SSNV236 - Law of behavior BETON_RAG and KIT_RGI: biaxial creep of a cube

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_ENDO_BETON. Let us specify that KIT_RGI is a set of three modules allowing to take into account the deformation differed from the concrete with FLUA_PORO_BETON, the damage of the concrete with ENDO_PORO_BETON and the reaction alkali-aggregate with RGI_BETON. The behavior of a cubic test-tube subjected to a biaxial loading is simulated.

1 Problem of Reference

The digital simulations carried out here aim to check if the module of creep (FLUA_PORO_BETON) of KIT_RGI is able to reproduce the evolution of the deformations of clean creep.

1.1 Geometry

The test is pressed on a unit cubic finite element.1 mesh HEXA8

1.2 Property of materials

Young modulus: $E=41838\,MPa$
Poisson's ratio: $\nu=0.13$
Thermal dilation coefficient: $\alpha=1.0e^{-5}$
Tensile strength: $\sigma_{ft}=3\,MPa$
Compressive strength: $\sigma_{fc}=29\,MPa$
Deformation with the peak of compression: $\varepsilon_{fc}=2.10^{-3}$
Deformation with the peak of traction: $\varepsilon_{ft}=1{,}3.10^{-4}$

Before the loading, the test-tube was preserved at a relative humidity of 98% . The age of loading is 8 days. For more precision, it is possible to refer to [K.S. Gopalakrishnanand al., 1969].

The characteristics of the test-tube tested are given in table 1.2-1 for law KIT_RGI.

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

$CBIO=0{,}3$	$MU=18845$
$MSAT=0$	$DT80=0{,}3$
$SFLD=27$	$STMP=1{,}0$
$MG=100$	$KTMP=4{,}5$
$VG0=0{,}01$	$Y1SY=20$
$PORO=0{,}12$	$TAU1=1{,}5$
$TKVP=1$	$TAU2=22$
$NRJA=36500$	$EKFL=3{,}1E\text{-}4$
$MSHR=0$	$DFMX=1$
$KD=18512$	$TREF=0{,}0014$

Let us recall that KIT_RGI is a model in KIT which makes it possible either to couple the models of creep (FLUA_PORO_BETON), of damage (ENDO_PORO_BETON) and of RAG-RSI (RGI_BETON) or or to use the models separately. In all the cases, the properties materials are specified in DEFI_MATERIAU with name PORO_BETON. For this case test, only the model of creep is employed by using in STAT_NON_LINE law FLUA_PORO_BETON.

1.3 Boundary conditions and loadings

A schematization of the ways of the biaxial loading applied is given on figure 1.3-1.

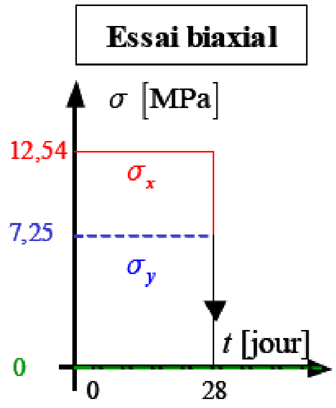

Figure 1.3-a : Way of the constraints of the studied series [K.S. Gopalakrishnanand al., 1969]

The loading results in the application of two pressures of 12.54MPa and 7.25MPa associated with the following function:

Table 1.3-1 : Multiplying function associated with the pressures

Moment (day)	Value
0	0
0,1	1
28	1
28,1	0,0001
200	0,0001

The boundary conditions and the loading are schematized on the following figure:

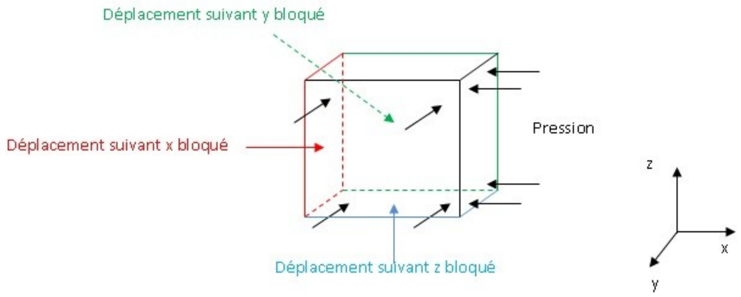

Figure 1.3-2 : Boundary conditions and mechanical loading on a cube of 1 mm of with dimensions.

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 K.S. Gopalakrishnan et al. [bib1]. Tests of nonregression are carried out in to make sure more of the reproducibility of the results got with KIT_RGI.

2.2 Sizes and results of reference

The answer of the model is given on the figures below.

