Structures of data sd_mater and mater_code

Summary:

One describes here the 3 structures of data built starting from the description and the value of the various parameters associated with the behaviors of a material (compor, to subdue, mater_code).

The three structures of data are presented:

- SD in access by name: to subdue and compor
- the SD in access by address: mater_code (which replaces the preceding ones in the routines TExxxx).

Contents

1 General information

The material appears in many orders of *Code_Aster* and intervenes in most routines of calculation of the elementary terms (TExxxx).

Indeed, and contrary to other codes, *in Code_Aster*, one distinguishes the concept of "material", defined by the order DEFI_MATERIAU, and being able to be filed in the form of catalogue, (see the order INCLUDE_MATERIAU [U4.43.02]) of the concept of behavior used during a given calculation. The material is composed of values of parameters associated with a certain number of models with behaviors. In practice these parameters are defined via simple keywords, under keywords ratios control DEFI_MATERIAU. These keywords factors (for example ELAS, ECRO_LINE, CIN1_CHAB, LEMAITRE) allow to define whole or part of the parameters necessary to a model of behavior. For example, the behavior (chosen by the user in STAT_NON_LINE or DYNA_NON_LINE under the keyword factor BEHAVIOR) VMIS_CINE_LINE will use the parameters material defined under the keywords factor ELAS and ECRO_LINE of DEFI_MATERIAU. The behavior VISC_CIN1_CHAB will use those definite by ELAS, CIN1_CHAB and possibly LEMAITRE.

By abuse language, in this document, one will call "behavior" a keyword factor of DEFI_MATERIAU.

Moreover, certain total orders (MECA_STATIQUE, THER_LINEAIRE,...) do not allow the user to choose the behavior used for calculation. It is necessary thus that calculation (for example matrix of rigidity in the preceding examples) can be done without ambiguity. This is why it is necessary that certain behaviors of comparable nature (ELAS_xxx, THER_xx) are single in material. By convention of language in this document, one will say that the whole of the behaviors of comparable nature (even prefix: ELAS, THER) belong to the same "phenomenon". Certain "behaviors" can thus be classified by "phenomenon" in which they are excluded mutually.

The structure of data associated with material contains the name and the values associated with the parameters describing each behavior. The parameters can be of type real, complex or function. Within this structure of data one reaches the values of the parameters by name.

For reasons of performances of the code (in particular in the case of linear behaviors not -), the coded material was introduced. The structure of data associated with coded material is temporary, it contains the addresses of the various objects constituting the structure of data to subdue. The access to the values of the parameters does not require any more in this case a setting in memory of objects JEVEUX and a research by name with each time one uses material. The access by name to the parameters remains nevertheless.

These two structures of data are based on structures of the type function (constant function, function of a parameter or tablecloth) and objects simple JEVEUX of type vector.

The creation of a structure of data function (. &&RDEP) prefixed by the name of material allows to then have a permanent space of memory necessary to the interpolation of the tablecloths defining the traction diagrams depending on the temperature. This structure of data is created on the basis TOTAL in order to be exchanged between the various orders of the code.

2 The structure of data to subdue

The name of the “phenomenon” is the root of the name of the “behavior”. In the order where the user does not choose the model of behavior, it is necessary to know to find without ambiguity the material characteristics necessary, for example, the calculation of the matrices of rigidity through the order MECA_STATIQUE cannot make the distinction enters ELAS and ELAS_ORTHO, this is why these two behaviors are excluded. On the other hand, a material can contain the phenomena ELAS and THER. For the mechanical non-linear behaviors, unicity is not necessary, because the user chooses a relation of behavior on the level of the total order (STAT_NON_LINE).

For example, behaviors ELAS, ELAS_FLUI, ELAS_ISTR, ELAS_ORTH, ELAS_THM, ELAS_COQUE constitute the phenomenon ELAS.

The structure of data to subdue is made up:

- several phenomena,
- possibly of a function &&RDEP for the behaviors TRACTION and META_TRACTION,
- possibly of a function &&MZP for the parameter RELA_MZ behavior DIS_CONTACT.

```
to subdue  (K8):: = record
    '.MATERIAU.NOMRC'   : OJB S V K32
     % Behavior Rubber bands Generals
     |  /   '.ELAS      '          : COMPOR
        /   '.ELAS_FLUI'          : COMPOR
        /   '.ELAS_ISTR'          : COMPOR
        /   '.ELAS_ORTH'          : COMPOR
        /   '.ELAS_THM  '         : COMPOR
        /   '.ELAS_COQUE'         : COMPOR


    % Behaviors Mechanical Non Linéaires Généraux
    |       '.TRACTION  '         : COMPOR
            '. &&RDEP'                 : FUNCTION
    |       '.ECRO_LINE'          : COMPOR
    |       '.PRAGER    '         : COMPOR
    |       '.CIN1_CHAB'          : COMPOR
    |       '.CIN2_CHAB'          : COMPOR
    |       '.TAHERI    '         : COMPOR
    |   /   '.LEMAITRE  '         : COMPOR
    |       '.NORTON_HOFF'         : COMPOR


    % Behaviors related to the damage and the rupture
    …
```

