WTNP129 – Modeling HM of a bar saturated with compressible liquid

Summary:

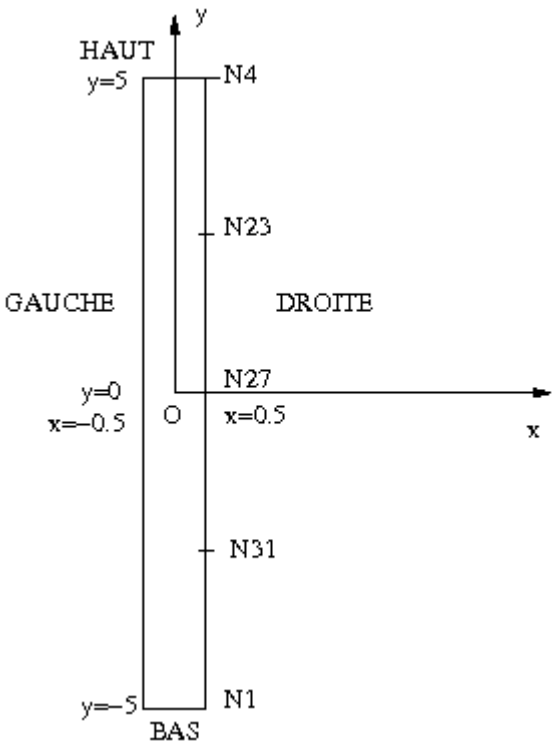
One studies here a problem HM saturated with liquid in dimension 2. Considering symmetries of with the dealt problem, the solution is unidimensional. The structure is subjected to a water pressure imposed on its upper part. Its mechanical behavior is elastic. The purpose of this test is to compare the resolution by coupling with the resolution by chaining (cf documentation “Note of use of model THM” [U2.04.05])
There are thus 3 modelings in this test:

- Modeling a: one solves the physical problem using the “classical” method, by total coupling
- Modeling b: one solves the problem using the method by chaining of the equations
- Modeling C: This modeling is identical to modeling A but with the element under-integrated HM_SI
- Modeling D: This modeling is identical to modeling B but called on the law of behavior DRUCK_PRAGER [R7.01.16] only with an aim of validating certain data-processing routines. The parameters materials are identified so that calculation remains in the elastic range and does not have physical direction.

1 Problème of reference

1.1 Geometry

One considers a rectangular bar directed according to the axis Oy .



The coordinates of the points are given in the following table:

Not	*N4*	*N23*	*N27*	*N31*	*N1*
X-coordinate (*m*)	0.5	0.5	0.5	0.5	0.5
Ordinate (*m*)	5	2.5	0	-2.5	-5

The problem is modelled on the time interval $[0;10\mathrm{s}]$.

1.2 Properties of material

The parameters of the bar here are given

Liquid water	ρ : density ($kg.m^{-3}$)	1000
	$1/K_{lq}$: opposite of compressibility (Pa^{-1})	0.5E-9
Coefficients material	r : homogenized density ($kg.m^{-3}$)	2800
	E : Young modulus (Pa)	5.8E9
	ν : Poisson's ratio (--)	0.
	b : coefficient of Biot (–)	1
	K_{int} : intrinsic permeability (m^2)	1.E-8
Additional coefficients material for DRUCK_PRAGER	$ECROUISSAGE$: form of work hardening	$LINEAIRE$
	α : coefficient of dependence in pressure (--)	0.33
	P_{ultm} : ultimate cumulated plastic deformation (--)	1.0
	σ_Y : constraint of plasticity (Pa)	1.E8
	H : module of work hardening (Pa)	0.0

1.3 Boundary conditions and loadings

On $HAUT$, the conditions are imposed $\sigma \cdot n = 0$ and $p = 3.E6$ Pa.
On $GAUCHE$ and $DROITE$, the conditions are imposed $u_x = 0$ and flow of null liquid $M.n = 0$.
On BAS , the conditions are imposed $u_x = u_y = 0$ and flow of null liquid $M \cdot n = 0$.

1.4 Initial conditions

The initial pressure of fluid is taken equalizes to 2 MPa . Initial porosity is taken equalizes to 0.5.

