SSNV235 - Law of behavior KIT_RGI : Influence of the temperature in the evolution of creep

Summary:

This document presents a test making it possible to validate the capacities of the model of behavior KIT_RGI, and more precisely the module FLUA_PORO_BETON to take into account the influence of the temperature in the kinetics of the deformations related to creep. A clean creep test in temperature is simulated. The results of simulation are compared with the experimental tests of the thesis of Ladaoui [bib1]

1 Problem of Reference

The loading consists of the application of a pressure on the higher face of a cube. The value of this pressure corresponds to 30 %-35% of the resistance of the concrete in compression to 20°C. Properties of the concrete evolving slightly between the test with $T=20°C$ and that with $T=50°C$, the load varies between 25.8 MPa and 26.2 MPa.

1.1 Geometry

The test is pressed on a unit cubic finite element with 8 nodes.

1.2 Property of materials

The studied material is a concrete whose properties are defined in the thesis of [Ladaoui, 2010]. These elastic properties and the thresholds of damage are slightly different between the two tests.

With $T=20°C$:

Young modulus: $E=44700\,MPa$
Poisson's ratio: $\nu=0.27$
Tensile strength: $\sigma_{ft}=2.4\,MPa$
Compressive strength: $\sigma_{fc}=86.3\,MPa$
Deformation with the peak of compression: $\varepsilon_{fc}=2.10^{-3}$
Deformation with the peak of traction: $\varepsilon_{ft}=5{,}4.10^{-5}$

With $T=50°C$:
Young modulus: $E=41600\,MPa$
Poisson's ratio: $\nu=0.28$
Tensile strength: $\sigma_{ft}=2.4\,MPa$
Compressive strength: $\sigma_{fc}=84\,MPa$
Deformation with the peak of compression: $\varepsilon_{fc}=2.10^{-3}$
Deformation with the peak of traction: $\varepsilon_{ft}=5{,}7.10^{-5}$

Table 1.2-1 : Values of the parameters of clean creep, identified starting from the experimental results. (Unit of time in the D-day and the lengths are in mm)

$CBIO=0{,}3$	$MU=0$
$MSAT=0$	$DT80=0{,}28$
$SFLD=27$	$STMP=1{,}0$
$MG=0$	$KTMP=5$
$VG0=0$	$Y1SY=10$
$PORO=0{,}12$	$TAU1=10$
$TKVP=1,$	$TAU2=50$
$NRJA=15000$	$EKFL=4E\text{-}4$
$MSHR=0$	$DFMX=1$
$KD=0$	$TREF=1$

Let us recall that them the properties materials are specified in DEFI_MATERIAU with the name PORO_BETON. The module FLUA_PORO_BETON is indicated in STAT_NON_LINE.

1.3 Boundary conditions

Perpendicular displacements according to three faces of the cubes are blocked in order to model an unconfined compression test. On another face, a surface pressure of $SIZZ=26{,}3\,MPa$ is applied in $t=0.1\ jour$ and maintained for one duration of $t=350\ jours$

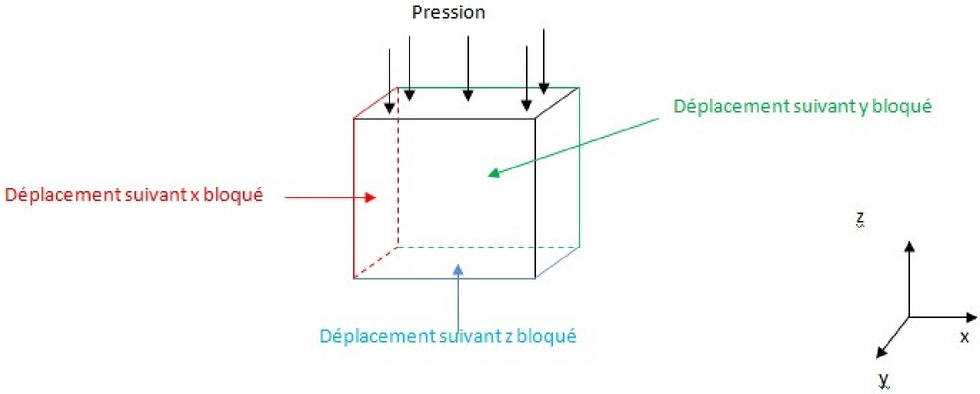

Figure 1.3-1 : Boundary conditions and mechanical loading on a cube of 1 mm of with dimensions.

Two simulations (modeling A and modeling B) are carried out at two distinct temperatures: $T=20°C$ and $T=50°C$. Let us recall that this model requires temperatures in °C.

1.4 Initial conditions

Nothing

2 Reference solution

2.1 Method of calculating

The results of calculations are compared at the same time with the results got under the computation software by finite elements CASTEM and with the experimental data coming from work of Ladaoui [bib1]. Tests of nonregression are carried out in to make sure more of the reproducibility of the got results with KIT_RGI.

2.2 Sizes and results of reference

The following curve traces the evolution of the deformations in the course of time for two simulations and it makes it possible to compare the results got with the values coming from the thesis from Ladaoui [bib1].