Note:

The structure of data to subdue does not contain information on the form of the laws of behavior: elasticity, Lemaitre, etc… These last do not exist in the form of structures of data, but only in “hard” in FORTRAN.

2.1 Contents of the structure of data to subdue

```
.MATERIAU.NOMRC:        S   V   K32
```

Vector of the type CHARACTER*16 dimensioned with the number of behaviors present at the time of the definition of material.

The name of the behaviors affected in the order contains DEFI_MATERIAU or DEFI_COMPOSITE.

The order DEFI_COMPOSITE there the name of the behavior stores ELAS_COQMU or THER_COQMU, a white chain and the name of each material for each layer. The parameter LONMAX (attribute length of associated object JEVEUX) of this object is recovered in various routines to obtain the number of layers.

```
. &&RDEP:               FUNCTION
```

Is present only if the behaviors TRACTION and META_TRACTION appear in material. It is a function of a variable dimensioned with the maximum number of points of the functions composing the traction diagrams depending on the temperature.

```
. &&MZP:                FUNCTION
```

Is present only if the parameter RELA_MZ behavior DIS_CONTACT figure in material. It is a function representing the curve (moment) according to DR. (degree of rotation).

3 The structure of data compor

One defines first of all a structure of data related to each behavior which can define material. A behavior is a set of named parameters (K16) associated with a value. If the value is one K16 the parameter is associated with a function.

```
compor (K19):: = record

    '.VALK':     OBJ S V K16
    '.VALR':     OBJ S V R
    '.VALC':     OBJ S V C
```

The complete name of the structure of data compor (K19) is consisted the name user of material (K8) follow-up of chain ".CPT." followed by the value of the index of storage in object .MATERIAU.NOMRC of the keyword factor appearing in the catalogue of the order DEFI_MATERIAU.

3.1 Contents of the structure of data compor

```
VALK:      S   V   K16
```

Vector of the type CHARACTER*16 dimensioned for 2 times the maximum number of parameters (it is necessary to be able to store all the names of parameters and all the names of functions, if all the parameters are associated with functions $2 \times NBPAR$) for the law of behavior considered. For example E and NAKED are parameters of the elastic behavior ELAS.

Contains in the order:

- names of the parameters associated with actual values,
- names of the parameters associated with complex values,
- names of the parameters associated with functions,
- names of the functions.

The order DEFI_COMPOSITE fills this object with names with parameters associated with the coefficients homogenized like for each layer. An actual value is stored for each one.

.VALR: S V R

Vector of the type REAL*8 dimensioned with the maximum number of parameters (NBPAR) for the law of behavior considered.

Contains the values associated with the real parameters.

.VALC: S V C

Vector of the type COMPLEX*16 dimensioned with the maximum number of parameters (NBPAR) for the law of behavior considered.

Contains the values associated with the complex parameters.

4 The structure of data mater_code

It is a temporary structure of data (created on the basis BIRD) containing the addresses memory of objects JEVEUX constituting a material (SD MATER).

```
mater_code  (K19):: = record
      '.CODI'       : OBJ S V I
```

The name of this structure of data is indexed on the name specified by the developer and on the occurrence of material in cham_mater.

4.1 mater_code

.CODI: S V I

Vector of the type INTEGER whose dimension depends amongst behaviors described in the structures of data MATER. Object JEVEUX temporary created on the VOLATILE basis.

Parameters are associated with coded material

LMAT:	many parameters associated with the behavior
LFCT:	many parameters associated with the concepts (functions, tables)
LSUP:	many additional parameters (functions &&RDEP, &&MZP)

This vector is length 2 + NBCM*LMAT + NBCO*LFCT + NBT*LSUP where

NBCM:	many behaviors present in material
NBCO:	many concepts (functions, tables) present in material
NBT:	many traction diagrams present in material

This vector contains the addresses memory of the objects composing the structure of data MATER.

