SSNP124 – Biaxial test drained with a softening behavior DRUCK_PRAGER

Summarized:

This case test makes it possible to during implement a biaxial test drained according to local and NON-local approaches on four different modelizations a nonlinear computation. That makes it possible to propose the effect of type of the negative, parabolic or linear hardening, in the case of model D_PLAN or D_PLAN_GRAD_EPSI.

Modelization A
- Models of type "DRUCK_PRAGER" with linear negative hardening for a containment of $2\,Mpa$.
- model D_PLAN with meshes QUAD4.

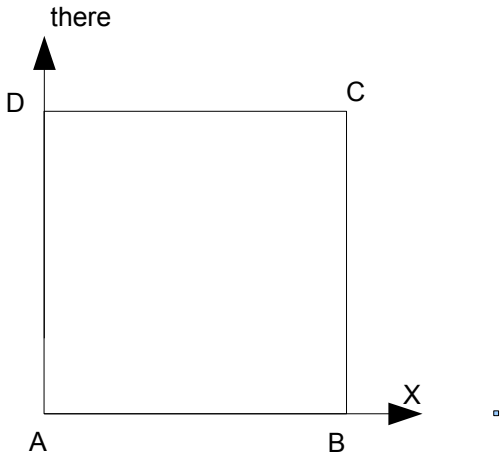
Modelization b:
- Models of type "DRUCK_PRAGER" with parabolic negative hardening for a containment of $2\,MPa$.
- model D_PLAN with meshes QUAD4.

Modelization C:
- Model of type "DRUCK_PRAGER" with linear negative hardening for a containment of $2\,MPa$.
- model D_PLAN_GRAD_EPSI with meshes QUAD8.

Modelization D:
- Model of type "DRUCK_PRAGER" with parabolic negative 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: $1\mathrm{m}\times 1\mathrm{m}$.

1.2 Properties of the Elastic

material
- $E=5800.0\,E6\,Pa$ Young Modulus
- $\nu=0.3$ Poisson's ratio

DRUCK_PRAGER with negative hardening linear
- $\alpha=0.33$ Coefficient of dependence in pressure
- $p_{ultm}=0.01$ cumulated Plastic strain ultimate
- $\sigma^{Y}=2.57\,E6\,Pa$ plastic Stress
- $h=-2.\,E8\,Pa$ Hardening modulus

DRUCK_PRAGER with negative hardening parabolic
- $\alpha=0.33$ Coefficient of dependence in pressure
- $p_{ultm}=0.01$ cumulated Plastic strain ultimate
- $\sigma^{Y}=2.57\,E6\,Pa$ ultimate Forced
- $\sigma^{Y}_{ultm}=0.57\,E6\,Pa$ plastic Stress

1.3 Boundary conditions and loadings

the boundary conditions and the loadings applied are the following:

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

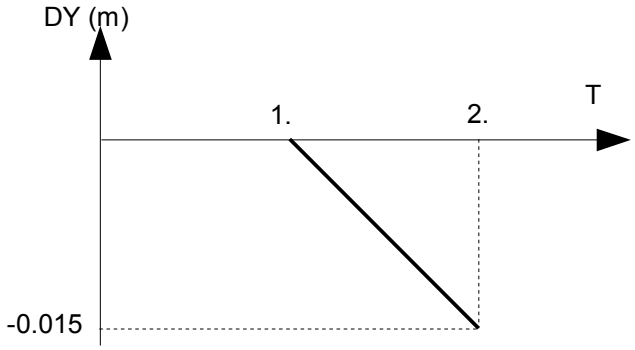
- With dimensions $BC \quad p = 2.10^6 \, Pa$

Displacements imposed on:

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

$t = 1. \quad DY = 0.$

$t = 2. \quad DY = -0.015$



1.4 Initial conditions

- Initial conditions (Pa)

SIXX	SIYY	SIZZ	SIXY	SIXZ	SIYZ
-2. E6	-2. E6	-2. E6	0.0.0.0.0.0		

SIP	M11	FH11X	FH11Y
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.

$DY=-0.015(t-1)$

•Stress $SIXX$

the stress $SIXX$ corresponds to the loading applied

•Forced $SIYY$ and cumulated plastic strain $V1$

the values of reference of the stress $SIYY$ and the cumulated plastic strain $V1$ are values of NON-regression.

