

SSNV158 - Triaxial compression test drained with the model of Laigle

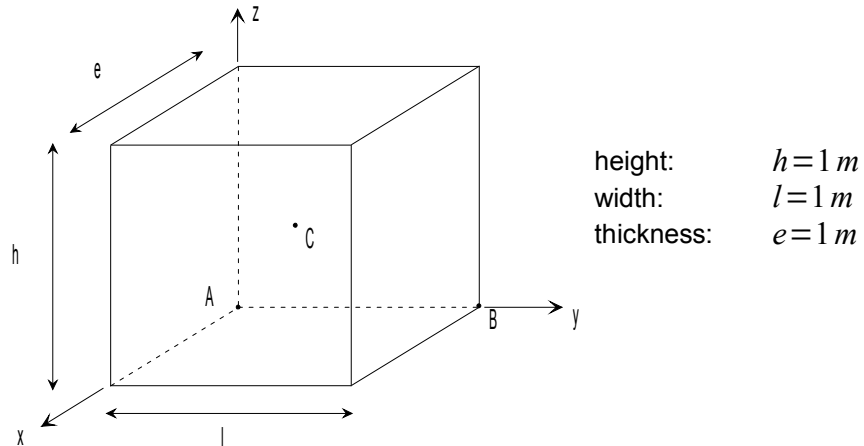
Summary

This test makes it possible to validate the model of Laigle in rock mechanics (formalism CIH). It is about a triaxial compression test in drained condition. Calculations are carried out only on the solid part of the ground without hydraulic coupling. One applies four levels of containment ($8\text{ MPa} - 4\text{ MPa} - 2\text{ MPa} - 1\text{ MPa}$). By reason of symmetry, one is interested only in the eighth of a sample subjected to a triaxial compression test. Modeling is axisymmetric.

It is about a test of nonregression.

1 Problem of reference

1.1 Geometry



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

$$E = 1500.00 \cdot 10^3 \text{ kPa}$$

$$\nu = 0.27$$

$$\gamma_{ult} = 0.132;$$

$$\gamma_e = 0.005;$$

$$m_{ult} = 2.0;$$

$$m_e = 7.0;$$

$$a_e = 0.65;$$

$$m_{pic} = 15.0;$$

$$a_{pic} = 0.5;$$

$$\eta = 0.45;$$

$$\xi = 0.25;$$

$$\gamma_{cjs} = 0.7;$$

$$\sigma_{p1} = 9.09 \cdot 10^6 \text{ Pa};$$

$$\sigma_{p2} = 23.05 \cdot 10^6 \text{ Pa};$$

1.3 Initial conditions, boundary conditions, and loading

Phase 1:

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

Phase 2:

One maintains displacements blocked on the faces postpones ($u_x=0$), side left ($u_y=0$) and lower ($u_z=0$), as well as the confining pressure on the front faces and side right-hand side. One applies a displacement imposed to the higher face: $u_z(t)$, in order to obtain a deformation $\varepsilon_{zz} = -20\%$ (counted starting from the beginning of phase 2).