2 Reference solution

One is interested in the values of DY, PRE1 and SIYY in 5 nodes ($N4$, $N23$, $N27$, $N31$, $N1$) located on the flat rim of the bar at the two moments $t = 1$ dryness and $t = 10$ seconds.
The tests carried out are tests of not-regression for modeling A.
For modelings B, C and D, the tests carried out are tests of adherence to the results of modeling A (of type AUTRE_ASTER).

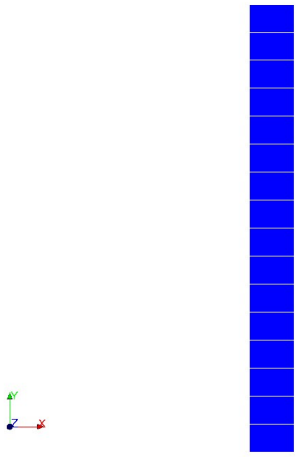
3 Modeling A

3.1 Characteristics of modeling

Modeling is used D_PLAN_HMS.

3.2 Characteristics of the grid

Many nodes: 83
Many meshs and types: 16 meshs QUAD8



3.3 Sizes tested and results

The following tests of not-regression are carried out.

Identification	Type of reference	Reference
$N23$ – PRE1 - $t=1$	NON_REGRESSION	1.4477057505633E+06
$N27$ – PRE1 - $t=1$	NON_REGRESSION	9.8618261792096E+05
$N31$ – PRE1 - $t=1$	NON_REGRESSION	6.8416253970115E+05
$N1$ – PRE1 - $t=1$	NON_REGRESSION	5.7968660741362E+05
$N23$ – PRE1 - $t=10$	NON_REGRESSION	1.9965914222579E+06
$N27$ – PRE1 - $t=10$	NON_REGRESSION	1.9937017653319E+06
$N31$ – PRE1 - $t=10$	NON_REGRESSION	1.9917709562082E+06
$N1$ – PRE1 - $t=10$	NON_REGRESSION	1.991092945817E+06
$N4$ – DY - $t=1$	NON_REGRESSION	1.8807606329922E-03
$N23$ – DY - $t=1$	NON_REGRESSION	1.139326750168E-03
$N27$ – DY - $t=1$	NON_REGRESSION	6.19182033214E-04
$N31$ – DY - $t=1$	NON_REGRESSION	2.6539252530741E-04

$N4$ – DY - $t=10$	NON_REGRESSION	3.4385071565836E-03
$N23$ – DY - $t=10$	NON_REGRESSION	2.5771817886894E-03
$N27$ – DY - $t=10$	NON_REGRESSION	1.7172304114012E-03
$N31$ – DY - $t=10$	NON_REGRESSION	8.5833064233171E-04
$N4$ – SIYY - $t=1$	NON_REGRESSION	2.00000E+06
$N23$ – SIYY - $t=1$	NON_REGRESSION	1.4477057505633E+06
$N27$ – SIYY - $t=1$	NON_REGRESSION	9.8618261792096E+05
$N31$ – SIYY - $t=1$	NON_REGRESSION	6.8416253970115E+05
$N1$ – SIYY - $t=1$	NON_REGRESSION	5.7968660741362E+05
$N4$ – SIYY - $t=10$	NON_REGRESSION	2.00000E+06
$N23$ – SIYY - $t=10$	NON_REGRESSION	1.9965914222579E+06
$N27$ – SIYY - $t=10$	NON_REGRESSION	1.9937017653319E+06
	NON_REGRESSION	1.9917709562082E+06

