# SSNV206 - Triaxial compression test with the model LETK of the CIH

**Summarized**

This test makes it possible to the model validate LETK in rock mechanics. It is about a triaxial compression test in pure mechanics or drained condition. Computations are carried out only on the solid part of the soil without hydraulic coupling. One applies a level of containment of $5\,MPa$ . By reason of symmetry, one is interested only in the eighth of a sample subjected to a triaxial compression test. The modelization is axisymmetric.

•Modelization a: the local algorithm of integration of the model explicit, is classified like specific thereafter.

•Modelization b: the local algorithm of integration of the model is implicit with the local jacobian matrix obtained by disturbance.

•Modelization C: The local algorithm of integration of the model is implicit with the local jacobian matrix obtained analytically.

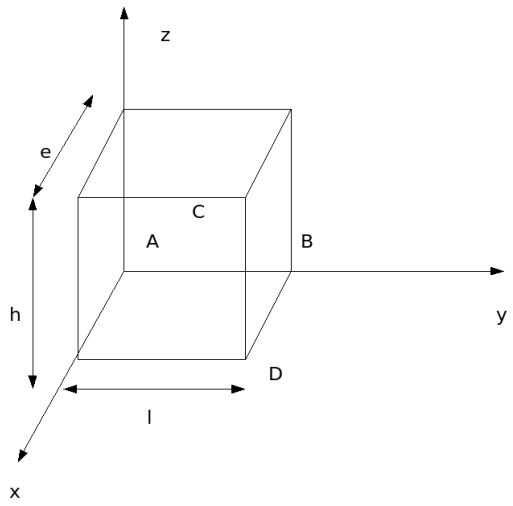
•Modelization D: The local algorithm of integration of the model explicit, is classified like specific thereafter. The loading is applied 100 times more slowly to propose the role of viscosity in the model

•Modelization E: The local algorithm of integration of the model is implicit with the local jacobian matrix obtained analytically. The loading is applied 100 times more slowly to propose the role of viscosity in the model

It acts of tests of non regression. The five modelization converge towards concordant solutions for fine discretizations of the loading applied.

# 1 Problem of reference

## 1.1 Geometry




height: $h=1\,m$
width: $l=1\,m$
thickness: $e=1\,m$

Coordinates of the points (in meters):

| | $A$ | $B$ | $C$ | $D$ |
|---|---|---|---|---|
| $x$ | 0. | 0. | 0.5 | 1. |
| $y$ | 0. | 1. | 0.5 | 1. |
| $z$ | 0. | 0. | 0.5 | 0. |

## 1.2 Material property

$E = 5000\,MPa$
$v = 0,12$
$\alpha = 0.$
$Pa = 0,1\,MPa$
$n_{elas} = 0.$
$\sigma_c = 12.\,MPa$
$H_0^{ext} = 1,10292$
$\gamma_{cjs} = 0,8$
$x_{ams} = 0,1$
$\eta = 0,04$
$a_0 = 0,25$
$a_e = 0,60$
$a_{pic} = 0,40$
$s_0 = 0,0005$
$m_0 = 0,01$
$m_e = 2.$
$m_{pic} = 6.$
$m_{ult} = 0,61$
$\xi_{ult} = 0,365$
$\xi_e = 0,028$
$\xi_{pic} = 0,015$
$m_{v-\max} = 3.$
$\xi_{v-\max} = 0,0039$
$A^v = 1,510^{-12}\,Pa$
$n^v = 4,5$
$\sigma_{p1} = 57,8\,MPa\ ;$
$\mu_{0,v} = 0,1$
$\xi_{0,v} = 0,3$
$\mu_1 = 0,1$
$\xi_1 = 0,3$

### 1.3 Initial conditions, boundary conditions, and loading

**Phase 1:**

One brings the sample in a homogeneous state: $\sigma^0_{xx}=\sigma^0_{yy}=\sigma^0_{zz}$ , by imposing the corresponding confining pressure on the front, side right and higher sides. Displacements are blocked on the sides postpones ( $u_x=0$ ), side left ( $u_y=0$ ) and lower ( $u_z=0$ ).