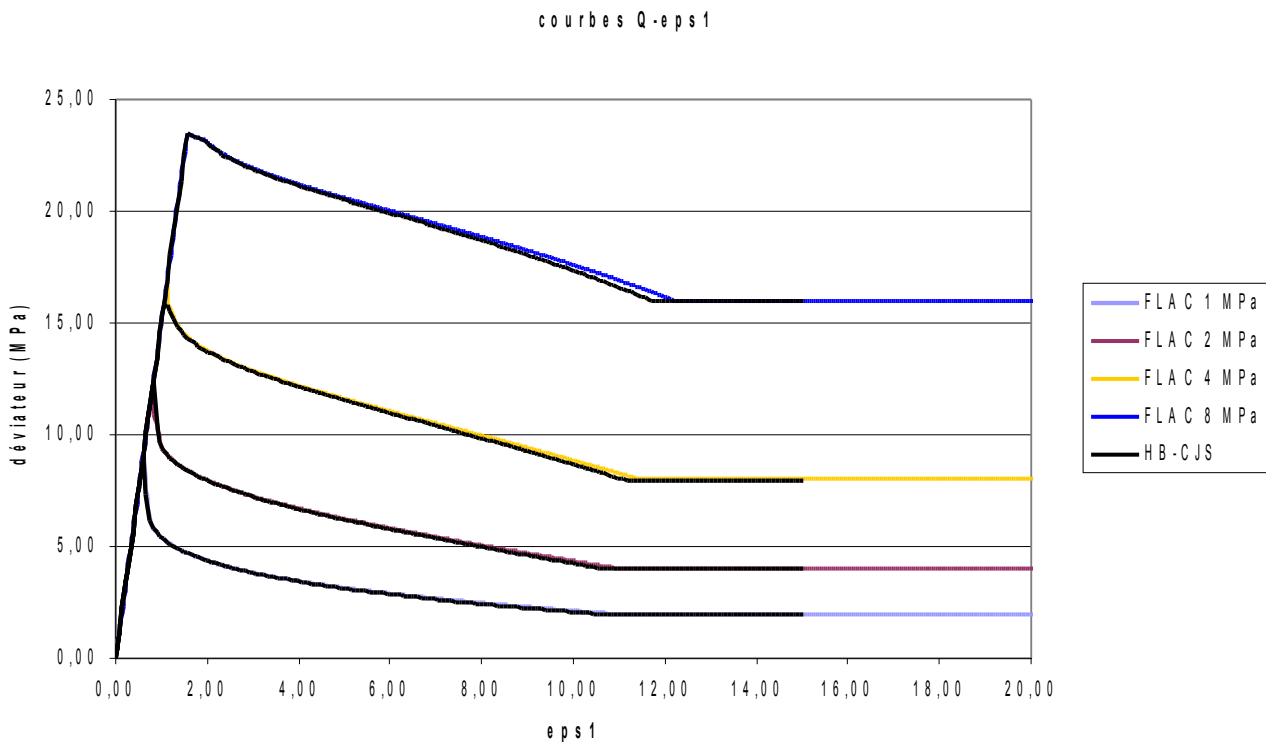
2 Reference solution

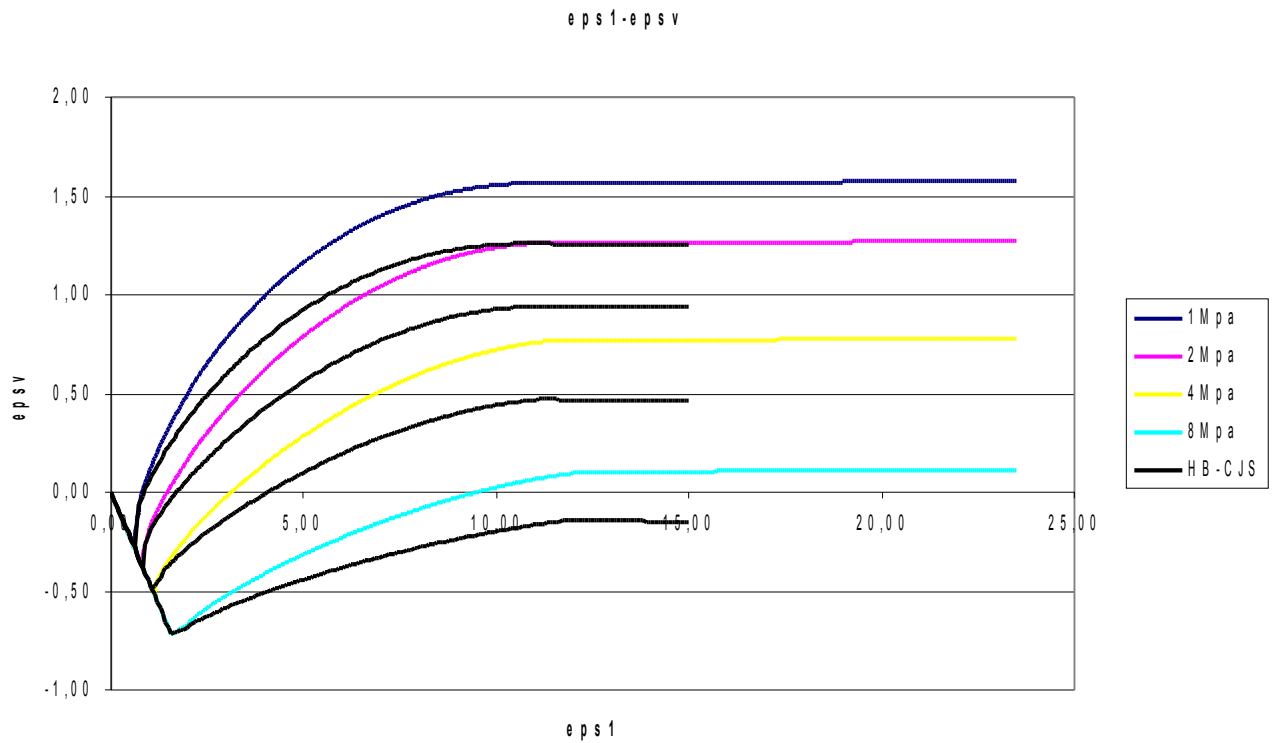
2.1 Results of reference

Constraints σ_{xx} , σ_{yy} and σ_{zz} at the point D .

