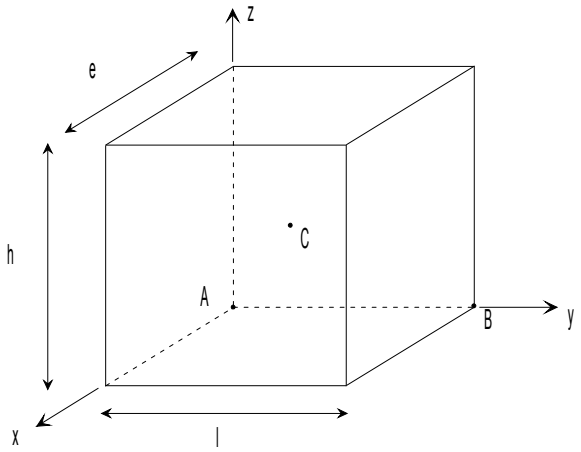
SSNV154 - Triaxial compression test drained with model CJS (level 3)

Summary

This test makes it possible to validate level 3 of model CJS. 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. The level of containment is of $400\,KPa$.
By reason of symmetry, one is interested only in the eighth of a sample subjected to a triaxial compression test. Two modelings are presented. Modeling A is axisymmetric. In modeling B, $3\mathrm{D}$, the sample tested is turned of an angle of $-\pi/6$ compared to the axis x . Consequently, directions x, y, z are not any more principal directions. That makes it possible to validate the operations of digital integration of the model which act on the nondiagonal terms of the tensors of the strains and the stresses.
It is about a test of nonregression. Nevertheless, results got with *Code_Aster* for model CJS3 are compared with those obtained with a private version of software FLAC-2D.

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
x	0.	0.	0.5
y	0.	1.	0.5
z	0.	0.	0.5

1.2 Material property

$E=35{,}6616541\,10^{3}\,kPa$
$\nu=0{,}15037594$

Parameters CJS3: $\beta=-0{,}55$ $\gamma=0{,}82$ $R_m=0{,}05$ $R_c=0{,}265$ $n=0{,}6$
$K_o^p=25{,}510^{3}\,kPa$ $b=7.0\,kPa$ $\mu=0.021$ $p_{co}=-600\,kPa$
$c=30.0$ $P_a=-100\,kPa$

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 Method of calculating used for the reference solution

The results got with a private version of the software SPLASH 2D are used as reference.

2.2 Results of reference

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

2.3 Bibliographical references

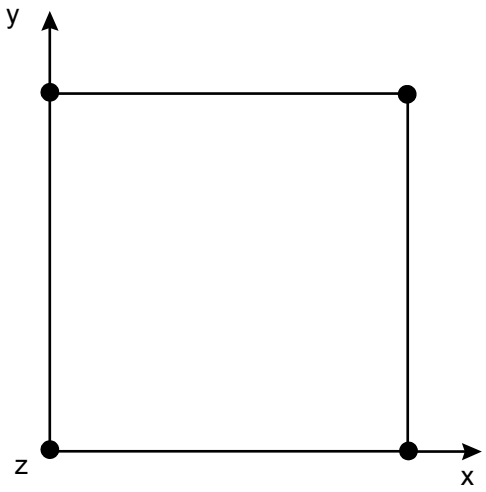
• Board, “SPLASH (Fast Lagrangian Analysis of Continua) Version 2.20. U.S. NRC”, NUREG/CR-5430, October 1989.

• “Splash Fast Lagrangian Analysis of Continua. Theory and Background.” Itasca Consulting Group.

3 Modeling A

3.1 Characteristic of modeling

3D :



Cutting: 1 in height, 1 in width.

