SSNV194 – Traction on an aggregate with 10 grains

Summary:

One presents here a test of traction on an aggregate to 10 grains with the law Monocrystal in *Code_Aster*. The orientations are defined in angles of Euler.

Modeling A corresponds to a calculation of complete aggregate, with definition of the orientations for each grain with a grid.

Modeling B corresponds to a calculation homogenized, on only one finite element.

Modeling C corresponds to a calculation homogenized in a material point.

Modeling D corresponds to a calculation homogenized, on a material point, for a polycrystal made up of 100 grains `DD_CC`.

Modeling E is similar to the modeling A, put except for one uses meshs TETRA10 and a modeling `3D_SI`.

Modeling F corresponds to a calculation homogenized, on a material point, for a polycrystal made up of 100 grains `DD_CC_IRRA`.

Modeling G corresponds to a calculation homogenized, on a material point, for a polycrystal made up of 100 grains `DD_CFC_IRRA`.

1 Problem of reference

1.1 Geometry

The geometry is that of a polycrystal, represented:
- Maybe by a grid on side 1, generated by a procedure python.
- Maybe by homogenisation on a material point.

1.2 Properties of materials

Modelings A, B, C, E

Young modulus: $E=145200\ MPa$, Coefficient of Fish: $\nu=0.3$

MONO_VISC1: $N=10 \quad K=40 \quad C=1$

MONO_ISOT1 : $R_0=75.5 \ b=19.34 \ Q=9.77 \ h_1=h_2=h_3=h_4=1$

MONO_CINE1: $D=36.68$

Orientations of the systems of slip of each grain, represented by a group of meshs GROUP_MA, are given in angles of Euler.

Modelings D and F: MONO_DD_CC

$TEMP=50\,K$, Poisson's ratio $\nu=0.35$ Young modulus: $E=(236-0{,}0459T)$ GPa
$D\_LAT=1000\,mm$ $K\_BOLTZ=8.62\ 10^{-5}$, $DELTA1=1.0$,
$GAMMA0=10^{-6}s^{-1}$ $TAU\_0=363\,MPa$ $TAU\_F=0$ $RHO\_MOB=10^5\ mm^{-2}$
$K\_F=75$ $K\_SELF=100$ $B=2.48\ 10^{-7}mm$ $N=50$ $DELTAG0=0.84$ $BETA=0.2$
$D=10^{-5}mm$ $GH=10^{11}$, $Y\_AT=2\,10^{-6}mm$
The internal variables representing the density of dislocations are initialized with $\rho_0=6.\,10^5\,mm^{-2}$,
The matrix of interaction is built in both cases starting from the following values
$H1=0.1$, $H2=0.7$, H3=H4=H5=H6=0.1

Modeling G: MONO_DD_CFC_IRRA

$A=0.13 \quad B=0.005 \quad \alpha=0.35 \quad \beta=2.5410^{-7}(2.54\ Angström)$
$Y=2.5\ \ 10^{-7}mm(2.5\ Angstrom) \quad \tau_f=20. \quad n=5. \quad \dot{\gamma}_0=10^{-3} \quad \rho_{ref}=10^6\,mm^{-2}$
$\alpha^{loops}=1 \quad \phi^{loops}=0.001 \quad \alpha^{voids}=1 \quad \rho^{voids}=1.e3$ with $\rho_0=10^5\,mm^{-2}$
$\rho_{sat}=4\,\rho_0 b^2 \quad \Phi_{sat}=0.04 \quad \xi_{irra}=10^7 \quad \zeta_{irra}=10^7$

The matrix of interaction is only made up of 1: $H1=H2=H3=H4=H5=1.0$,
The internal variables representing the density of dislocations are initialized with $\rho_0\times b^2$
Those which are related to the irradiation have as initial values: $\rho_s^{loops}=2\,\rho_0 b^2 \quad \Phi_s^{voids}=0.001$

1.3 Boundary conditions and loadings

	Modelings A, B, C, F	Modeling D, E
GROUP_NO: BACK	$DX=0$	$DX=0$
GROUP_NO: LOW	$DZ=0$	$DZ=0$
GROUP_NO: LEFT	$DY=0$	$DY=0$
GROUP_NO: HIGH	$DZ=\alpha t$, $\alpha=1$ $0<t<0{,}005$	$DZ=\alpha t$, $\alpha=3\,10^{-4}$, $\varepsilon_{max}=0.2$

2 Reference solution

It is a case test of not-regression with regard to modelings A, E, F, G.

