SSNV174 - Taking into account of the endogenous withdrawal and the withdrawal of desiccation in the models BETON_UMLV_FP and BETON_BURGER_FP

Summary:

This test makes it possible to validate the taking into account of the endogenous withdrawal and desiccation in the laws of behavior BETON_UMLV_FP and BETON_BURGER_FP. The results of this test are compared with a digital solution obtained with Scilab 2.7.2. in the case of a modeling 3D (BETON_UMLV_FP) and a digital solution obtained with python for BETON_BURGER_FP (SSNV174B.44).

Modeling a: endogenous Creep test with withdrawals and desiccation for the model BETON_UMLV_FP
Modeling b: endogenous Creep test with withdrawals and desiccation for the model BETON_BURGER_FP

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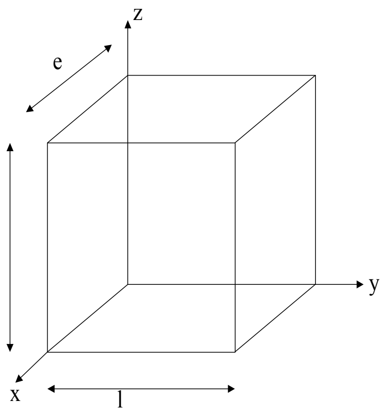
1 Problem of reference

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
$k_{re}=60\ [\mu m/m]$	endogenous coefficient of withdrawal
$k_{rd}=10\ [\mu m/m.m^3/l]$	coefficient of withdrawal of desiccation
$\alpha=10\ [\mu m/m/°C]$	thermal dilation coefficient

Here one informs also the curved sorption-desorption which connects the water content C with the hygroscopy h.
In this case one supposed that the two quantities were connected by the following linear relation:
C [l/m^3] = h [%].

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Parameters specific to BETON_UMLV_FP :

$k_r^s = 1{,}20E+5\ [MPa]$	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 BETON_BURGER_FP :

$k_r^s = 1{,}20E+5\ [MPa]$	spherical part: rigidity connects associated with the reversible field with the differed deformations
$k_r^d = 3{,}86E+4\ [MPa]$	deviatoric part: rigidity associated associated with the reversible field with the differed deformations
$\eta_r^s = 2{,}21E+10\ [MPa.s]$	spherical part: viscosity connects associated with the reversible field with the differed deformations
$\eta_i^s = 4{,}16E+10\ [MPa.s]$	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 deformations
$\eta_i^d = 1{,}64E+12\ [MPa.s]$	deviatoric part: viscosity connects associated with the irreversible mechanism of diffusion
$\kappa = 3.0 \times 10^{-3}$	Normalizes unrecoverable deformations controlling to it not linearity applied to the module of the long-term deformations

1.3 Boundary conditions and loadings

In this test, one creates a homogeneous field of drying in the structure varying linearly over duration a 750 days, initial moisture is worth 100% (condition of a sealed test-tube) and decrease gradually until 50% to the 750ème day.

The degree of hydration varies linearly from 0 to 1 between the initial moment and the 28ème day.

The mechanical loading corresponds to an one-way compression according to the vertical direction (z in $3D$); its intensity is of $12[MPa]$. The load is applied in $1s$ and is maintained constant for 100 days.

1.4 Initial conditions

The beginning of calculation is supposed at 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, a field of hydration corresponding to a null advance and a thermal field at the temperature of reference.

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2 Reference solution

2.1 Method of calculating

One did not develop the analytical solution for this hydro-mechanical loading. Also, the reference solution is obtained numerically by using the software Scilab 2.7.2 for BETON_UMLV_FP or python for BETON_BURGER_FP. Each component of deformation is calculated separately:

- the deformations of endogenous withdrawal are given starting from the relation:
  - $\varepsilon_{re} = k_{re} . \beta$ where β indicate the degree of hydration of material
- the deformations of withdrawal of desiccation are given starting from the relation:
  - $\dot{\varepsilon}_{rd} = k_{rd} . \dot{C}$ where C indicate the water content of material
- the deformations of clean creep are calculated numerically by using a discretization identical to that established in *Code_Aster* for BETON_UMLV_FP and an establishment according to a diagram clarifies for BETON_BURGER_FP. The temporal discretization is then necessarily finer for the explicit diagram.

