Code_Aster

Titre : Opérateur CALC_META
Responsable : Jean ANGLES

Version default

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Clé : U4.85.01 Révision : 9722

Operator `CALC_META`

1 Goal

Calculates the metallurgical evolution associated with a thermal history.

The operator functions as a postprocessing of result of thermal computation in the meaning where this last is a data "entering" of metallurgical computation and which there is not coupling between the metallurgy and the thermal. Two models of evolution are available:

- a model dedicated to the austénito-ferritic transformations of steel,
- a model dedicated to the transformations of zirconium alloys.

The computation is done with the nodes.

Result obtained could be used thereafter in data of loading of a mechanical computation thermo - with taking into account of the metallurgy. One can also at the conclusion of a computation metallurgy carry out a computation of postprocessing of hardness.

Operator reentrant, enriches a data structure `evol_ther`.

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2   Syntax

```
temper = CALC_META   (

      ◊reuse = temper,

      ♦MODELE=mo              ,
[model]

      ♦CHAM_MATER=chmat          ,
[cham_mater]

      ◊/TOUT=              "OUI',
[DEFAULT]
          /GROUP_MA     = lgrma,
[l_gr_maille]
          /MAILLE          = lma,
[l_ma]


      ♦RESULTAT=temper        ,                     [evol_ther]

      ♦ETAT_INIT=_F          (
          ♦/META_INIT_ELNO     = phasinit,            [card]

          /EVOL_THER    = temper                 [evol_ther]
              ♦/NUMÉRIQUE_INIT    = nuini_temper,      [I]
              /INST_INIT    = to,                [R]
                ◊/CRITERE      = "RELATIF"        [DEFAULT]
                    ◊PRECISION    = 1.E-6      [DEFAULT]
                              /prec          [R]
                  /CRITERE   = "ABSOLU"
                      ♦ accuracy =/prec          [R]
              ),

      ♦COMP_INCR=_F            (
          ♦RELATION  =  "ACIER",
                    /"ZIRC",
          ◊/ TOUT=            "OUI',               [DEFAULT]
            /GROUP_MA=    lgrma,
[l_gr_maille]
            /MAILLE=       lma   ,                  [l_ma]
              ),

      ◊OPTION   = |  ' DURT_ELNO',
                  |  ' DURT_NOEU',
                  |  ' META_ELNO',
                  |  ' META_NOEU',

          )
```

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3 Operands

3.1 Operands MODELS / CHAM_MATER

♦MODELE = Mo,

Name of the model whose elements are the object of metallurgical computation.

♦ CHAM_MATER = chmat,

Name of the field of the affected material on the model Mo.

3.2 Operand RESULTAT

♦RESULTAT = temper,

Name of result the evol_ther resulting from a thermal computation from which a metallurgy calculation is done. This result will be at the conclusion of the computation enriched by the metallurgical evolution of field, fields of local variables of which the number and the meaning depend on the model on transformation used (cf [§3.3.1]).

3.3 Selection of meshes concerned with computation

the key keys TOUT, GROUP_MA and MESH make it possible to the user meshes to choose on whom it wishes to do his elementary computations of postprocessing.

/TOUT all = "OUI'

meshes (carrying finite elements) will be treated. It is the value by default.

/ | GROUP_MA=l_grma
| MAILLE=l_maille

Only meshes included in l_grma and/or l_maille will be treated.

3.4 Key word COMP_INCR

♦ COMP_INCR =

Informs metallurgical evolution the model used. One cannot use that a model of evolution per computation.

3.4.1 Operand RELATION

♦RELATION=/ "ACIER",
/"ZIRC",

/ "ACIER"

Is used to specify the execution of the computation of the metallurgical transformations of steel, around $800\,°C$, of a ferritic phase (ferrite, pearlite, bainite, martensite) to an austenitic phase (and conversely with cooling). The model with the heating and cooling are different (for more detail on the models, to see [R4.04.01]).
This behavior model comprises 7 local variables:
$V1$: proportion of the phase ferrite
$V2$: proportion of the phase pearlite
$V3$: proportion of the phase bainite
$V4$: proportion of the phase martensite
$V5$: cut austenitic grain
$V6$: temperature with Gauss points.
$V7$: martensitic temperature of transformation,
the data materials necessary must be indicated in DEFI_MATERIAU under key word META_ACIER.

/ "ZIRC"

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Is used to specify the execution of computation for the metallurgical transformation (with cooling) of zirconium alloys, of a compact hexagonal phase to a cubic phase centered around $800\,°C$ (for more detail on the model, to see [R4.04.01]).

