SSNV179 - Cubic under creep via the law LEMA_SEUIL

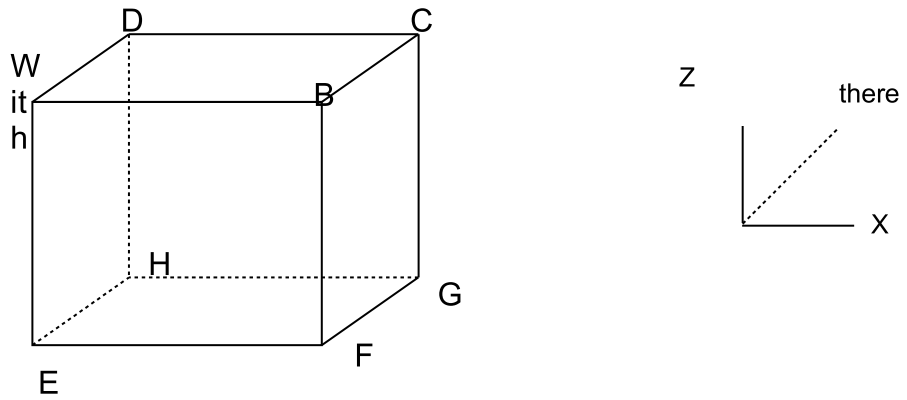
Summary:

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

A modeling 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 Material properties

Elastic properties:

$E=165000\,MPa$

$\nu=0.3$

Viscous properties:

Law 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

Surface force:

$F=220\,MPa$

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

Imposed displacements:

Node A : $DX=DY=DZ=0$.
Node E : $DX=DY=0$.
Node D and node H : $DX=0$.

On the first increment of time the force passes from 0 with its maximum value $220\,MPa$ linearly compared to time for then being maintained constant over all the duration 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 nonregression on displacements with the last step of time are added to check the total rigidity of the system.

For the analytical calculation of the threshold one a:

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

For the first step of time 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 worthless.
For the others not of time, $\sigma_{xx} = 220\,MPa$

However one a:

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

Maybe as in this case $\sigma_{eq} = \sigma_{xx}$, one obtains in an immediate way while 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 deformations are worthless and D 1 is worth.

2.2 Results of reference

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

2.3 Bibliographical references

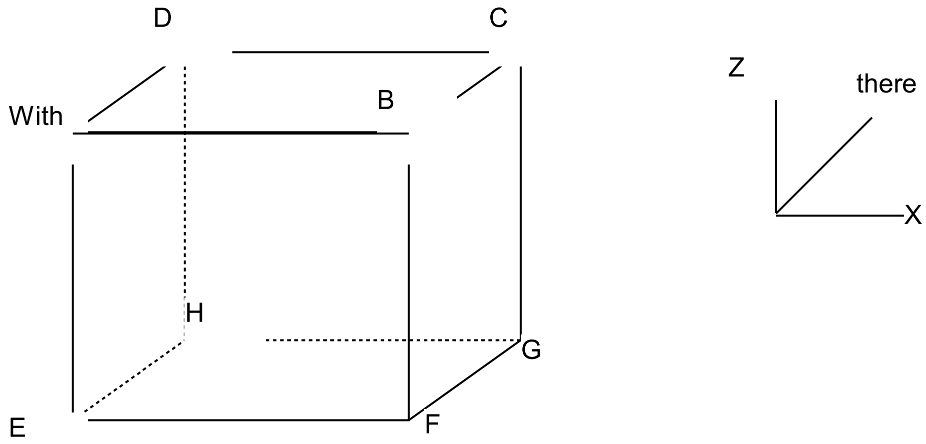
1) P. OF BONNIERES: Integration of the viscoelastic relations in STAT_NON_LINE [R5.03.08] February 2001

3 Modeling A

3.1 Characteristics of modeling

Elements 3D (HEXA8)

Only one element was modelled to represent the 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 grid

Many nodes: 8
Many meshs and types: 1 HEXA8 and 1 QUAD4 (faces external skin).

3.3 Sizes tested and results

Localization	Size	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 objective of this case test is 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.