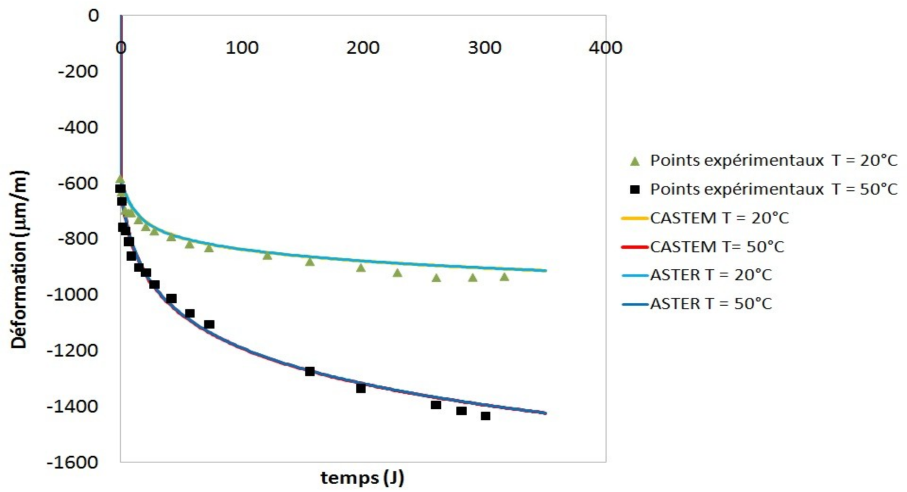

Figure 2.2-1 : Comparison of the evolutions of the deformation according to the temperature between experimental tests [bib1] and simulations.

It appears clearly that Ltemperature has accelerates the deformations related to clean creep. The model makes it possible to find the results of the thesis of Ladaoui [bib1].
The sizes tested are thus the total deflections $EPZZ(N7)$. The values of reference are given in the following tables.

Table 2.2-1 : Values of reference for a temperature of $T=20°C$

Identification	Moments	Origin	Value of reference
$EPZZ$	1	Castem	-0.000599484624719
$EPZZ$	50	Castem	-0.000794945188622
$EPZZ$	200	Castem	-0.000878374909193
$EPZZ$	350	Castem	-0.000912576232631
$EPZZ$	28	Experimental	-0.000771
$EPZZ$	74	Experimental	-0.000831
$EPZZ$	316	Experimental	-0.000933

Table 2.2-2 : Values of reference for a temperature of $T=50°C$

Identification	Moments	Types of Reference	Value of reference
$EPZZ$	1	'NON_REGRESSION'	-0.000649737723697
$EPZZ$	50	'NON_REGRESSION'	-0.00106673155169
$EPZZ$	200	'NON_REGRESSION'	-0.00131704464589
$EPZZ$	350	'NON_REGRESSION'	-0.00142217806342
$EPZZ$	28	'SOURCE_EXTERNE'	-0.000963
$EPZZ$	74	'SOURCE_EXTERNE'	-0.001106
$EPZZ$	316	'SOURCE_EXTERNE'	-0.001434

2.3 Uncertainties on the solution

Uncertainty on the tests of nonregression is of 0.5 % and 5 % for the comparison with the experimental data.

2.4 Bibliographical references

[1] Experimental W.Ladaoui, "Studies of the behavior long-term Thermo-Hydro-Mechanics of the BHP intended for the work of storage of the radioactive waste", *Doctorate* , University of Toulouse III-Paul Sabatier, 2010

3 Modeling A

3.1 Characteristic of modeling

The problem is modelled in 3D. The model employed is KIT_RGI and more precisely the module FLUA_PORO_BETON. The imposed temperature is $T=20°C$

3.2 Characteristic of the grid

1 mesh HEXA8

3.3 Sizes tested and results

All the sizes are calculated with the node $N7$.

Identification	Moments	Type of Reference	Value of reference	Tolerance
$EPZZ(N7)$	1	'SOURCE_EXTERNE'	-0.000599484624719	0.5%
$EPZZ(N7)$	50	'SOURCE_EXTERNE'	-0.000794945188622	0.5%
$EPZZ(N7)$	200	'SOURCE_EXTERNE'	-0.000878374909193	0.5%
$EPZZ(N7)$	350	'SOURCE_EXTERNE'	-0.000912576232631	0.5%
$EPZZ(N7)$	28	'SOURCE_EXTERNE'	-7.58E-04	5.0%
$EPZZ(N7)$	74	'SOURCE_EXTERNE'	8.18E-04	5.0%
$EPZZ(N7)$	316	'SOURCE_EXTERNE'	-9.06E-04	5.0%

4 Modeling B

4.1 Characteristic of modeling

The problem is modelled in 3D. The model employed is KIT_RGI and more precisely the module FLUA_PORO_BETON. The imposed temperature is $T=20°C$

4.2 Characteristic of the grid

1 mesh HEXA8

4.3 Sizes tested and results

All the sizes are calculated with the node $N7$.

Identification	Moments	Type of Reference	Value of reference	Tolerance
$EPZZ(N7)$	1	'SOURCE_EXTERNE'	-0.000649737723697	0.5%
$EPZZ(N7)$	50	'SOURCE_EXTERNE'	-0.00106673155169	0.5%
$EPZZ(N7)$	200	'SOURCE_EXTERNE'	-0.00131704464589	0.5%
$EPZZ(N7)$	350	'SOURCE_EXTERNE'	-0.00142217806342	0.5%
$EPZZ(N7)$	28	'SOURCE_EXTERNE'	-0.000971275886694	5.0%
$EPZZ(N7)$	74	'SOURCE_EXTERNE'	-0.00113509689347	5.0%
$EPZZ(N7)$	316	'SOURCE_EXTERNE'	-0.00139311161787	5.0%

5 Summary of the results

The results make it possible to show that the model takes into account the influence of the temperature. They are in agreement with the results of the thesis Ladaoui [bib1].