SSNV181 - Checking of the good taking into account of the shears in models BETON_UMLV_FP and Summarized

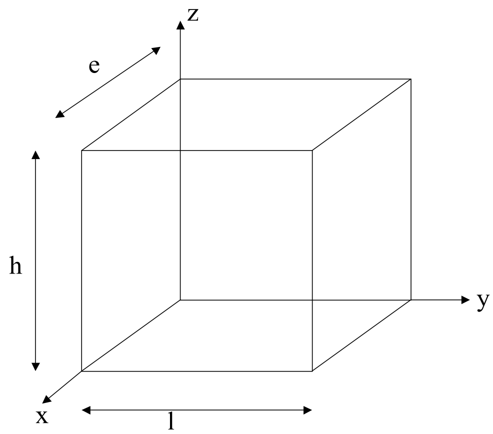
BETON_BURGER_FP:

This test makes it possible to validate the good taking into account of the shears in constitutive laws BETON_UMLV_FP and BETON_BURGER_FP. The results of this test are compared with an analytical solution.

- Modelization a: long-term Test shear with the model BETON_UMLV_FP.
- Modelization b: long-term Test shear with the model BETON_BURGER_FP.

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 the material

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

Parameters specific to model BETON_UMLV_FP :

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

Parameters specific to model `BETON_BURGER_FP` :

$k_r^s = 1{,}20E+5$ [MPa]	left spherical: stiffness connects associated with the reversible field with the strains differed
$\kappa = 10.0$	Norm from the unrecoverable deformations controlling to it not linearity applied to the modulus of the long-term strains
$k_r^d = 3{,}86E+4$ [MPa]	deviatoric part: stiffness associated associated with the reversible field with the differed strains
$\eta_r^s = 2{,}21E+10$ [$MPa.s$]	spherical part: viscosity connects associated with the reversible field with the differed strains
$\eta_i^s = 4{,}16E+10$ [$MPa.s$]	spherical part: viscosity connects associated with the irreversible mechanism of diffusion
$\eta_r^d = 6{,}19E+10$ [$MPa.s$]	deviatoric part: viscosity associated with the reversible field with the differed strains
$\eta_i^d = 1{,}64E+12$ [$MPa.s$]	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 structure.
The mechanical loading corresponds to shears in the plane 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 computation is supposed time – 1. A this time there is neither field of drying, nor forced mechanical.

To time 0, one applies a field of drying corresponding to $100\,\%$ 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 to a very large value ensures an equivalence between the two models for the loading applied.

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

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

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

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

where k_r^d indicates the stiffness 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 averages with hydrates.

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

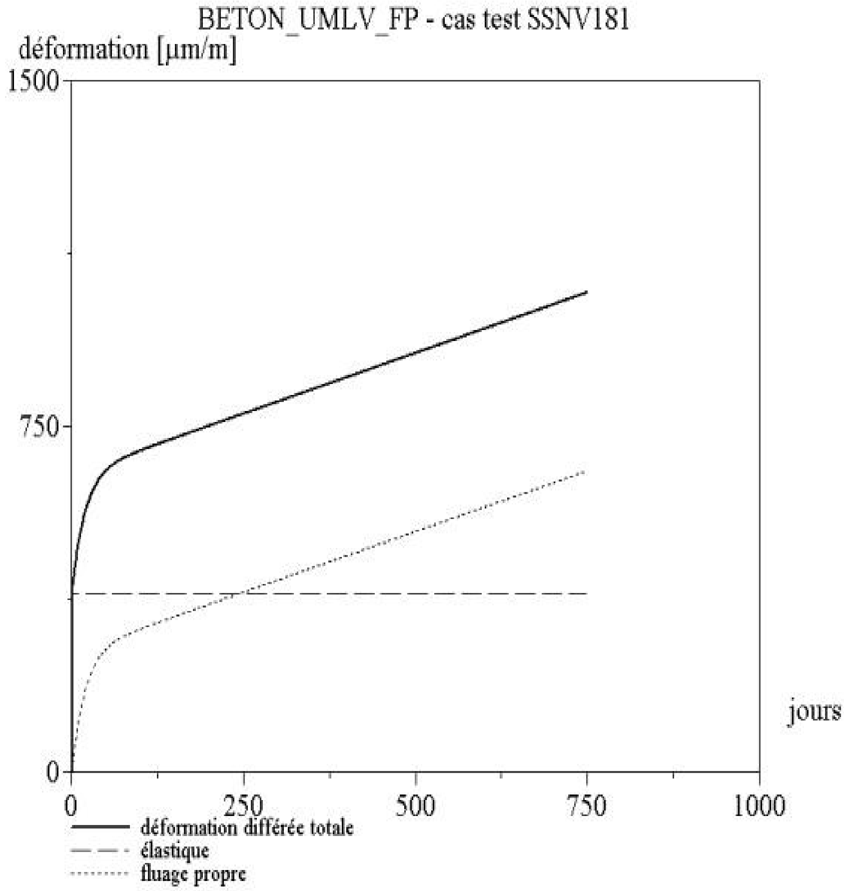
where η_i^d the viscosity of free water indicates.

