SZLZ107 - Criteria of starting in fatigue under multiaxial loadings for a localization criticizes structure

Summary:

The purpose of this test is the multiaxial calculation of the criteria of tiredness for the periodic loadings and not-periodicals while using **POST_FATIGUE** for a localization structure criticizes. The objective of this CAS-test is to find same the computation results got by CALC_FATIGUE.

modeling A	criteria CROSSLAND, DANG VAN-PAPADOPOULOS and in formula
modeling B	criteria in formulas (to find the results of CAS-test SSLV135D), 'MATAKE_MODI_AC', DANG_VAN_MODI_AC (to find the results of CAS-tests SSLV135With) ;
modeling C	criteria in formulas (to find the results of CAS-test SSLV135E) ;
modeling D	criteria in formulas (to find the results of CAS-test SSLV135F);
modeling E	criteria in formulas, 'MATAKE_MODI_AV', DANG_VAN_MODI_AV, FATESOCI_MODI_AV (to find the results of CAS-tests SSLV135B)
modeling F	criteria MATAKE_MODI_AC , DANG_VAN_MODI_AC, MATAKE_MODI_AV, DANG_VAN_MODI_AV, FATESOCI_MODI_AV. One tests the change of the direction of the critical plan on which the damage or shearing is maximum
modeling G	criteria in formulas of the standard plan criticizes with keyword FORMULE_CRITIQUE (to find the results of CAS-tests SSLV135H and SSLV135A);

Results provided by the operator POST_FATIGUE are completely satisfactory.

1 Problem of reference

1.1 Modeling A

The analysis consists in determining the criterion of CROSSLAND and the criterion of DANG VAN - PAPADOPOULOS in a point of a structure subjected to a radial periodic multiaxial loading.

Criterion of CROSSLAND:

$$\tau_a + a\,P_{max} - b \le 0$$ where:

$$\tau_a = \frac{1}{2} \underset{0\le t_0\le T}{Max}\ \underset{0\le t_1\le T}{Max} \left\| \tilde{s}(t_1) - \tilde{s}(t_0) \right\| = \frac{1}{2} \underset{0\le t_0\le T}{Max}\ \underset{0\le t_1\le T}{Max} \sqrt{\frac{1}{2}\left(\tilde{s}_{11}^2 + \tilde{s}_{22}^2 + \tilde{s}_{33}^2 + 2\tilde{s}_{12}^2 + 2\tilde{s}_{13}^2 + 2\tilde{s}_{23}^2\right)}$$

amplitude de scission avec $\tilde{s}$ déviateur du tenseur des contraintes σ

$$P_{max} = \underset{0\le t\le T}{Max}\left(\frac{1}{3} trace(\sigma)\right) =$$ maximum hydrostatic pressure

$$a = \left(\tau_0 - \frac{d_0}{\sqrt{3}}\right) / \frac{d_0}{3}$$ and $b = \tau_0$

with τ_0 = limit of endurance in alternate pure shearing
d_0 = limit of endurance in alternate pure traction and compression

The criterion is: $Rcrit = \tau_a + a\,P_{max} - b$

If $Rcrit$ is negative or null, there is no damage. If $Rcrit$ is positive, it is likely to have damage there.

Criterion of DANG VAN-PAPADOPOULOS:

$$K^* + a\,P_{max} - b \le 0$$

where $K^* = R/\sqrt{2}$ where R ray of the smallest sphere circumscribed with the way of loading within the space of diverters of constraints $\tilde{s}$.

