

## WTNV142 - Triaxial compression test not-drained with the law of Mohr-Coulomb

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### Summary

One carries out a triaxial calculation in conditions not-drained with the law of Mohr-Coulomb. The solutions calculated with a model HM are compared with those given by SIMU\_POINT\_MAT. This test comprises a modeling:

- a modeling 3D\_HM\_SI (STAT\_NON\_LINE);

## 1 Problem of reference

### 1.1 Geometry

The triaxial compression test is carried out on only one isoparametric finite element of cubic form *CUB8*. The length of each edge is worth 1. The various facets of this cube are named groups of meshes *HAUT*, *BAS*, *DEVANT*, *DERRIERE*, *DROIT* and *GAUCHE*. The group of meshes *SYM* contains the groups of meshes in addition *BAS*, *DEVANT* and *GAUCHE*; the group of meshes *COTE* groups of meshes *DERRIERE* and *DROIT*.

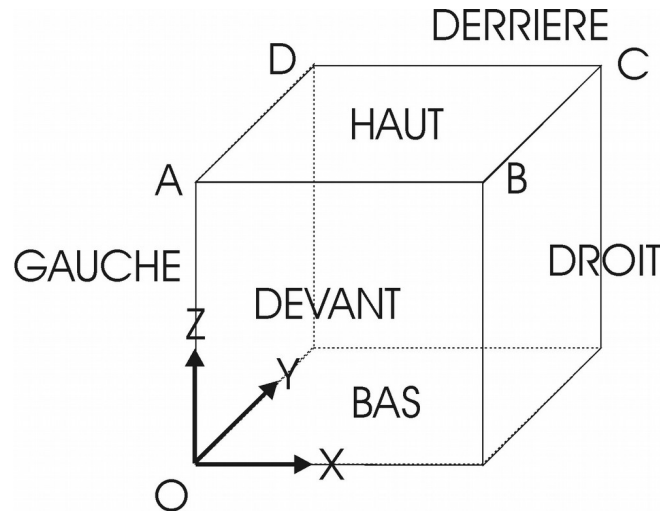


Table 1.1-1 : mesh of the sample

### 1.2 Material properties

The elastic properties are:

- isotropic module of compressibility:  $K = 516,2 \text{ MPa}$
- modulus of rigidity:  $\mu = 238,2 \text{ MPa}$

The hydraulic properties are:

- coefficient of Biot:  $b = 1$
- module of compressibility of the fluid:  $K_f = 1000 \text{ GPa}$

The parameters of the law of Mohr-Coulomb are:

- angle of friction:  $\varphi = 33^\circ$
- angle of dilatancy:  $\psi = 27^\circ$
- cohesion:  $c_0 = 1 \text{ kPa}$

### 1.3 Boundary conditions and loadings

A triaxial compression test consists in imposing on the test-tube a vertical radial force all while keeping the side pressure constant. It can be drained (the pore water pressure of fluid does not vary during the test) or not-drained (one turns off the tap: the pore water pressure of fluid evolves in the sample). One is interested here in the case not drained.

In the model considered, the cubic element represents a eighth of the sample. The limiting conditions are thus the following ones:

- Conditions of symmetry:
  - $u_z = 0$  on the group of mesh *BAS*
  - $u_x = 0$  on the group of mesh *GAUCHE*
  - $u_y = 0$  on the group of mesh *DEVANT*
- Conditions of side pressure:
  - $P_n = 1$  on the group of mesh *COTE*
- Conditions of loading:
  - $P_n = 1$  on the group of mesh *HAUT* (phase 1)

- $u_z = -1$  on the group of mesh *HAUT* (phase 2)

The loading is carried out in two phases:

- Initialization. Isotropic loading enters  $t \in [-2; 0]$  secondes : pressure  $P$  on the groups of meshes *COTE* and *HAUT* vary 0 with  $P = P_0 = 50 \text{ kPa}$ , isotropic pressure of preconsolidation to the state initial;
- triaxial test properly-known as : displacement imposed on the group of meshes *HAUT* with  $t$  varying enters  $t \in [0-12]$  secondes and  $u_z$  varying enters  $u_z \in [0; -0,12]$  mm . Vertical deformation  $\varepsilon_{zz}$  total is of 0,012% ;

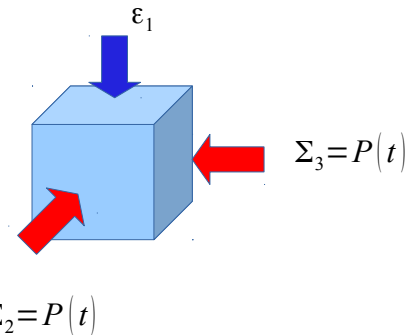


Table 1.3-1 : Description of the triaxial compression test

## 1.4 Results

The solutions given by a true coupled hydraulic calculation are compared with those given by SIMU\_POINT\_MAT, which solves the problem *purely mechanical* according to:

$$\Sigma = \sigma + b p = C : \varepsilon - \frac{b K_l}{3} \text{trace}(\varepsilon) = P(t)$$

The solutions post-are treated with the point  $C$  for the terms of horizontal effective constraint  $\sigma_{xx}$ , of water pressure  $p$ , like those of plastic voluminal deformation  $\varepsilon_v^p$  and of plastic

deviatoric deformation  $|\varepsilon_d^p| = \sqrt{\frac{3}{2} \left( \varepsilon - \frac{\varepsilon_v^p}{3} I \right) : \left( \varepsilon - \frac{\varepsilon_v^p}{3} I \right)}$ .

## 2 Modeling A

### 2.1 Characteristics of modeling

Modeling A is carried out under-integrated 3D (3D\_HM\_SI), using STAT\_NON\_LINE.

The step of time is of  $\Delta t=0,4\text{sec}$  until  $t=9,6\text{sec}$  (purely elastic phase), then of  $\Delta t=0,025\text{sec}$  until  $t=12\text{sec}$  (plastic phase). The automatic recutting of the step of time is activated.

### 2.2 Sizes tested and results

#### 2.2.1 Values tested

The solutions are calculated at the point  $C$  and compared with the solution given by SIMU\_POINT\_MAT at the final moment  $t=12\text{sec}$ . They are given in terms of horizontal effective constraint  $\sigma_{xx}$ , of water pressure  $p$ , like those of plastic voluminal deformation  $\varepsilon_v^p$  and of plastic deviatoric deformation  $|\varepsilon_d^p| = \sqrt{\frac{3}{2} \left( \varepsilon - \frac{\varepsilon_v^p}{3} I \right) : \left( \varepsilon - \frac{\varepsilon_v^p}{3} I \right)}$ , and recapitulated in the following table:

$t=12\text{sec}$	Reference	Error relative	Absolute error
$\sigma_{xx}$	-30777.31	3. E-4	-
$p$	-19226.58	5. E-4	-
$\varepsilon_v^p$	1.262378E-05	-	1. E6
$\varepsilon_d^p$	2.270058E-05	-	1. E6

Table 2.2.1-1 : Validation of the results for modeling A

## 3 Summary of the results

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The good agreement of the results with the reference makes it possible to validate the use of the law of Mohr-Coulomb with the THM.