CODI (1):	Many different materials (N)
CODI (2):	Index in CODI of first material.
CODI (3):	Index in CODI of second material (if necessary)
.....	….
CODI (n+1):	Index in CODI of nth material (if necessary)
CODI (n+2):	address of .MATERIAU.NOMRC. (for first material)

CODI (n+3): NBCM many behaviors present in material.
CODI (n+2+1: n+2+NBCM): pointer of Kth behavior in CODI, for K=1 with NBCM

for each Kth behavior of material 1

that is to say ipi = CODI (n+2+K)

CODI (n+2+k): ipi, pointer of Kth behavior
CODI (ipi) : many parameters associated with realities.
CODI (ipi+1): many parameters associated with complexes.
CODI (ipi+2): many parameters associated with concepts (functions, tables)
CODI (ipi+3): address memory of the object .VALK.
CODI (ipi+4): address memory of the object .VALR.
CODI (ipi+5): address memory of the object .VALC.

for Lième concept of the type table associated with a parameter of Kth behavior,
that is to say IPyew = ipi+LMAT-1

CODI (ipif+LFCT* (L-1)) :	the table is transformed into a list of realities (LIST_R8) address memory of the object .VALE of the LIST_R8
CODI (ipif+LFCT* (L-1) +1):	0
CODI (ipif+LFCT* (L-1) +2):	0
CODI (ipif+LFCT* (L-1) +3):	ISNNEM ()
CODI (ipif+LFCT* (L-1) +4):	ISNNEM ()
CODI (ipif+LFCT* (L-1) +5):	ISNNEM ()
CODI (ipif+LFCT* (L-1) +6):	ISNNEM ()
CODI (ipif+LFCT* (L-1) +7):	ISNNEM ()
CODI (ipif+LFCT* (L-1) +8):	ISNNEM ()

for Lième concept of the type function associated with a parameter of Kth behavior,
that is to say IPyew = ipi+LMAT-1

CODI (ipif+LFCT* (L-1)) :	many points of the associated function.
CODI (ipif+LFCT* (L-1) +1):	address memory of the object .PROL.
CODI (ipif+LFCT* (L-1) +2):	address memory of the object .VALE.
CODI (ipif+LFCT* (L-1) +3):	address memory of the pointer length for a tablecloth.
CODI (ipif+LFCT* (L-1) +4):	address memory of the object .PARA for a tablecloth
CODI (ipif+LFCT* (L-1) +5):	attribute LONUTI object .PARA for a tablecloth.
CODI (ipif+LFCT* (L-1) +6):	pointer in CODI for the traction diagrams &&RDEP or for the fuel assemblies &&MZP
CODI (ipif+LFCT* (L-1) +7):	safeguard of the index of the interval of interpolation.
CODI (ipif+LFCT* (L-1) +8):	safeguard of an index of research (nonlinear equation in thermics).

that is to say IPifc = CODI (ipif+LFCT* (L-1) +6)

CODI (ipifc) :	address memory of the object &&MZP.PROL.
CODI (ipifc+1):	address memory of the object &&MZP.VALE.

or

CODI (ipifc) :	address memory of the object &&RDEP.PROL.
CODI (ipifc+1):	address memory of the object &&RDEP.VALE.

5 Example

5.1 Command file

The orders below make it possible to define 3 laws of behavior: elasticity, plasticity with traction diagram depending on the temperature and linear thermics.

```
BEGINNING ()

#
# given of modeling
#
F_E = DEFI_FONCTION (NOM_PARA    = 'TEMP',
                     PROL_DROITE = 'LINEAR',
                     PROL_GAUCHE = 'LINEAR',
                     VALE = (  0. ,   200.E+03,
                              50. ,   198.E+03,  ),
                    )
#
F_NU = DEFI_CONSTANTE (VALE = 0.3      )
#
F_AL = DEFI_CONSTANTE (VALE = 10.E+06  )
#
FCT1 = DEFI_FONCTION (NOM_PARA    = 'EPSI',
                      PROL_DROITE = 'LINEAR',
                      PROL_GAUCHE = 'LINEAR',
                      VALE = (  0.200E-02,   400. ,
                                0.400E-02,   500. ,  ),
                     )
#
FCT2 = DEFI_FONCTION (NOM_PARA    = 'EPSI',
                      PROL_DROITE = 'LINEAR',
                      PROL_GAUCHE = 'LINEAR',
                      VALE = (  0.100E-02,   200. ,
                                0.300E-02,   300. ,  ),
                     )
#
CTRACB = DEFI_NAPPE (NOM_PARA    = 'TEMP',
                     PROL_DROITE = 'LINEAR',
                     PROL_GAUCHE = 'LINEAR',
                     PARA     = (  0. ,     50. ,   ),
                     FUNCTION = (  FCT1,   FCT2,  ),
                    )
#
# material isotropic
#
CHECHMATE = DEFI_MATERIAU (  THER     =_F (RHO_CP = 0.0E-03,  LAMBDA = 1.0E-
03,),
                       ELAS_FO  =_F (E = F_E,  NAKED = F_NU,  ALPHA =
                                     F_AL, TEMP_DEF_ALPHA=20.0,),
                       TRACTION =_F (SIGM = CTRACB,),
                    )
#
IMPR_CO (CONCEPT =_F (NOM= CHECHMATE), ATTRIBUT=' OUI', CONTENU=' OUI')
```

