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

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);

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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 meshs $HAUT$, BAS, $DEVANT$, $DERRIERE$, $DROIT$ and $GAUCHE$. The group of meshs *SYM* contains the groups of meshs in addition BAS, $DEVANT$ and $GAUCHE$; the group of meshs $COTE$ groups of meshs $DERRIERE$ and $DROIT$.

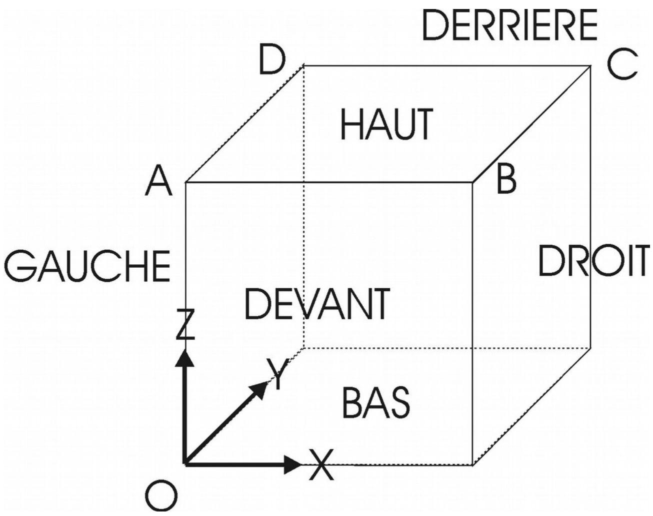

Table 1.1-1 : mesh of the sample

1.2 Material properties

The elastic properties are:

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

The hydraulic properties are:

- coefficient of Biot: $b=1$
- module of compressibility of the fluid: $K_l=1000\,GPa$

The parameters of the law of Mohr-Coulomb are:

- angle of friction: $\varphi=33°$
- angle of dilatancy: $\psi=27°$
- cohesion: $c_0=1\,kPa$

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)

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- $u_z=-1$ 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 meshs $COTE$ and $HAUT$ vary 0 with $P=P_0=50\,kPa$, isotropic pressure of preconsolidation to the state intial;

- triaxial test properly-known as : displacement imposed on the group of meshs $HAUT$ with t varying enters $t\in[0-12]\,secondes$ and u_z varying enters $u_z\in[0;-0{,}12]\,mm$. Vertical deformation ε_{zz} total is of $0{,}012\,\%$;

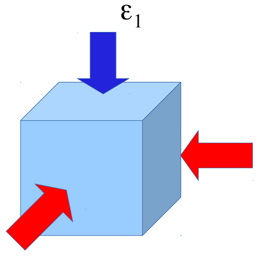

Table 1.3-1 : Description of the triaxial compression test

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:

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

The solutions post-are treated with the point C for the terms of horizontal effective constraint σ_{xx} , of water pressure p , like those of plastic voluminal deformation ε_v^p and of plastic deviatoric deformation $|\varepsilon_d^p|=\sqrt{\frac{3}{2}\left(\varepsilon-\frac{\varepsilon_v^p}{3}I\right):\left(\varepsilon-\frac{\varepsilon_v^p}{3}I\right)}$.

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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 $\Delta t = 0{,}4\,sec$ until $t = 9{,}6\,sec$ (purely elastic phase), then of $\Delta t = 0{,}025\,sec$ until $t = 12\,sec$ (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 $t = 12\,sec$. They are given in terms of horizontal effective constraint σ_{xx}, of water pressure p, like those of plastic voluminal deformation ε_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:

$t = 12\,sec$	Reference	Error relative	Absolute error
σ_{xx}	-30777.31	3. E-4	-
p	-19226.58	5.E-4	-
ε_v^p	1.262378E-05	-	1. E6
ε_d^p	2.270058E-05	-	1. E6

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

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3 Summary of the results

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.

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