Code_Aster

Titre : Opérateur CALC_THETA
Responsable : GÉNIAUT Samuel

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Operator CALC_THETA

1   Goal

To define a field theta for the calculation of the rate of refund of energy and stress intensity factors.

Within the framework of the breaking process, this operator allows to define on all the nodes of the grid:

- the module of the field theta,
- in 2D direction of propagation of the bottom of crack (equalizes with that of the field theta) with the keyword DIRECTION,
- in 3D direction of the field theta calculated automatically starting from the directions of propagation of the nodes in bottom of crack. These directions are recovered by the concept of the type fond_fiss (produced by the operator DEFI_FOND_FISS), or by the keywords DIRE_THETA or DIRECTION,
- rays $Rinf$ and $Rsup$ crowns surrounding the bottom of crack and used to define the field theta geometrically.

In 2D the bottom of crack is tiny room to a node and the crowns are circular. In 3D the rays can be variable with the curvilinear X-coordinate of the bottom of crack and $Rinf$, $Rsup$ two deformed and variable cylinders define then surrounding the bottom of crack.

The field theta is used in the order CALC_G [U4.82.03] for the calculation of the parameters characteristic of the breaking process. The field theta can be directly defined besides in this operator.

The produced concept is of type cham_no_sdaster.

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2   Syntax

```
theta [cham_no_sdaster] = CALC_THETA

(  ◊   OPTION = /   'CROWN',                          [DEFECT]
                 /   'BAND',
    ♦   MODEL = Mo,                                   [model]
    ♦   /  ♦   FOND_FISS = FF,                        [fond_fiss]
           ♦   THETA_3D = _F ( ♦  /   ALL     = 'YES',
                                   /   GROUP_NO = lgno , [l_gr_noeud]
                                   /   NODE    = lno, [l_noeud])
                               ♦  / ♦  MODULE    = theta , [R]
                                  ◊   R_INF     = R,   [R]
                                  ◊   R_SUP     = R,   [R]
                                  / ♦  MODULE_FO = thetaZ, [function]
                                  ♦  R_INF_FO  = rz, [function]
                                  ♦  R_SUP_FO  = Rz, [function]
                           ),
       /   ♦   THETA_2D  = _F (  ♦  /   GROUP_NO = gno,    [l_gr_noeud]
                                   /   NODE    = No ,     [l_noeud])
                               ♦   MODULE = module,       [R]
                               ♦   R_INF  = rinf,         [R]
                               ♦   R_SUP  = rsup,         [R]
                           ),
    ◊   /   DIRECTION =  (  d1, d2, d3),                [l_R]
        /   DIRE_THETA   = chamno ,                     [cham_no_sdaster]
    ◊   IMPRESSION=_F(  ◊   FORMAT =  /  'EXCEL',       [DEFECT]
                                      /  'AGRAF',
                        ◊   UNIT   =  /  8,             [DEFECT]
                                      /  links,         [I]
                     )
)
```

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3   Operands

This manner of introducing the field θ is geometrical [R7.02.01]. It amounts giving itself two rays R_{inf}, R_{sup}, and $|\theta|$ in each node of the bottom of crack by the keyword factor `THETA_3D` or `THETA_2D`. One carries out calculations of distance from a knot slip at the bottom of crack to determine the value of θ in this node.

More precisely, in any node of the bottom of crack Γ_0, located by its curvilinear X-coordinate S, one can define a normal plan P in which the field θ is introduced in such way that after being itself given 2 volumes T and S (deformed cylinders) surrounding the bottom of crack, one a:

- $|\theta| = \theta_0 = cste$ in $T(R_{inf})$
- $|\theta|$ vary linearly compared to the ray in the crown $S(R_{sup})/T(R_{inf})$
- $|\theta| = 0$ outside $S(R_{sup})$
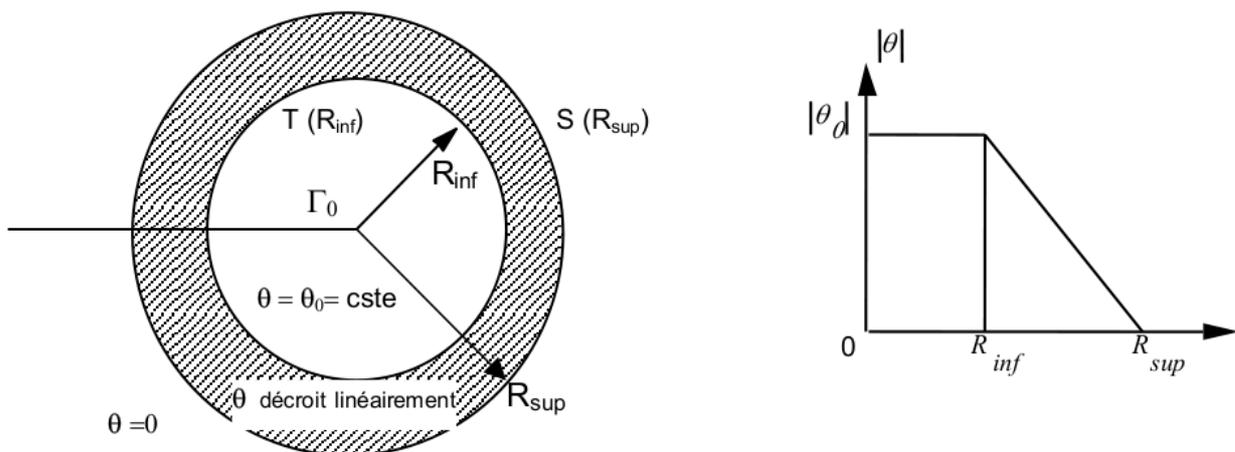
3.1   Operand MODEL

♦   MODEL = Mo,
Name of the concept `model` who defines the elements on which the field is calculated θ.

3.2   Breaking process - 3D problem

3.2.1   Operand FOND_FISS

/   ♦   FOND_FISS = FF,
Name of the concept FF of type `fond_fiss`, product by the order `DEFI_FOND_FISS`, container:

- the ordered list of the nodes describing the bottom of crack,

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- the list of the meshs describing the upper lip of the crack,
- the list of the meshs of the lower lip of the crack if this one exists (case of a nonsymmetrical problem).

3.2.2 Operand THETA_3D

/ ♦ THETA_3D =

Defines the nodes or the groups of nodes entirely describing the bottom of crack where one affects the rays of the crown and the module of θ .
The whole of the nodes of the bottom of crack is specified by the operands:

/ ALL = taking into account of the totality of the nodes of the bottom of crack.
/ GROUP_NO = taking into account of a under-part of the bottom of crack made up of the list of groups of nodes specified.
/ NODE = taking into account of a under-part of the bottom of crack made up of the list of the nodes specified.

Two rays defining the crown and the module of θ can be introduced either by constant actual values which are arguments of the simple keywords R_INF, R_SUP and MODULE ; maybe by functions of the curvilinear X-coordinate on the bottom of crack directed, which are arguments of the simple keywords R_INF_FO, R_SUP_FO and MODULE_FO.
When the rays are not function of the curvilinear X-coordinate, operands R_INF and R_SUP are optional. If they are not indicated, they are automatically calculated starting from the maximum H sizes of meshs connected to the nodes of the bottom of crack. These sizes of meshs in each nodes of the bottom are calculated in the order DEFI_FOND_FISS and are present in the concept fond_fiss [D4.10.01]. It was selected to pose R_SUP = 4:00 and R_INF = 2:00. If one chooses the value automatically calculated for R_SUP and R_INF, it is advisable however to make sure that these values (displayed in the file .mess) are coherent with dimensions of the structure.

3.2.3 Operands DIRE_THETA and DIRECTION

/ DIRECTION = (d1, d2, d3),

List of the values of the three components of the direction of the field θ on the bottom of crack when this one is not calculated.

/ DIRE_THETA = chamno ,

Allows to introduce in 3D the direction of the field θ on all the nodes of the bottom of crack by the means of one CREA_CHAMP precondition.

These options are optional: by defaults these directions are calculated automatically starting from the concept FF resulting from the order DEFI_FOND_FISS [U4.82.01] (normal at the bottom of crack in the plan of the lips). If the direction is given, it must be orthogonal with the normal with the lips of the crack, which is defined in the operator DEFI_FOND_FISS (keyword NORMAL).

3.3 Breaking process - problem 2D

3.3.1 Operand THETA_2D

/ ♦ THETA_2D =

Keyword factor defining the node of the bottom of crack:
/ GROUP_NO = gno (group of nodes limited to a node)
/ NODE = No

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The module of θ and the two rays are arguments of the simple keywords MODULE, R_INF, R_SUP.

3.3.2 Operand DIRECTION

/ DIRECTION = (d1, d2, d3),

List of the values of the three components of the direction of the field θ on the bottom of crack when this one is not calculated. In 2D this keyword is obligatory: it is necessary to provide a vector of the form (d1, d2, 0).

The direction must be orthogonal with the normal with the lips of the crack, which can be defined in the operator DEFI_FOND_FISS (keyword NORMAL).