$$R = \underset{0\le t\le T}{Max} \sqrt{(\tilde{s}(t) - C^*) : (\tilde{s}(t) - C^*)}$$ where C^* is the center of the hypersphère

$$C^* = \underset{C\in K}{Min}\ \underset{0\le t\le T}{Max} \sqrt{(\tilde{s}(t) - C) : (\tilde{s}(t) - C)}$$

$$P_{max} = \underset{0\le t\le T}{Max}\left(\frac{1}{3} trace(\sigma)\right) =$$ maximum hydrostatic pressure

$$a = \left(\tau_0 - \frac{d_0}{\sqrt{3}}\right) / \left(\frac{d_0}{3}\right)$$ and $b = \tau_0$

with τ_0 = limit of endurance in alternate pure shearing
d_0 = limit of endurance in alternate pure traction and compression

The criterion is: $R_{crit} = K^* + a\,P_{max} - b$

If $Rcrit$ is negative or null, there is no damage. If $Rcrit$ is positive, it is likely to have damage there.

1.1.1 Material properties

τ_0 = limit of endurance in alternate pure shearing = $352.\ MPa$
d_0 = limit of endurance in alternate pure traction and compression = $540.97\ MPa$

1.1.2 History of the loading

t	1.	2.	3.
$\sigma_{xx}(t)$	411.	0.	– 411.
$\sigma_{xy}(t)$	205.	0.	– 205.
$\sigma_{yy}(t)=\sigma_{zz}(t)=\sigma_{xz}(t)=\sigma_{yz}(t)$	0.	0.	0.

The loading is considered periodic.

1.2 Modeling B

The material properties and the history of loading identical and are obtained starting from CAS-tests SSLV135A.

1.3 Modeling C

The material properties and the history of loading identical and are obtained starting from CAS-test SSLV135E .

1.4 Modeling D

The material properties and the history of loading identical and are obtained starting from CAS-test SSLV135F .

1.5 Modeling E

Properties of materials and the history of loading identical and are obtained starting from CAS-test SSLV135B .

1.6 Modeling F

Properties of materials and the history of loading identical and are obtained starting from the cases test SSLV135G

1.7 Modeling G

Properties of materials and the history of loading identical and are obtained starting from the cases test SSLV135H and SSLV135With

2 Reference solution

2.1 Modeling A

2.1.1 Method of calculating used for the reference solution

The results of reference result from the thesis of I. PAPADOPOULOS [bib1]. For the criterion of CROSSLAND, one can also obtain them manually.

The loading being radial the two criteria must provide the same results.

2.1.2 Results of Reference

For **criterion of CROSSLAND**, the value of the amplitude of scission, the value of the maximum hydrostatic pressure and the value of the criterion are tested:

$$\tau_a = 313.579\,Mpa \quad P_{max} = 137.\,Mpa \quad Rcrit = -8.281$$

For **criterion of DANG VAN-PAPADOPOULOS**, the value of the ray of the smallest sphere circumscribed with the loading, the value of the maximum hydrostatic pressure and the value of the criterion are tested:

$$K^* = 313.579\,Mpa \quad P_{max} = 137.\,Mpa \quad Rcrit = -8.281$$

2.2 Modelings B, C, D, E, F and G

One bases oneself on the modelings calculated by `CALC_FATIGUE` in CAS-test SSLV135. See [V3.04.135] for the reference solutions.

2.3 Uncertainty on the solution

Solutions analytical or obtained from `CALC_FATIGUE`.

2.4 Bibliographical references

1. Thesis of I. PAPADOPOULOS “Tires polycyclic metals: a new approach” (1987) ENPC.

3 Modeling A

3.1 Characteristics of modeling

The criteria are tested CROSSLAND , DANG VAN-PAPADOPOULOS and in formula.

3.2 Characteristics of the grid

The grid is not necessary.