**Phase 2:**

One maintains displacements blocked on the sides postpones ( $u_x=0$ ), side left ( $u_y=0$ ) and lower ( $u_z=0$ ), as well as the confining pressure on the front sides and side right. One applies a displacement imposed to the upper face: $u_z(t)$ , in order to obtain a strain $\varepsilon_{zz}=-6$ over a period of 6e3 seconds for the modelizations A, B and C and a period of 6e5 seconds for the modelizations D and E.

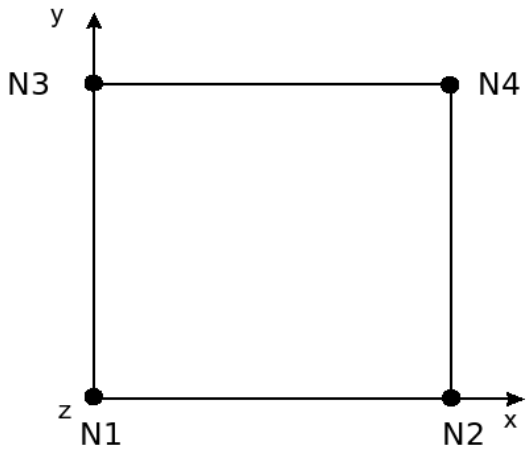
## 2 Reference solutions

the reference solutions are obtained by fine discretization of the loading. It does not exist a priori of known analytical solutions for the integration of model LETK according to a triaxial compression test of compression.

# 3 Modelization A

## 3.1 Characteristic of modelization

AXIS :




Cutting: 1 in height, 1 in width.

Loading of phase 1:
Confining pressure: $\sigma^0_{xx}=\sigma^0_{zz}=-5\,MPa$ .

## 3.2 Characteristic of the mesh

Many nodes: 4
Number of meshes and types: 1 QUAD4 and 4 SEG2

## 3.3 Quantities tested and results

the values are tested into non regression with a given tolerance of $0{,}1\%$ .

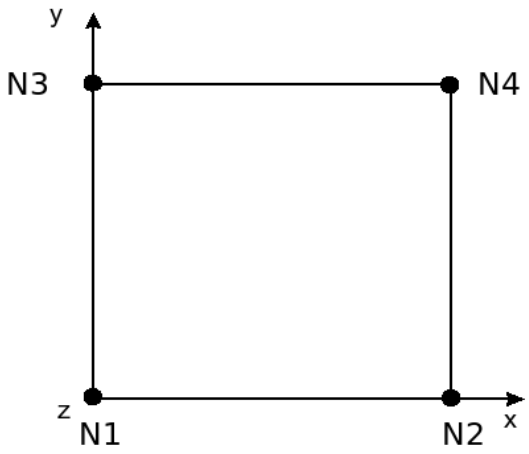
| Localization | Time | Forced ( $MPa$ ) | *Aster* |
|---|---|---|---|
| Not $N4$ | 7000. | $\sigma_{yy}$ | – 5.000 |
| | 13000. | $\sigma_{yy}$ | – 11.941 |

| Localization | Time | Aster | *Displacement* |
|---|---|---|---|
| Not $N4$ | 7000. | $DX$ | -7.6 10-4 |
| | 13000. | $DX$ | 3.020 10-2 |

# 4 Modelization B

## 4.1 Characteristic of modelization

AXIS :




Cutting: 1 in height, 1 in width.

Loading of phase 1:
Confining pressure: $\sigma^0_{xx}=\sigma^0_{zz}=-5\,MPa$ .

## 4.2 Characteristic of the mesh

Many nodes: 4
Number of meshes and types: 1 QUAD4 and 4 SEG2

## 4.3 Quantities tested and results

the values are tested into non regression with a given tolerance of $0{,}1\%$ .

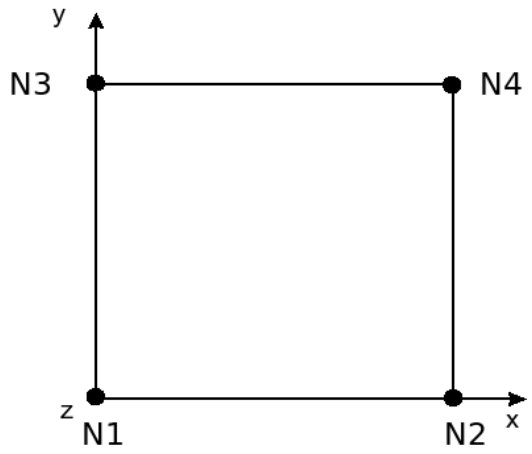
| Localization | Time | Forced ( $MPa$ ) | *Aster* |
|---|---|---|---|
| Not $N4$ | 7000. | $\sigma_{yy}$ | – 5.000 |
| | 13000. | $\sigma_{yy}$ | – 11.945 |

| Localization | Time | Aster | *Displacement* |
|---|---|---|---|
| Not $N4$ | 7000. | $DX$ | -7.6 10-4 |
| | 13000. | $DX$ | 3.026 10-2 |

