SSNV181 - Checking of the good taking into account of shearing in the models BETON_UMLV and BETON_BURGER

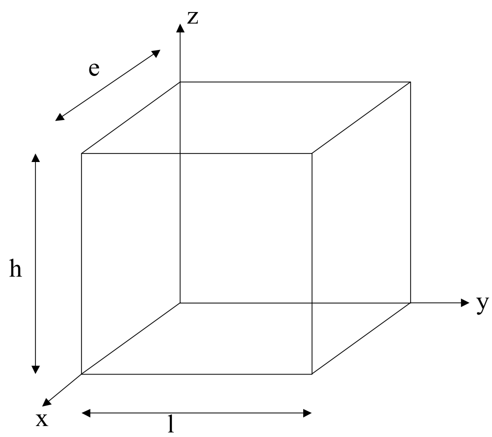
Summary:

This test makes it possible to validate the good taking into account of shearing in the laws of behavior BETON_UMLV and BETON_BURGER. The results of this test are compared with an analytical solution.

- Modeling a: long-term Test shear with the model BETON_UMLV.
- Modeling b: long-term Test shear with the model BETON_BURGER.

1 Problem of reference

1.1 Geometry



Height: $h=1,00[m]$
Width: $l=1,00[m]$
Thickness: $e=1,00[m]$

1.2 Properties of material

$E=31[GPa]$ modulus of elasticity
$\nu=0.2$ Poisson's ratio

Parameters specific to the model BETON_UMLV :

$k_r^s = 1{,}20E+5$ [MPa]	spherical part: rigidity connects associated with the skeleton formed by blocks with hydrates on a mesoscopic scale
$k_i^s = 6{,}22E+4$ [MPa]	spherical part: rigidity connects intrinsically associated with the hydrates on a microscopic scale
$k_r^d = 3{,}86E+4$ [MPa]	deviatoric part: rigidity associated with the capacity with water adsorbed to transmit loads (*load bearing toilets*)
$\eta_r^s = 2{,}21E+10$ [$MPa.s$]	spherical part: viscosity connects associated with the mechanism with diffusion within capillary porosity
$\eta_i^s = 4{,}16E+10$ [$MPa.s$]	spherical part: viscosity connects associated with the mechanism with diffusion interlamellaire
$\eta_r^d = 6{,}19E+10$ [$MPa.s$]	deviatoric part: viscosity associated with the water adsorbed by the layers with hydrates
$\eta_i^d = 1{,}64E+12$ [$MPa.s$]	deviatoric part: viscosity of free water.

Parameters specific to the model BETON_BURGER :

k_r^s =1,20E+5 [MPa]	spherical part: rigidity connects associated with the reversible field with the differed deformations
$\kappa=10.0$	Normalizes unrecoverable deformations controlling to it not linearity applied to the module of the long-term deformations
k_r^d =3,86E+4 [MPa]	deviatoric part: rigidity associated associated with the reversible field with the differed deformations
η_r^s =2,21E+10 [$MPa.s$]	spherical part: viscosity connects associated with the reversible field with the differed deformations
η_i^s =4,16E+10 [$MPa.s$]	spherical part: viscosity connects associated with the irreversible mechanism of diffusion
η_r^d =6,19E+10 [$MPa.s$]	deviatoric part: viscosity associated with the reversible field with the differed deformations
η_i^d =1,64E+12 [$MPa.s$]	deviatoric part: viscosity connects associated with the irreversible mechanism of diffusion

1.3 Boundary conditions and loadings

In this test, one creates a field of homogeneous and constant drying in the structure.
The mechanical loading corresponds to a shearing in the plan xz ; its intensity is of $10\,[MPa]$. The load is applied in $1\mathrm{s}$ and is maintained constant for 750 days.

1.4 Initial conditions

The beginning of calculation is supposed the moment – 1. At this moment there is neither field of drying, nor forced mechanical.

To moment 0, one applies a field of drying corresponding to $100\,\%$ of hygroscopy.

2 Reference solution

2.1 Method of calculating

The analytical solution rests on the resolution of the two differential equations which control the deviatoric part of the behavior (cf [R7.01.06] and [R7.01.35]). The choice of the parameter κ a very large value an equivalence between the two models for the loading applied ensures.