3.3 Sizes tested and results

For criteria called by the names:

Identification	Type of reference	Value of reference
Criterion of CROSSLAND		
PRES_HYDRO_MAX ($Pmax$)	' SOURCE_EXTERNE '	137.
AMPLI_CISSION (τ_a)	' SOURCE_EXTERNE '	313,579
Criterion ($Rcrit$)	' SOURCE_EXTERNE '	– 8,281
Criterion of DANG VAN-PAPADOPOULOS		
PRES_HYDRO_MAX ($Pmax$)	' SOURCE_EXTERNE '	137.
RAYON_SPHERE ($k*$)	' SOURCE_EXTERNE '	313,579
Criterion ($Rcrit$)	' SOURCE_EXTERNE '	– 8,281

For criteria called by the formula:

Identification	Type of reference	Value of reference
Criterion of CROSSLAND		
PHYDRM ($Pmax$)	' SOURCE_EXTERNE '	137.
AMPCIS (τ_a)	' SOURCE_EXTERNE '	313,579
Criterion ($Rcrit$)	' SOURCE_EXTERNE '	– 8,281
Criterion of DANG VAN-PAPADOPOULOS		
PHYDRM ($Pmax$)	' SOURCE_EXTERNE '	137.
RAYSPH ($k*$)	' SOURCE_EXTERNE '	313,579
Criterion ($Rcrit$)	' SOURCE_EXTERNE '	– 8,281

4 Modeling B

4.1 Characteristics of modeling

One tests the criteria in formulas (to find the results of CAS-test SSLV135D), `'MATAKE_MODI_AC'` `DANG_VAN_MODI_AC` (to find the results of CAS-tests SSLV135With) ;

4.2 Characteristics of the grid

The grid is not necessary.

4.3 Sizes tested and results

For the sizes of SSLV135D:

Identification	Type of reference	Value of reference
'DEPSPE'	'ANALYTICAL'	7.5E-4
'EPSPR1'	'ANALYTICAL'	7.625E-4
'SIGNM1'	'ANALYTICAL'	200
'APHYDR'	'ANALYTICAL'	66.6666
'DENDIS'	'ANALYTICAL'	0.45
'DENDIE'	'ANALYTICAL'	0.173333
'DSIGEQ'	'ANALYTICAL'	200
'EPSNM1'	'ANALYTICAL'	1.75E-3
'INVA2S'	'ANALYTICAL'	1.616666E-3
'DSITRE'	'ANALYTICAL'	50
'DEPTRE'	'ANALYTICAL'	6.0625E-4
'DEPTRE'	'ANALYTICAL'	3.67423E-3
'DEPSEE'	'ANALYTICAL'	0.00086666666

For the criteria `'MATAKE_MODI_AC'` and the criterion in formula associated (SSLV135A) with the option `COURBE_GRD_VIE = 'WOHLER'` and for the option `COURBE_GRD_VIE = 'FORMES_VIE'` and `FORMULE_VIE = WHOL`:

Identification	Type of reference	Value of reference
$\Delta\tau(n_1)$	'ANALYTICAL'	1 . 500000E+02
component x of n_1	'ANALYTICAL'	– 7.071068E-01
component y of n_1	'ANALYTICAL'	7.071068E-01
component z of n_1	'ANALYTICAL'	0.0
$N_{\max}(n_1)$	'ANALYTICAL'	5.000000E+01
$N_m(n_1)$	'ANALYTICAL'	0.0

$\varepsilon_{max}(n_1)$	'ANALYTICAL'	1.750000E-04
$\varepsilon_m(n_1)$	'ANALYTICAL'	0.0
$\sigma_{eq}(n_1)$	'ANALYTICAL'	3.000000E+02
$Nb_{cr}(n_1)$	'ANALYTICAL'	1.094600E+04
$ENDO(n_1)$	'ANALYTICAL'	9.135647E-05
$\Delta\tau(n_2)$	'ANALYTICAL'	1 . 500000E+02
component x of n_2	'ANALYTICAL'	7.071068E-01
component y of n_2	'ANALYTICAL'	7.071068E-01
component z of n_2	'ANALYTICAL'	0.0
$N_{max}(n_2)$	'ANALYTICAL'	5.000000E+01
$N_m(n_2)$	'ANALYTICAL'	0.0
$\varepsilon_{max}(n_2)$	'ANALYTICAL'	1.750000E-04
$\varepsilon_m(n_2)$	'ANALYTICAL'	0.0
$\sigma_{eq}(n_2)$	'ANALYTICAL'	3.000000E+02
$Nb_{cr}(n_2)$	'ANALYTICAL'	1.094600E+04
$ENDO(n_2)$	'ANALYTICAL'	9.135647E-05

