WTNV109 – Hydrous and mechanical loading of a Summarized saturated porous environment

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One considers a three-dimensional problem of coupling thermo-hydro-mechanics of a saturated porous environment.

This test consists in studying the effect of the mechanics and the hydraulics on the thermal. One stretches the element by imposing a displacement in the direction to him z, one applies a constant water pressure to him and one studies the effect of these two loadings on the temperature of the model. One limits oneself to the first time step.

The studied models are $2D$ plane (DPQ8 and DPTR6) and $3D$ voluminal (HEXA20) with a linear behavior for the hydraulics and the thermal.

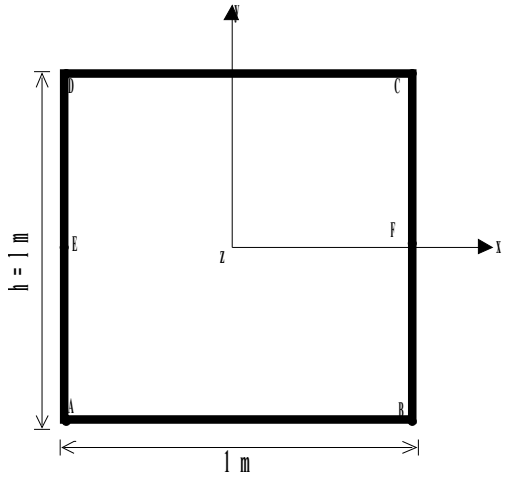
The reference solution is unidimensional because it depends only on the vertical coordinate.
This test is currently a test of non regression.

1 Problem of reference

1.1 Presentation

One studies in this case test the behavior thermo-hydro-mechanics of a saturated porous environment consisted only one fluid: water in its liquid phase. It acts in *Code_Aster* of a modelization THM. The associated constitutive law of the fluid is of type LIQU_SATU.

1.2 Geometry



Coordinated of the points (m) :

A	$-0,5-0,5$	C	$0,50,5$
B	$0,5-0,5$	D	$-0,50,5$

1.3 formula Properties of

the solid	material Density $(kg.m^{-3})$	$2.\times10^{3}$
	Young Modulus $E(Pa)$	$225.\times10^{6}$
	drained	$0.$
	thermal Poisson's ratio Coefficient of thermal expansion of (K^{-1})	$8.\times10^{-6}$
Fluid	solid Density $(kg.m^{-3})$	10^{3}
	Heat with constant $(J.K^{-1})$	2.85×10^{6}
	pressure thermal Coefficient of thermal expansion of (K^{-1})	10^{-4}
	the fluid Derived from the conductivity of the fluid Thermal	$0.$
temperature	homogenized Conductivity $(W.K^{-1}m^{-1})$	1.7
	Derived from conductivity homogenized compared to the temperature	$0.$
Coefficients of homogenization	Coefficient of $Biot$	10^{-12}

	Porosity	0.4
homogenized Coefficients	Density $(kg.m^{-3})$	1.6×10^{3}
	Heat with constant stress $(J.K^{-1})$	2.85×10^{6}

1.4 Boundary conditions and loadings

•complete Element:
•pressure of the fluid $PRE1=500.0\,Pa$

•lower Face:
•temperature $T=0.0\,K$
•Upper face $u_x=0.0\,m\,,u_y=0.0\,m\,,u_z=0.0\,m.$

•displacements:
•initial conditions $u_z=10^{-3}m$

1.5 displacement

the fields of displacement, pressure, temperature are initially all null, the reference temperature is worth $T_0=273\,°\,K$.

2 Reference solution

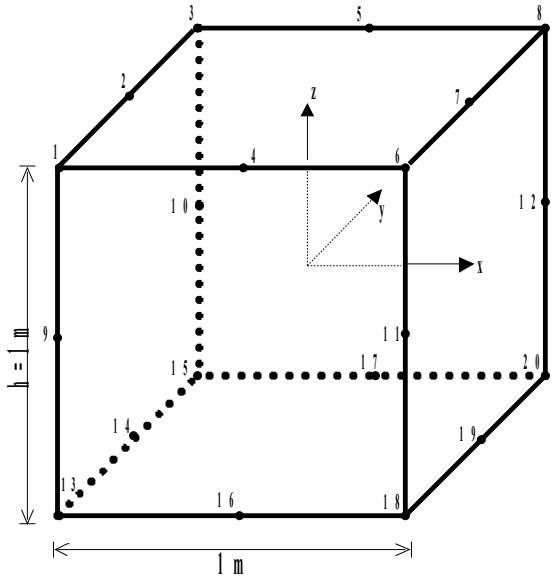
the test is here into non regression.

Note: This modelization is carried out on linear elements in thermal and hydraulics. An analytical solution was conceived at the origin for this test then into quadratic on T and H: The computation of a new adapted analytical solution is the object of file 16737.