The deviatoric constraints are at the origin of a mechanism of slip (or mechanism of quasi dislocation) of the layers of HSC in nano-porosity. Under deviatoric constraint, creep is carried out with constant volume. In addition, the law of creep UMLV supposes the deviatoric isotropy of creep. Phénoménologiquement, the mechanism of slip comprises a viscoelastic reversible contribution of water strongly adsorbed to the layers of HSC and a viscous irreversible contribution of free water:

$$\underbrace{\underline{\underline{\varepsilon}}^{fd}}_{\substack{\textit{déformation}\\ \textit{déviatorique}\\ \textit{totale}}} = \underbrace{\underline{\underline{\varepsilon}}_r^{fd}}_{\substack{\textit{contribution}\\ \textit{eau}\\ \textit{absobée}}} + \underbrace{\underline{\underline{\varepsilon}}_i^{fd}}_{\substack{\textit{contribution}\\ \textit{eau}\\ \textit{libre}}} \quad \text{éq 2.1-1}$$

$j^{ème}$ principal component of the total deviatoric deformation is governed by the equations [éq 2.1 - 2] and [éq 2.1- 3]:

$$\eta_r^d \dot{\varepsilon}_r^{d,j} + k_r^d \varepsilon_r^{d,j} = h \cdot \sigma^{d,j} \quad \text{éq 2.1-2}$$

where k_r^d indicate rigidity associated with the capacity with water adsorbed to transmit loads (*load bearing toilets*);
and η_r^d viscosity associated with the water adsorbed by the layers with hydrates.

$$\eta_i^d \dot{\varepsilon}_i^{d,j} = h \cdot \sigma^{d,j} \quad \text{éq 2.1-3}$$

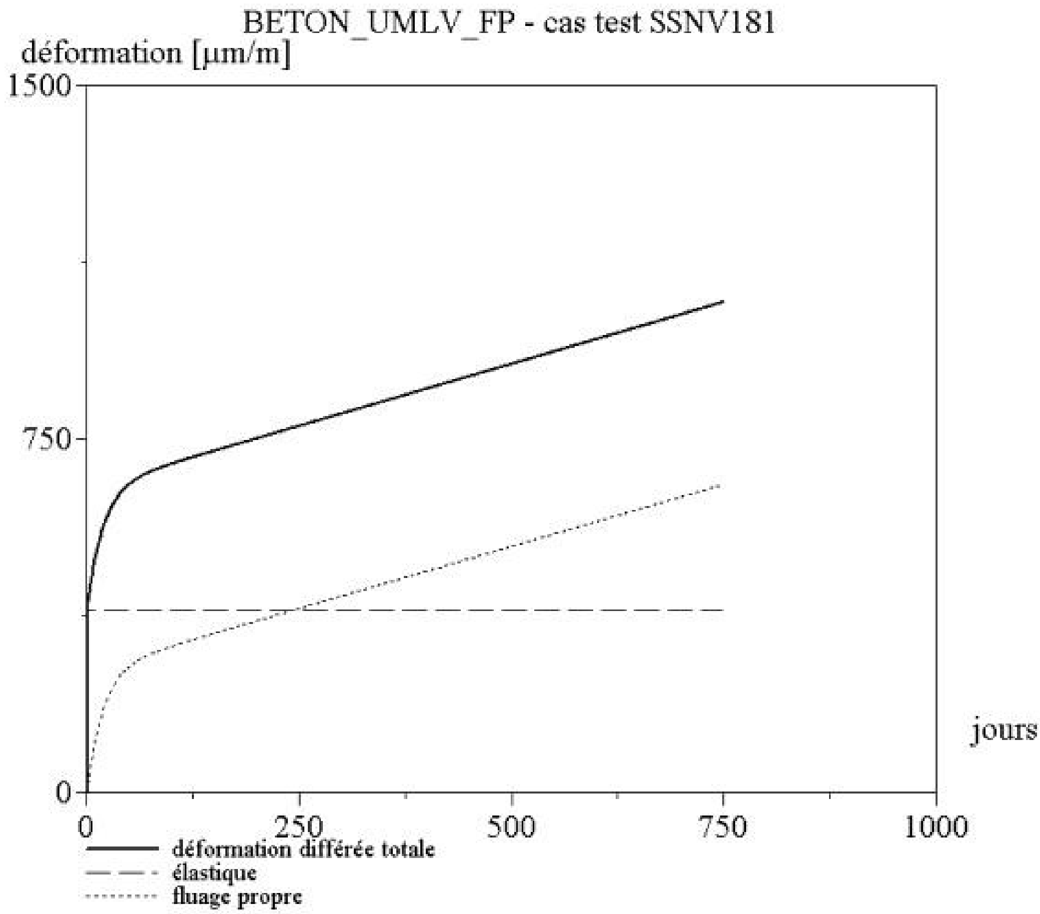
where η_i^d indicate the viscosity of free water.

In the case of a level of constraint σ_{xz}, the corresponding deformation of creep deviatoric is immediately deduced:

$$\varepsilon_{xz}^f = \sigma_{xz} \cdot \left(\frac{t}{\eta_i^d} + \left(1 - e^{-\frac{k_i^d t}{\eta_i^d}} \right) \right) \quad \text{éq 2.1-4}$$

When the elastic part is added, it follows that the total deflection of shearing is worth:

$$\varepsilon_{xz}^f = \sigma_{xz} \cdot \left(\frac{1+\nu}{E} + \frac{t}{\eta_i^d} + \left(1 - e^{-\frac{k_i^d t}{\eta_i^d}} \right) \right) \quad \text{éq 2.1-5}$$



2.2 Sizes and results of reference

The test is homogeneous. One tests the deformation in an unspecified node.

