

Structure of data sd_compor

Summary:

One describes the structure of data here `sd_compor` , resulting from the call to the order `DEFI_COMPOR` . Its contents vary according to the 3 use potential of the order:

- MONOCRYSTAL;
- POLYCRISTRAL;
- MULTIFIBRE .

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1 The structure of data sd_compor for the monocrystals

The order `DEFI_COMPOR` allows to build behaviors of monocrystals in 'kit' in the following way: to a family of system of slip, one associates a material, a law of flow, an isotropic work hardening, a kinematic work hardening (possible), a kind of elasticity [U4.43.06]:

```

MONOCRYSTAL = ( _F (
  ♦ MATER= mat1, [to subdue]
  ♦ FLOW =          / 'MONO_VISC1'
                    / 'MONO_VISC2'
                    / 'MONO_DD_KR'
                    / 'MONO_DD_CFC'
                    / 'MONO_DD_CC'
                    / 'MONO_DD_FAT'
  ♦ ECRO_ISOT=     / 'MONO_ISOT1'
                    / 'MONO_ISOT2'
  ♦ ECRO_CINE=     / 'MONO_CINE1'
                    / 'MONO_CINE2'
  ♦ ELAS=          / 'ELAS'
                    / 'ELAS_ORTH'
  ♦ FAMI_SYST_G LIS = / 'BCC24',
                    / 'OCTAHEDRAL',
                    / 'CUBIQUE1',
                    / 'CUBIQUE2',
                    / 'ZIRCONIUM',
                    / 'UNIAXIAL'

  ◇ TABL_SYST_G LIS= tabsys, [table]
),),
◇ MATR_INTER=      tabinter [table]

◇ ROTA_RESEAU =   / 'NOT' [DEFECT]
                  / 'POST'
                  / 'CALC'

```

A monocrystal can be defined by several occurrences of the keyword `MONOCRYSTAL` (5 at the most). That is used in practice to associate several families of systems of slip with a monocrystal.

The structure of data `sd_compor`, transmitted to the routines of integration of these laws of behavior, contains this information:

```

sd_compor (K19) :: = record

      \.CPRK' :      OBJ S V K24
      \.CPRI' :      OBJ S V I          long=13
      \.CPRR' :      OBJ S V R          long= NBSYST*NBSYST

```

⇒ the object `' .CPRI '` contains 8 entreties:

v (1)	Type = 1 (means: monocrystal)
v (2)	Nb_phases = 1 (useless for the monocrystal)
v (3)	NVI = many internal variables: $NVI=9+3*NBSYST$, NBSYST being the number of systems of total slip (nap amongst systems of each family) [R5.03.11].
v (4)	= 0 by default, 1 if a matrix of interaction is given via <code>MATR_INTER</code>
v (5)	Many occurrences of monocrystal = many families of systems of slip
v (6)	= 1 if <code>ROTA_RESEAU=' POST'</code> , 2 if <code>ROTA_RESEAU=' CALC'</code> , 0 if not

v (7)	NVI
V (8)	Many systems of total slip
V (9)	Many systems of family 1, if TABL_SYST_G LIS is provided, 0 if not
V (10)	Many systems of family 2, if TABL_SYST_G LIS is provided, 0 if not
V (11)	Many systems of family 3, if TABL_SYST_G LIS is provided, 0 if not
V (12)	Many systems of family 4, if TABL_SYST_G LIS is provided, 0 if not
V (13)	Many systems of family 5, if TABL_SYST_G LIS is provided, 0 if not

for example (test SSNV172):

```
SEGMENT IMPRESSION OF VALUES >COMPORZ4.CPRI <
      1 -          1          1          99          1          5
      6 -          0          99          30          3          3
     11 -          6          12           6
```

⇒ the object '. CPRK image (in the form of a vector 'is L' of K16) of a table containing for each occurrence of the keyword MONOCRYSTAL information below.

```
FAMI_SYST_G LIS  NOM_MATER  FLOW  ECRO_ISOT  ECRO_CINE
FAMI_SYST_G LIS  NOM_MATER  FLOW  ECRO_ISOT  ECRO_CINE
```

for example (test SSNV172):

```
SEGMENT IMPRESSION OF VALUES >COMPORZ4.CPRK <
      1 - >UTIL1__prism_al<>ACIER1          <>MONO_VISC1 <
      4 - >MONO_ISOT1          <>MONO_CINE1          <>UTIL2__bas1 <
      7 - >ACIER2          <>MONO_VISC1          <>MONO_ISOT1 <
     10 - >MONO_CINE1          <>UTIL3__pyr_a          <>ACIER3 <
     13 - >MONO_VISC1          <>MONO_ISOT1          <>MONO_CINE1 <
     16 - >UTIL4__pyr_c_a <>ACIER4          <>MONO_VISC1 <
     19 - >MONO_ISOT1          <>MONO_CINE1          <>UTIL5__pyr2_c_a<
     22 - >ACIER5          <>MONO_VISC1          <>MONO_ISOT1 <
     25 - >MONO_CINE1          <>ELAS          <
```

