYY	-5.724×10^{-4}	0.2
MA1	1	7260.	EPXX	7.061×10^{-4}	0.2
			EPYY	-5.724×10^{-4}	0.2

MA1	1	7320.	EPXX	-2.443×10^{-5}	0.2
			EPYY	1.377×10^{-4}	0.2
MA1	1	7350.	EPXX	-7.788×10^{-4}	0.2
			EPYY	8.423×10^{-4}	0.2
MA1	1	11010.	EPXX	-1.534×10^{-3}	0.2
			EPYY	1.432×10^{-3}	0.2

6 Modeling D

6.1 Characteristics of modeling D

Identical to modeling A. the behavior used is Norton, with implicit integration (NEWTON_PERT)
The reference solution is identical to modeling A.

6.2 Sizes tested and results

Mesh	Not	Moment (s)	Component	Reference	Tolerance (%)
MA1	1	30.	EPXX	6.125×10^{-7}	0.6
			EPYY	-4.684×10^{-7}	0.6
MA1	1	3630.	EPXX	7.056×10^{-4}	0.2
			EPYY	-5.720×10^{-4}	0.2
MA1	1	3660.	EPXX	7.061×10^{-4}	0.2
			EPYY	-5.724×10^{-4}	0.2
MA1	1	7260.	EPXX	7.061×10^{-4}	0.2
			EPYY	-5.724×10^{-4}	2
MA1	1	7320.	EPXX	-2.443×10^{-5}	0.3
			EPYY	1.377×10^{-4}	0.3
MA1	1	7350.	EPXX	-7.788×10^{-4}	0.3
			EPYY	8.423×10^{-4}	0.3
MA1	1	11010.	EPXX	-1.534×10^{-3}	0.2
			EPYY	1.432×10^{-3}	0.2

7 Modeling E

7.1 Characteristics of modeling E

Identical to modeling A. the behavior used is Norton, with integration ex plicite (RUNGE_KUTTA)
The reference solution is identical to modeling A.

7.2 Sizes tested and results

Mesh	Not	Moment (s)	Component	Reference	Tolerance (%)
MA1	1	30.	*EPXX*	6.125×10^{-7}	0.2
			EPYY	-4.684×10^{-7}	0.2
MA1	1	3630.	*EPXX*	7.056×10^{-4}	0.2
			EPYY	-5.720×10^{-4}	0.2
MA1	1	3660.	*EPXX*	7.061×10^{-4}	0.2
			EPYY	-5.724×10^{-4}	0.2
MA1	1	7260.	*EPXX*	7.061×10^{-4}	0.2
			EPYY	-5.724×10^{-4}	0.2
MA1	1	7320.	*EPXX*	-2.443×10^{-5}	0.2
			EPYY	1.377×10^{-4}	0.2
MA1	1	7350.	*EPXX*	-7.788×10^{-4}	0.2
			EPYY	8.423×10^{-4}	0.2
MA1	1	11010.	*EPXX*	-1.534×10^{-3}	0.2
			EPYY	1.432×10^{-3}	0.2

8 Summary of the results

The got results are satisfactory.