2.3 Uncertainties on the solution

Analytical solution.

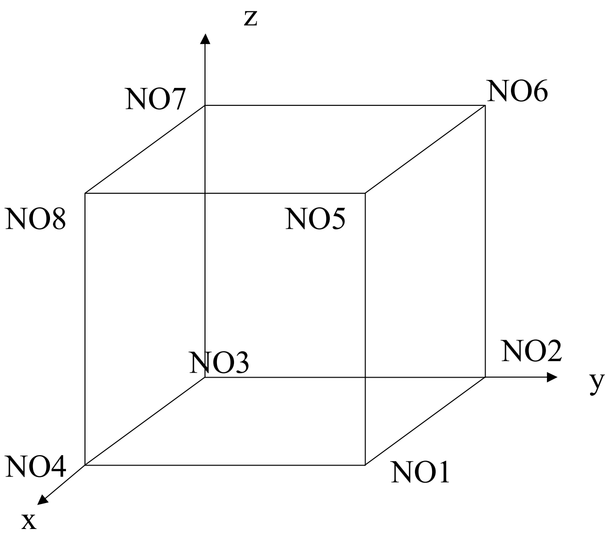
2.4 Bibliographical references

- POPE Y.: Relation of behavior UMLV for the clean creep of the concrete, Reference material of *Code_Aster* [R7.01.06] 16 p (2002).
- FOUCAULT, A.: Relation of behavior `BETON_BURGER`, Reference material of Code-Aster [R7.01.35], 2011.

3 Modeling A

3.1 Characteristics of modeling

Modeling 3D



3.2 Characteristics of the grid

Many nodes:	8
Many meshs:	1 of type HEXA 8
	6 of type QUAD 4

The following meshs are defined:

S_ARR	*NO3 NO7 NO8 NO4*
S_AVT	*NO1 NO2 NO6 NO5*
S_DRT	*NO1 NO5 NO8 NO4*
S_GCH	*NO3 NO2 NO6 NO7*
S_INF	*NO1 NO2 NO3 NO4*
S_SUP	*NO5 NO6 NO7 NO8*

The boundary conditions in displacement imposed are:

On the nodes $NO1$, $NO2$, $NO3$ and $NO4$: $DZ=0$
On the nodes $NO3$, $NO7$, $NO8$ and $NO4$: $DY=0$
On the nodes $NO2$, $NO6$, $NO7$ and $NO8$: $DX=0$

The loading is consisted by the same field of drying and of the same nodal force 1/4 applied out of the four nodes of S_SUP .

3.3 Sizes tested and results

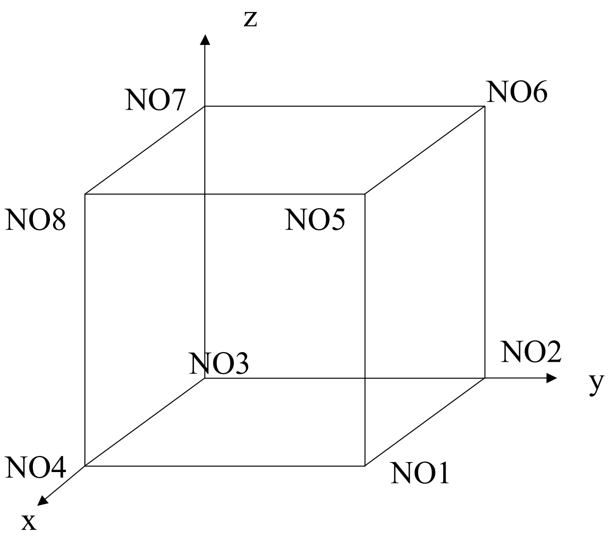
The component ε_{xz} with the node $NO6$ was tested.

Moment	Type of Reference	Reference	% tolerance
64800	'ANALYTICAL'	+3.975E-04	0.5
648000	'ANALYTICAL'	+4.770E-04	0.5
6480000	'ANALYTICAL'	+6.811E-04	0.5
64800000	'ANALYTICAL'	+10.413E-04	0.5

4 Modeling B

4.1 Characteristics of modeling

Modeling `3D`



4.2 Characteristics of the grid

Many nodes:	8
Many meshs:	1 of type `HEXA 8`
	6 of type `QUAD 4`

The following meshs are defined:

S_ARR	*NO3 NO7 NO8 NO4*
S_AVT	*NO1 NO2 NO6 NO5*
S_DRT	*NO1 NO5 NO8 NO4*
S_GCH	*NO3 NO2 NO6 NO7*
S_INF	*NO1 NO2 NO3 NO4*
S_SUP	*NO5 NO6 NO7 NO8*

The boundary conditions in displacement imposed are:

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6480000	'ANALYTICAL'	+6.811E-04	0.5
64800000	'ANALYTICAL'	+10.413E-04	0.5

5 Summary of the results

Values obtained with *Code_Aster* are in agreement with the values of the analytical solution of reference.