The results of modelings B and C are compared with those of modeling A.

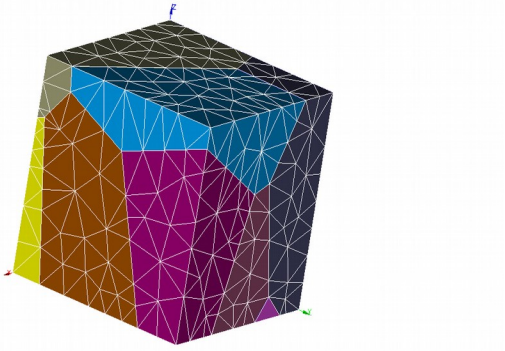
3 Modeling A

3.1 Characteristics of modeling

The structure contains 10 grains. To each grain corresponds 3 angles of Euler which lay down the directions of the systems of slip. Families of systems of slip of the type *bcc24*.

3.2 Characteristics of the grid

Many nodes: 552.
Modeling 3D : 2269 tetrahedral elements of volume: TETRA4.



3.3 Sizes tested and results

The first calculation (boundary conditions AFFE_CHAR_MECA)

Identification	Type of reference	Value of reference	Tolerance
SIEF_ELGA σ_{xx} mesh $M1$ not 1	'NON_REGRESSION'	-25.172 Mpa	0.01%
EPSI_ELGA ε_{xx} mesh $M1$ not 1	'NON_REGRESSION'	-1,49584E-03	0.01%
EPSI_ELGA ε_{yy} mesh $M1$ not 1	'NON_REGRESSION'	-2,70269E-03	0.01%
EPSP_ELGA ε_{yy} mesh $M1$ not 1	'NON_REGRESSION'	-2,587725E-03	0.01%
VARI_ELGA $V79$ maximum	'NON_REGRESSION'	488.168492	1,0E-4%
VARI_ELGA $V80$ maximum	'NON_REGRESSION'	8,015907E-03	1,0E-4%

The second calculation (boundary conditions AFFE_CHAR_CINE)

Identification	Type of reference	Value of reference	Tolerance
SIEF_ELGA σ_{xx} mesh $M1$ not 1	'AUTRE_ASTER'	-25.172 Mpa	0.01%
EPSI_ELGA ε_{xx} mesh $M1$ not 1	'AUTRE_ASTER'	-1,49584E-03	0.01%
EPSI_ELGA ε_{yy} mesh $M1$ not 1	'AUTRE_ASTER'	-2,70269E-03	0.01%
EPSP_ELGA ε_{yy} mesh $M1$ not 1	'AUTRE_ASTER'	-2,587725E-03	0.01%
VARI_ELGA $V79$ maximum	'AUTRE_ASTER'	488.168492	1,0E-4%
VARI_ELGA $V80$ maximum	'AUTRE_ASTER'	8,015907E-03	1,0E-4%

4 Modeling B

4.1 Characteristics of modeling

Homogenized material including 10 bainitic phases, with families of systems of slip of the type *bcc24*. With each phase, one in the same way associates 3 angles of Euler which lay down the directions of the systems of slip, that for modeling A.

4.2 Characteristics of the grid

Many nodes: 8
Many meshs and types: 1 HEXA8

4.3 Sizes tested and results

Identification	Type of reference	Value of reference	Tolerance
SIEF_ELGA σ_{zz} average	'AUTRE_ASTER'	279.777 Mpa	9.0%
EPSP_ELGA ε_{zz} average	'AUTRE_ASTER'	3,07316E-03	6.0%

5 Modeling C

5.1 Characteristics of modeling

Homogenized material including 10 grains, with families of systems of slip of the type *bcc24*. With each phase, one in the same way associate 3 angles of Euler which lay down the directions of the systems of slip, that for modeling A.
Two successive calculations are carried out: one with a format of table result in columns, the other with a format in lines. In both cases, an automatic recutting of the step of time is carried out by controlling the increase in the internal variable $V_3=\varepsilon_{zz}^{vp}<2.10^{-5}$.

5.2 Characteristics of the grid

Pas de grid (SIMU_POINT_MAT)

5.3 Sizes tested and results

Identification	Type of reference	Value of reference	Tolerance
SIEF_ELGA σ_{zz}	'AUTRE_ASTER'	279.777 Mpa	9.0%
VARI_ELGA $V3$	'AUTRE_ASTER'	3,07316E-03	6.0%
SIEF_ELGA σ_{zz}	'NON_REGRESSION'	301.135 Mpa	0.1%
VARI_ELGA $V3$	'NON_REGRESSION'	2,926067E-03	0.1%

6 Modeling D

6.1 Characteristics of modeling

Homogenized material including 100 grains, with families of systems of slip of the cubic type (MONO_DD_CC.. Simulation on material point.