For the criteria 'DANG_VAN_MODI_AC' and the associated criterion in formula (SSLV135With) with the option COURBE_GRD_VIE = 'WOHLER' and for the option COURBE_GRD_VIE = 'FORMES_VIE' and FORMULE_VIE = 'WHOL' :

Identification	Type of reference	Value of reference
$\Delta\tau(n_1)$	'ANALYTICAL'	1 . 500000E+02
component x of n_1	'ANALYTICAL'	7.071068E-01
component y of n_1	'ANALYTICAL'	7.071068E-01
component z of n_1	'ANALYTICAL'	0.0
$N_{max}(n_1)$	'ANALYTICAL'	5.000000E+01
$N_m(n_1)$	'ANALYTICAL'	0.0
$\varepsilon_{max}(n_1)$	'ANALYTICAL'	1.750000E-04
$\varepsilon_m(n_1)$	'ANALYTICAL'	0.0
$\sigma_{eq}(n_1)$	'ANALYTICAL'	2.750000E+02

$Nb_{cr}(n_1)$	'ANALYTICAL'	1.490300E+04
$ENDO(n_1)$	'ANALYTICAL'	6.709959E-05
$\Delta\tau(n_2)$	'ANALYTICAL'	1 . 500000E+02
component x of n_2	'ANALYTICAL'	– 7.071068E-01
component y of n_2	'ANALYTICAL'	7.071068E-01
component z of n_2	'ANALYTICAL'	0.0
$N_{max}(n_2)$	'ANALYTICAL'	5.000000E+01
$N_m(n_2)$	'ANALYTICAL'	0.0
$\varepsilon_{max}(n_2)$	'ANALYTICAL'	1.750000E-04
$\varepsilon_m(n_2)$	'ANALYTICAL'	0.0
$\sigma_{eq}(n_2)$	'ANALYTICAL'	2.750000E+02
$Nb_{cr}(n_2)$	'ANALYTICAL'	1.490300E+04
$ENDO(n_2)$	'ANALYTICAL'	6.709959E-05

5 Modeling C

5.1 Characteristics of modeling

They are tested criteria in formulas (to find the results of CAS-test SSLV135E)

5.2 Characteristics of the grid

The grid is not necessary.

5.3 Sizes tested and results

The value of reference corresponds to the endommagemenT (ENDO1) and the results were got via **formula of Basquin** :

Identification	Type of reference	Value of reference
Criteria		
$\frac{\|SIPR1-SIPR2\|}{2}$	'ANALYTICAL'	1.0707149E-03
$\frac{\|SITN1-SITN2\|}{2}$	'ANALYTICAL'	1.0707149E-03
$\frac{SIPN1-SIPN2}{2}$	'ANALYTICAL'	1.0707149E-03
$\frac{SIGEQ1-SIGEQ2}{2}$	'ANALYTICAL'	4.287285E-03

The value of reference always corresponds to the damage (ENDO1) and the results were got with one **interpolation** curve of Wöhler :

Identification	Type of reference	Value of reference
Criteria		
$\frac{\|SIPR1-SIPR2\|}{2}$	'ANALYTICAL'	1.9212572E-03
$\frac{\|SITN1-SITN2\|}{2}$	'ANALYTICAL'	1.9212572E-03
$\frac{SIPN1-SIPN2}{2}$	'ANALYTICAL'	1.9212572E-03
$\frac{SIGEQ1-SIGEQ2}{2}$	'ANALYTICAL'	5.8175699E-03

6 Modeling D

6.1 Characteristics of modeling

They are tested criteria in formulas (to find the results of CAS-test sslv135F)

6.2 Characteristics of the grid

The grid is not necessary.

