SSNV179 - Cubic under creep via model LEMA_SEUIL

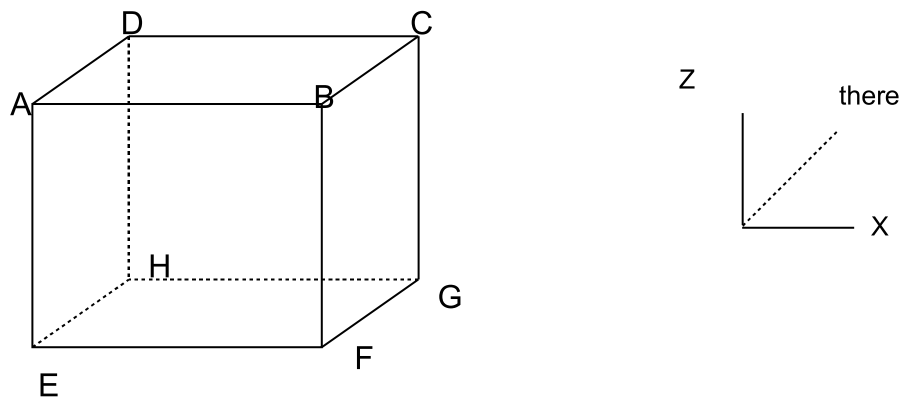
Summarized:

The purpose of this test is validating model LEMA_SEUIL derived from the classical model of LEMAITRE. In particular, we will be delayed on the activation of the specific threshold to this model. One thus carries out a creep test on a geometry simple to know a cube here.

A modelization 3D with elements HEXA8 is currently available.

1 Problem of reference

1.1 Geometry



Coordinates of the points:

A	B	C	D	E	F	G	H
0.	1.	1.	0.	0.	1.	1.	0.
0.	0.	1.	1.	0.	0.	1.	1.
0.	0.	0.	0.	-1.	-1.	-1.	-1.

1.2 Elastic

material properties Properties:

$E=165000\,MPa$

$\nu=0.3$

Viscous properties:

Model of `LEMA_SEUIL`

$A=14.143\,10^{-13}\,MPa^{-1}.\,neutron^{-1}$
$S=0.0788\,10^{10}\,MPa^{-1}.\,s^{-1}$

1.3 Boundary conditions and loadings

Forces surface:

$F=220\,MPa$

Irradiation:
Flux of irradiation: $1.85\,10^{15}\,neutrons\,.\,cm^2\,.\,s^{-1}$.

Imposed displacements:

The node is outside the field of definition with a right profile of the EXCLU type node: A $DX=DY=DZ=0$.

The node is outside the field of definition with a right profile of the EXCLU type node: E $DX=DY=0$.
Node D and the node is outside the field of definition with a right profile of the EXCLU type node: H $DX=0$.
On the first increment of time the force passes from 0 to its maximum value $220\,MPa$ linearly compared to time for then being maintained constant over all the period of the experiment.

2 Reference solution

2.1 Method of calculating used for the reference solution

the goal of the reference solution is analytically to calculate the value of the threshold from which creep appears.
Some results of non regression on displacements with the last time step are added to check the total stiffness of the system.

For the analytical computation of the threshold one a:

As long as the structure remains elastic and because of the boundary conditions, the tensor of the stresses is written:

For the first time step understood enters 0 and $106\,s$

$\sigma_{xx}(t) = 2.2\ 10^{-4} t$, T in second and σ_{xx} in MPa . The other components of the tensor are null.

For the others time step, $\sigma_{xx} = 220\,MPa$

But one a:

$$D = \frac{1}{S} \int_0^t \sigma_{eq}(u)\,du$$

Is as in this case, $\sigma_{eq} = \sigma_{xx}$ one obtains in an immediate way by solving $D=1$ the value of the time from which creep is declared: $t_1 = 4.08181818\,10^6\,s$

Thus for a time equal to t_1 , the viscous strains are null and D is worth 1.

2.2 Results of reference

Local variable $V1$ and $V2$ at the point A B , C and E as well as the displacement of the point B to the last time step

2.3 bibliographical References

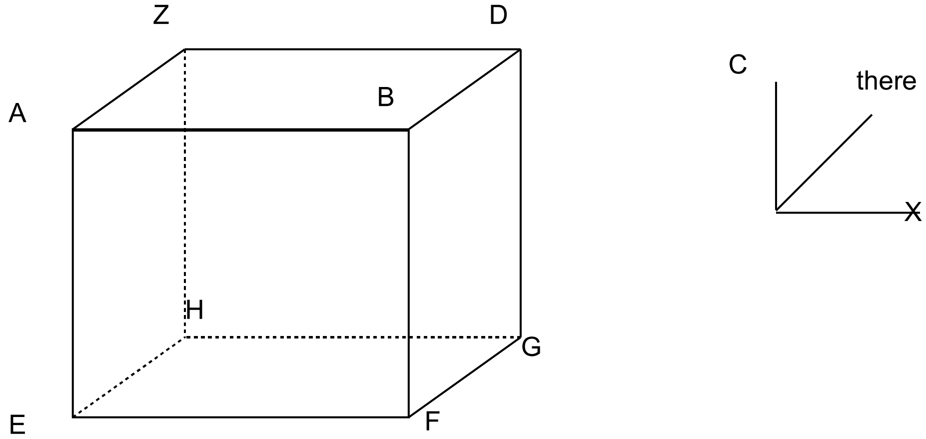
1) P. OF BONNIERES: Integration of the viscoelastic relations in STAT_NON_LINE [R5.03.08] February 2001

3 Modelization A

3.1 Characteristic of the modelization

Elements 3D (HEXA8)

Only one element was modelled to represent cube



Along the axis Z :	1 layer of elements
total Thickness:	1

limiting Conditions:

Node A	$DX=DY=DZ=0.$
Node E	$DX=DY=0.$
Node D	$DX=0.$
Node H	$DX=0.$
pressure on the face $BCFG$	$F=220.\ MPa$

3.2 Characteristics of the mesh

Many nodes: 8
Number of meshes and types: 1 `HEXA8` and 1 `QUAD4` (sides external skin).

3.3 Quantities tested and results

Localization	Quantity	Reference	*Aster*	% difference
A	*V1*	0.00000000	0.00000000	0%
	V2	1.00000000	9.9999999949239 10.-01	-5.08 10 -8%
B	*V1*	0.00000000	0.00000000	0%
	V2	1.00000000	9.9999999949239 10.-01	-5.08 10 -8%
	DX	/	7.8380536694423 10 -2	/
	DY	/	1.2984914071992 10.-16	/
	DZ	/	1.2984914071992 10.-16	/
C	*V1*	0.00000000	0.00000000	0%
	V2	1.00000000	9.9999999949239 10.-01	-5.08 10 -8%
E	*V1*	0.00000000	0.00000000	0%
	V2	1.00000000	9.9999999949239 10.-01	-5.08 10 -8%

4 Summary of the results

the purpose of this case test are completely filled since the activation of creep via the detection of the threshold is very precise (about $10^{-8}\%$ of error). Of course, since it is about viscous phenomenon, the discretization in time plays a very important part in particular in the surrounding of the activation of the threshold. In this case test a very particular care was taken to surround time when the threshold is reached in a precise way to get satisfactory results.