WTNP114 - Case test of reference for the computation of the mechanical strains

Summarized:

This test aims to validate the postprocessing of the mechanical strains in THM: EPSI_ELGA and EPSI_ELNO.

With this two-dimensional problem is dealt with a modelization 2D .

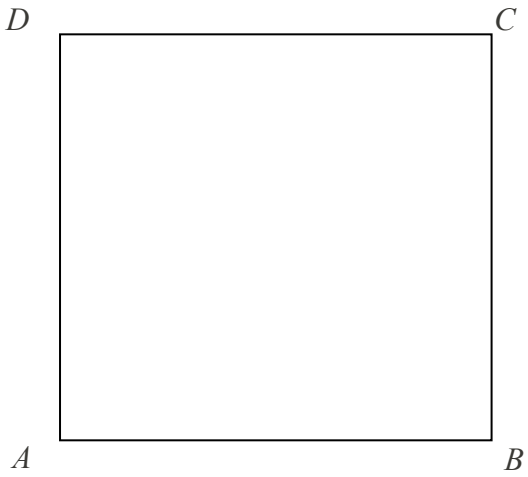
The treated features are, in particular:

- distributed pressure,
- strains and nodal stresses,

the reference solution is an analytical solution.

1 Problem of reference

1.1 Geometry



Coordinated of the points:

	A	B	C	D
x	-1.	1.	1.	-1
y	-1.	-1.	1.	1

1.2 Material properties

elastic Properties

$E=5800\,MPa$

$\nu=0.3$

Parameters of coupling law

the These data, although present in the command file does not play any part in the analytical solution since one imposes a condition to block the thermohydraulic part.

1.3 Boundary conditions and loadings

Conditions of symmetry :
- Segment AB : $DY=0$.
- Segment AD : $DX=0$.

Loading :
- Segment CD : distributed pressure $P_1=15.4\,MPa$
- Segment BC : distributed pressure $P_1=11\,MPa$
- On all the geometry: Pressure of the fluid $P_l=0\,MPa$

2 Reference solution

2.1 Method of calculating used for the reference solution

It acts of an analytical solution.

Indeed, although the introduced model is a model of THM, only the mechanical part is active here because the fluid pressure is imposed null everywhere on the field.
Moreover with regard to the mechanical part, one imposed an elastic model by choosing KIT_THM ELAS like mechanical model.

Thus, being given the boundary conditions and the loading, one a:

$\sigma_{xx}=11\ MPa$ on all surface
$\sigma_{yy}=15.4\ MPa$ on all the surface
Moreover, we is in plane strains either $\varepsilon_{zz}=0$

Gold as $\varepsilon=\frac{1+\nu}{E}\sigma-\frac{\nu}{E}Tr(\sigma)\ I$

Or $\varepsilon_{zz}=0=\frac{\sigma_{zz}}{E}-\frac{\nu}{E}\sigma_{xx}-\frac{\nu}{E}\sigma_{yy}$
From where $\sigma_{zz}=\nu(\sigma_{xx}+\sigma_{yy})$

Thus $\sigma_{zz}=7.92\ MPa$

One thus obtains the values of the strains thanks to the elastic model

$\varepsilon_{xx}=6.9034482759\ 10^{-4}$
$\varepsilon_{yy}=1.67655172414\ 10^{-3}$

the other values of the tensor of the strains (and of stresses) are null.

One calculates also the displacement of structure.