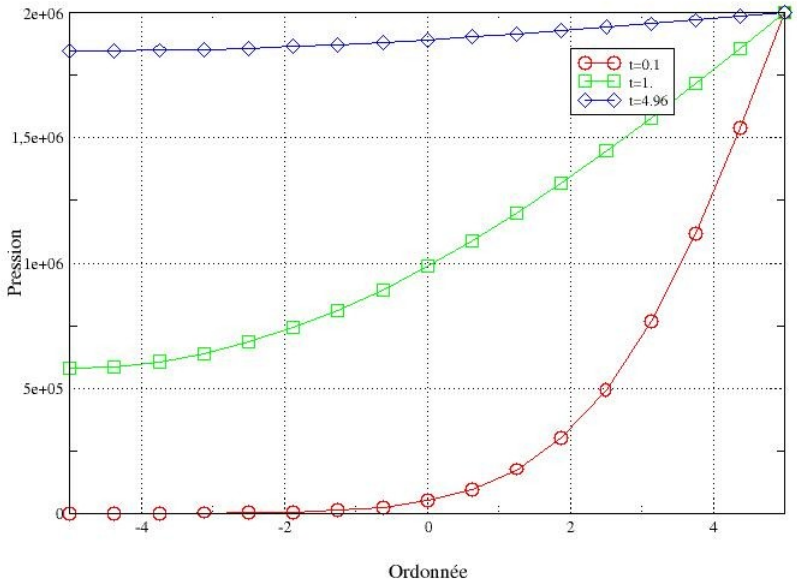


Illustration 1: Pressure on the flat rim at 3 moments

$N31$ – SIYY - $t=10$		
$N1$ – SIYY - $t=10$	NON_REGRESSION	1.991092945817E+06

4 Modeling B

4.1 Characteristics of modeling

Modelings are used D_PLAN_HS for hydraulics and D_PLAN_SI for mechanics.

4.2 Characteristics of the grid

The grid is identical to that of modeling A.
Many nodes: 83
Many meshs and types: 16 meshs QUAD8
The grids mechanics and hydraulics are identical.

4.3 Sizes tested and results

Identification	Type of reference	Reference	Error
$N23$ – PRE1 - $t=1$	AUTRE_ASTER	1.4477057505633E+06	0.0495%
$N27$ – PRE1 - $t=1$	AUTRE_ASTER	9.8618261792096E+05	0,294%
$N31$ – PRE1 - $t=1$	AUTRE_ASTER	6.8416253970115E+05	0,850%
$N1$ – PRE1 - $t=1$	AUTRE_ASTER	5.7968660741362E+05	1.24%
$N4$ – DY - $t=1$	AUTRE_ASTER	1.8807606329922E-03	0,299%
$N23$ – DY - $t=1$	AUTRE_ASTER	1.139326750168E-03	0,483%
$N27$ – DY - $t=1$	AUTRE_ASTER	6.19182033214E-04	0,772%
$N31$ – DY - $t=1$	AUTRE_ASTER	2.6539252530741E-04	1.09%
$N4$ – SIYY - $t=1$	AUTRE_ASTER	2.00000E+06	1.0E-08%
$N23$ – SIYY - $t=1$	AUTRE_ASTER	1.4477057505633E+06	0.0495%
$N27$ – SIYY - $t=1$	AUTRE_ASTER	9.8618261792096E+05	0,294%
$N31$ – SIYY - $t=1$	AUTRE_ASTER	6.8416253970115E+05	0,850%
$N1$ – SIYY - $t=1$	AUTRE_ASTER	5.7968660741362E+05	1.24%
$N23$ – PRE1 - $t=10$	AUTRE_ASTER	1.9965914222579E+06	0.0202%
$N27$ – PRE1 - $t=10$	AUTRE_ASTER	1.9937017653319E+06	0.0373%
$N31$ – PRE1 - $t=10$	AUTRE_ASTER	1.9917709562082E+06	0.0488%
$N1$ – PRE1 - $t=10$	AUTRE_ASTER	1.991092945817E+06	0.0528%
$N4$ – DY - $t=10$	AUTRE_ASTER	3.4385071565836E-03	0.0335%
$N23$ – DY - $t=10$	AUTRE_ASTER	2.5771817886894E-03	0.0414%
$N27$ – DY - $t=10$	AUTRE_ASTER	1.7172304114012E-03	0.0475%
$N31$ – DY - $t=10$	AUTRE_ASTER	8.5833064233171E-04	0.0514%
$N4$ – SIYY - $t=10$	AUTRE_ASTER	2.00000E+06	9.31E-14%
$N23$ – SIYY - $t=10$	AUTRE_ASTER	1.9965914222579E+06	0.0202%

$N27$ – SIYY - $t=10$	AUTRE_ASTER	1.9937017653319E+06	0.0373%
$N31$ – SIYY - $t=10$	AUTRE_ASTER	1.9917709562082E+06	0.0488%
$N1$ – SIYY - $t=10$	AUTRE_ASTER	1.991092945817E+06	0.0528%

