SZLZ109 - Damage of Lemaitre in postprocessing

Summary:

The purpose of this test is calculation of the damage of LEMAITRE starting from a history of multiaxial loading unspecified and history of the cumulated plastic deformation.

The damage is calculated $D(t)$ starting from the data of the tensor of the constraints $\sigma(t)$ and of the cumulated plastic formation $p(t)$ in every moment t_i (provided by the user). Moreover, the total damage is calculated $D=\sum_{i=1}^{N} D(t_i)$.

The characteristics material E (Young modulus), ν (Poisson's ratio) and S (parameter of material) must depend on the temperature T ($T(t)$ must thus be provided by the user at the same moments as $\sigma(t)$ and $p(t)$).

1 Problem of reference

The damage is calculated $D(t)$ starting from the data of the tensor of the constraints $\sigma(t)$ and of the cumulated plastic deformation $p(t)$.

$$\dot{D}=\frac{1}{(1-D)^2}\left[\frac{1}{3ES}(1+\nu)\sigma_{eq}^2+\frac{3}{2ES}(1-2\nu)\sigma_H^2\right]\dot{p} \quad \text{if } p>p_d$$

$$D=0 \quad \text{if not}$$

σ_{eq} is the equivalent constraint of von Mises
σ_H is the hydrostatic constraint
p_d represent the threshold of damage
S is a characteristic materials (MPa)

The total damage is also calculated $D=\sum_{i=1}^{N} D(t_i)$.

1.1 Material properties

$Temp(°C)$	$E(MPa)$	ν	$S(MPa)$
0.	2.E+5	0.	07/12/09
20.	2.E+5	0.	7.
40.	2.E+5	0.	7.

$p_d=0.02$

1.2 Boundary conditions and loading

History of the loading:

t	43.11	100.	1000.	10000.	20000.	21000.	22000.	22200.	22400.
$\sigma_{xx}(t)$	300.	300.	300.	300.	300.	300.	300.	300.	300.
$\sigma_{yy}(t)$ $\sigma_{zz}(t)$ $\sigma_{xy}(t)$ $\sigma_{xz}(t)$ $\sigma_{yz}(t)$	0.	0.	0.	0.	0.	0.	0.	0.	0.
$Temp$	20.	20.	20.	20.	20.	20.	20.	20.	20.

t	$p(t)$ **(Cumulated Plastic deformation)**
43.11	0.019996
100.	0.046384
1000.	0.46384
10000.	4.6384
20000.	9.2768
21000.	9.74064
22000.	10.20448
22200.	10.297248
22400.	10.390016

2 Reference solution

2.1 Method of calculating used for the reference solution

The history of loading being very simple, the results of reference can be obtained manually by applying the algorithms presented in the reference document [R7.04.01]

2.2 Results of Reference

t	$p(t)$ **(Cumulated Plastic deformation)**
43.11	0.
100.	0.000848907
1000.	0.014474925
10000.	0.178374238
20000.	0.524693005
21000.	0.602827469
22000.	0.73829052
22200.	0.792149807
22400.	0.967604351

The value of the cumulated damage is: 3.819263222

2.3 Uncertainty on the solution

Analytical solution.

2.4 References

[1] Estimate, reference material Code_Aster R7.04.01 of the lifetime in fatigue to great numbers of cycles and in fatigue oligocyclic.

3 Modeling A

3.1 Characteristic of modeling

One calculates the damage of LEMAITRE starting from a history of multiaxial loading unspecified and history of the cumulated plastic deformation (given starting from functions).

3.2 Characteristic of the grid

There is no grid.

3.3 Size tested and results

Identification		Reference
Point 1	Too bad	0.
Point 2	Too bad	0.000848907
Point 3	Too bad	0.014474925
Point 4	Too bad	0.178374238
Point 5	Too bad	0.524693005
Point 6	Too bad	0.602827469
Point 7	Too bad	0.73829052
Point 8	Too bad	0.792149807
Point 9	Too bad	0.967604351

4 Summary of the results

Results provided by *Code_Aster* coincide with the values of reference.