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

Summarized:

There are two modelizations:

- The purpose of modelization a: This test is computation of the damage from a load history purely uniaxial in strains by methods TAHERI_MANSON or TAHERI_MIXTE.
- The purpose of modelization b: This test is computation of the damage from a constant load history by the three methods of counting RAIN_FLOW, NATUREL and RCCM.

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

1 Problem of reference

1.1 Modelization To

the analysis consists in determining the damage undergone by a structure subjected to a load history in strains. 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 structure by the method of TAHERI_MANSON and the method of TAHERI_MIXTE.

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

On the other hand if a cycle i presents 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.

- The method of TAHERI_MANSON consists in determining an amplitude of stress $\frac{\Delta\sigma_i}{2}$ from $\frac{\Delta\varepsilon_i}{2}$ and ε_{max} (maximum value of the half amplitude of strain met before the cycle i).

  For this making, the user must provide a three-dimensions function $\frac{\Delta\sigma}{2}\left(\frac{\Delta\varepsilon}{2},\varepsilon_{max}\right)$ under operand TAHERI_NAPPE.

  From $\frac{\Delta\sigma_i}{2}$, one determines a half amplitude of strains $\frac{\Delta\varepsilon_i^*}{2}$ using a function introduced under 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 method "TAHERI_MIXTE", one proceeds in the same way for the determination of the half amplitude of stress $\frac{\Delta\sigma_i}{2}$, 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 damages.

1.1.1 Material properties

For the computation of the damage of TAHERI_MANSON, one needs the curve of Manson_Coffin, a three-dimensions function 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 three-dimensions function (cyclic curve of hardening with pre-hardening) is introduced under the operand TAHERI_NAPPE and the function (cyclic curve of hardening) under operand TAHERI_FONC. The curve of Manson_Coffin as for it is introduced into DEFI_MATERIAU.

For the computation of the damage of TAHERI_MIXTE, one needs the curve of Manson_Coffin, the curve of Wöhler and a three-dimensions function (cyclic curve of hardening with pre-hardening) allowing to calculate $\frac{\Delta\sigma}{2}$ from ($\frac{\Delta\varepsilon}{2}$ and ε_{max}). The three-dimensions function is introduced under 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 Modelization B

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

1.2.1 Material properties

Identical to those of modelization A.

1.2.2 Histoire 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 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 Uncertainty on the analytical

solution Solution.

3 Modelization A

3.1 Quantities tested and results

Identification		Reference
Method " TAHERI_MANSON " (counting **RAINFLOW**)		
Cycle 1	DOMMAGE	5.7142857E-6
Cycles 2	DOMMAGE	5.7142857E-6
Cycles 3	DOMMAGE	8.E-6
Cycles 4	DOMMAGE	6.6666667E-6
Cycles 5	DOMMAGE	4.E-5
computation of the total damage by linear office plurality To undermine		6.6095E-5
Method " TAHERI_MIXTE " (counting **NATUREL**)		
Cycle 1	DOMMAGE	5.7142857E-6
Cycles 2	DOMMAGE	5.7142857E-6
Cycles 3	DOMMAGE	8.E-6
Cycles 4	DOMMAGE	6.6666667E-6
Cycles 5	DOMMAGE	4.E-5
computation of the total damage by linear office plurality To undermine		6.6095E-5
Method "TAHERI_MANSON " (counting **RAINFLOW_ MAX**)		
Cycle 1	DOMMAGE	4.E-05
Cycles 2	DOMMAGE	1.E-5
Cycles 3	DOMMAGE	1.E-5
Cycles 4	DOMMAGE	1.33333E-05
Cycles 5	DOMMAGE	1.E-5
computation of the total damage by linear office plurality To undermine		8.33333E-5

4 Modelization B

4.1 Quantities tested and results

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

Identification	Value of reference
DOMMAGE	
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

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