

SSNV174 - Taking into account of the endogenous shrinkage and the shrinkage of desiccation in models BETON_UMLV_FP and Summarized

BETON_BURGER_FP:

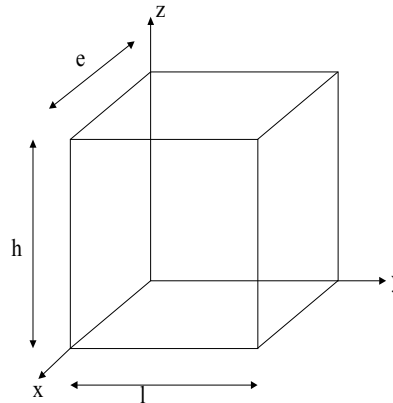
This test makes it possible to validate the taking into account of the endogenous shrinkage and desiccation in constitutive laws BETON_UMLV_FP and BETON_BURGER_FP. The results of this test are compared with a numerical solution obtained with Scilab 2.7.2 in the case of a modelization 3D (BETON_UMLV_FP)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

Modelization a: endogenous Creep test with shrinkages and desiccation for the model BETON_UMLV_FP

Modelization b: endogenous Creep test with shrinkages and desiccation for 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
$k_{re} = 60 [\mu m/m]$	endogenous coefficient of shrinkage
$k_{rd} = 10 [\mu m/m.m^3/l]$	coefficient of shrinkage of thermal
$\alpha = 10 [\mu m/m/^{\circ}C]$	desiccation coefficient of thermal expansion

Here one informs also the curved sorption-desorption which connects the water content C to the hygroscoy h .

In this case one supposed that the two quantities were connected by the following linear relation:

$$C [l/m^3] = h [\%].$$

Parameters specific to BETON_UMLV_FP :

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

Parameters specific to BETON_BURGER_FP :

$k_r^s = 1,20E + 5$ [MPa]	spherical part: stiffness connects associated with the reversible field with the differed 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 mechanism with deviatoric left
$\eta_r^d = 6,19E + 10$ [MPa.s]	irreversible diffusion: 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
$\kappa = 3.0 \times 10^{-3}$	Normalizes unrecoverable deformations controlling to it not linearity applied to the modulus of the long-term strains

1.3 Boundary conditions and loadings

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

The degree of hydration varies linearly from 0 to 1 between initial time and the 28th 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 computation is supposed with time -1 . At this time there is neither field of drying, nor forced mechanical.

To time 0, one applies a field of drying corresponding to 100% hygroscopy, a field of hydration corresponding to a null advance and a thermal field with the reference temperature.

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 means of the software Scilab 2.7.2 for `BETON_UMLV_FP` or python for `BETON_BURGER_FP`. Each component of strain is calculated separately:

the strains of endogenous shrinkage are given from the relation:

$$\varepsilon_{re} = k_{re} \cdot \beta \text{ where } \beta \text{ the degree of hydration of the material indicates}$$

the strains of shrinkage of desiccation are given from the relation:

$$\dot{\varepsilon}_{rd} = k_{rd} \cdot \dot{C} \text{ where } C \text{ the water content of the material indicates}$$

the strains of clean creep are calculated numerically by means of a discretization identical to that established in *the Code_Aster* for `BETON_UMLV_FP` and an establishment according to an explicit diagram for `BETON_BURGER_FP`. The temporal discretization is then necessarily finer for the explicit diagram.

2.2 Quantities and results of reference

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

2.3 Uncertainties on the solution

Result numerical obtained with Scilab 2.7.2 or python (SSNV174B.44)

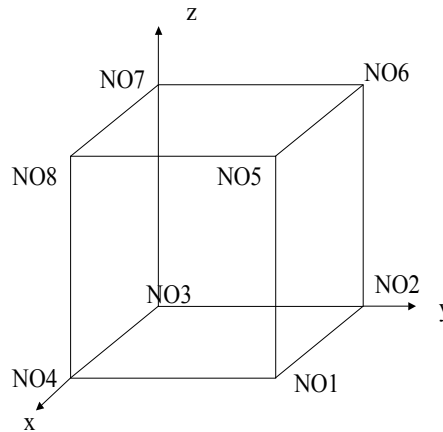
2.4 bibliographical References

- [1] LE POPE Y.: Behavior model UMLV for the clean creep of the concrete, Documentation of reference of *Code_Aster*, [R7.01.06] 16 p (2002).
- [2] FOUCAULT A.: Behavior model `BETON_BURGER_FP` for the clean creep of the concrete, 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 to the four nodes of *S_SUP* .

3.3 Quantities tested and results

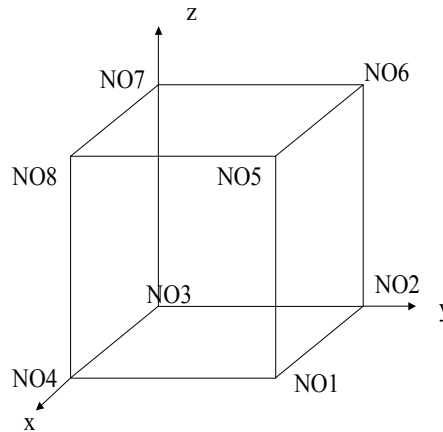
One of the mesh tests the strains obtained with $N6$ the node MI .

Standard	identification of reference	Value of reference	Tolerance
ε_{zz} to the node $NO6$ to time 0.0	"ANALYTIQUE"	0.0	-
ε_{zz} to the node $NO6$ to time 64800	"ANALYTIQUE"	-4.07E-04	0.50%
ε_{zz} to the node $NO6$ to time 648000	"ANALYTIQUE"	-5.16E-04	0.50%
ε_{zz} to the node $NO6$ to time 6480000	"ANALYTIQUE"	-8.13E-04	0.50%
ε_{zz} to the node $NO6$ to time 64800000	"ANALYTIQUE"	-1.37E-03	0.50%

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* : $DX=0$

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* .

4.3 Quantities tested and results

One of the mesh tests the strains obtained with $N6$ the node MI .

Standard	identification of reference	Value of reference	Tolerance
ε_{zz} to the node $NO6$ to time 0.0	"ANALYTIQUE"	0.0	-
ε_{zz} with the node $NO6$ at time 1.0	"ANALYTIQUE"	-3.87E-04	0.50%
ε_{zz} with the node $NO6$ at time 64800	"SOURCE_EXTERNE"	-4.13E-04	0.50%
ε_{zz} with the node $NO6$ at time 648000	"SOURCE_EXTERNE"	-5.73E-04	0.50%
ε_{zz} with the node $NO6$ at time 6480000	"SOURCE_EXTERNE"	-1.27E-03	0.50%
ε_{zz} with the node $NO6$ at time 64800000	"SOURCE_EXTERNE"	-3.45E-03	0.50%

5 Summary of the results

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