3 Modelization A

3.1 Characteristic of the voluminal modelization

A Modelization 3D_THM



1 nets HEXA20 of modelization 3D_THM : THM_HEXA20

3.2 Result of the modelization A

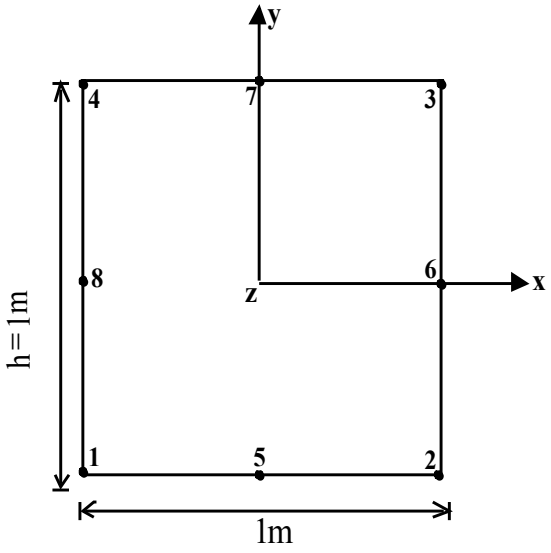
Discretization in time: only one time step: $10^3 s$. The time scheme is implicit $(\theta=1)$.

Standard	node of value	Time (s)	Reference (analytical)	Tolerance $(\%)$
N1 , N3	*TEMP*	10^3	-1.28600×10^{-8}	0.1
N6 , N8	*TEMP*	10^3	-1.28600×10^{-8}	0.1

4 Modelization B

4.1 Characteristic of the modelization B

plane Modelization: D_PLAN_THM



1 nets DPQ8 of modelization D_PLAN_THM : THM_DPQ8

4.2 Result of the modelization B

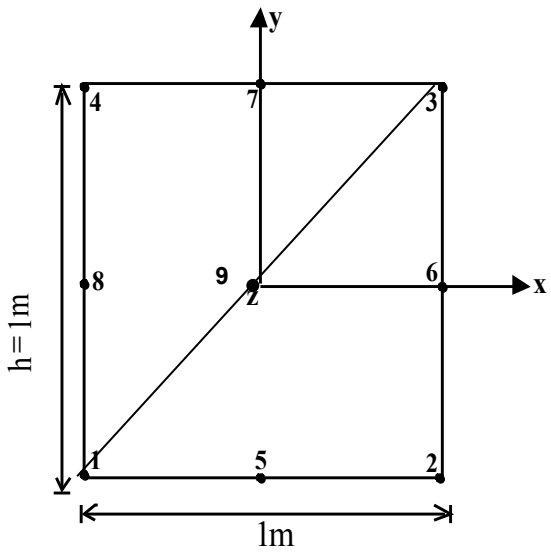
Discretization in time: only one time step: $10^3 s$. The time scheme is implicit $(\vartheta = 1)$.

Standard	node of value	Time (S)	Reference (analytical)	Tolerance $(\%)$
N3	*TEMP*	10^3	-1.28600×10^{-8}	10^{-3}
N4	*TEMP*	10^3	-1.28600×10^{-8}	10^{-3}

5 Modelization C

5.1 Characteristic of the modelization C

plane Modelization: D_PLAN_THM



2 meshes DPTR6 of modelization D_PLAN_THM : THM_DPTR6

5.2 Result of the modelization C

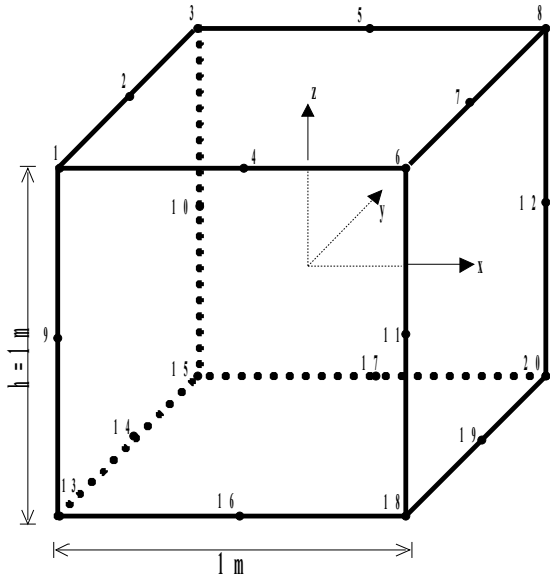
Discretization in time: only one time step: $10^3 s$. The time scheme is implicit $(\vartheta = 1)$.

Standard	node of value	Time (S)	Reference (analytical)	Tolerance (%)
N3	*TEMP*	10^3	-1.28600×10^{-8}	10^{-3}
N4	*TEMP*	10^3	-1.28600×10^{-8}	10^{-3}

6 Modelization D

6.1 Characteristic of the voluminal modelization

D Modelization 3D_THM



a mesh PENTA15 of modelization 3D_THM: THM_ PENTA15

6.2 Result of the modelization D

Discretization in time: only one time step: $10^3 s$. The time scheme is implicit $(\theta = 1)$.

Standard	node of value	Time (S)	Reference (analytical)	Tolerance (%)
N3	*TEMP*	10^3	-1.28600×10^{-8}	0.1
N4	*TEMP*	10^3	-1.28600×10^{-8}	0.1

7 Summary of the results

the results are into coherent physically and will have to be consolidated by an analytical solution (file 16737).