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

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

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

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



2.2 Quantities and results of reference

the test is homogeneous. One tests the strain in an unspecified node.

2.3 Uncertainties on the analytical

solution Solution.

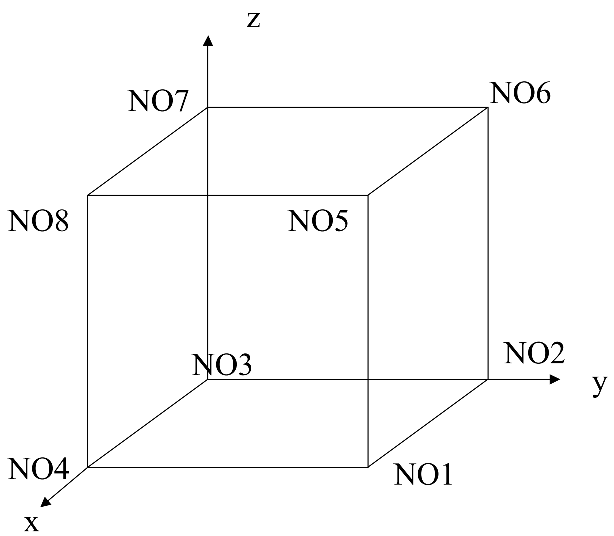
2.4 Bibliographical references

•POPE Y.: Behavior model UMLV for the clean creep of the concrete, Documentation of reference of *Code_Aster* [R7.01.06] 16 p (2002).
•FOUCAULT, A.: Behavior model `BETON_BURGER_FP`, Documentation of reference of Code-Aster [R7.01.35], 2011.

3 Modelization A

3.1 Characteristic of the modelization

Modelization 3D



3.2 Characteristic of the mesh

Many nodes: 8
Number of meshes: 1 of type HEXA 8
6 of type QUAD4

One defines the meshes following ones:

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 Quantities tested and results

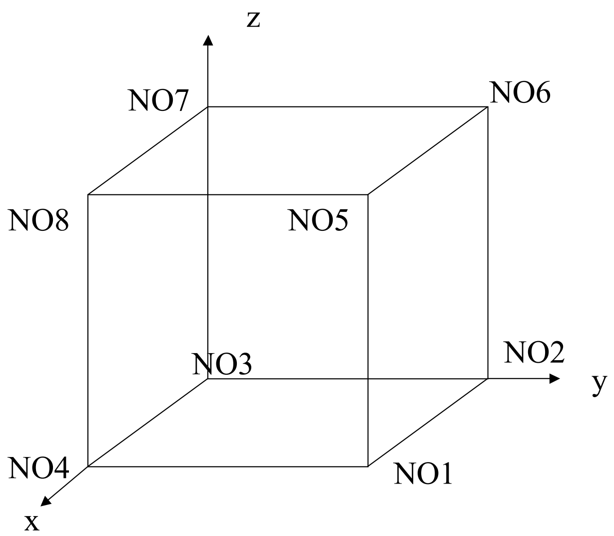
the component ε_{xz} with the node $NO6$ was tested.

Standard	time of Reference	Reference	% tolerance
64800	"ANALYTIQUE"	+3.975E-04	0.5
648000	"ANALYTIQUE"	+4.770E-04	0.5
6480000	"ANALYTIQUE"	+6.811E-04	0.5
64800000	"ANALYTIQUE"	+10.413E-04	0.5

4 Modelization B

4.1 Characteristic of the modelization

Modelization 3D



4.2 Characteristic of the mesh

Many nodes:	8
Number of meshes:	1 of type HEXA 8
	6 of type QUAD4

One defines the meshes following ones:

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 $NO8$: $DX=0$

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5 Summary of the results

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