SZLZ100 - Tiredness on an eccentric cycle

Summary:

The purpose of this test is calculation of the damage starting from a history of loading in constraints, then of a history of loading in deformations.

Starting from a simple history of loading defined by DEFI_FONCTION, one extracts the elementary cycles by the method of counting of cycles of the RCCM [R7.04.01], then one calculates the elementary damage associated with each cycle, by interpolation on the curve of Wöhler of material (if history of loading in constraints and by interpolation on the curve of Manson-Whetstone sheath of material) (if history of loading in deformations).

The curve of Wöhler is defined by DEFI_FONCTION. The interpolation is of standard logarithmic curve on the number of cycles to the rupture N and on the alternate constraint $Salt$.

The curve of Manson-Whetstone sheath is also defined by DEFI_FONCTION.

To finish, one determines the total damage undergone by the part by cumulating all the elementary damage by the linear rule To mine.

In this test, one also checks the taking into account of the value of the average constraint on the calculation of the elementary damage by the method of Wöhler. The first calculation is carried out without correction, a second with a correction To stack and the third with a correction of Goodman.

On this simple example, the extraction of the elementary cycles and the calculation of the damage can be made manually, by applying the algorithms presented in the reference document [R7.04.01].

Results provided by the operator POST_FATIGUE are of this fact very satisfactory.

1 Problem of reference

1.1 Geometry

The analysis consists in determining the damage undergone by a part in a point to which one provides the history of loading.

To test the calculation of the damage by the method of Wöhler, one considers the history of loading in constraints and one extracts the elementary cycles by a method of counting of cycles, which is in this test the method of the RCCM. Then one calculates the elementary damage due to each elementary cycle, by interpolation on the curve of Wöhler of material.

The curve of Wöhler is founie in the form of a function point by point, which gives the value amongst cycles to the rupture according to the alternate constraint $Salt=\frac{\Delta\sigma}{2}$.

The interpolation is of standard logarithmic curve on the X-coordinate and the ordinate and one authorizes to prolong linearly this function on the right and on the left.

Three different calls to the operator `POST_FATIGUE` allow to take account or not of the average constraint of each elementary cycle.

The adopted correction is that of the diagram of Haigh, either according to the line of Goodman or according to the parabola To stack [R7.04.01].

One determines the total damage by the linear rule of office plurality To mine.

To test the calculation of the damage by the method of Manson-Whetstone sheath, one considers the history of loading in deformations and one extracts the elementary cycles by a method of counting of cycles, which is in this test the method of the RCCM. Then one calculates the elementary damage due to each elementary cycle, by interpolation on the curve of Manson-Whetstone sheath of material.

The curve of Manson-Whetstone sheath is provided in the form of a function point by point, which gives the value amongst cycles to the rupture according to $\frac{\Delta\varepsilon}{2}$.

One determines the total damage by the linear rule of office plurality To mine.

1.2 Material properties

The curve of Wöhler of the material, which gives the value amongst cycles to the rupture according to the alternate constraint is point by point defined by:

$Salt$	138.	152.	165.	180.	200.	250.	295.	305.
N	1000000.	500000.	200000.	100000.	50000.	20000.	12000.	10000.

340.	430.	540.	690.	930.	1210.	1590.	2210.	2900.
5000.	2000.	1000.	500.	200.	100.	50.	20.	10.

Su = limit with the rupture of material = 850.

History of the loading

t	0.	1.	2.	3.	4.
$\sigma(t)$	50.	600.	50.	– 500.	50.

The curve of Manson-Whetstone sheath of the material, which gives the value amongst cycles to the rupture according to $\frac{\Delta\varepsilon}{2}$ is point by point defined by:

$\frac{\Delta\varepsilon}{2}$	138.	152.	165.	180.	200.	250.	295.	305.
N	1000000.	500000.	200000.	100000.	50000.	20000.	12000.	10000.

340.	430.	540.	690.	930.	1210.	1590.	2210.	2900.
5000.	2000.	1000.	500.	200.	100.	50.	20.	10.

History of the loading

t	0.	1.	2.	3.	4.
$\varepsilon(t)$	50.	600.	50.	– 500.	50.

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

The counting of the elementary cycles by method RCCM leads to:

Nb_Cycl = 2	Cycle 1	Vale_Min:	-500.	Vale_Max:	600.
	Cycle 2	Vale_Min:	50.	Vale_Max:	50.

- **First call** with `POST_FATIGUE` :

  calculation of the elementary damage by the method of Wöhler without correction of HAIGH:

Cycle 1	Too bad:	1.053257E-3
Cycle 2	Too bad:	0.

  calculation of the total damage by linear office plurality To mine:

  Too bad: 1.053257E-3

- **Second call** with `POST_FATIGUE` :

  calculation of the elementary damage by the method of Manson-Whetstone sheath:

Cycle 1	Too bad:	1.053257E-3
Cycle 2	Too bad:	0.

  calculation of the total damage by linear office plurality To mine:

  Too bad: 1.053257E-3

- **Third call** with `POST_FATIGUE` :

  calculation of the elementary damage by the method of Wöhler with correction To stack:

Cycle 1	Too bad:	1.063631E-3
Cycle 2	Too bad:	0.

  calculation of the total damage by linear office plurality To mine:

  Too bad: 1.063631E-3

- **Fourth call** with `POST_FATIGUE` :

  calculation of the elementary damage by the method of Wöhler with correction of Goodman:

Cycle 1	Too bad:	1.250219E-3
Cycle 2	Too bad:	0.

  calculation of the total damage by linear office plurality To mine:

  Too bad: 1.250219E-3

2.3 Uncertainty on the solution

Analytical solution.

2.4 Bibliographical references

1.Estimate of tiredness to great numbers of cycles. Document [R7.04.01].

3 Modeling A

3.1 Sizes tested and results

Identification		Reference
NB_CYCL		2.
Cycle 1	VALE_MIN	– 500.
	VALE_MAX	600.
Cycle 2	VALE_MIN	50.
	VALE_MAX	50.
First call to POST_FATIGUE :		
Calculation of the damage: Wöhler without correction		
Cycle 1	TOO BAD	1.053257E-3
Cycle 2	TOO BAD	0.
DOMM_CUMU		1.053257E-3
Second call to POST_FATIGUE :		
Calculation of the damage: Manson-whetstone sheath		
Cycle 1	TOO BAD	1.053257E-3
Cycle 2	TOO BAD	0.
DOMM_CUMU		1.053257E-3
Third call to POST_FATIGUE :		
Calculation of the damage: Wöhler correction To stack		
Cycle 1	TOO BAD	1.063631E-3
Cycle 2	TOO BAD	0.
DOMM_CUMU		1.063631E-3
Fourth call to POST_FATIGUE :		
Calculation of the damage: Wöhler Goodman correction		
Cycle 1	TOO BAD	1.250219E-3
Cycle 2	TOO BAD	0.
DOMM_CUMU		1.250219E-3

4 Summary of the results

This test is very simple and makes it possible to determine the values of reference manually, by applying the algorithms described in the reference document [R7.04.01].

So results of *Code_Aster* coincide perfectly with the values of reference.