6.2 Characteristics of the grid

Without object

6.3 Sizes tested and results

Identification	inst	Value of reference	Tolerance
SIEF_ELGA means σ_{zz}	tmax	825,2	2,00%
EPSP_ELGA means $EPZZ$	tmax	0.1	0,10%

7 Modeling E

7.1 Characteristics of modeling

Aggregate of 10 grains, identical to modeling A, the finite elements.

7.2 Characteristics of the grid

Many nodes: 3712
Modeling 3D_SI: 2269 tetrahedral elements of volume: TETRA10.

7.3 Sizes tested and results

The first calculation (boundary conditions AFFE_CHAR_MECA)

Identification	Type of reference	Value of reference	Tolerance
SIEF_ELGA σ_{xx} mesh $M1$ not 1	'NON_REGRESSION'	-43,488 Mpa	0.01%
EPSI_ELGA ε_{xx} mesh $M1$ not 1	'NON_REGRESSION'	-1.22889E-03	0.01%
EPSI_ELGA ε_{yy} mesh $M1$ not 1	'NON_REGRESSION'	-3.15043E-03	0.01%
EPSP_ELGA ε_{yy} mesh $M1$ not 1	'NON_REGRESSION'	-2.91648E-03	0.01%
VARI_ELGA $V79$ maximum	'NON_REGRESSION'	502.94757	1,0E-4%
VARI_ELGA $V80$ maximum	'NON_REGRESSION'	0.121881	1,0E-4%

8 Modeling F

8.1 Characteristics of modeling

Homogenized material including 100 grains, with families of systems of slip of the cubic type (MONO_DD_CC_IRRA) . Simulation on material point.

8.2 Characteristics of the grid

Without object

8.3 Sizes tested and results

Identification	inst	Value of reference
SIEF_ELGA means σ_{zz}	tmax	856.587
EPSP_ELGA means $EPZZ$	tmax	0.15

9 Modeling G

9.1 Characteristics of modeling

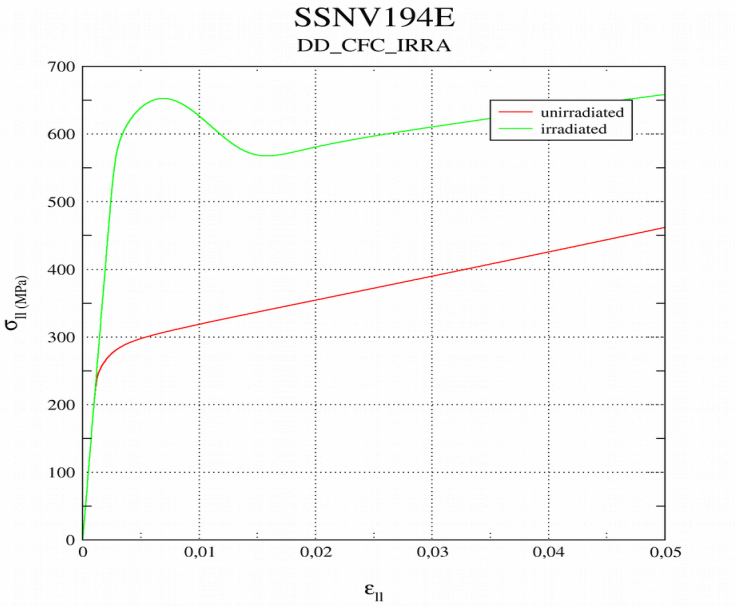
Homogenized material including 100 grains, with families of systems of slip of the cubic type (MONO_DD_CFC_IRRA). Simulation on material point.

9.2 Characteristics of the grid

Without object

9.3 Sizes tested and results

Identification	inst	Value of reference
SIEF_ELGA means σ_{zz}	tmax	658.5459
SIEF_ELGA means σ_{zz} not irradiated	tmax	461.9796



The validation of the results is qualitative: the influence of the irradiation is well taken into account and the shape of the curve is correct, according to the bibliography.

10 Summary of the results

This test makes it possible to validate by intercomparison a modeling of an aggregate, either with a grid, or homogenized at the level of a hexahedron or that of a material point.