One adds then the name of the elastic behavior (single for the monocrystal). The length of this object is thus $5 \times \text{NBOCCM} + 1$.

⇒ the object '. CPRR' length 1800 (30×30 is + $5 \times 6 \times 30$). It contains:

- for each family of systems of slip, if TABL_SYST_G LIS is provided, the definitions of the corresponding systems (6*nbsys values)
- the matrix of interaction given via MATR_INTER (dimension NBSYST*NBSYST)

for example (test SSNV172):

```
SEGMENT IMPRESSION OF VALUES >COMPORZ4.CPRR <
      1 -  5.00000D+00  1.93000D+02  3.00000D+00  1.30000D+01  3.00000D+00
      6 -  3.10000D+01  6.00000D+00  4.90000D+01  1.20000D+01  8.50000D+01
     11 -  6.00000D+00  1.57000D+02  1.00000D+00  0.00000D+00  0.00000D+00
     16 -  0.00000D+00 -1.00000D+00  0.00000D+00 -5.00000D-01  8.66025D-01
     ...
     191 - 7.33481D-01  5.31671D-01  1.00000D+00  0.00000D+00  0.00000D+00
           Matrix of interaction
```

```
196 - 0.000000D+00 0.000000D+00 0.000000D+00 0.000000D+00 0.000000D+00
201 - 0.000000D+00 0.000000D+00 0.000000D+00 0.000000D+00 0.000000D+00
206 - 0.000000D+00 0.000000D+00 0.000000D+00 0.000000D+00 0.000000D+00
...
```

2 The structure of data `sd_compor` for the polycrystals

The order `DEFI_COMPOR` allows to build polycrystalline behaviors (homogenized), built starting from monocrystals (`s.d. sd_compor`), definition of the proportions of each single-crystal phase, with its orientation, and of a law of localization/homogenisation.

```
POLYCRYSTAL = (
  _F ( ♦ MONOCRYSTAL = mono1, [sd_compor]
    ♦ FRAC_VOL = fvol, [R]
    ♦ / ♦ ANGL_REP = (α, β, γ) [1_R]
    / ♦ ANGL_EULER = (phi1, phi, phi2) [1_R])
  LOCALIZATION = ♦ MU_LOCA,
    / 'BZ',
    / 'BETA',
    # if LOCALIZATION = BETA
    ♦ DL = dl, [R]
    ♦ DA = da, [R]),)
```

A polycrystal (homogenized) is defined by several occurrences of the keyword `POLYCRYSTAL`. With each occurrence a single-crystal phase, definite corresponds by:

- the name of `s.d. sd_compor` exit of one `DEFI_COMPOR` precedent,
- the proportion defined by the keyword `FRAC_VOL`,
- orientation of this monocrystal, defined by the keywords `ANGL_REP` or `ANGL_EULER`.

One defines moreover the method of localization, parameter `MU_LOCA` used in this law, and possibly the associated parameters.

The structure of data `sd_compor`, transmitted to the routines of integration of the law of behavior `POLYCRYSTAL`, contains this information:

```
sd_compor (K19) :: = record
  \.CPRK' : OBJ S V K24
  \.CPRI' : OBJ S V I
  \.CPRR' : OBJ S V R
```

⇒ the object `\.CPRK'` stores information below:

One defines moreover the method of localization and possibly the parameters associated.

