SSND107: Multiple tractions rotations in great deformations, kinematic and mixed work hardening

Summary:

This test models an element subjected to four cycles traction-rotation of rigid body of $45°$, with the elastoplastic laws of behaviour with kinematic and mixed work hardening in great hypoelastic deformations (GDEF_LOG). One checks on the one hand the invariance of the equivalent constraint of von Mises during the phases of rotation, and that the values obtained with the various laws of behavior are identical. This test validates the treatment of kinematic work hardening makes within the framework as of great hypoelastic deformations.

1 Problem of reference

1.1 Geometry

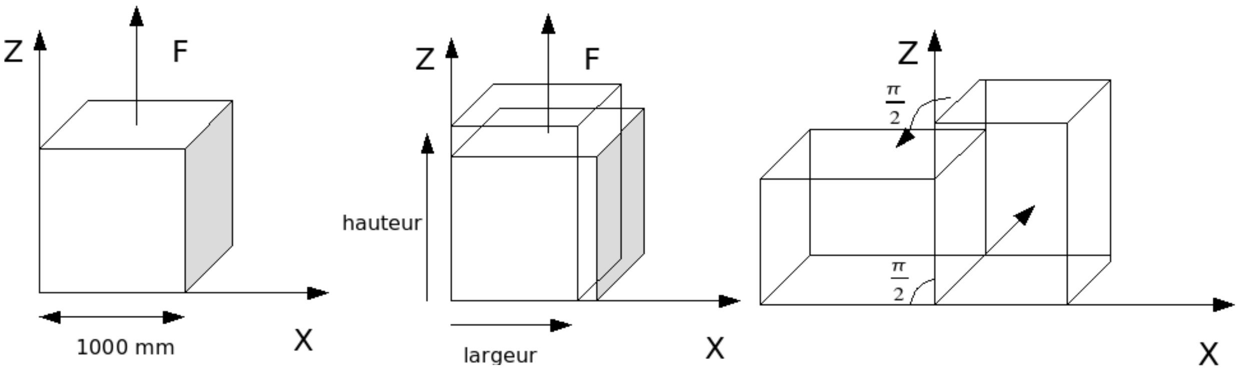

Figure1: Problem of reference (for a rotation of $90°$)

One considers a cubic matter element of $1000\,mm$ on side subjected alternatively to a force of traction then to an overall rotation of $45°$. It undergoes in all 4 cycles traction/rotation.

1.2 Data material

One considers here 6 elastoplastic laws of behavior to kinematic work hardening or kinematic/isotropic compound of type von Mises:
`VMIS_CINE_LINE`, `VMIS_ECMI_LINE`, `VMIS_ECMI_TRAC`,
`VMIS_CIN1_CHAB` and `VMIS_CIN2_CHAB VMIS_CIN2_MEMO`.

Table below list parameters used; in order to reinforce the comparison, the parameters used lead to identical laws of behavior in the 5 cases (linear work hardening).

Mot_Clé	Parameter	Value
ELAS	E	$200\,000\,MPa$
	NAKED	$0{,}3$
TRACTION	SIGM	$(0.001,200);(0.002,202)$
ECRO_LINE	D_SIGM_EPSI	$2\,000\,MPa$
	SY	$200\,MPa$
PRAGER	C	$\frac{2}{3}\frac{E*\mathrm{D\_SIGM\_EPSI}}{E-\mathrm{D\_SIGM\_EPSI}}\simeq 1346{,}8\,MPa$
CIN1_CHAB	C_I	$\frac{E*\mathrm{D\_SIGM\_EPSI}}{E-\mathrm{D\_SIGM\_EPSI}}\simeq 2020{,}2\,MPa$
	R_0	$200\,MPa$
	R_I	$200\,MPa$

	G_0	0
CIN2_CHAB	C1_I	$\frac{1}{2}\frac{E*\text{D\_SIGM\_EPSI}}{E-\text{D\_SIGM\_EPSI}}\simeq 1010{,}1\,MPa$
	C2_I	$\frac{1}{2}\frac{E*\text{D\_SIGM\_EPSI}}{E-\text{D\_SIGM\_EPSI}}\simeq 1010{,}1\,MPa$
	R_0	$200\,MPa$
	R_I	$200\,MPa$
	G1_0	0
	G2_0	0

MEMO_ECRO	DRIVEN	0
	Q_M	0
	Q_0	0
	ETA	0

1.3 Boundary conditions and loadings

Two types of phase must be distinguished: phases of traction and phases of rotation. During the phases of traction, one blocks normal displacements of the front and back faces.