Displacements ε_{xx} , ε_{yy} at the point D .

References provided by software FLAC-2D:

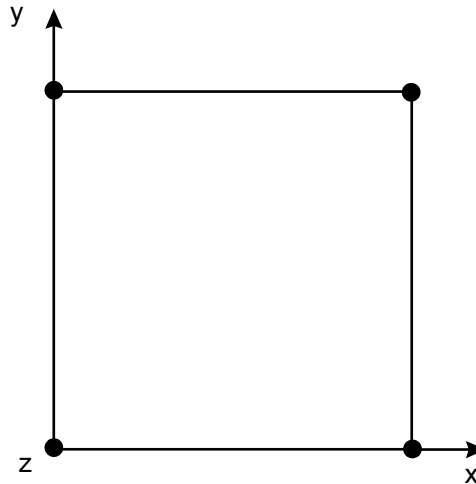




3 Modeling A

3.1 Characteristic of modeling

2D :



Cutting: 1 in height, 1 in width.

Loading of phase 1:

Confining pressure: $\sigma_{xx}^0 = \sigma_{zz}^0 = -8 \text{ MPa}$

3.2 Characteristic of the grid

Many nodes: 4

Many meshes and types: 1 QUAD4 and 4 SEG2

3.3 Sizes tested and results

For $\sigma_{xx}^0 = \sigma_{zz}^0 = -8 \text{ MPa}$

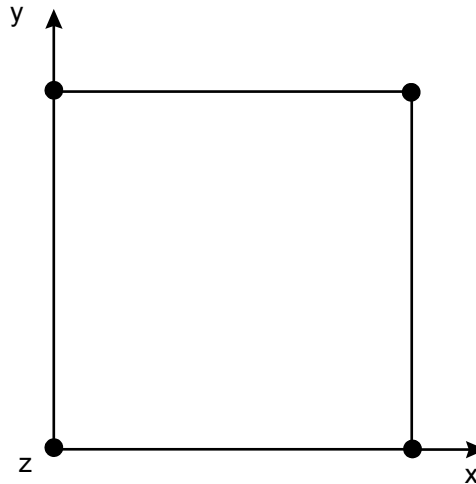
Localization	Sequence number	Constraint (MPa)	Aster
Not <i>D</i>	5	σ_{xx}	- 8,000
	49	σ_{xx}	- 8,000
	5	σ_{zz}	- 8,000
	49	σ_{zz}	- 8,000
	5	σ_{yy}	- 31.5966
	10	σ_{yy}	- 31.1055
	16	σ_{yy}	- 29.9622
	25	σ_{yy}	- 26.3670
	30	σ_{yy}	- 24.3922
	40	σ_{yy}	- 24.0000

	49	σ_{yy}	- 24.0000
Localization	Sequence number	Deformation	Aster * E-02
Not <i>D</i>	1	ϵ_{xx}	0,324
	10	ϵ_{xx}	0.692805
	40	ϵ_{xx}	7,140
	1	ϵ_{yy}	- 1,200
	5	ϵ_{yy}	- 1,580
	10	ϵ_{yy}	- 2,053
	25	ϵ_{yy}	- 8,000
	48	ϵ_{yy}	- 19.04

4 Modeling B

4.1 Characteristic of modeling

2D :



Cutting: 1 in height, 1 in width.

Loading of phase 1:

Confining pressure: $\sigma_{xx}^0 = \sigma_{zz}^0 = -4 \text{ MPa}$.

4.2 Characteristic of the grid

Many nodes: 4

Many meshes and types: 1 QUAD4 and 4 SEG2

4.3 Sizes tested and results

For $\sigma_{xx}^0 = \sigma_{zz}^0 = -4 \text{ MPa}$

Localization	Sequence number	Constraint (MPa)	Aster
Not <i>D</i>	5	σ_{xx}	- 4,000
	49	σ_{xx}	- 4,000
	5	σ_{zz}	- 4,000
	49	σ_{zz}	- 4,000
	5	σ_{yy}	- 19.6729
	10	σ_{yy}	- 17.9207
	16	σ_{yy}	- 16.9627
	25	σ_{yy}	- 14.1850
	30	σ_{yy}	- 12.4257