6.3 Sizes tested and results

Result got with the first loading (**SOL_NL** SSLV135F):
The value of reference corresponds to the damage (ENDO1) and the results were got via **formula of Basquin** :

Identification	Type of reference	Value of reference
Criteria		
$\frac{\lvert EPSN1-EPSN2\rvert}{2}$	'ANALYTICAL'	1.08363973E-05
$\frac{\lvert ETPR1-ETPR2\rvert}{2}$	'ANALYTICAL'	1.0 8363973 E-0 5
$\frac{\lvert ETEQ1-ETEQ2\rvert}{2}$	'ANALYTICAL'	1.06338423E-05

The value of reference always corresponds to the damage (ENDO1) and the results were got with one **interpolation** curve of Wöhler :

Identification	Type of reference	Value of reference
Criteria		
$\frac{\lvert EPSN1-EPSN2\rvert}{2}$	'ANALYTICAL'	3.26558686E-05
$\frac{\lvert ETPR1-ETPR2\rvert}{2}$	'ANALYTICAL'	3.26558686E-05
$\frac{\lvert ETEQ1-ETEQ2\rvert}{2}$	'ANALYTICAL'	3.21404432E-05

Result got with the second loading (**SOL_NL2** SSLV135F):
The value of reference corresponds to the damage (ENDO1) and the results were got via **formula of Basquin** :

Identification	Type of reference	Value of reference
Criteria		
$\frac{\lvert EPSN1-EPSN2\rvert}{2}$	'ANALYTICAL'	1.449229E-04

$\frac{\lvert ETPR1-ETPR2\rvert}{2}$	'ANALYTICAL'	1. 449229 E-0 4
$\frac{\lvert ETEQ1-ETEQ2\rvert}{2}$	'ANALYTICAL'	6.5320499E-05

The value of reference always corresponds to the damage (ENDO1) and the results were got with one **interpolation** curve of Wöhler :

Identification	Type of reference	Value of reference
Criteria		
$\frac{\lvert EPSN1-EPSN2\rvert}{2}$	'ANALYTICAL'	2.408735E-04
$\frac{\lvert ETPR1-ETPR2\rvert}{2}$	'ANALYTICAL'	2.408735 E-0 4

Result got with the third loading (**SOL_NL3** SSLV135F):
The value of reference corresponds to the damage (ENDO1) and the results were got via **formula of Basquin** :

Identification	Type of reference	Value of reference
Criteria		
$\frac{\lvert EPPR1-EPPR2\rvert}{2}$	'ANALYTICAL'	1.377855E-02

The value of reference always corresponds to the damage (ENDO1) and the results were got with one **interpolation** curve of Wöhler :

Identification	Type of reference	Value of reference
Criteria		
$\frac{\lvert EPPR1-EPPR2\rvert}{2}$	'ANALYTICAL'	2.1858445E-03

7 Modeling E

7.1 Characteristics of modeling

They are tested criteria in formulas, `'MATAKE_MODI_AV'`, `'DANG_VAN_MODI_AV'`, `'FATESOCI_MODI_AV'` (to find the results of CAS-tests SSLV135B)

7.2 Characteristics of the grid

The grid is not necessary.

7.3 Sizes tested and results

For the criteria `'MATAKE_MODI_A V '` and the associated criterion in formula (SSLV135B)

For the results with the option `COURBE_GRD_VIE=' WOHLER'` and for the option `COURBE_GRD_VIE = 'FORMES_VIE'` and `FORMULE_VIE = 'WHOL'` :

Identification	Type of reference	Value of reference
component x of n_1 and n_2	'AUTRE_ASTER'	-0.38268343236509 0.38268343236509
component y of n_1 and n_2	'AUTRE_ASTER'	0.92718385456679 0.92387953251129
component z of n_1 and n_2	'AUTRE_ASTER'	0.0000000000000E+00
$ENDO(n_1)$	'AUTRE_ASTER'	7.0532362250863E-04

In the table above, the components x and y of n_1 and n_2 two values have because there exist two vectors which correspond to the same value of damage $ENDO(n_1) = ENDO(n_2)$.