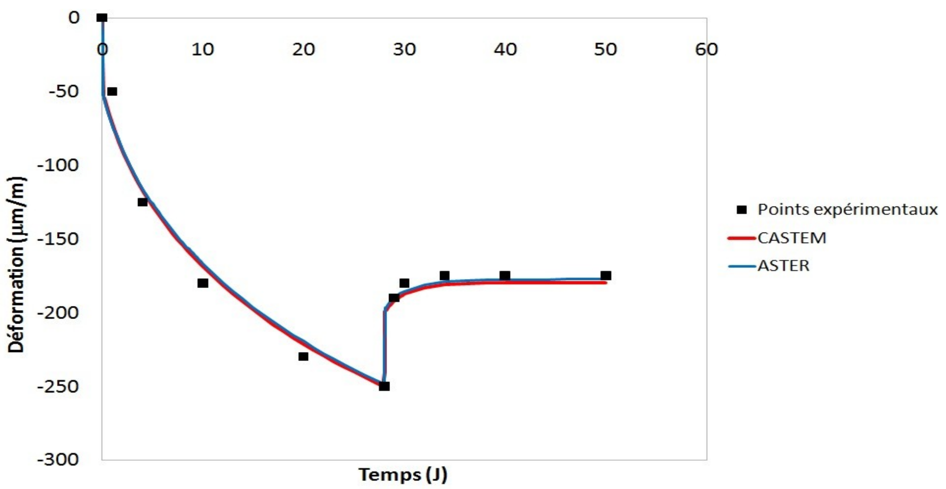

Figure 2.2-a : Comparison enters the evolutions experimental and simulated deformations $EPXX$ **of clean creep for the biaxial test with KIT_RGI under CASTEM and ASTER**

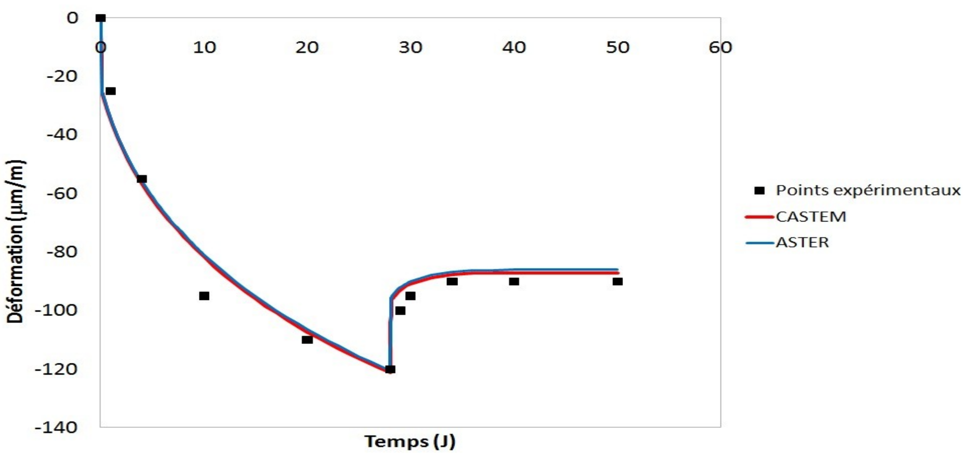

Figure 2.2-b : Comparison enters the evolutions experimental and simulated deformations $EPYY$ of clean creep for the biaxial test with KIT_RGI under CASTEM and ASTER

The sizes tested are thus the total deflections $EPXX$ and $EPYY$:
_Test of nonregression at the moments: $t=28\,Jours$ and $t=50\,Jours$.
_Comparaison with the experimental data at the moments: $t=28\,Jours$ and $t=50\,Jours$.

Table 2.2-1 : Values of reference in the case test

Identification	Moments	Origin	Reference
$EPXX$	28.0	Castem	-5.256874 E-04
$EPYY$	28.0	Castem	-2.547323 E-04
$EPXX$	50.0	Castem	-1.777467 E-04
$EPYY$	50.0	Castem	-8.599525 E-05
$EPXX$	28.0	Experimental	-5.15E-04
$EPYY$	28.0	Experimental	-2.33E-04
$EPXX$	50.0	Experimental	-1.75E-04
$EPYY$	50.0	Experimental	-9.0E-05

2.3 Uncertainties on the solution

Uncertainty on the values resulting from Castem is of 0.5 % and 2 % to 5 % for the comparison with the experimental data.

2.4 Bibliographical references

[1] K.S. Gopalakrishnan, A.M. Neville, A. Ghali, “Creep Poisson' S ratio of concrete under multiaxial compression”, ACI Newspaper, 66(90), p. 1008-1020, 1969

3 Modeling A

3.1 Characteristic of modeling

The problem is modelled in 3D. The model employed is FLUA_PORO_BETON of KIT_RGI.

3.2 Characteristic of the grid

1 mesh HEXA20. LE grid is modifilé with order CREA_MAILLAGE (QUAD_LINE) because it is advised to employ KIT_RGI on cubic elements with 8 nodes.

3.3 Sizes tested and results

Identification	Moments	Type of reference	Value of reference	Tolerance
$EPXX(N19)$	28.0	'SOURCE_EXTERNE'	-5.256874 E-04	0.5%
$EPYY(N19)$	28.0	'SOURCE_EXTERNE'	-2.547323 E-04	0.5%
$EPXX(N19)$	50.0	'SOURCE_EXTERNE'	-1.777467 E-04	0.5%
$EPYY(N19)$	50.0	'SOURCE_EXTERNE'	-8.599525 E-05	0.5%
$EPXX(N19)$	28.0	'SOURCE_EXTERNE'	-5.256874 E-04	5.0%
$EPYY(N19)$	28.0	'SOURCE_EXTERNE'	-2.547323 E-04	5.0%
$EPXX(N19)$	50.0	'SOURCE_EXTERNE'	-1.777467 E-04	2.0%
$EPYY(N19)$	50.0	'SOURCE_EXTERNE'	-8.599525 E-05	2.0%

4 Summary of the results

Results calculated by *Code_Aster* check the not-regression. The model makes it possible to find the expérimenaux results of Gopalakrishnan et al. [bib1] on a biaxial creep test.