

SSNP124 – Biaxial test drained with a behavior DRUCK_PRAGER polishing substance

Summary:

This case test makes it possible to implement a biaxial test drained according to local and not-local approaches on four different modelings during a nonlinear calculation. That makes it possible to propose the effect of the type of work hardening negative, parabolic or linear, in the case of models D_PLAN or D_PLAN_GRAD_EPSI.

Modeling A

- Model of the type “DRUCK_PRAGER” with linear negative work hardening for a containment of 2 Mpa .
- model D_PLAN with meshes QUAD4.

Modeling b:

- Model of the type “DRUCK_PRAGER” with parabolic negative work hardening for a containment of 2 MPa .
- model D_PLAN with meshes QUAD4.

Modeling C:

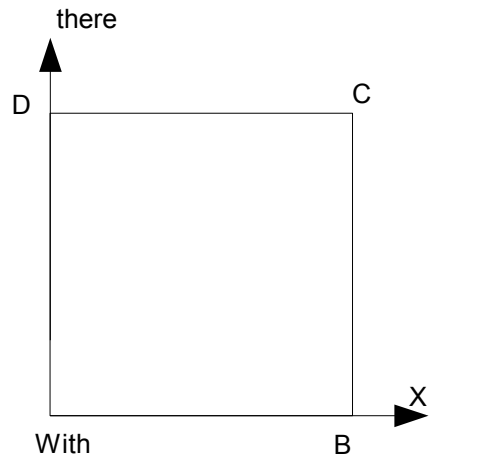
- Model of the type “DRUCK_PRAGER” with linear negative work hardening for a containment of 2 MPa .
- model D_PLAN_GRAD_EPSI with meshes QUAD8.

Modeling D:

- Model of the type “DRUCK_PRAGER” with parabolic negative work hardening for a containment of 2 Mpa
- model D_PLAN_GRAD_EPSI with meshes QUAD8.

1 Problem of reference

1.1 Geometry



- Dimension of the square: $1\text{ m} \times 1\text{ m}$.

1.2 Properties of material

Rubber band

- $E = 5800.0 \text{ E6 Pa}$ Young modulus
- $\nu = 0.3$ Poisson's ratio

DRUCK_PRAGER with linear negative work hardening

- $\alpha = 0.33$ Coefficient of dependence in pressure
- $p_{ultm} = 0.01$ Ultimate cumulated plastic deformation
- $\sigma^y = 2.57 \text{ E6 Pa}$ Plastic constraint
- $h = -2. \text{ E8 Pa}$ Module of work hardening

DRUCK_PRAGER with parabolic negative work hardening

- $\alpha = 0.33$ Coefficient of dependence in pressure
- $p_{ultm} = 0.01$ Ultimate cumulated plastic deformation
- $\sigma^y = 2.57 \text{ E6 Pa}$ Plastic constraint
- $\sigma_{ultm}^y = 0.57 \text{ E6 Pa}$ Ultimate constraint

1.3 Boundary conditions and loadings

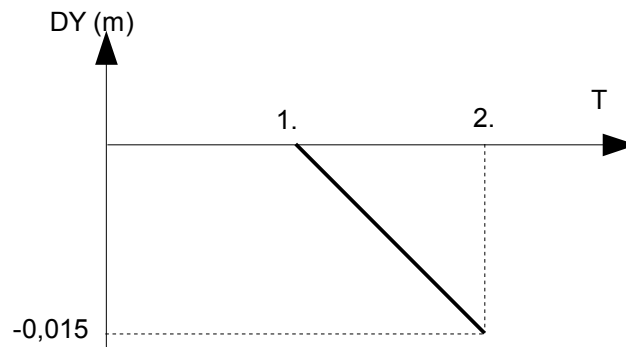
The boundary conditions and the loadings applied are the following:

Imposed loadings: the loadings are constant $t \in]1,2.]$

- Dimensioned BC $p = 2.10^6 Pa$

Displacements imposed on:

- Dimensioned AB $DY = 0$.
- Dimensioned DA $DX = 0$.
- Displacements vary on CD gradually, on the interval $t \in]1,2.]$, according to a slope, as on the figure below:
 $t = 1.$ $DY = 0$.
 $t = 2.$ $DY = -0.015$



1.4 Initial conditions

- Initial conditions (Pa)

S_{IXX}	S_{IYY}	S_{IZZ}	S_{IXY}	S_{IXZ}	S_{IYZ}
-2. E6	-2. E6	-2. E6	0.0	0.0	0.0

S_{IP}	M_{II}	F_{H11X}	F_{H11Y}
0.0	0.0	0.0	0.0

2 Reference solution

2.1 Method of calculating used for the reference solution

- Displacement DY
Displacement DY of reference to the point C corresponds to imposed displacement.
 $DY = -0.015(t-1)$
- Constraint $SIXX$
The constraint $SIXX$ corresponds to the loading applied
- Constraint $SIYY$ and cumulated plastic deformation VI
Values of reference of the constraint $SIYY$ and of the cumulated plastic deformation VI are values of not-regression.