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

Digital result got with Scilab 2.7.2 or python (SSNV174B.44)

2.4 Bibliographical references

[1] POPE Y.: Relation of behavior UMLV for the clean creep of the concrete, Reference material of *Code_Aster*, [R7.01.06] 16 p (2002).

[2] FOUCAULT A.: Relation of behavior BETON_BURGER_FP for the clean creep of the concrete, Reference material of Code-Aster, [R7.01.35], 2011.

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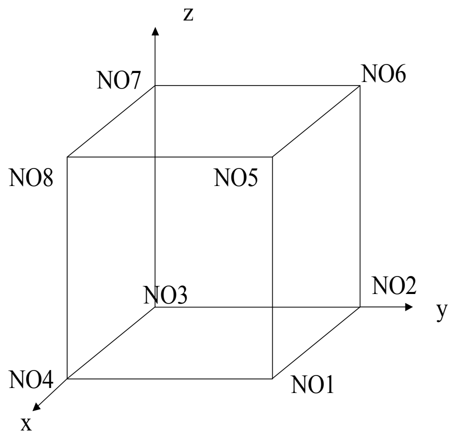
3 Modeling A

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 to the four nodes of S_SUP .

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3.3 Sizes tested and results

One tests the deformations obtained with the node $N6$ mesh $M1$.

Identification	Type of reference	Value of reference	Tolerance
ε_{zz} with the node $NO6$ at moment 0.0	'ANALYTICAL'	0.0	-
ε_{zz} with the node $NO6$ at moment 64800	'ANALYTICAL'	-4.07E-04	0,50%
ε_{zz} with the node $NO6$ at moment 648000	'ANALYTICAL'	-5.16E-04	0,50%
ε_{zz} with the node $NO6$ at moment 6480000	'ANALYTICAL'	-8.13E-04	0,50%
ε_{zz} with the node $NO6$ at moment 64800000	'ANALYTICAL'	-1.37E-03	0,50%

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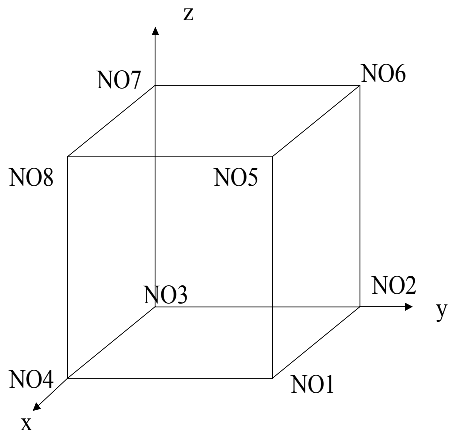
4 Modeling B

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:

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 to the four nodes of S_SUP .

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4.3 Sizes tested and results

One tests the deformations obtained with the node $N6$ mesh $M1$.

Identification	Type of reference	Value of reference	Tolerance
ε_{zz} with the node $NO6$ at moment 0.0	'ANALYTICAL'	0.0	-
ε_{zz} with the node $NO6$ at moment 1.0	'ANALYTICAL'	-3.87E-04	0.50%
ε_{zz} with the node $NO6$ at moment 64800	'SOURCE_EXTERNE'	-4.13E-04	0,50%
ε_{zz} with the node $NO6$ at moment 648000	'SOURCE_EXTERNE'	-5.73E-04	0,50%
ε_{zz} with the node $NO6$ at moment 6480000	'SOURCE_EXTERNE'	-1.27E-03	0,50%
ε_{zz} with the node $NO6$ at moment 64800000	'SOURCE_EXTERNE'	-3.45E-03	0,50%

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5 Summary of the results

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

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