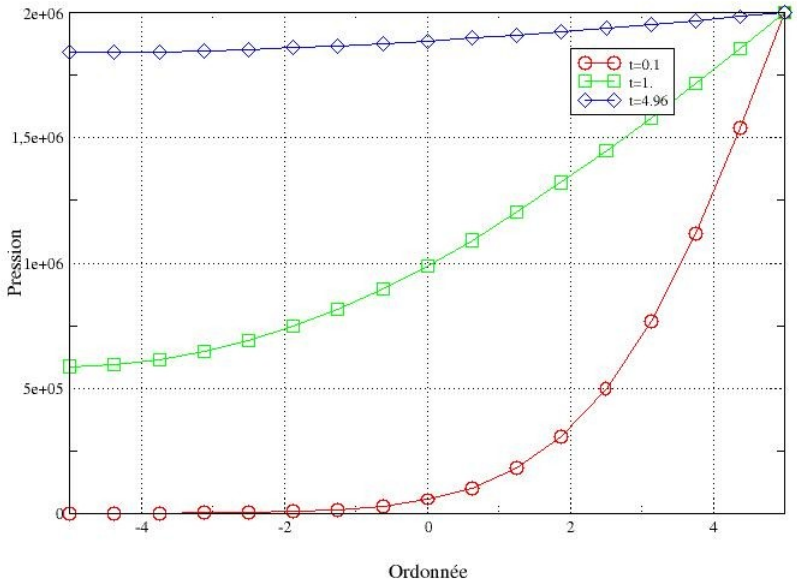


Illustration 2: Pressure on the flat rim at 3 moments

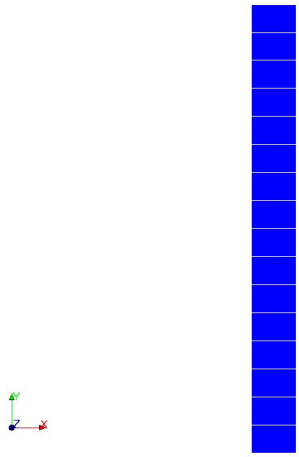
5 Modeling C

5.1 Characteristics of modeling

Modeling is used D_PLAN_HM_SI.

5.2 Characteristics of the grid

Many nodes: 83
Many meshs and types: 16 meshs QUAD8



5.3 Sizes tested and results

The tests of not-regression are carried out in version 11.0.25.

Identification	Type of reference	Reference	Error
$N23$ – PRE1 - $t=1$	AUTRE_ASTER	1.4477057505633E+06	0.0044%
$N27$ – PRE1 - $t=1$	AUTRE_ASTER	9.8618261792096E+05	0.0462%
$N31$ – PRE1 - $t=1$	AUTRE_ASTER	6.8416253970115E+05	0,151%
$N1$ – PRE1 - $t=1$	AUTRE_ASTER	5.7968660741362E+05	0,226%
$N4$ – DY - $t=1$	AUTRE_ASTER	1.8807606329922E-03	0.0506%
$N23$ – DY - $t=1$	AUTRE_ASTER	1.139326750168E-03	0.0829%
$N27$ – DY - $t=1$	AUTRE_ASTER	6.19182033214E-04	0,136%
$N31$ – DY - $t=1$	AUTRE_ASTER	2.6539252530741E-04	0,197%
$N4$ – SIYY - $t=1$	AUTRE_ASTER	2.00000E+06	1.0E-13%
$N23$ – SIYY - $t=1$	AUTRE_ASTER	1.4477057505633E+06	0.0044%
$N27$ – SIYY - $t=1$	AUTRE_ASTER	9.8618261792096E+05	0.0462%
$N31$ – SIYY - $t=1$	AUTRE_ASTER	6.8416253970115E+05	0,151%
$N1$ – SIYY - $t=1$	AUTRE_ASTER	5.7968660741362E+05	0,226%

