WTNA101 – Triaxial compression test not-drained with a lenitive behavior DRUCK_PRAGER

Summary:

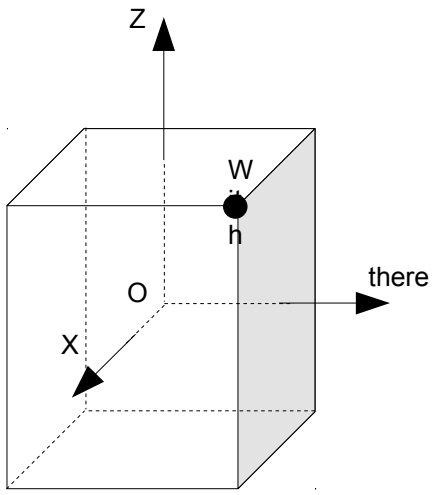
This CAS-test makes it possible to implement a triaxial compression test not-drained on two different modelings during a nonlinear calculation. That makes it possible to propose the effect of work hardening negative, parabolic or linear, in the case of models 3D_HM.

Modeling a:
- Model of the type " DRUCK_PRAGER " with linear negative work hardening for a containment of $2\,MPa$.
- Modeling 3D_HM with meshs HEXA20 .

Modeling b:
- Model of the type " DRUCK_PRAGER " with parabolic negative work hardening for a containment of $2\,MPa$.
- Modeling 3D_HM with meshs HEXA20 .

1 Problem of reference

1.1 Geometry



Geometry of the cube:

Center $O(0.,0.,0.)$
Not $A(0.5,0.5,0.5)$
Cubic of with dimensions $1\,m$

1.2 Properties of material

- Rubber band
  - $E=5800.0\,E6\,Pa$ Young modulus
  - $\rho=2500\,kg.m^{-3}$ Density
  - $\nu=0.3$ 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
  - $\sigma^{Y}=2.57\,E6\,Pa$ Plastic constraint
  - $h=-2.00\,E8\,Pa$ 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
  - $\sigma^{Y}=2.57\,E6\,Pa$ Plastic constraint
  - $\sigma^{Y}_{ultm}=0.57\,E6\,Pa$ Ultimate constraint

- Hydraulic behavior: saturated liquid

• $Pre1=1\ Pa$	Pressure of liquid of reference
• $\rho_{pre1}=1000\,kg.m^{-3}$	Density of water
• $Poro=0.14$	Initial porosity
• $\rho_{vh}=2400\ kg.m^{-3}$	Density homogenized
• $bio=1$	Coefficient of Biot
• $K_{intrinsèque}=1\,E-18\ m^2$	Intrinsic permeability
• $\frac{1}{K_l}=0$	Liquide incompressible
• $vi=1.0\,E-3\ Pa.s$	Viscosity

1.3 Boundary conditions and loadings

The boundary conditions and the loadings are applied in two stages:

- Stage A : $t\in[0,1.]$

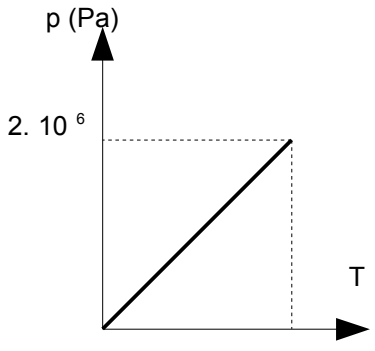
Boundary conditions

- Pressure with the nodes $PRE1=0.$
- Imposed displacements, of symmetry, on the faces of the cube pertaining to the plans

$X=-0.5 \quad DX=0$
$Y=-0.5 \quad DY=0$
$Z=-0.5 \quad DZ=0$

Loadings

- A compression gradually is applied $p=2.10^6\ Pa$ on the faces of the cube pertaining to the plans: $X=0.5$, $Y=0.5$ and $Z=0.5$



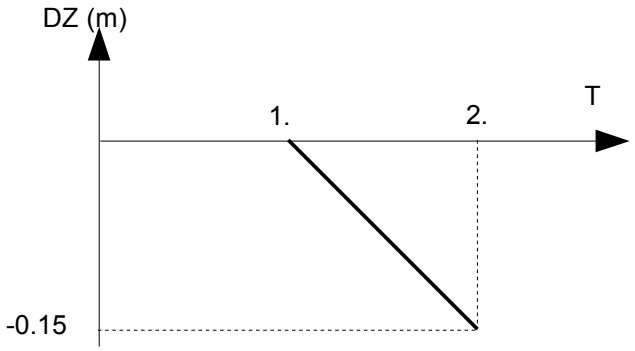
1.

- Stage b: $t \in]1,2.]$

From the state of stresses obtained at the moment $t=1.s$, one bracket on the faces of the cube following conditions:

Displacements

- For the face belonging to the plan $Z=0.5$ displacement gradually is applied DZ , according to a slope:



- For the faces belonging to the plans $X=-0.5, Y=-0.5, Z=-0.5$ conditions of symmetry are applied.