V (1)	loca = name of the method of localization
V (1+1)	mono1 = name of monocrystal 1, i.e. of <code>sd_compor</code> associated
V (1+2)	nbfam1 = many families of systems of slip of <code>mono1</code>
V (1+2+1)	beginning of the recopy of the object <code>mono1.CPRK</code>
...	
V (1+2+5*nbfam1+1)	end of the recopy of the object <code>mono2.CPRK</code>
V	mono2 = name of monocrystal 2, i.e. of <code>sd_compor</code> associated

(1+2+5*nbfam1+2)	
V (1+2+5*nbfam1+3)	nbfam2 = many families of systems of slip of mono2
V (1+2+5*nbfam1+4)	beginning of the recopy of the object mono2.CPRK
etc...	

the dimension of this object is: 1 + nap (2+ length of the .CPRK of mono_i) The number of different monocystals is noted nbmono .

for example for a polycrystal with two phases:

```
SEGMENT IMPRESSION OF VALUES >CPP2      .CPRK      <
1 - >BZ                <>CMP_F          <
3 - >                   1<>CUBIQUE1         <
5 - >FER                <>MONO_DD_CC        <
7 - >MONO_DD_CC         <>                   <
9 - >ELAS               <>CMP_F2          <
11 - >                  1<>CUBIQUE1         <
13 - >FER2              <>MONO_DD_CC        <
15 - >MONO_DD_CC        <>                   <
17 - >ELAS              <>                   <
```

⇒ the object '.CPRI' is length 7+3*nbphases :

V (1)	Type = 2 (means: polycrystal)
V (2)	nbphases = many phases: many occurrences of the keyword POLYCRYSTAL
V (3)	NVITOT = many internal variables total
V (4)	many phases (monocystals) different
V (4+1)	nbfam1 : many families of systems of slip of phase 1 (occurrence 1)
V (4+2)	number of the monocystal associated with phase 1 (ranging between 1 and nbmono)
V (4+3)	NVI1 many internal variables of the monocystal associated with phase 1
V (4+3+1)	nbfam2 : many families of systems of slip of phase 2 (occurrence 2)
V (4+3+2)	number of the monocystal associated with phase 2 (ranging between 1 and nbmono)
V (4+3+3)	NVI2 many internal variables of the monocystal associated with phase 2
...	etc.
V (4+3*nbphases+1)	dimension of the object .CPRK
V (4+3*nbphases+2)	many parameters associated with the law with localization.

for example for a polycrystal with two phases:

```
SEGMENT IMPRESSION OF VALUES >CPP2      .CPRI      <
```

1 -	2	2	104	2	1
6 -	1	57	1	2	57
11 -	17	1	0		

⇒ the object '.CPRR' is length $3+4*\text{nbphases}$ (+ $\text{nbsyst}*\text{nbsyst}$ if `TABL_SYST_GLIS` is provided, therefore if `V (4+3*nbphases+3)` is nonnull).

V (1)	frac_vol_1 : voluminal fraction of phase 1
V (2)	1 ^{er} phase 1
V (3)	2 ^{ème} phase 1
V (4)	3 ^{ème} phase 1
V (4+1)	frac_vol_2 : voluminal fraction of phase 2
V (4+2)	1 ^{er} phase 2
V (4+3)	2 ^{ème} phase 2
V (4+4)	3 ^{ème} phase 2
...	etc.
V (4*nbphases+1)	MU_LOCA = parameter μ for the law of localization
V (4*nbphases+2)	d1 = parameter of localization (for method BETA)
V (4*nbphases+3)	da = parameter of localization (for method BETA)

for example for a polycrystal with two phases:

```
IMPRESSION SEGMENT OF VALUES >CPP2      .CPRR      <
      1 - 5.00000D-01  2.72085D+01  3.18678D+02  2.85599D+02  5.00000D-01
      6 - 2.72085D+01  3.18678D+02  2.85599D+02  1.16000D+05  0.00000D+00
     11 - 0.00000D+00
```

Note:

angles stored in the object '.CPRR' are measured in degrees and they correspond to the nautical angles.

3 The structure of data sd_compor for the multifibre beams

In the case of multifibre beams, the order `DEFI_COMPOR` allows to associate with each group of fibres a behavior, a material, and assumptions on the deformations and the treatment of the relations 1D. For an example of use of the keyword `MULTIFIBRE` to see the test `ssn1119a`.

The structure of data `sd_compor`, transmitted to the routines of integration of the laws of behavior for each fibre, contains following information:

```
sd_compor (K19) :: = record
    \.CPRK' :   OBJ  S  V  K24
    \.CPRI' :   OBJ  S  V  I
```

⇒ the object `\.CPRK'` is a vector of K24, containing for each occurrence of the keyword `MULTIFIBRE`, (thus each law of behavior) and for each group of fibres informed of an occurrence information above:

- `grfib1` = name of the group of fibres defined by `DEFI_GEOM_FIBRE`
- `Mater1` = name of material associated with the group with fibres `grfib1`
- `loifib1` = name of the law of associated behavior
- `Algo1D` = treatment of the behavior 1D
- `DEFORMATION` = assumption on the deformations
- `nfib` = many fibres of the group of fibres `grfib1`

For the groups of fibres which are not indicated in any occurrence of the keyword `MULTIFIBRE`, `grfib1` the name of the group contains well, but `Mater1` contains "VACUUM" and `loifib1`, `Algo1D`, `DEFORMATION` and `nfib` are empty. During the checking of the coherence of the structure of data have makes sure that if `Mater1` is "VACUUM", `loifib1`, `Algo1D`, `DEFORMATION`, `nfib` are also "VACUUM".