5.2 Impression of the structure of data

```
 ====> IMPR_CO OF THE STRUCTURE OF DATA: CHECHMATE     ??????????????????
 ATTRIBUTE:  T  CONTENTS:  T  BASE: >G<
 MANY OBJECTS (OR COLLECTIONS) FIND:                   12

================================================================================
  IMPRESSION OF THE ATTRIBUTES OF THE LOST PROPERTY:
```

```
--------------------------------------------------------------------------------
JEIMPA  IMPRESSION OF THE ATTRIBUTES OF >MAT     . &&RDEP    .PROL<

CLAS    G
GENR    V
TYPE    K
LTYP              24
DOCU
DATE               0
LONMAX             6
LONUTI             6
LONO               6
IADM         6065610
IADD               0
LADD               0
USE   X D
--------------------------------------------------------------------------------
JEIMPA  IMPRESSION OF THE ATTRIBUTES OF >MAT     . &&RDEP    .VALE<

CLAS    G
GENR    V
TYPE    R
LTYP               8
DOCU
DATE               0
LONMAX             8
LONUTI             8
LONO               8
IADM         6167256
IADD               0
LADD               0
USE   X D
--------------------------------------------------------------------------------
JEIMPA  IMPRESSION OF THE ATTRIBUTES OF >MAT     .CPT.000001.VALC<

CLAS    G
GENR    V
TYPE    C
LTYP              16
DOCU
DATE               0
LONMAX             1
LONUTI             0
LONO               1
IADM         6149700
IADD               0
LADD               0
USE   X D
--------------------------------------------------------------------------------
JEIMPA  IMPRESSION OF THE ATTRIBUTES OF >MAT     .CPT.000001.VALK<

CLAS    G
GENR    V
TYPE    K
LTYP              16
DOCU
DATE               0
LONMAX             2
LONUTI             2
LONO               2
IADM         6133526
IADD               0
LADD               0
USE   X D
--------------------------------------------------------------------------------
JEIMPA  IMPRESSION OF THE ATTRIBUTES OF >MAT     .CPT.000001.VALR<
```

```
CLAS    G
GENR    V
TYPE    R
LTYP              8
DOCU
DATE              0
LONMAX            1
LONUTI            0
LONO              1
IADM        6122038
IADD              0
LADD              0
USE   X D
--------------------------------------------------------------------------------
JEIMPA  IMPRESSION OF THE ATTRIBUTES OF >MAT     .CPT.000002.VALC<

CLAS    G
GENR    V
TYPE    C
LTYP             16
DOCU
DATE              0
LONMAX            2
LONUTI            0
LONO              2
IADM        6048544
IADD              0
LADD              0
USE   X D
--------------------------------------------------------------------------------
JEIMPA  IMPRESSION OF THE ATTRIBUTES OF >MAT     .CPT.000002.VALK<

CLAS    G
GENR    V
TYPE    K
LTYP             16
DOCU
DATE              0
LONMAX            4
LONUTI            2
LONO              4
IADM        6168824
IADD              0
LADD              0
USE   X D
--------------------------------------------------------------------------------
JEIMPA  IMPRESSION OF THE ATTRIBUTES OF >MAT     .CPT.000002.VALR<

CLAS    G
GENR    V
TYPE    R
LTYP              8
DOCU
DATE              0
LONMAX            2
LONUTI            2
LONO              2
IADM        6167274
IADD              0
LADD              0
USE   X D
--------------------------------------------------------------------------------
JEIMPA  IMPRESSION OF THE ATTRIBUTES OF >MAT     .CPT.000003.VALC<

CLAS    G
```

```
GENR    V
TYPE    C
LTYP              16
DOCU
DATE               0
LONMAX             7
LONUTI             0
LONO               7
IADM         6096860
IADD               0
LADD               0
USE   X D
--------------------------------------------------------------------------------
JEIMPA  IMPRESSION OF THE ATTRIBUTES OF >MAT     .CPT.000003.VALK<

CLAS    G
GENR    V
TYPE    K
LTYP              16
DOCU
DATE               0
LONMAX            14
LONUTI            10
LONO              14
IADM         6121528
IADD               0
LADD               0
USE   X D
--------------------------------------------------------------------------------