For the results with the option `COURBE_GRD_VIE= 'FORMES_VIE'` and `FORMULE_VIE = WHOL_F`:

Identification	Type of reference	Value of reference
component x of n_1 and n_2	'AUTRE_ASTER'	-0.38268343236509 0.38268343236509
component y of n_1 and n_2	'AUTRE_ASTER'	0.92718385456679 0.92387953251129
component z of n_1 and n_2	'AUTRE_ASTER'	0.0000000000000E+00
$ENDO(n_1)$	'AUTRE_ASTER'	3.3180845213285E-04

In the table above, the components x and y of n_1 and n_2 two values have because there exist two vectors which correspond to the same value of damage $ENDO(n_1) = ENDO(n_2)$.

For the criteria `' DANG_VAN_MODI_AV '` and the associated criterion in formula (SSLV135B)

For the results with the option COURBE_GRD_VIE=' WOHLER' and for the option COURBE_GRD_VIE=' FORMES_VIE' and FORMULE_VIE = WHOL:

Identification	Type of reference	Value of reference
component x of n_1 and n_2	'AUTRE_ASTER'	-7.0710678118655E-01 7.0710678118655E-01
component y of n_1 and n_2	'AUTRE_ASTER'	7.0710678118655E-01
component z of n_1 and n_2	'AUTRE_ASTER'	0.0000000000000E+00
$ENDO(n_1)$	'AUTRE_ASTER'	1.3419917535855E-04

In the table above, the components x and y of n_1 and n_2 two values have because there exist two vectors which correspond to the same value of damage $ENDO(n_1)$ = $ENDO(n_2)$.

For the results with the option COURBE_GRD_VIE= 'FORMES_VIE' and FORMULE_VIE = WHOL_F:

Identification	Type of reference	Value of reference
component x of n_1 and n_2	'AUTRE_ASTER'	-7.0710678118655E-01 7.0710678118655E-01
component y of n_1 and n_2	'AUTRE_ASTER'	7.0710678118655E-01
component z of n_1 and n_2	'AUTRE_ASTER'	0
$ENDO(n_1)$	'AUTRE_ASTER'	8.7633062468223E-05

In the table above, the components x and y of n_1 and n_2 two values have because there exist two vectors which correspond to the same value of damage $ENDO(n_1)$ = $ENDO(n_2)$.

For the criteria ' FATESOCI_MODI_AV ' and the associated criterion in formula (SSLV135B)

For the results with the option COURBE_GRD_VIE=' WOHLER', COURBE_GRD_VIE=' FORMES_VIE' and FORMULE_VIE = MANCO1:

Identification	Type of reference	Value of reference
component x of n_1 and n_2	'AUTRE_ASTER'	-4.3837114678908E-01 4.3837114678908E-01
component y of n_1 and n_2	'AUTRE_ASTER'	0.90258528434986
component z of n_1 and n_2	'AUTRE_ASTER'	0
$ENDO(n_1)$	'AUTRE_ASTER'	0.43649132038876

In the table above, the component x of n_1 and n_2 has two values because there exist two vectors which correspond to the same value of damage $ENDO(n_1)$ = $ENDO(n_2)$.

8 Modeling F

8.1 Characteristics of modeling

They are tested criteria MATAKE_MODI_AC, DANG_VAN_MODI_AC, MATAKE_MODI_AV, DANG_VAN_MODI_AV, FATESOCI_MODI_AV. One tests the change of the direction of the critical plan on which the damage or shearing is maximum (to find the results of CAS-tests SSLV135G)

8.2 Characteristics of the grid

The grid is not necessary.