The last element of this table is the name of material containing the useful characteristics for torsion. The length of the object `.CPRK` is thus: `6*nbxmax +1`.

⇒ the object `\.CPRI'` contains 3 entières:

- `Type` = 3 (means: `MULTIFIBRE`)
- `NVIMAX` = many internal variables maximum for the whole of the affected laws of behavior
- `NBGMAX` = maximum number of groups of fibres (= many groups of fibres present in the concept `geom_fibre` as starter of `DEFI_COMPOR`).

4 Examples

4.1 Command file for MONOCRYSTAL

The orders below make it possible to illustrate the contents of sd_compor for a behavior monocystal:

```
COMPOR1=DEFI_COMPOR (
    MONOCRISTAL= (
        _F (MATER=ACIER,
            ECOULEMENT=' MONO_VISC1',
            ECRO_ISOT=' MONO_ISOT1',
            ECRO_CINE=' MONO_CINE1',
            ELAS=' ELAS',
            FAMI_SYST_GLIS=' OCTAEDRIQUE',),),);
```

4.2 Impression of the structure of data

```
=====> IMPR_CO OF THE STRUCTURE OF DATA: COMPOR1????????????????
ATTRIBUTE: F CONTENTS: T BASE: >G<
MANY OBJECTS (OR COLLECTIONS) FIND: 2
```

```
=====
IMPRESSION OF THE CONTENTS OF THE LOST PROPERTY:
-----
```

```
SEGMENT IMPRESSION OF VALUES >COMPOR1 .CPRI <
1 - 1 1 44 1 1 1
6 - 1 44
```

```
SEGMENT IMPRESSION OF VALUES >COMPOR1 .CPRK <
```

```
1 - >OCTAEDRIQUE <>ACIER <>MONO_VISC1 <
4 - >MONO_ISOT1 <>MONO_CINE1 <>ELAS <
```

```
=====> FINE IMPR_CO OF STRUCTURE OF DATA: COMPOR1????????????????
```

4.3 Command file for POLYCRYSTAL

The orders below make it possible to illustrate the contents of sd_compor for a behavior polycrystal (test homogenizes SSNV171B) being pressed on the preceding monocystal:

```
COMPORP=DEFI_COMPOR (POLYCRISTAL= (
    _F (MONOCRISTAL=COMPOR1,
        FRAC_VOL=0.25,
        ANGL_REP= (30. , 0. , 0.)),
    _F (MONOCRISTAL=COMPOR1,
        FRAC_VOL=0.25,
        ANGL_REP= (20. , 0. , 0.)),
    _F (MONOCRISTAL=COMPOR1,
        FRAC_VOL=0.25,
        ANGL_REP= (10. , 0. , 0.)),
    _F (MONOCRISTAL=COMPOR1,
        FRAC_VOL=0.25,
        ANGL_REP= (40. , 0. , 0.)),
    ),
LOCALISATION=' BETA', DA=0., DL=0.,
);
```

4.4 Impression of the structure of data

```
=====> IMPR_CO OF THE STRUCTURE OF DATA: COMPORP????????????????????
ATTRIBUTE: F CONTENTS: T BASE: >G<
MANY OBJECTS (OR COLLECTIONS) FIND: 3
```