2.2 Reference variables

- Constraint $SIXX$ at the point C
- Constraint $SIYY$ at the point C
- Cumulated plastic deformation VI at the point C
- Displacement DY at the point C

2.3 Result of reference

Size	Not	Inst	Référence*	Reference **
$SIXX (Pa)$	C	2.0	$-2.0 E6$	$-2.0 E6$
$SIYY (Pa)$	C	1.07	$-8.69 E6$	$-8.69 E6$
		1.16	$-1.39 E7$	$-1.37 E7$
		1.34	$-9.90 E6$	$-9.90 E6$
		1.53	$-9.91 E6$	$-9.90 E6$
VI	C	1.07	0	0
		1.16	$1.20 E-3$	$1.26 E-3$
		1.34	$1.12 E-2$	$1.12 E-2$
		1.53	$2.01 E-2$	$2.01 E-2$
$DY (m)$	C	1.07	$-1.05 E-3$	$-1.05 E-3$
		1.16	$-2.40 E-3$	$-2.40 E-3$
		1.34	$-5.10 E-3$	$-5.10 E-3$
		1.53	$-7.95 E-3$	$-7.95 E-3$

* linear work hardening ** parabolic work hardening

2.4 Uncertainty on the solution

- Analytical solution for the sizes DY and $SIXX$

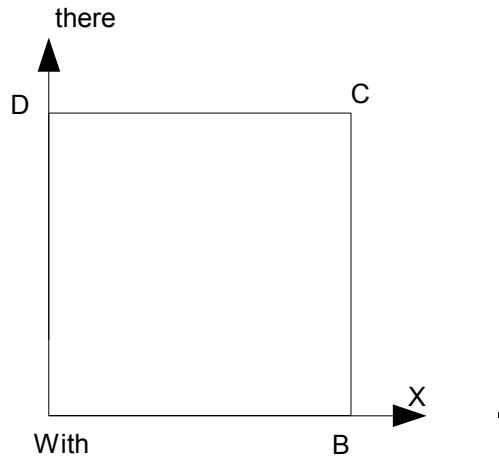
- Digital solution for the sizes $SIYY$ and VI

3 Modeling A

3.1 Characteristics of modeling A

Modeling D_PLAN.

Behavior of DRUCK_PRAGER with linear negative work hardening.



Many nodes	4	
Many meshes	5	That is to say:
		SEG2 4
		QUAD4 1

The square is in space $[0.,1.] \times [0.,1.]$.

Coordinates of the points (m) :

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

Groups of nodes:

A, B

Meshs

$M1$: surface $ABDC$
 $M2$: segment AB
 $M3$: segment BC
 $M4$: segment CD
 $M5$: segment DA

3.2 Results

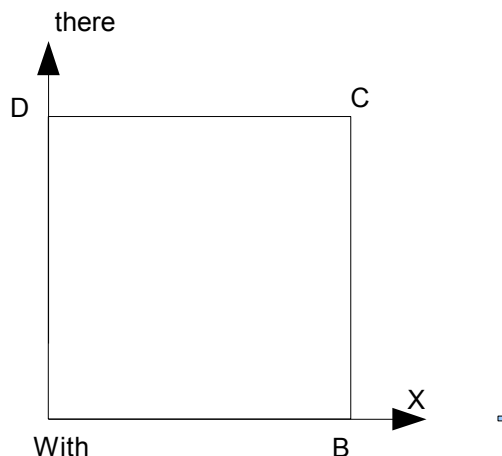
Size	Not	Inst	Reference	Tolerance (%)
S_{IXX} (Pa)	C	2.0	$-2.0 E6$	0.1
S_{IYY} (Pa)	C	1.07	$-8.69 E6$	0.1
		1.16	$-1.39 E7$	0.1
		1.34	$-9.90 E6$	0.1
		1.53	$-9.91 E6$	0.1
VI	C	1.07	0	0.1
		1.16	$1.20 E-3$	0.1
		1.34	$1.12 E-2$	0.1
		1.53	$2.01 E-2$	0.1
DY (m)	C	1.07	$-1.05 E-3$	0.1
		1.16	$-2.40 E-3$	0.1
		1.34	$-5.10 E-3$	0.1
		1.53	$-7.95 E-3$	0.1

4 Modeling B

4.1 Characteristics of modeling B

Modeling D_PLAN.

Behavior of DRUCK_PRAGER with parabolic negative work hardening.



Many nodes	4	
Many meshes	5	That is to say:
		SEG2 4
		QUAD4 1

The square is in space $[0.,1.] \times [0.,1.]$.

