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_GLIS =  /'BCC24',
                        /'OCTAHEDRAL',
                        /'CUBIQUE1',
                        /'CUBIQUE2',
                        /'ZIRCONIUM',
                        /'UNIAXIAL'
   ◊ TABL_SYST_GLIS= 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 entireties:

v (1)	Type = 1 (means: monocrystal)
v (2)	Nb_phases = 1 (useless for the monocrystal)
v (3)	NVI = many internal variables: NVI=9+3*NBSYS , NBSYS 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 MATR_INTER
v (5)	Many occurrences of monocrystal = many families of systems of slip
v (6)	= 1 if ROTA_RESEAU=' POST', 2 if ROTA_RESEAU=' CALC', 0 if not

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v (7)	NVI
V (8)	Many systems of total slip
V (9)	Many systems of family 1, if TABL_SYST_GLIS is provided, 0 if not
V (10)	Many systems of family 2, if TABL_SYST_GLIS is provided, 0 if not
V (11)	Many systems of family 3, if TABL_SYST_GLIS is provided, 0 if not
V (12)	Many systems of family 4, if TABL_SYST_GLIS is provided, 0 if not
V (13)	Many systems of family 5, if TABL_SYST_GLIS 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_GLIS  NOM_MATER  FLOW  ECRO_ISOT  ECRO_CINE
  FAMI_SYST_GLIS  NOM_MATER  FLOW  ECRO_ISOT  ECRO_CINE
```

```
for example (test SSNV172):
 SEGMENT IMPRESSION OF VALUES >COMPORZ4.CPRK                     <

      1 - >UTIL1___prism_a1<>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*NBOCCM + 1 .

⇒ the object '. CPRR ' length 1800 (30*30 is + 5*6*30). It contains:

– for each family of systems of slip, if TABL_SYST_GLIS 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
….                                    Matrix of interaction
    191 -  7.33481D-01  5.31671D-01  1.00000D+00  0.00000D+00  0.00000D+00
```

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```
    196 -  0.00000D+00  0.00000D+00  0.00000D+00  0.00000D+00  0.00000D+00
    201 -  0.00000D+00  0.00000D+00  0.00000D+00  0.00000D+00  0.00000D+00
    206 -  0.00000D+00  0.00000D+00  0.00000D+00  0.00000D+00  0.00000D+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)                 [l_R]
             / ◊ ANGL_EULER = (phi1, phi, phi2)       [l_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 sd_compor associated
V (1+2)	nbfam1 = many families of systems of slip of mono1
V (1+2+1)	beginning of the recopy of the object mono1.CPRK
…	
V (1+2+5*nbfam1+1)	end of the recopy of the object mono2.CPRK
V	mono2 = name of monocrystal 2, i.e. of sd_compor associated

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(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 monocrystals 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 (monocrystals) different
V (4+1)	nbfam1 : many families of systems of slip of phase 1 (occurrence 1)
V (4+2)	number of the monocrystal associated with phase 1 (ranging between 1 and nbmono)
V (4+3)	NVI1 many internal variables of the monocrystal 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 monocrystal associated with phase 2 (ranging between 1 and nbmono)
V (4+3+3)	NVI2 many internal variables of the monocrystal 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                    <
```

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

⇒ the object '. CPRR ' is length 3+4*nbphases (+ nbsyst*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)	1er phase 1
V (3)	2ème phase 1
V (4)	3ème phase 1
V (4+1)	frac_vol_2 : voluminal fraction of phase 2
V (4+2)	1er phase 2
V (4+3)	2ème phase 2
V (4+4)	3ème phase 2
...	etc.
V (4*nbphases+1)	MU_LOCA = parameter μ for the law of localization
V (4*nbphases+2)	dl = 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.

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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 ssnl119a.

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*nbgmax +1.
⇒ the object '. CPRI ' contains 3 entireties:

- 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).

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4 Examples

4.1 Command file for MONOCRYSTAL

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

```
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
      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 POLYCRISTAL

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 monocrystal:

```
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.,
                           );
```

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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,
)
```

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```
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???????????????
```

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