=====

IMPRESSION OF THE CONTENTS OF THE LOST PROPERTY:

```
SEGMENT IMPRESSION OF VALUES >COMPORP .CPRI <

  1 -          2          4          176          1          1
  6 -          1          44          1          1          44
 11 -          1          1          44          1          1
 16 -          44          9          2
```

```
SEGMENT IMPRESSION OF VALUES >COMPORP .CPRK <

  1 - >BETA          <>COMPOR1          <>          1<
  4 - >OCTAEDRIQUE  <>ACIER          <>MONO_VISC1 <
  7 - >MONO_ISOT1   <>MONO_CINE1        <>ELAS          <
```

```
SEGMENT IMPRESSION OF VALUES >COMPORP .CPRR <

  1 - 2.50000D-01 3.00000D+01 0.00000D+00 0.00000D+00 2.50000D-01
  6 - 2.00000D+01 0.00000D+00 0.00000D+00 2.50000D-01 1.00000D+01
 11 - 0.00000D+00 0.00000D+00 2.50000D-01 4.00000D+01 0.00000D+00
 16 - 0.00000D+00 0.00000D+00 0.00000D+00
```

```
=====> FINE IMPR_CO OF STRUCTURE OF DATA: COMPORP????????????????????
```

4.5 Command file for MULTIFIBRE

The orders below make it possible to illustrate the contents of sd_compor for a multifibre behavior (test SSNL119B):

```
GF=DEFI_GEOM_FIBRE (
  FIBRE = _F (GROUP_FIBRE=' SACI', CARA = 'DIAMETER',
    COOR_AXE_POUTRE = (0. , 0. ,),
    VALE = (0.066,-0.218,32.E-3,
      -0.066,-0.218,32.E-3,
      0.066,0.218,8.E-3,
      -0.066,0.218,8.E-3,)),
  SECTION = _F (GROUP_FIBRE=' SBET', MAILLAGE_SECT = MASEC,
    TOUT_SECT = 'YES', COOR_AXE_POUTRE = (0. , 0. ,),),
);

MOPOU=AFFE_MODELE (
  MAILLAGE=MAPOU,
  AFFE=_F (TOUT=' OUI', PHENOMENE=' MECANIQUE', MODELISATION=' POU_D_EM',),
);

EB = 37272.0E+06
CONCRETE = DEFI_MATER_GC (
  MAZARS=_F (UNITE_LONGUEUR = 'ME,
    FCJ=40.963E+06, EIJ=EB, EPSI_C=1.75754E-03, AT=1.0, NU=0.2,
  ),
  RHO=2400.0, INFO=2,
)
```

```
ACIER=DEFI_MATER_GC (
  ACIER=_F (E = 2.0E+11, D_SIGM_EPSI=3.28E+9, SY=4.E+8,,),
  RHO=7800.,
)

MATOR=DEFI_MATERIAU (ELAS=_F (E=2.E11, NU=0.0, RHO=7800.0,,),);

POUCA=AFFE_CARA_ELEM (MODELE=MOPOU, INFO=1,
  POUTRE=_F (GROUP_MA= ('BEAM'),
    SECTION=' RECTANGLE', CARA= ('HY', 'HZ'),
    VALE= (0.2, 0.5), PREC_AIRE=5., PREC_INERTIE=10.,),
  ORIENTATION=_F (GROUP_MA= ('BEAM'), CARA=' ANGL_VRIL',
    VALE=-90.0,),
  GEOM_FIBRE=GF,
  MULTIFIBRE=_F (GROUP_MA= ('BEAM'), GROUP_FIBRE= ('SBET', 'SACI')),
);

COMPPMF=DEFI_COMPOR (GEOM_FIBRE=GF,
  MATER_SECT=MATOR,
  MULTIFIBRE= (
    _F (GROUP_FIBRE=' SACI', MATER=ACIER, RELATION=' VMIS_CINE_LINE'),
    _F (GROUP_FIBRE=' SBET', MATER=BETON, RELATION=' MAZARS_GC'),
  ),
)

IMPR_CO (CONCEPT=_F (NOM=COMPPMF))
```

4.6 Impression of the structure of data

```
=====> IMPR_CO OF THE STRUCTURE OF DATA: COMPPMF????????????????????
ATTRIBUTE: F CONTENTS: T BASE: >G<
MANY OBJECTS (OR COLLECTIONS) FIND: 2
```

=====

IMPRESSION OF THE CONTENTS OF THE LOST PROPERTY:

SEGMENT IMPRESSION OF VALUES >COMPPMF .CPRI <

1 - 3 7 2

SEGMENT IMPRESSION OF VALUES >COMPPMF .CPRK <

1 -	>SBET	<>BETON	<>MAZARS_GC	<
4 -	>ANALYTIQUE	<>PETIT	<>	40<
7 -	>SACI	<>ACIER	<>VMIS_CINE_LINE	<
10 -	>ANALYTIQUE	<>PETIT	<>	4<
13 -	>MATOR	<		

```
=====> FINE IMPR_CO OF STRUCTURE OF DATA: COMPPMF????????????????????
```