Phases of traction:

First phase of traction

Entity	Type charges	Value
Lower face	FACE_IMPO	$DNOR=0$
Higher face	FACE_IMPO	$DNOR=500\text{mm}$
Axis rotation	DDL_IMPO	$DX=0$
Front face	FACE_IMPO	$DNOR=0$
Back face	FACE_IMPO	$DNOR=0$

Following tractions:

Entity	Type charges	Value
Lower face	LIAISON_OBLIQUE	$DZ=0$
Higher face	LIAISON_OBLIQUE	$DZ=200\text{mm}$
Side $X=0$; $Z=1\text{mm}$	LIAISON_OBLIQUE	$DX=0$
Axis rotation	DDL_IMPO	$DX=0, DZ=0$
Front face	DDL_IMPO	$DY=0$
Back face	DDL_IMPO	$DY=0$

Each phase of traction is made up of 5 identical increments.

Phase of rotation:

Limiting conditions

Entity	Type charges	Value
Axis rotation	DDL_IMPO	$DX=0, DZ=0$
Front face	DDL_IMPO	$DY=0$
Back face	DDL_IMPO	$DY=0$

The loading of rotation is imposed via macro named CHAR_ROTA ; one imposes an overall rotation of $45°$ by phase, cut out in 5 increments of $9°$.

One obtains at the end of the loading a deformation of 2,145.

2 Results of reference

This test does not have result of reference as tel.

One compares the solutions provided by each law between them (they are supposed to be equivalent).

Moreover, one checks the constant character of the equivalent constraint of Von Mises during the phases of rotation.

3 Modeling With

3.1 Characteristic of modeling

This modeling makes it possible to test GDEF_LOG in 3D.

3.2 Characteristics of the grid

The grid consists of a linear hexahedral mesh (with 8 nodes).

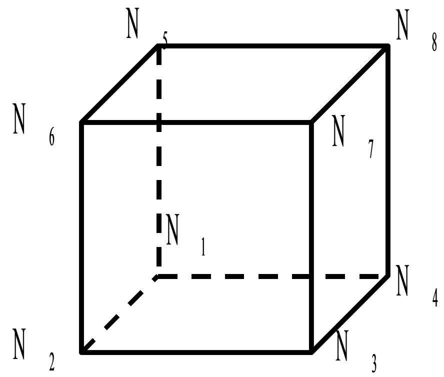

Figure 2: Grid of modeling With

3.3 Sizes tested and results

Behavior VMIS_CINE_LINE, GDEF_LOG

Imposed displacement	Sizes tested	Reference MPa	Tolerance %
$500\,mm$	SIEQ_ELGA	1126,9	0.2
$800\,mm$	SIEQ_ELGA	1543	0.1
$1100\,mm$	SIEQ_ELGA	1893,8	0.1
$1400\,mm$	SIEQ_ELGA	2197	0.1

Behavior VMIS_ECMI_LINE

Imposed displacement	Sizes tested	Reference MPa	Tolerance %
$500\,mm$	SIEQ_ELGA	1126,9	0.2
$800\,mm$	SIEQ_ELGA	1543	0.1
$1100\,mm$	SIEQ_ELGA	1893,8	0.1
$1400\,mm$	SIEQ_ELGA	2197	0.1

Behavior VMIS_ECMI_TRAC

Imposed displacement	Sizes tested	Reference MPa	Tolerance %
$500\,mm$	SIEQ_ELGA	1126,9	0.2
$800\,mm$	SIEQ_ELGA	1543	0.1
$1100\,mm$	SIEQ_ELGA	1893,8	0.1
$1400\,mm$	SIEQ_ELGA	2197	0.1

Behavior VMIS_CIN1_CHAB

Imposed displacement	Sizes tested	Reference MPa	Tolerance %
$500\,mm$	SIEQ_ELGA	1126,9	0.2
$800\,mm$	SIEQ_ELGA	1543	0.1
$1100\,mm$	SIEQ_ELGA	1893,8	0.1
$1400\,mm$	SIEQ_ELGA	2197	0.1

Behavior VMIS_CIN2_CHAB

Imposed displacement	Sizes tested	Reference MPa	Tolerance %
$500\,mm$	SIEQ_ELGA	1126,9	0.2
$800\,mm$	SIEQ_ELGA	1543	0.1
$1100\,mm$	SIEQ_ELGA	1893,8	0.1
$1400\,mm$	SIEQ_ELGA	2197	0.1

Behavior VMIS_CIN2_MEMO

Imposed displacement	Sizes tested	Reference MPa	Tolerance %
$500\,mm$	SIEQ_ELGA	1126,9	0.2
$800\,mm$	SIEQ_ELGA	1543	0.1
$1100\,mm$	SIEQ_ELGA	1893,8	0.1
$1400\,mm$	SIEQ_ELGA	2197	0.1

4 Summary of the results

Got results are satisfactory. It is noted that all the laws of behavior lead well to identical results and that the rotation of rigid body does not generate any additional constraint. The models of great deformations tested are thus quite objective.