$\varepsilon_{xx}=\frac{\partial u_x}{\partial x}$
$\varepsilon_{yy}=\frac{\partial u_y}{\partial y}$

$u_x(x,y)=\varepsilon_{xx}x+u_x(0,0)$
$u_y(x,y)=\varepsilon_{yy}y+u_y(0,0)$

However by reason of symmetry $u_A=u(-1,-1)=0$, therefore
$u_x(0,0)=\varepsilon_{xx}$
$u_y(0,0)=\varepsilon_{yy}$
one is interested in displacement at the point C, of coordinates $(1,1)$
One thus has:

$$u_x(C) = 2\,\varepsilon_{xx} = 1.3806896551\ 10^{-3}$$
$$u_y(C) = 2\,\varepsilon_{yy} = 3.35310344828\ 10^{-3}$$

2.2 Results of reference

Displacements u_x and u_y at the point C and strains $\left(\varepsilon_{xx},\ \varepsilon_{yy}\right)$ with the points A B, C and D

2.3 Uncertainty on the analytical

solution Solution

2.4 bibliographical References

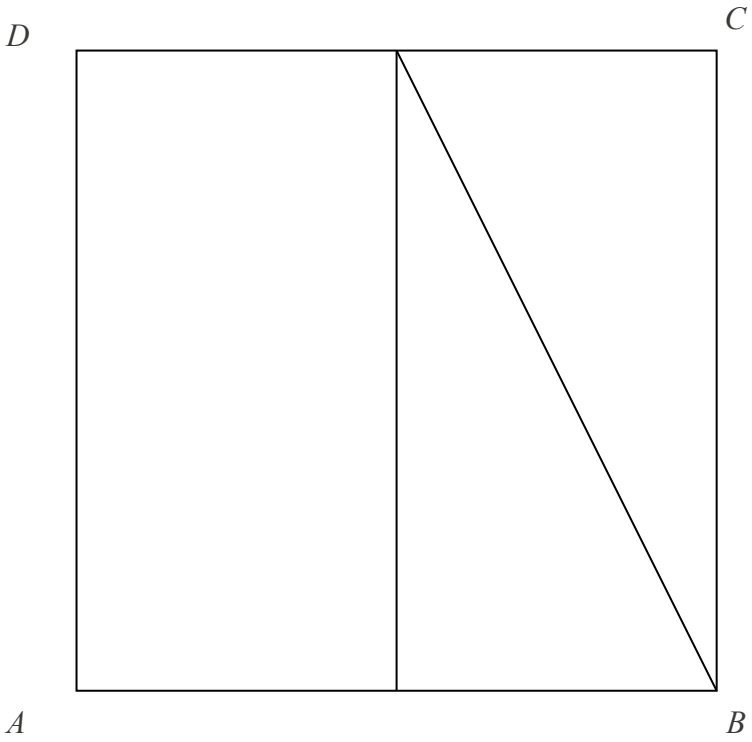
1.C. CHAVANT: Modelizations THHM. General information and algorithms, document R7.01.10

2.C. CHAVANT, B. CIREE: Constitutive law with double Drücker-Prager criterion for the cracking and the compression of the concrete, document R7.01.03

3 Modelization A

3.1 Characteristic of the modelization

Elements $2D$ (QUAD8 and TRIA6)



limiting Conditions:

- line AB blocked in dy
- line AD blocked in dx
- pressure on line BC : $p=11.$
- pressure on line CD : $p=15.4$
- Names of the nodes:
  - $A=N1$
  - $B=N2$
  - $C=N3$
  - $D=N4$

3.2 Characteristics of the mesh

Many nodes: 14
Number of meshes and types: 1 QUA8, 2 TRIA6 and 6 SEG3

3.3 Quantities tested and results

Localization	Quantity	Reference	% tolerance
A	ε_{xx}	formulates -6.9034482759000	10-4
	ε_{yy}	formula -1.6765517241400	10-3

B	ε_{xx}	formula -6.9034482759000 ^{10}	-4
	ε_{vv}	formula -1.6765517241400	10-3
C	u_x	<10-4 -1.3806896558000 ^{10}	-3
	u_v	<10-4 -3.3531034482800 ^{10}	-3
	ε_{xx}	formula -6.9034482759000	10-4
	ε_{vv}	formula -1.6765517241400	10-3
<10-4	ε_{xx}	-6.9034482759000 10 $^{-4}$	<10-4
	ε_{vv}	-1.6765517241400 10-3	<10-4

4 Summary of the results

the results got by Code_Aster are perfectly in conformity with the analytical references.