# 5 Modelization C

## 5.1 Characteristic of modelization

AXIS :




Cutting: 1 in height, 1 in width.

Loading of phase 1:
Confining pressure: $\sigma^0_{xx} = \sigma^0_{zz} = -5\,MPa$ .

## 5.2 Characteristic of the mesh

Many nodes: 4
Number of meshes and types: 1 QUAD4 and 4 SEG2

## 5.3 Quantities tested and results

the values are tested into non regression with a given tolerance of $0{,}1\%$ .

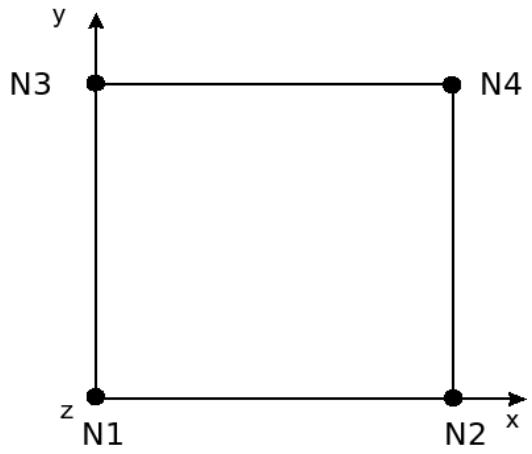
| Localization | Time | Forced ( $MPa$ ) | *Aster* |
|---|---|---|---|
| Not $N4$ | 7000. | $\sigma_{yy}$ | – 5.000 |
| | 13000. | $\sigma_{yy}$ | – 11.945 |

| Localization | Time | Aster | *Displacement* |
|---|---|---|---|
| Not $N4$ | 7000. | $DX$ | -7.6 10-4 |
| | 13000. | $DX$ | 3.026 10-2 |

# 6 Modelization D

## 6.1 Characteristic of modelization

AXIS :




Cutting: 1 in height, 1 in width.

Loading of phase 1:
Confining pressure: $\sigma^0_{xx} = \sigma^0_{zz} = -5\,MPa$ .
The loading is applied 100 times less quickly than for the modelizations A, B and C.

## 6.2 Characteristic of the mesh

Many nodes: 4
Number of meshes and types: 1 QUAD4 and 4 SEG2

## 6.3 Quantities tested and results

the values are tested into non regression with a given tolerance of $0{,}1\%$ .

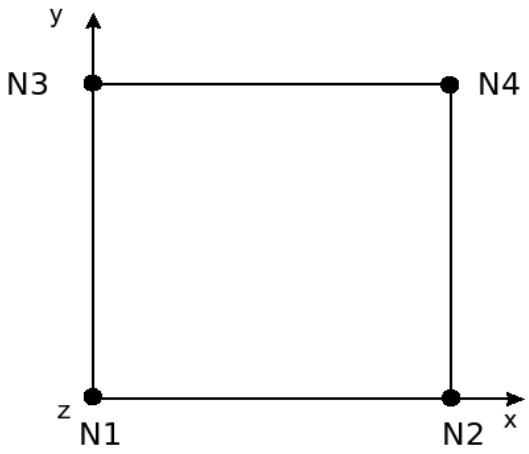
| Localization | Time | Forced ( $MPa$ ) | *Aster* |
|---|---|---|---|
| Not $N4$ | 7000. | $\sigma_{yy}$ | – 5.000 |
| | 13000. | $\sigma_{yy}$ | – 12.01 |

| Localization | Time | Aster | *Displacement* |
|---|---|---|---|
| Not $N4$ | 7000. | $DX$ | -7.6 10-4 |
| | 13000. | $DX$ | 2,98 10-2 |

# 7 Modelization E

## 7.1 Characteristic of modelization

AXIS :




Cutting: 1 in height, 1 in width.

