SZLZ109 - Damage of Lemaitre in Summarized

postprocessing:

The purpose of this test is computation of the damage of LEMAITRE from an unspecified load history multiaxial and history of the cumulated plastic strain.

One calculates the damage $D(t)$ from the data of the tensor of the stresses $\sigma(t)$ and the plastic training cumulated $p(t)$ in all times 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 the material) must depend on the temperature T ($T(t)$ must thus be provided by the user at same times as $\sigma(t)$ and $p(t)$).

1 Problem of reference

One calculates the damage $D(t)$ from the data of the tensor of the stresses $\sigma(t)$ and the cumulated plastic strain $p(t)$.

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

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

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

One also calculates the total damage $D=\sum_{i=1}^{N} D(t_i)$.

1.1 Material properties

$Temp(°C)$	$E(MPa)$	ν	$S(MPa)$
0.	2.E+5	0.	12/07/09
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.
$\sigma_{yy}(t)$	0.	0.	0.	0.	0.	0.	0.	0.	0.
$\sigma_{zz}(t)$									
$\sigma_{xy}(t)$									
$\sigma_{xz}(t)$									
$\sigma_{yz}(t)$									
$Temp$	20.	20.	20.	20.	20.	20.	20.	20.	20.

t	$p(t)$ **(Cumulated Plastic strain)**
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 load history 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 strain)**
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.	the 0.967604351

value of the cumulated damage is: 3.819263222

2.3 Uncertainty on the analytical

solution Solution.

2.4 References

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

3 Modelization A

3.1 Characteristic of the modelization

One calculates the damage of LEMAITRE from an unspecified load history multiaxial and history of the cumulated plastic strain (given from functions).

3.2 Characteristic of the mesh

It does not have there mesh.

3.3 Quantity tested and results

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

4 Summary of the results

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