JEIMPA  IMPRESSION OF THE ATTRIBUTES OF >MAT     .CPT.000003.VALR<

CLAS    G
GENR    V
TYPE    R
LTYP               8
DOCU
DATE               0
LONMAX             7
LONUTI             4
LONO               7
IADM         6048560
IADD               0
LADD               0
USE   X D
--------------------------------------------------------------------------------
JEIMPA  IMPRESSION OF THE ATTRIBUTES OF >MAT     .MATERIAU.NOMRC <

CLAS    G
GENR    V
TYPE    K
LTYP              32
DOCU
DATE               0
LONMAX             3
LONUTI             3
LONO               3
IADM         6099382
IADD               0
LADD               0
USE   X D
================================================================================
  IMPRESSION OF THE CONTENTS OF THE LOST PROPERTY:
--------------------------------------------------------------------------------

 SEGMENT IMPRESSION OF VALUES >MAT      . &&RDEP     .PROL        <
```

```
      1 - >FONCTION               <> LIN LIN                <
      3 - >EPSI                   <>TOUTRESU               <
      5 - >                       <>                       <
-------------------------------------------------------------------------------

 SEGMENT IMPRESSION OF VALUES >MAT     . &&RDEP    .VALE        <

      1 -  0.00000D+00  0.00000D+00  0.00000D+00  0.00000D+00  0.00000D+00
      6 -  0.00000D+00  0.00000D+00  0.00000D+00
-------------------------------------------------------------------------------

 SEGMENT IMPRESSION OF VALUES >MAT     .CPT.000001.VALC        <


      1 - (0.00000D+00, 0.00000D+00)
-------------------------------------------------------------------------------

 SEGMENT IMPRESSION OF VALUES >MAT     .CPT.000001.VALK        <

      1 - >SIGM           <>CTRACB          <
-------------------------------------------------------------------------------

 SEGMENT IMPRESSION OF VALUES >MAT     .CPT.000001.VALR        <


      1 -  0.00000D+00
-------------------------------------------------------------------------------

 SEGMENT IMPRESSION OF VALUES >MAT     .CPT.000002.VALC        <

      1 - (0.00000D+00, 0.00000D+00) (0.00000D+00, 0.00000D+00)
-------------------------------------------------------------------------------

 SEGMENT IMPRESSION OF VALUES >MAT     .CPT.000002.VALK        <

      1 - >RHO_CP         <>LAMBDA          <>               <
      4 - >               <
-------------------------------------------------------------------------------

 SEGMENT IMPRESSION OF VALUES >MAT     .CPT.000002.VALR        <


      1 -  0.00000D+00  1.00000D-03
-------------------------------------------------------------------------------

 SEGMENT IMPRESSION OF VALUES >MAT     .CPT.000003.VALC        <

      1 - (0.00000D+00, 0.00000D+00) (0.00000D+00, 0.00000D+00)
      3 - (0.00000D+00, 0.00000D+00) (0.00000D+00, 0.00000D+00)
      5 - (0.00000D+00, 0.00000D+00) (0.00000D+00, 0.00000D+00)
      7 - (0.00000D+00, 0.00000D+00)
-------------------------------------------------------------------------------

 SEGMENT IMPRESSION OF VALUES >MAT     .CPT.000003.VALK        <

      1 - >B_ENDOGE       <>PRECISION       <>K_DESSIC       <
      4 - >TEMP_DEF_ALPHA <>E               <>ALPHA          <
      7 - >NU             <>F_E             <>F_AL           <
     10 - >F_NU           <>                <>               <
     13 - >               <>                <
-------------------------------------------------------------------------------

 SEGMENT IMPRESSION OF VALUES >MAT     .CPT.000003.VALR        <

      1 -  0.00000D+00  1.00000D+00  0.00000D+00  2.00000D+01  0.00000D+00
      6 -  0.00000D+00  0.00000D+00
```

```
 --------------------------------------------------------------------------------

  SEGMENT IMPRESSION OF VALUES >MAT     .MATERIAU.NOMRC         <

       1 - >TRACTION                          <
       2 - >THER                              <
       3 - >ELAS                              <
 ====> FINE IMPR_CO OF STRUCTURE OF DATA: CHECHMATE     ??????????????
```