The behavior model comprises 3 local variables:

$V1$: proportion of the cold phase α

$V2$: initially without meaning and obligatorily no one; for a postprocessing, the fraction of phase α is given by $V1+V2$

$V3$: temperature with the nodes

$V4$: time corresponding is with the initial temperature of transformation to the equilibrium if the fraction of phase α is worth 1 initially, that is to say with the temperature of end of transformation to the equilibrium if the fraction of phase α is worth 0 initially. This variable is used to compute: the velocity with the heating, respectively with the cooling (method the slipping secant), which is used to determine the initial temperatures of transformation with the heating or cooling.

The data materials necessary must be indicated in `DEFI_MATERIAU` under key word `META_ZIRC`.

3.4.2 Operands `TOUT` / `GROUP_MA` / `MESH`

```
                ◊/TOUT=' OUI',
/GROUP_MA      =lgrma        ,
/MAILLE        =lma            ,
```

meshes Specify on which the model is used and allows to affect computation that on under part of the total mesh.

3.5 Key word `ETAT_INIT`

♦   `ETAT_INIT=`

♦   `/META_INIT_ELNO = phasinit,`
     `/EVOL_THER      = temper`

initial metallurgical State.

3.5.1 Operand `META_INIT_ELNO`

`/META_INIT_ELNO  = phasinit`

Defines the assignment of the constant field of local variables initial by element from a card defined by `CREA_CHAMP`. Only the variables whose initial assignment has a meaning are to be informed. One thus informs only the variables corresponding to a proportion of phase, more possibly that corresponding in keeping with austenitic grain if it is not null.
In the case of "ACIER", one informs obligatorily $V1$ $V2$ $V3$, $V4$ and $V5$ if not the code stops in fatal error.

In the case of "ZIRC", one informs obligatorily $V1$, $V2$ (equal to 0 obligatorily) and $V4$ if not the code stops in fatal error.

3.5.2 Operands `EVOL_THER` / `NUME_INIT` / `INST_INIT` / `accuracy` / `CRITERE`

```
/EVOL_THER = temper
     ♦/NUME_INIT = nuini_temper,
       /INST_INIT = to,
     ◊ /CRITERE = "RELATIF"
            ◊ accuracy =/1.E-6
```

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```
                                        /prec
              /CRITERE = ' ABSOLU'
                    ♦ accuracy =/prec
                     ),
```

Defines the concept `evol_ther` in which one will extract the initial state from which computation will be carried out. This concept must contain metallurgical quantities.
The definition of the initial state can be done by stored sequence number or time associated with computation.
`NUME_INIT` allows the definition starting from the stored sequence number and `INST_INIT` allows the definition from the time of computation.
In this case, `PRECISE DETAILS` and `CRITERE` make it possible to define the accuracy and the criterion according to which the extraction will be carried out. If `CRITERE` = "ABSOLU" is chosen, it is compulsory to inform the field `accuracy` ; for `CRITERE` = "RELATIF", an accuracy of $1.E-6$ is given by default, and can be possibly modified by informing the field `accuracy`.

3.6   Operand OPTION

◊OPTION   =

| ' DURT_ELNO'

Hardness with the nodes by element starting from the metallurgical phases (cf [R4.04.01]).

| ' DURT_NOEU'

Hardness with the nodes starting from the metallurgical phases (cf [R4.04.01]).

| ' META_ELNO'

metallurgical Proportion of phase to the nodes by elements.

| ' META_NOEU'

metallurgical Proportion of phase to the nodes.

4   Example in the case of a steel

```
# CREATION OF the FIELD OF Local variables INITIAL (FERRITE 70% AND BAINITE
30%)

phasinit = CREA_CHAMP (OPERATION = ' AFFE',
                       TYPE_CHAM = "CART_VAR2_R",
                       MAILLAGE  = mail,
                       AFFE =_F (  TOUT    = "OUI',
                               NOM_CMP = ("V1", "V2", "V3", "V4", "V5"),
                               VALE    = (0.7, 0.0, 0.3, 0.0, 0.))),

# CALCUL OF the EVOLUTION THERMAL

temple = THER_LINEAIRE (  MODELS    = moth,
                       CHAM_MATER = chmat,
                       EXCIT     = _F (CHARGE=   chth1),
                       INCREMENT = (LIST_INST= lr8),
                       TEMP_INIT = (VALE=  700),)

# CALCUL OF the EVOLUTION OF the METALLURGICAL PHASES

temple = CALC_META (   reuse      = temple,
                   MODELS     = moth,
```

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```
CHAM_MATER = chmat,
RESULTAT  = temple,
ETAT_INIT  =_F (META_INIT_ELNO = phasinit),
COMP_INCR  = (RELATION = ' ACIER',
TOUT       = "OUI'))
```