2.2 Variables reference

•Forced $SIXX$ to the point C
•Forced $SIYY$ at the point C
•Plastic strain cumulated $V1$ at the point C
•Displacement DY at the point C

2.3 Result of reference

Quantity	Not	$Inst$	Référence*	linear 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	$-9.91\,E6$	$-9.90\,E6$
$V1$	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	$-7.95\,E-3$	$-7.95\,E-3$

** * hardening ** parabolic hardening

2.4 Uncertainty on the analytical

•solution Solution for the quantities DY and $SIXX$

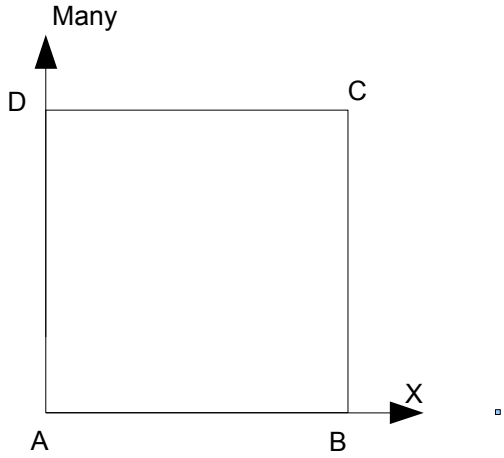
•numerical Solution for the quantities $SIYY$ and $V1$

3 Modelization A

3.1 Characteristic of the modelization A

Modelization D_PLAN.

Behavior of DRUCK_PRAGER with linear negative hardening.



nodes Number of meshes 4

Is 5 there :

SEG2 4

QUAD4 1

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

Coordinates of the points (m) :

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

Nodes groups :

A, B

Meshes :

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

3.2 Quantity

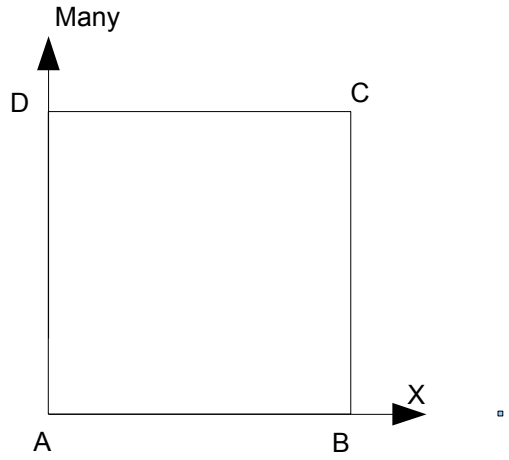
Results	Not	*Inst*	Reference	Tolerance (%)
$SIXX\ (Pa)$	C	2.0	$-2.0\ E6$	0.1.0.1.0.1
$SIYY\ (Pa)$	C	1.07	$-8.69\ E6$	
		1.16	$-1.39\ E7$	
		1.34	$-9.90\ E6$	0.1.0.1.0.1
		1.53	$-9.91\ E6$	
$V1$	C	1.07	0	
		1.16	$1.20\ E-3$	0.1.0.1.0.1
		1.34	$1.12\ E-2$	
		1.53	$2.01\ E-2$	
$DY\ (m)$	C	1.07	$-1.05\ E-3$	0.1.0.1.0.1
		1.16	$-2.40\ E-3$	
		1.34	$-5.10\ E-3$	
		1.53	$-7.95\ E-3$	0.1

4 Modelization B

4.1 Characteristic of the modelization B

Modelization D_PLAN.

Behavior of DRUCK_PRAGER with parabolic negative hardening.



nodes Number of 4
meshes
Is 5 there :

SEG2	4
QUAD4	1

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

Coordinates of the points (m) :

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

Nodes groups :

A, B

Meshes :

