

## WTNA101 – Triaxial compression test not-drained with a lenitive behavior DRUCK\_PRAGER

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### 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:

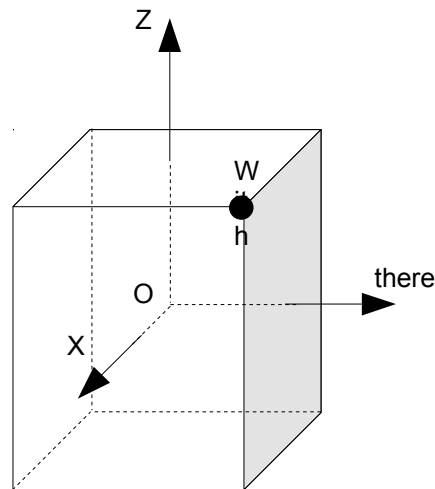
- Model of the type “ DRUCK\_PRAGER ” with linear negative work hardening for a containment of 2 MPa .
- Modeling 3D\_HM with meshes HEXA20 .

### Modeling b:

- Model of the type “ DRUCK\_PRAGER ” with parabolic negative work hardening for a containment of 2 MPa .
- Modeling 3D\_HM with meshes 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  $1\text{ m}$

### 1.2 Properties of material

- Rubber band
  - $E = 5800.0\text{ E}6\text{ Pa}$  Young modulus
  - $\rho = 2500\text{ kg.m}^{-3}$  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
  - $\sigma^Y = 2.57\text{ E}6\text{ Pa}$  Plastic constraint
  - $h = -2.00\text{ E}8\text{ Pa}$  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
  - $\sigma^Y = 2.57\text{ E}6\text{ Pa}$  Plastic constraint
  - $\sigma_{ultm}^Y = 0.57\text{ E}6\text{ Pa}$  Ultimate constraint

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

## 1.3 Boundary conditions and loadings

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

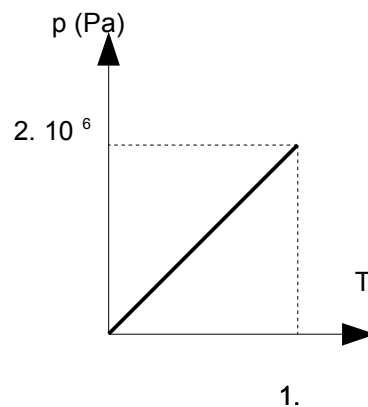
- Stage A :  $t \in [0, 1.]$

### Boundary conditions

- Pressure with the nodes  $PRE1 = 0.$
- Imposed displacements, of symmetry, on the faces of the cube pertaining to the plans
 
$$\begin{array}{ll} X = -0.5 & DX = 0 \\ Y = -0.5 & DY = 0 \\ Z = -0.5 & DZ = 0 \end{array}$$

### Loadings

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

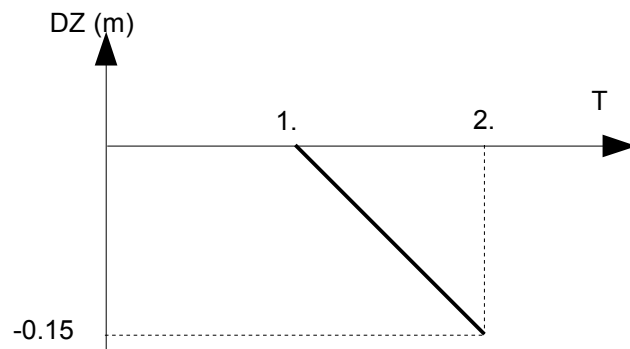


- Stage b:  $t \in ]1,2.]$

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

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### 2.1 Reference variables

The reference variables are the following ones:

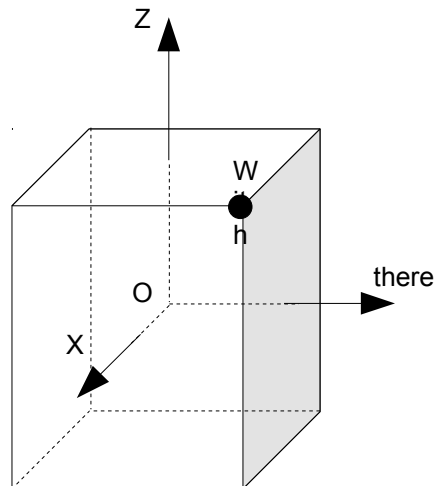
- Constraint *SIXX* with the node *A*
- Constraint *SIZZ* with the node *A*
- Pressure *Pre1* with the node *A*

### 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 meshes	7	That is to say:
		QUAD8 6
		HEXA20 1

Groups of meshes:

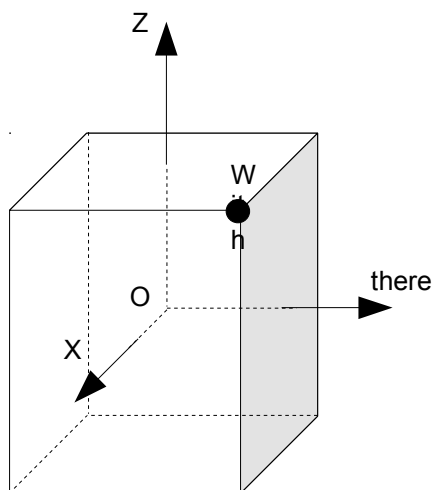
<i>BAS</i> :	surface of the cube pertaining to the plan	$Z = -0.5$
<i>HAUT</i> :	surface of the cube pertaining to the plan	$Z = +0.5$
<i>DROITE</i> :	surface of the cube pertaining to the plan	$Y = +0.5$
<i>GAUCHE</i> :	surface of the cube pertaining to the plan	$Y = -0.5$
<i>DERRIERE</i> :	surface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

## 3.2 Results

Size	Not	Inst	Reference	Tolerance (%)
<i>SIXX (Pa)</i>	<i>A</i>	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
<i>SIZZ (Pa)</i>	<i>A</i>	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
<i>Pre1 (Pa)</i>	<i>A</i>	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 meshes	7	That is to say:
		QUAD8 6
		HEXA20 1

Groups of meshes:

<i>BAS</i> :	surface of the cube pertaining to the plan	$Z = -0.5$
<i>HAUT</i> :	surface of the cube pertaining to the plan	$Z = +0.5$
<i>DROITE</i> :	surface of the cube pertaining to the plan	$Y = +0.5$
<i>GAUCHE</i> :	surface of the cube pertaining to the plan	$Y = -0.5$
<i>DERRIERE</i> :	surface of the cube pertaining to the plan	$X = -0.5$
<i>DEVANT</i> :	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 ( % )
<i>SIXX (Pa)</i>	<i>A</i>	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
<i>SIZZ (Pa)</i>	<i>A</i>	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
<i>Pre1 (Pa)</i>	<i>A</i>	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

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