Loadings: the loadings applied are constant:

- Face belonging to plan $X=0.5$ $p=2.10^6\,Pa$
- Face belonging to the plan $Z=0.5$ $p=2.10^6\,Pa$

2 Reference solution

2.1 Reference variables

The reference variables are the following ones:

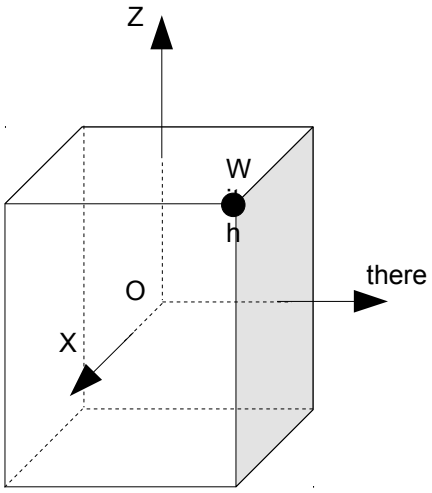
- Constraint $SIXX$ with the node A
- Constraint $SIZZ$ with the node A
- Pressure $Pre1$ with the node A

2.2 Result of reference

The reference variables correspond to those of modeling A obtained with version 7.2.6 of Code_Aster. They are values of not-regression.

3 Modeling A

3.1 Characteristics of modeling A



Modeling 3D_HM,

Law of behavior of the type DRUCK_PRAGER with a linear negative work hardening:

Many nodes 20

Many meshs 7 That is to say:

QUAD8	6
HEXA20	1

Groups of meshs:

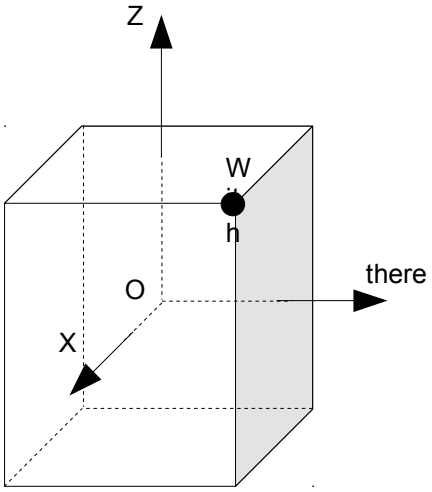
BAS :	surface of the cube pertaining to the plan	$Z=-0.5$
$HAUT$:	surface of the cube pertaining to the plan	$Z=+0.5$
$DROITE$:	surface of the cube pertaining to the plan	$Y=+0.5$
$GAUCHE$:	surface of the cube pertaining to the plan	$Y=-0.5$
$DERRIERE$:	surface of the cube pertaining to the plan	$X=-0.5$
$DEVANT$:	surface of the cube pertaining to the plan	$X=+0.5$

3.2 Results

Size	Not	$Inst$	Reference	Tolerance (%)
$SIXX\ (Pa)$	A	1.004	$-9.69\ E5$	0.01
		1.16	$-4.52\ E7$	0.01
		1.34	$-9.59\ E7$	0.01
		1.60	$-1.69\ E8$	0.01
$SIZZ\ (Pa)$	A	1.004	$-4.06\ E6$	0.01
		1.16	$-1.13\ E8$	0.01
		1.34	$-2.38\ E8$	0.01
		1.60	$-4.20\ E8$	0.01
$Pre1\ (Pa)$	A	1.004	$1.03\ E6$	0.01
		1.16	$-4.32\ E7$	0.01
		1.34	$-9.39\ E7$	0.01
		1.60	$-1.67\ E8$	0.01

4 Modeling B

4.1 Characteristics of modeling B



Modeling 3D_HM,

Law of behavior of the type DRUCK_PRAGER with a parabolic negative work hardening:

Many nodes	20		
Many meshs	7	That is to say:	
		QUAD8	6
		HEXA20	1

Groups of meshs:

BAS :	surface of the cube pertaining to the plan	$Z=-0.5$
$HAUT$:	surface of the cube pertaining to the plan	$Z=+0.5$
$DROITE$:	surface of the cube pertaining to the plan	$Y=+0.5$
$GAUCHE$:	surface of the cube pertaining to the plan	$Y=-0.5$
$DERRIERE$:	surface of the cube pertaining to the plan	$X=-0.5$
$DEVANT$:	surface of the cube pertaining to the plan	$X=+0.5$

4.2 Results

The got results are identical to those of modeling A.

Size	Not	$Inst$	Reference	Tolerance (%)
$SIXX\ (Pa)$	A	1.004	$-9.69\ E5$	0.01
		1.16	$-4.52\ E7$	0.01
		1.34	$-9.59\ E7$	0.01
		1.60	$-1.69\ E8$	0.01
$SIZZ\ (Pa)$	A	1.004	$-4.06\ E6$	0.01
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$Pre1\ (Pa)$	A	1.004	$1.03\ E6$	0.01
		1.16	$-4.32\ E7$	0.01
		1.34	$-9.39\ E7$	0.01
		1.60	$-1.67\ E8$	0.01

5 Summary of the results

The whole of the results got with this CAS-test are satisfactory.