$N23$ – PRE1 - $t=10$	AUTRE_ASTER	1.9965914222579E+06	0.0012%
$N27$ – PRE1 - $t=10$	AUTRE_ASTER	1.9937017653319E+06	0.0023%
$N31$ – PRE1 - $t=10$	AUTRE_ASTER	1.9917709562082E+06	0,003%
$N1$ – PRE1 - $t=10$	AUTRE_ASTER	1.991092945817E+06	0.0032%
$N4$ – DY - $t=10$	AUTRE_ASTER	3.4385071565836E-03	0,002%
$N23$ – DY - $t=10$	AUTRE_ASTER	2.5771817886894E-03	0.0025%
$N27$ – DY - $t=10$	AUTRE_ASTER	1.7172304114012E-03	0.0029%
$N31$ – DY - $t=10$	AUTRE_ASTER	8.5833064233171E-04	0.0031%
$N4$ – SIYY - $t=10$	AUTRE_ASTER	2.00000E+06	1E-13%
$N23$ – SIYY - $t=10$	AUTRE_ASTER	1.9965914222579E+06	0.0012%
$N27$ – SIYY - $t=10$	AUTRE_ASTER	1.9937017653319E+06	0.0023%
$N31$ – SIYY - $t=10$	AUTRE_ASTER	1.9917709562082E+06	0,003%
$N1$ – SIYY - $t=10$	AUTRE_ASTER	1.991092945817E+06	0.0032%

6 Modeling D

6.1 Characteristics of modeling

Modelings are used D_PLAN_HS for hydraulics and D_PLAN_SI for mechanics.

6.2 Characteristics of the grid

The grid is identical to that of modeling A.
Many nodes: 83
Many meshs and types: 16 meshs QUAD8
The grids mechanics and hydraulics are identical.

6.3 Sizes tested and results

The sizes tested are identical to those of modeling B.

Identification	Type of reference	Reference	Error
$N23$ – PRE1 - $t=1$	AUTRE_ASTER	1.4477057505633E+06	0.0495%
$N27$ – PRE1 - $t=1$	AUTRE_ASTER	9.8618261792096E+05	0,294%
$N31$ – PRE1 - $t=1$	AUTRE_ASTER	6.8416253970115E+05	0,850%
$N1$ – PRE1 - $t=1$	AUTRE_ASTER	5.7968660741362E+05	1.24%
$N4$ – DY - $t=1$	AUTRE_ASTER	1.8807606329922E-03	0,299%
$N23$ – DY - $t=1$	AUTRE_ASTER	1.139326750168E-03	0,483%
$N27$ – DY - $t=1$	AUTRE_ASTER	6.19182033214E-04	0,772%
$N31$ – DY - $t=1$	AUTRE_ASTER	2.6539252530741E-04	1.09%
$N4$ – SIYY - $t=1$	AUTRE_ASTER	2.00000E+06	1.0E-08%
$N23$ – SIYY - $t=1$	AUTRE_ASTER	1.4477057505633E+06	0.0495%
$N27$ – SIYY - $t=1$	AUTRE_ASTER	9.8618261792096E+05	0,294%
$N31$ – SIYY - $t=1$	AUTRE_ASTER	6.8416253970115E+05	0,850%
$N1$ – SIYY - $t=1$	AUTRE_ASTER	5.7968660741362E+05	1.24%
$N23$ – PRE1 - $t=10$	AUTRE_ASTER	1.9965914222579E+06	0.0202%
$N27$ – PRE1 - $t=10$	AUTRE_ASTER	1.9937017653319E+06	0.0373%
$N31$ – PRE1 - $t=10$	AUTRE_ASTER	1.9917709562082E+06	0.0488%
$N1$ – PRE1 - $t=10$	AUTRE_ASTER	1.991092945817E+06	0.0528%
$N4$ – DY - $t=10$	AUTRE_ASTER	3.4385071565836E-03	0.0335%
$N23$ – DY - $t=10$	AUTRE_ASTER	2.5771817886894E-03	0.0414%
$N27$ – DY - $t=10$	AUTRE_ASTER	1.7172304114012E-03	0.0475%
$N31$ – DY - $t=10$	AUTRE_ASTER	8.5833064233171E-04	0.0514%
$N4$ – SIYY - $t=10$	AUTRE_ASTER	2.00000E+06	9.31E-14%
$N23$ – SIYY - $t=10$	AUTRE_ASTER	1.9965914222579E+06	0.0202%

$N27$ – SIYY - $t=10$	AUTRE_ASTER	1.9937017653319E+06	0.0373%
$N31$ – SIYY - $t=10$	AUTRE_ASTER	1.9917709562082E+06	0.0488%
$N1$ – SIYY - $t=10$	AUTRE_ASTER	1.991092945817E+06	0.0528%

7 Summary of the results

Values provided by *Code_Aster* are in perfect agreement with the values of reference.