SZLZ108 - Damage by the methods of TAHERI (TAHERI_MANSON and TAHERI_MIXTE)

Summary:

There are two modelings:

- The purpose of modeling a: This test is calculation of the damage starting from a history of purely uniaxial loading in deformations by the methods TAHERI_MANSON or TAHERI_MIXTE.
- The purpose of modeling b: This test is calculation of the damage starting from a constant history of loading by the three methods of counting RAIN_FLOW, NATURALNESS and RCCM.

The methods of Taheri apply only to loadings in deformations and do not allow contrary to the method of Manson-Whetstone sheath to take account about appearance of the cycles of constraints.

1 Problem of reference

1.1 Modeling A

The analysis consists in determining the damage undergone by a structure subjected to a history of loading in deformations. One uses the method of Rainflow to determine the number of elementary cycles and it half amplitude of each cycle.

For the loadings considered, the method of Rainflow determines 5 cycles of half amplitude:
$\frac{\Delta \varepsilon_1}{2}=0.25$, $\frac{\Delta \varepsilon_2}{2}=0.25$, $\frac{\Delta \varepsilon_3}{2}=0.75$, $\frac{\Delta \varepsilon_4}{2}=0.25$ and $\frac{\Delta \varepsilon_5}{2}=1.75$.

Then one calculates the damage undergone by the structure by the method of TAHERI_MANSON and method of TAHERI_MIXTE.

As long as the amplitude of deformations of the various cycles applied to the structure remains increasing $\frac{\Delta \varepsilon_1}{2} \leq \frac{\Delta \varepsilon_2}{2} \leq \ldots \leq \frac{\Delta \varepsilon_n}{2}$, methods of TAHERI_MANSON and TAHERI_MIXTE are identical to the method of MANSON_COFFIN (calculation amongst cycles with the rupture, N_{rupt} , by interpolation on the curve of Manson-Whetstone sheath and calculation of the damage by $1/N_{rupt}$).

On the other hand if a cycle i present a half amplitude $\frac{\Delta \varepsilon_i}{2}$ lower than $\frac{\Delta \varepsilon_{i-1}}{2}$, the methods of Taheri differ from the method of Manson-Whetstone sheath.

- Method of TAHERI_MANSON consist in determining an amplitude of constraint $\frac{\Delta \sigma_i}{2}$ from $\frac{\Delta \varepsilon_i}{2}$ and ε_{max} (maximum value of the half amplitude of deformation met before the cycle i).

  With this intention, the user must provide a tablecloth $\frac{\Delta \sigma}{2}\left(\frac{\Delta \varepsilon}{2}, \varepsilon_{max}\right)$ under the operand TAHERI_NAPPE.

  From $\frac{\Delta \sigma_i}{2}$, one determines a half amplitude of deformations $\frac{\Delta \varepsilon_i^*}{2}$ using a function introduced under the operand TAHERI_FONC. The value of the elementary damage of the cycle i , is determined by interpolation of $\frac{\Delta \varepsilon_i^*}{2}$ on the curve of Manson_Coffin.

- For the method 'TAHERI_MIXTE', one proceeds in the same way for the determination of the half amplitude of constraint $\frac{\Delta \sigma_i}{2}$, then one determines the value of the elementary damage of the cycle i by interpolation of $\frac{\Delta \sigma_i}{2}$ on the curve of Wöhler.

  This method thus requires the data of the curves of Wöhler and Manson_Coffin.

One determines the total damage by linear office plurality of the elementary damage.

1.1.1 Material properties

For the calculation of the damage of TAHERI_MANSON, one needs the curve of Manson_Coffin, a tablecloth allowing to calculate $\frac{\Delta\sigma}{2}$ from ($\frac{\Delta\varepsilon}{2}$ and ε_{max}) and of a function allowing to calculate $\frac{\Delta\varepsilon^*}{2}$ from $\frac{\Delta\sigma}{2}$. The tablecloth (cyclic curve of work hardening with pre-work hardening) is introduced under the operand TAHERI_NAPPE and the function (cyclic curve of work hardening) under the operand TAHERI_FONC. The curve of Manson_Coffin as for it is introduced into DEFI_MATERIAU.

For the calculation of the damage of TAHERI_MIXTE, one needs the curve of Manson_Coffin, the curve of Wöhler and a tablecloth (cyclic curve of work hardening with pre-work hardening) allowing to calculate $\frac{\Delta\sigma}{2}$ from ($\frac{\Delta\varepsilon}{2}$ and ε_{max}). The tablecloth is introduced under the operand TAHERI_NAPPE. The curve of Manson_Coffin and the curve of Wöhler are introduced into DEFI_MATERIAU.

1.1.2 History of the loading

t	0.	1.	2.	3.	4.	5.	6.
$\varepsilon(t)$	0.	3.5	3.	3.5	3.	3.5	1.

7.	8.	9.
2.5	0.	0.5

1.2 Modeling B

The analysis consists with a special case where the history of loading is constant (for example, average loading applied). Code_Aster will count the whole history of loading like one cycle of worthless amplitude for the methods of counting RAIN_FLOW, NATURALNESS and RCCM.

1.2.1 Material properties

Identical to those of modeling A.

1.2.2 History of the loading

t	0.	1.	2.	3.
$\varepsilon(t)$	1	1	1	1

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 Uncertainty on the solution

Analytical solution.

3 Modeling A

3.1 Sizes tested and results

Identification		Reference
Method ' TAHERI_MANSON ' (counting RAINFLOW)		
Cycle 1	TOO BAD	5.7142857E-6
Cycle 2	TOO BAD	5.7142857E-6
Cycle 3	TOO BAD	8.E-6
Cycle 4	TOO BAD	6.6666667E-6
Cycle 5	TOO BAD	4.E-5
calculation of the total damage by linear office plurality To mine		6.6095E-5
Method ' TAHERI_MIXTE ' (counting NATURALNESS)		
Cycle 1	TOO BAD	5.7142857E-6
Cycle 2	TOO BAD	5.7142857E-6
Cycle 3	TOO BAD	8.E-6
Cycle 4	TOO BAD	6.6666667E-6
Cycle 5	TOO BAD	4.E-5
calculation of the total damage by linear office plurality To mine		6.6095E-5
Method 'TAHERI_MANSON ' (counting RAINFLOW_MAX)		
Cycle 1	TOO BAD	4.E-05
Cycle 2	TOO BAD	1.E-5
Cycle 3	TOO BAD	1.E-5
Cycle 4	TOO BAD	1.33333E-05
Cycle 5	TOO BAD	1.E-5
calculation of the total damage by linear office plurality To mine		8.33333E-5

4 Modeling B

4.1 Sizes tested and results

For all the three methods of counting (RAIN_FLOW, NATURALNESS and RCCM), the amplitude is zero. The number of cycle to the rupture is 200000 and the damage is 5.0E-6 .

Identification	Value of reference
TOO BAD	
COMPTAGE/DOMMAGE	
RAINFLOW/TAHERI_MANSON	5.0E-6
RAINFLOW/TAHERI_MIXTE	5.0E-6
NATUREL/TAHERI_MANSON	5.0E-6
NATUREL/TAHERI_MIXTE	5.0E-6
RCCM/WOHLER	5.0E-6

5 Summary of the results

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