Coordinates of the points (m) :

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

Groups of nodes:

A, B

Meshs

$M1$: surface $ABDC$
 $M2$: segment AB
 $M3$: segment BC
 $M4$: segment CD
 $M5$: segment DA

4.2 Sizes tested and results

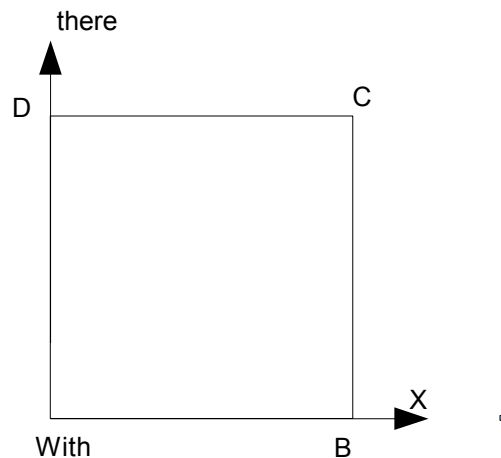
Size	Not	Inst	Reference	Tolerance (%)
S_{IXX} (Pa)	C	2.0	$-2.0 E6$	0.1
S_{IYY} (Pa)	C	1.07	$-8.69 E6$	0.1
		1.16	$-1.37 E7$	0.1
		1.34	$-9.90 E6$	0.1
		1.53	$-9.91 E6$	0.1
VI	C	1.07	0	0.1
		1.16	$1.26 E-3$	0.1
		1.34	$1.12 E-2$	0.1
		1.53	$2.01 E-2$	0.1
DY (m)	C	1.07	$-1.05 E-3$	0.1
		1.16	$-2.40 E-3$	0.1
		1.34	$-5.10 E-3$	0.1
		1.53	$-7.95 E-3$	0.1

5 Modeling C

5.1 Characteristics of modeling C

Modeling D_PLAN_GRAD_EPSI.

Behavior of DRUCK_PRAGER with linear negative work hardening.



Many nodes	8	
Many meshes	5	That is to say:
		SEG3 4
		QUAD8 1

The square is in space $[0.,1.] \times [0.,1.]$.

Coordinates of the points (m) :

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

Groups of nodes:

A, B, C, D

Groups of meshes:

$BLOC$: surface ABCD

AB, BC, CD, DA

5.2 Sizes tested and results

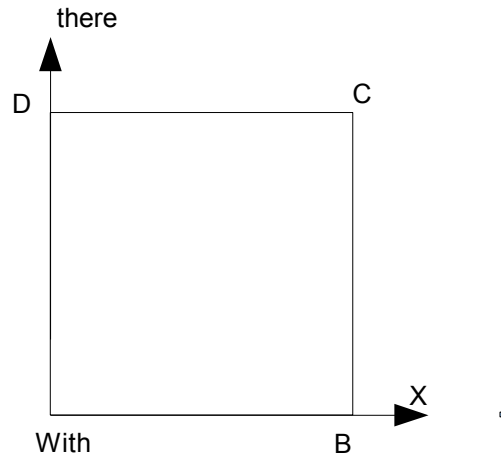
Size	Not	Inst	Reference	Tolerance (%)
S_{IXX} (Pa)	C	2.0	$-2.0 E6$	0.1
S_{IYY} (Pa)	C	1.07	$-8.69 E6$	0.1
		1.16	$-1.39 E7$	0.1
		1.34	$-9.90 E6$	0.1
		1.53	$-9.91 E6$	0.1
VI	C	1.07	0	0.1
		1.16	$1.20 E-3$	0.1
		1.34	$1.12 E-2$	0.1
		1.53	$2.01 E-2$	0.1
DY (m)	C	1.07	$-1.05 E-3$	0.1
		1.16	$-2.40 E-3$	0.1
		1.34	$-5.10 E-3$	0.1
		1.53	$-7.95 E-3$	0.1

6 Modeling D

6.1 Characteristics of modeling D

Modeling D_PLAN_GRAD_EPSI.

Behavior of DRUCK_PRAGER with parabolic negative work hardening.



Many nodes	8	
Many meshes	5	That is to say:
		SEG3 4
		QUAD8 1

The square is in space $[0.,1.] \times [0.,1.]$.

Coordinates of the points (m) :

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

Groups of nodes:

A, B, C, D

Groups of meshes:

$BLOC$: surface $ABDC$
 AB, BC, CD, DA

6.2 Sizes tested and results

Size	Not	Inst	Reference	Tolerance (%)
S_{IXX} (Pa)	C	2.0	$-2.0 E6$	0.1
S_{IYY} (Pa)	C	1.07	$-8.69 E6$	0.1
		1.16	$-1.37 E7$	0.1
		1.34	$-9.90 E6$	0.1
		1.53	$-9.91 E6$	0.1
VI	C	1.07	0	0.1
		1.16	$1.26 E-3$	0.1
		1.34	$1.12 E-2$	0.1
		1.53	$2.01 E-2$	0.1
DY (m)	C	1.07	$-1.05 E-3$	0.1
		1.16	$-2.40 E-3$	0.1
		1.34	$-5.10 E-3$	0.1
		1.53	$-7.95 E-3$	0.1

7 Summary of the results

The law of behavior of the type `DRUCK_PRAGER` with a linear negative work hardening and a parabolic negative work hardening gives satisfactory results with modelings `D_PLAN` and `D_PLAN_GRAD_EPSI`.