3.4 Operand IMPRESSION

◊ FORMAT= / 'EXCEL' ,   [DEFECT]
                / 'AGRAF' ,
◊ UNIT = / 8 ,   [DEFECT]
                / links,

Keyword factor allowing to print on the logical file of unit links (para defect 8) for each node of the bottom of crack rinf, rsup, the module and direction of the field theta. The format 'AGRAF' allows post-to treat the impression by Agraf.

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4 Examples

4.1 Assignment of a field θ in 2D by actual values

One affects on the node of the bottom of crack $|\theta|=1$ R_INF = 1 and R_SUP = 2

```
THET2 = CALC_THETA (   MODEL      = Mo,
                     THETA_2D =_F (  NODE  = ('NO29'),
                              MODULE = 1. , R_INF = 1. , R_SUP =
2.),
                     DIRECTION  = (1. , 1. , 0.),
                )
```

with Mo the concept model product by the order AFFE_MODELE.

4.2 Assignment of a field θ in 3D by actual values

On the bottom of crack one affects on all the nodes $|\theta|=1$, $R_{INF}=2.$ and $R_{SUP}=5.$ by constant actual values.

Direction of the field θ is given on each one of these nodes, it is worth $(1.0.0.)$.

```
THET3 = CALC_THETA (  OPTION     = ' COURONNE', MODELS =MO,
                     FOND_FISS =ff1,
                     THETA_3D  =_F (ALL = 'YES',
                              MODULE = 1. , R_INF = 2. , R_SUP =
5.),
                     DIRECTION = (  1. , 0. , 0.),
                )
```

with Mo the concept model product by the order AFFE_MODELE.
ff1 the concept of the type fond_fiss product by the order DEFI_FOND_FISS.

4.3 Assignment of a field θ in 3D by actual values and function with rule of overload

•On the bottom of crack one affects on the group of nodes *GRN1* , $|\theta|=1$. $R_{inf}=2.$ and $R_{sup}=5.$ by constant actual values, and on the group of nodes *GRN2* , $|\theta|$, R_{inf} and R_{sup} by functions.

Direction of the field θ is calculated automatically with the nodes of the bottom of crack.

```
THETA1 = CALC_THETA ( OPTION   = 'CROWN', = Mo MODELS,
                     FOND_FISS =ff1,
                     THETA_3D = (_F (GROUP_NO = 'GRN1',
                              MODULE = 1. ,
                              R_INF = 2. , R_SUP = 5.),
                             _F (GROUP_NO = 'GRN2',
                              MODULE_FO=fo,
                              R_INF_FO=f 1,R _SUP_FO=f2),
                )
```

with:

Mo the concept model product by the order AFFE_MODELE.
ff1 the concept of the type fond_fiss product by the order DEFI_FOND_FISS.

GRN1 = {NO3 NO7 NO10}, GRN2 = {NO13 NO15}

The bottom of crack is made up by the nodes: *NO3* , *NO7* , *NO10* , *NO13* , *NO15* in an ordered way.

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`f0, f1, f2` are respectively the functions defining $|\theta|$ and two rays of the crowns for $GRN2$ products by the order `DEFI_FONCTION`.

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Note:

|*GRN1 and GRN2 must completely describe the bottom of crack represented in the concept* `ff1` *.*

• On the bottom of crack one affects $|\theta|$, R_{inf} and R_{sup} by function except with the nodes *NO29* and *NO15* where one affects $|\theta|=1.$ $R_{INF}=2.$ $R_{SUP}=3.$ by constant actual values.

Direction of the field θ is calculated with the nodes of the bottom of crack.

```
    THETA2 = CALC_THETA ( OPTION   = ' COURONNE', MODELS = Mo, FOND_FISS
=ff3,
                         THETA_3D =_F (ALL = ' OUI'
                               MODULE_FO=fa,
                               R_INF_FO=fb, R_SUP_FO=fc),
                              _F (NODE = ('NO29', 'NO15'),
                               MODULE = 1. ,
                               R_INF = 2. , R_SUP = 3.  ),),
                    )
```

with:

`Mo` the concept `model` product by the order `AFFE_MODELE`.

`ff3` the concept of the type `fond_fiss` product by the order `DEFI_FOND_FISS`.

`F, Bfr, FC` are respectively the functions defining $|\theta|$ and two rays of the crowns for all the bottom of crack, produced by the order `DEFI_FONCTION`.

Note:

|*The rule of overload applies here for the nodes of the bottom of crack* *NO29* *and* *NO15* *.*