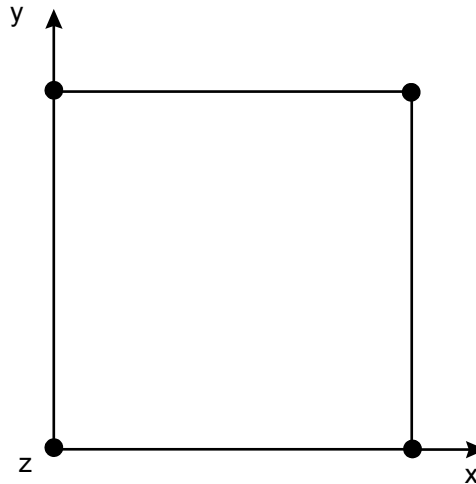
40	σ_{yy}	- 12.0000
49	σ_{yy}	- 12.0000

Localization	Sequence number	Deformation	Aster * E-02
Not D	1	ϵ_{xx}	0,216
	10	ϵ_{xx}	0,757
	40	ϵ_{xx}	7,195
	1	ϵ_{yy}	- 0,800
	5	ϵ_{yy}	- 1,240
	10	ϵ_{yy}	- 1,789
	25	ϵ_{yy}	- 7,000
	48	ϵ_{yy}	- 16,000

5 Modeling C

5.1 Characteristic of modeling

2D :



Cutting: 1 in height, 1 in width.

Loading of phase 1:

Confining pressure: $\sigma_{xx}^0 = \sigma_{zz}^0 = -2 \text{ MPa}$

5.2 Characteristic of the grid

Many nodes: 4

Many meshes and types: 1 QUAD4 and 4 SEG2

5.3 Sizes tested and results

For $\sigma_{xx}^0 = \sigma_{zz}^0 = -2 \text{ MPa}$

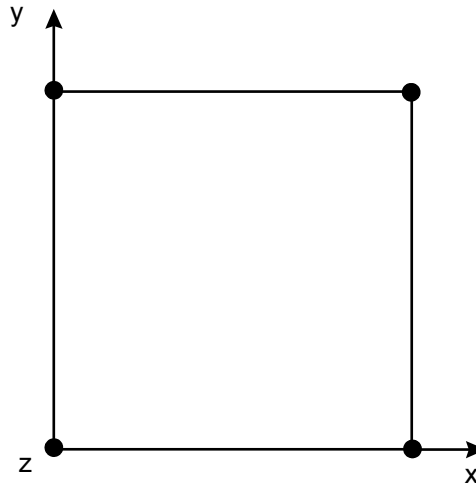
Localization	Sequence number	Constraint (MPa)	Aster
Not <i>D</i>	5	σ_{xx}	- 2,000
	5	σ_{zz}	- 2,000
	5	σ_{yy}	- 10.7188
	10	σ_{yy}	- 9.7927
	16	σ_{yy}	- 9.1268
	25	σ_{yy}	- 6.2033
	30	σ_{yy}	- 6.0968
	40	σ_{yy}	- 5.9965
	49	σ_{yy}	- 5.9942

Localization	Sequence number	Deformation	Aster * E-02
Not <i>D</i>	1	ϵ_{xx}	0,216
	10	ϵ_{xx}	1,151
	40	ϵ_{xx}	8,048
	1	ϵ_{yy}	- 0,800
	5	ϵ_{yy}	- 1,387
	10	ϵ_{yy}	- 2,120
	25	ϵ_{yy}	- 12,000
	48	ϵ_{yy}	- 15,500

6 Modeling D

6.1 Characteristic of modeling

2D :



Cutting: 1 in height, 1 in width.

Loading of phase 1:

Confining pressure: $\sigma_{xx}^0 = \sigma_{zz}^0 = -1 \text{ MPa}$

6.2 Characteristic of the grid

Many nodes: 4

Many meshes and types: 1 QUAD4 and 4 SEG2

6.3 Sizes tested and results

For $\sigma_{xx}^0 = \sigma_{zz}^0 = -1 \text{ MPa}$

Localization	Sequence number	Constraint (MPa)	Aster
Not <i>D</i>	296	σ_{xx}	- 1,000
	596	σ_{xx}	- 1,000
	296	σ_{zz}	- 1,000
	596	σ_{zz}	- 1,000
	196	σ_{yy}	- 4.7247
	296	σ_{yy}	- 4.1666
	312	σ_{yy}	- 4.0928
	496	σ_{yy}	- 3.4030
	596	σ_{yy}	- 3.1056

Localization	Sequence number	Deformation	Aster * E-02
Not <i>D</i>	196	ϵ_{xx}	2.4608
	396	ϵ_{xx}	4.7711
	596	ϵ_{xx}	6.8830
	196	ϵ_{yy}	- 3.9200
	296	ϵ_{yy}	- 5.9200
	396	ϵ_{yy}	- 7.9200
	496	ϵ_{yy}	- 9.9200
	596	ϵ_{yy}	- 11.9200