Loading of phase 1:
Confining pressure: $\sigma^0_{xx}=\sigma^0_{zz}=-5\,MPa$ .
The loading is applied 100 times less quickly than for the modelizations A, B and C. the loading is identical to that applied for the modelization D

## 7.2 Characteristic of the mesh

Many nodes: 4
Number of meshes and types: 1 QUAD4 and 4 SEG2

## 7.3 Quantities tested and results

the values are tested into non regression with a given tolerance of $0{,}1\%$ .

| Localization | Time | Forced ( $MPa$ ) | *Aster* |
|---|---|---|---|
| Not $N4$ | 7000. | $\sigma_{yy}$ | – 5.000 |
| | 13000. | $\sigma_{yy}$ | – 12.01 |

| Localization | Time | Aster | *Displacement* |
|---|---|---|---|
| Not $N4$ | 7000. | $DX$ | -7.6 10-4 |
| | 13000. | $DX$ | 3,00 10-2 |

# 8 Summary of the results

It acts of tests of non regression developed to validate LETK in pure mechanics the model. The comparison between the two diagrams of integration makes it possible to identify certain tendencies on the profiles of convergence.

An explicit diagram of integration makes it possible for a fine discretization of the loading to guarantee converged results and an execution time machine less than the implicit scheme. It is on the other hand difficult to quantify the level of smoothness of the loading to be applied to guarantee the convergence of the studies with a diagram of explicit integration.
The implicit diagram of integration guarantees a level of explicit accuracy higher than diagram for the same discretization of loading. It also makes it possible to have a local tangent operator consist. These advantages thus ensure on a broad range of discretizations of the loading a convergence on the results got with the implicit scheme.

The following figures illustrate the preceding sales leaflet.

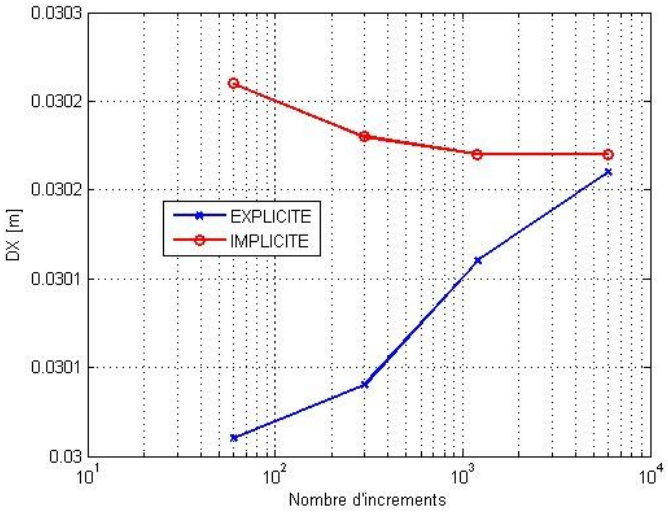



**Illustration 1: Maximum side displacement of the sample of laboratory during a triaxial compression test of compression according to the level of discretization of the loading**

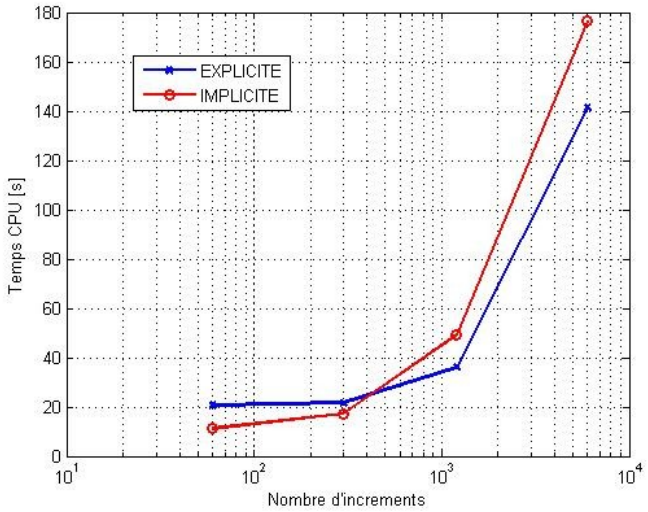



**Illustration 2: TEMPS CPU cumulated for the triaxial compression test of compression according to the level of discretization of the loading**