8.3 Sizes tested and results

- **Criteria of DANG_VAN _MODI_AC, of MATAKE_MODI_AC, of DANG_VAN_MODI_AV**

For the results of ϕ_z with the node $N1$ for an elastic material.

Value of α	Type of reference	Value of reference
−1,-0.5,0..10	'ANALYTICAL'	45

For the results of ϕ_z with the node $N1$ for an elastoplastic material.

Value of α	Type of reference	Value of reference
0,1,2,3,4	'ANALYTICAL'	45

- Criterion of **MATAKE_MODI_AV**

Value of α	Type of reference	Value of reference
−1	'ANALYTICAL'	45
−0.5	'ANALYTICAL'	45,72
0	'ANALYTICAL'	46,43
0,5	'ANALYTICAL'	47,14
1	'ANALYTICAL'	47,86
1,5	'ANALYTICAL'	48,56
2	'ANALYTICAL'	49,27
2,5	'ANALYTICAL'	49,96
3	'ANALYTICAL'	50,65
3,5	'ANALYTICAL'	51,34
4	'ANALYTICAL'	52,02
4,5	'ANALYTICAL'	52,69
5	'ANALYTICAL'	53,35
5,5	'ANALYTICAL'	54
6	'ANALYTICAL'	54,65
6,5	'ANALYTICAL'	55,28

7	'ANALYTICAL'	55,9
7,5	'ANALYTICAL'	56,51
8	'ANALYTICAL'	57,11
8,5	'ANALYTICAL'	57,7
9	'ANALYTICAL'	58,28
9,5	'ANALYTICAL'	58,85
10	'ANALYTICAL'	59,41

For the results of ϕ_z **with the node** $N1$ for an elastoplastic material.

Value of α	**Type of reference**	**Value of reference**
0	'ANALYTICAL'	46,43
1	'ANALYTICAL'	47,86
2	'ANALYTICAL'	49,27
3	'ANALYTICAL'	50,65
4	'ANALYTICAL'	52,02

- **Criterion of FATESOCI_MODI_AV**

For the results of ϕ_z **with the node** $N1$ for an elastic material.

Value of α	**Type of reference**	**Value of reference**
−1	'ANALYTICAL'	45
−0.5	'ANALYTICAL'	45,34
0	'ANALYTICAL'	45,67
0,5	'ANALYTICAL'	45,99
1	'ANALYTICAL'	46,31
1,5	'ANALYTICAL'	46,61
2	'ANALYTICAL'	46,91
2,5	'ANALYTICAL'	47,2
3	'ANALYTICAL'	47,48
3,5	'ANALYTICAL'	47,75
4	'ANALYTICAL'	48,01
4,5	'ANALYTICAL'	48,27
5	'ANALYTICAL'	48,51
5,5	'ANALYTICAL'	48,75
6	'ANALYTICAL'	48,98
6,5	'ANALYTICAL'	49,2
7	'ANALYTICAL'	49,42

7,5	'ANALYTICAL'	49,63
8	'ANALYTICAL'	49,83
8,5	'ANALYTICAL'	50,03
9	'ANALYTICAL'	50,22
9,5	'ANALYTICAL'	50,4
10	'ANALYTICAL'	50,58

For the results of ϕ_z **with the node** $N1$ for an elastoplastic material.

Value of α	Type of reference	Value of reference
0	'ANALYTICAL'	45,67
1	'ANALYTICAL'	46,31
2	'ANALYTICAL'	46,91
3	'ANALYTICAL'	47,48
4	'ANALYTICAL'	48,01

9 Modeling G

9.1 Characteristics of modeling

The features tested are new sizes and the keyword `FORMULE_CRITIQUE`. Only the option `CRITERE='FORMULE_CRITERE'`, `MATAKE_MODI_AC` and `DANG_VAN_MODI_AC` order `POST_FATIGUE` and the curves of life called by the formulas are used.