Loading of phase 1:
Confining pressure: $\sigma_{xx}^{0} = \sigma_{yy}^{0} = -400\,kPa$.
Level 3 of model CJS

3.2 Characteristic of the grid

Many nodes: 4
Many meshs and types: 1 QUAD4 and 4 SEG2

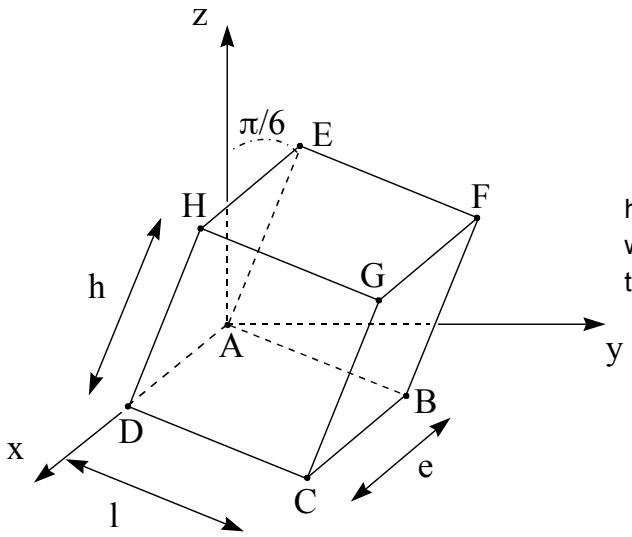
3.3 Sizes tested and results

For $\sigma_{xx}^0 = \sigma_{yy}^0 = -400\,kPa$

Localization	Sequence number	axial deformation ε_{zz} (%)	Constraint (kPa)	Reference SPLASH 2D	*Aster*	% difference
Not A	10	– 4.0%	σ_{xx}	– 400.0	– 400,000	< 0.05
	50	– 20.0%	σ_{xx}	– 400.0	– 400,000	< 0.05
	10	– 4.0%	σ_{zz}	– 400.0	– 400,000	< 0.05
	50	– 20.0%	σ_{zz}	– 400.0	– 400,000	< 0.05
	2	– 0.8%	σ_{yy}	– 667,209	– 667.2087	< 0.05
	5	– 2.0%	σ_{yy}	– 917,634	– 917.6343	< 0.05
	10	– 4.0%	σ_{yy}	– 1184.57	– 1184.5705	< 0.05
	20	– 8.0%	σ_{yy}	– 1337.38	– 1337.3821	< 0.05
	34	– 12.0%	σ_{yy}	– 1351.76	– 1351.7551	< 0.05
	40	– 16.0%	σ_{yy}	– 1350.80	– 1350.8029	< 0.05
	50	– 20.0%	σ_{yy}	– 1348.54	– 1348.5422	< 0.05

4 Modeling B

4.1 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.	1.	1.
y	0.	0.86602540378445	0.86602540378445	0.
z	0.	– 0.5	– 0.5	0.

4.2 Characteristic of modeling

3D :

Cutting: 1 in height, in width and thickness.

Loading of phase 1:
Confining pressure: $-400\,kPa$.
Level 3 of model CJS

4.3 Characteristic of the grid

Many nodes: 8
Many meshs and types: 1 HEXA8 and 6 QUA4

4.4 Sizes tested and results

For containment: $-400\,kPa$

Localization	Sequence number	axial deformation ε_{zz} (%)	constraint (kPa)	Reference	*Aster*	% difference
Not A	10	– 2.0%	σ_{xx}	– 400.0	– 400,000	< 10^{-6}
	50	– 10.0%	σ_{xx}	– 400.0	– 400,000	< 10^{-6}
	100	– 20.0%	σ_{xx}	– 400.0	– 400,000	< 10^{-6}
	10	– 2.0%	σ_{yy}	– 53,221	– 53.22098	< 10^{-6}
	50	– 10.0%	σ_{yy}	– 63.7665	– 63.76653	< 10^{-6}
	100	– 20.0%	σ_{yy}	– 63.7165	– 63.71645	< 10^{-6}
	10	– 2.0%	σ_{zz}	– 79.6629	– 79.66294	< 10^{-6}
	50	– 10 .0%	σ_{zz}	– 111.3	– 111.29959	< 10^{-6}
	100	– 20.0%	σ_{zz}	– 111,149	– 111.14935	< 10^{-6}
	10	– 2.0%	σ_{yz}	– 22.8994	– 22.89941	< 10^{-6}
	50	– 10.0%	σ_{yz}	– 41.1648	– 41.16483	< 10^{-6}
	100	– 20.0%	σ_{yz}	– 41.0781	– 41.07809	< 10^{-6}

5 Summary of the results

Results of*Aster* coincide with those of SPLASH with a lower deviation than $0,05\%$.