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

4.2 Quantities tested and Quantity

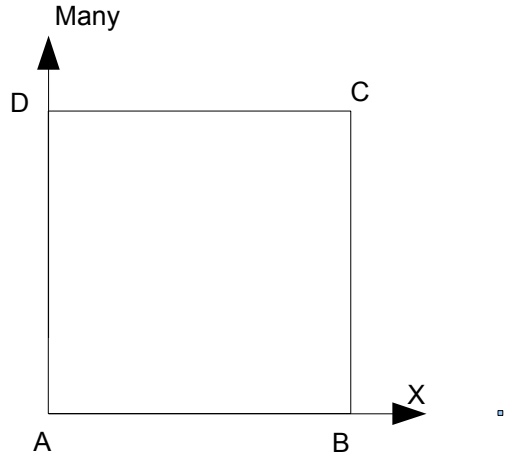
results	Not	*Inst*	Reference	Tolerance (%)
$SIXX\ (Pa)$	C	2.0	$-2.0\ E6$	0.1.0.1.0.1
$SIYY\ (Pa)$	C	1.07	$-8.69\ E6$	
		1.16	$-1.37\ E7$	
		1.34	$-9.90\ E6$	0.1.0.1.0.1
		1.53	$-9.91\ E6$	
$V1$	C	1.07	0	
		1.16	$1.26\ E-3$	0.1.0.1.0.1
		1.34	$1.12\ E-2$	
		1.53	$2.01\ E-2$	
$DY\ (m)$	C	1.07	$-1.05\ E-3$	0.1.0.1.0.1
		1.16	$-2.40\ E-3$	
		1.34	$-5.10\ E-3$	
		1.53	$-7.95\ E-3$	0.1

5 Modelization C

5.1 Characteristic of the modelization C

Modelization D_PLAN_GRAD_EPSI.

Behavior of DRUCK_PRAGER with linear negative hardening.



nodes Number of meshes 8

Is 5 there :

SEG3	4
QUAD8	1

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

Coordinates of the points (m) :

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

Nodes groups :

A, B, C, D

Mesh groups :

$BLOC$: surface ABCD

AB, BC, CD, DA

5.2 Quantities tested and Quantity

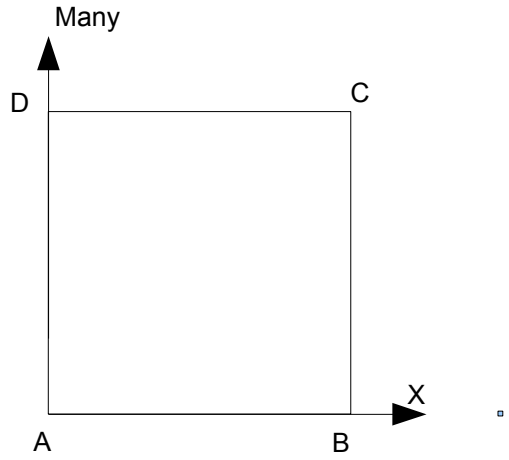
results	Not	*Inst*	Reference	Tolerance (%)
$SIXX\ (Pa)$	C	2.0	$-2.0\,E6$	0.1.0.1.0.1
$SIYY\ (Pa)$	C	1.07	$-8.69\,E6$	
		1.16	$-1.39\,E7$	
		1.34	$-9.90\,E6$	0.1.0.1.0.1
		1.53	$-9.91\,E6$	
$V1$	C	1.07	0	
		1.16	$1.20\,E-3$	0.1.0.1.0.1
		1.34	$1.12\,E-2$	
		1.53	$2.01\,E-2$	
$DY\ (m)$	C	1.07	$-1.05\,E-3$	0.1.0.1.0.1
		1.16	$-2.40\,E-3$	
		1.34	$-5.10\,E-3$	
		1.53	$-7.95\,E-3$	0.1

6 Modelization D

6.1 Characteristic of the modelization D

Modelization D_PLAN_GRAD_EPSI.

Behavior of DRUCK_PRAGER with parabolic negative hardening.



nodes Number of meshes 8

Is 5 there :

SEG3 4

QUAD8 1

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

Coordinates of the points (m) :

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

Nodes groups :

A, B, C, D

Mesh groups :

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

6.2 Quantities tested and Quantity

results	Not	*Inst*	Reference	Tolerance (%)
$SIXX\ (Pa)$	C	2.0	$-2.0\,E6$	0.1.0.1.0.1
$SIYY\ (Pa)$	C	1.07	$-8.69\,E6$	
		1.16	$-1.37\,E7$	
		1.34	$-9.90\,E6$	0.1.0.1.0.1
		1.53	$-9.91\,E6$	
$V1$	C	1.07	0	
		1.16	$1.26\,E-3$	0.1.0.1.0.1
		1.34	$1.12\,E-2$	
		1.53	$2.01\,E-2$	
$DY\ (m)$	C	1.07	$-1.05\,E-3$	0.1.0.1.0.1
		1.16	$-2.40\,E-3$	
		1.34	$-5.10\,E-3$	
		1.53	$-7.95\,E-3$	0.1

7 Summary of the results

the constitutive law of the type DRUCK_PRAGER with a linear negative hardening and a parabolic negative hardening gives satisfactory results with modelizations D_PLAN and D_PLAN_GRAD_EPSI.