To find the results of CAS-tests SSLV135G and SSLV135A

9.2 Characteristics of the grid

The grid is identical to that of modeling A.

9.3 Sizes tested and results

To find the results of CAS-tests SSLV135:

Identification	Type of reference	Value of reference
FORMULE_CRITIQUE = 'DTAUCR' or 'MTAUCR'		
'SIGEQ1'	'ANALYTICAL'	100 MPa
'ENDO1'	'ANALYTICAL'	1.028E-6
'NBRUP1'	'ANALYTICAL'	9.73E5
'VNM1X', 'VNM1Y', 'VNM1Z'	'ANALYTICAL'	(0,707, -0,707), 0,707.0
FORMULE_CRITIQUE = 'DGAMCR' or 'MGAMCR'		
'SIGEQ1'	'ANALYTICAL'	9.73E5
'ENDO1'	'ANALYTICAL'	1.583E-4
'NBRUP1'	'ANALYTICAL'	6.3163E3
'VNM1X', 'VNM1Y', 'VNM1Z'	'ANALYTICAL'	(0,707, -0,707), 0,707.0
FORMULE_CRITIQUE = 'DSINCR' or 'MSINCR'		
'SIGEQ1'	'ANALYTICAL'	200
'ENDO1'	'ANALYTICAL'	1.348E-5
'NBRUP1'	'ANALYTICAL'	7.418E4
'VNM1X', 'VNM1Y', 'VNM1Z'	'ANALYTICAL'	(- 1.1), 0.0174,0
FORMULE_CRITIQUE = 'DEPNCR' or 'MEPNCR'		
'SIGEQ1'	'ANALYTICAL'	1.75E-3
'ENDO1'	'ANALYTICAL'	2.11E-5

'NBRUP1'	'ANALYTICAL'	4.74E4
'VNM1X', 'VNM1Y', 'VNM1Z'	'ANALYTICAL'	(- 1, 1), 0.0174,0
FORMULE_CRITIQUE = 'DGAMPC' or 'MGAMPC'		
'SIGEQ1'	'ANALYTICAL'	1.125E-3
'ENDO1'	'ANALYTICAL'	1.3782E-6
'NBRUP1'	'ANALYTICAL'	7.256E5
'VNM1X', 'VNM1Y', 'VNM1Z'	'ANALYTICAL'	(0,707, -0,707), 0,707.0
FORMULE_CRITIQUE = 'DEPNPC' or 'MEPNPC'		
'SIGEQ1'	'ANALYTICAL'	0.75E-3
'ENDO1'	'ANALYTICAL'	1.126E-7
'NBRUP1'	'ANALYTICAL'	8.88E6
'VNM1X', 'VNM1Y', 'VNM1Z'	'ANALYTICAL'	(- 1.1), 0.0174,0

To find the results of CAS-tests SSLV135A:

Identification	Type of reference	Value of reference
CRITERION = MATAKE_MODI_AC FORMULE_CRITIQUE = 'DTAUCR'		
'DTAUCR'	'ANALYTICAL'	1.50E+02 MPa
'MSINCR'	'ANALYTICAL'	5.0000000000000E+01
'VNM1X' 'VNM1Y' 'VNM1Z'	'ANALYTICAL'	7.0710678118655E-01 7.0710678118655E-01 0
CRITERION = DANG_VAN_MODI_AC FORMULE_CRITIQUE = 'DTAUCR'		
'DTAUCR'	'ANALYTICAL'	1.50E+02 MPa
'PHYDRM'	'ANALYTICAL'	33.333333333333
'VNM1X' 'VNM1Y' 'VNM1Z'	'ANALYTICAL'	7.0710678118655E-01, 7.0710678118655E-01, 0

10 Summary of the results

Results provided by *Code_Aster* with POST_FATIGUE coincide perfectly with those and values of reference obtained with CALC_FATIGUE.