

Operator DEFI_FOND_FISS

1 Goal

To define the geometric standards relative to a crack, in particular the bottom of crack and the upper lips and lower of this crack, in a grid 2D or 3D.

The definition of the bottom of the crack can be done starting from entities (nodes or meshes) or starting from groups of entities. The nodes can be ordered in the direction of the increasing curvilinear X-coordinates. If it is not the case and if the bottom of crack is given by a list of meshes or groups of meshes, the operator will order the nodes with the help of the definition of a node origin.

Two initial configurations of the upper lips and lower are takenS in account for the definition of the direction of propagation and the lips.

This operator creates a concept of the type `fond_fiss` who is usable by the operators `CALC_G` [U4.82.03] and `POST_K1_K2_K3` [U4.82.05].

2 Syntax

```
FF [fond_fiss] = DEFI_FOND_FISS (

♦ GRID = my , [grid]
◇ INFORMATION = / 1,
  [DEFECT]
  / 2,

# For the definition of a bottom of crack
♦ / FOND_FISS = _F (

# A kind of bottom is defined

◇ TYPE_FOND = / 'OPENED', [DEFECT]
  / 'FIRM',

# In 2D: one defines a group containing a single node

♦ / GROUP_NO = grno, [gr_noeud]

# In 3D: one defines a list of meshes whose nodes can be already ordered or not

/ GROUP_MA = grma, [gr_maille]

# In this last case it is then necessary to define an origin of the X-coordinates

◇ / NOEUD_ORIG = No , [node]
  / GROUP_NO_ORIG= grno, [gr_noeud]

# If GROUP_MA is defined and if the bottom is not closed, one can then define an end of the X-
coordinates
◇ / NOEUD_EXTR = No , [node]
  / GROUP_NO_EXTR = grno,
[gr_noeud]

# If GROUP_MA is defined and if the bottom is closed, one can then define one direction X-
coordinates curvilinear crescents

◇ / MESH_ORIG = No , [node]
  / GROUP_MY_ORIG = gr. my , [gr_
mesh ]

# For the definition of the initial configuration of the lips

◇ / CONFIG_INIT = / 'COLLEE', [DEFECT]
  / 'DECOLLEE',

# Symmetry of the structure
♦ SYME = / 'NOT',
  / 'YES',

Définition of the lips of the crack
♦ LEVRE_SUP = _F (
  ♦ / MESH = lma, [l_mesh]
  / GROUP_MA = lgrma, [l_gr_maille]
  ),
```

If the structure is not symmetrical, the lower lip should be defined

```
◆ LEVRE_INF = _F (
  ◆ / MESH = lma, [l_mesh]
  / GROUP_MA = lgrma, [l_gr_maille]
```

If the initial configuration is DECOLLEE : definition of the normal

```
◆ NORMAL = (Nx, Ny, Nz) [l_R]
```

```
◇ PREC_NORM = / 1.E-1, [DEFECT]
              / epsi, [R]
```

```
)
```

3 Operands

3.1 Operand GRID

◆ GRID = my

Name of the grid on which one will define the bottom of crack and the lips.

3.2 Description of the bottom of crack

The bottom of crack is defined by the whole of the ordered nodes of the bottom of crack. If none the keywords `NOEUD_ORIG` or `GROUP_NO_ORIG` is not defined, the order of declaration of these nodes, via meshes segments, will define the direction of course of the curvilinear X-coordinate of the bottom of crack. Load is thus left to the user compose an ordered list, within the meaning of the connectivity of the grid, by increasing curvilinear X-coordinate.

It is also possible to provide a list of meshes segments without worrying about the order. The data of a node origin, provided that it corresponds well at an end of the way defined by the meshes segments, then makes it possible to order the list of nodes.

In addition, in 3D, for a knot slip of the bottom of crack, the direction of propagation is defined as being the average of the normals to the meshes segments of the bottom of crack on its left and its right-hand side. For the nodes ends, the normal is calculated starting from one only mesh, and can thus be less precise.

The code thus envisages a correction of this normal by taking of account the edges of the structure.

3.2.1 Keyword factor FOND_FISS

3.2.1.1 Keyword TYPE_FOND

There is two possibilities to define the bottom of crack:

- 1) SI it bottom of crack is defined by an open curve (in opposition to the bottom defined by closed curve), one informs `TYPE_FOND = 'OPEN'`. This value is the value by default.
- 2) If the bottom of crack is defined by a closed curve, one inform `TYPE_FOND = 'FIRM'`.

3.2.1.2 Keyword GROUP_NO

/ ◆ GROUP_NO = grno

This keyword can be used only in 2D.

One expects a group containing a single node corresponding to the bottom of crack.

This keyword can be used only in 2D.

3.2.1.3 Keyword GROUP_MA

/ ◆ GROUP_MA = grma

This keyword can be used only in 3D.

Groupe of meshes of the type `SEG2` or `SEG3`, ordinates or not compared to the bottom of crack.

3.2.1.4 WordS- keyS NO_ORIG/GROUP_NO_ORIG

/ NO_ORIG = No
/ GROUP_NO_ORIG = grno

Single node, or Groupe of node, containing a single node. To be an end of the way defining the bottom of crack, it must rest on one and only one nets `grma`. This keyword can be defined only if `GROUP_MA` is defined. This keyword can be used only in 3D.

3.2.1.5 Keyword NO_EXTR/GROUP_NO_EXTR

```
/ NO_EXTR = No  
/ GROUP_NO_EXTR = grno
```

Single node, or Groupe of node, containing a single node. This data is optional and is only used to check that the node end obtained by the operator is well that of which the user thinks. The code will stop in error if it is not the case. This keyword can be defined only if `NO_ORIG/GROUP_NO_ORIG` is defined. This keyword can be used only in 3D.

3.2.1.6 Keyword MAILLE_ORIG/GROUP_MY_ORIG

```
/ MESH_ORIG = my  
/ GROUP_MY_ORIG = gr.my
```

Single mesh, or Groupe of mesh, containing oneE mesh single. This data, obligatory in the case of a face closed in 3D, allows, jointly with the keywords `NO_ORIG/GROUP_NO_ORIG` to define a direction of course of the face of crack by curvilinear X-coordinates crescents. This direction goes from the node defines by `NO_ORIG/GROUP_NO_ORIG` with the second node end of the mesh defined by `MESH_ORIG/GROUP_MA_ORIG`.

3.3 Description of the lips

Two initial configurations are treated:

- 1) if the lips are stuck
- 2) if the lips are separated

In the case of stuck lips, two cases are distinguished:

- if the grid is complete then the algorithm require the definition of the upper lips and lower.
- if the grid is to be supplemented by symmetry compared to the average plan of the lips then the algorithm requires only definition DE the upper lip.

Direction of propagation of the crack and the normal with the plan of the crack are calculatedS for each node of the bottom of crack.

In the case of separated lips, it is necessary to give the normal to the plan of the crack using the operand `NORMAL` (2D and 3D for the plane cracks only).

For a posterior use in `POST_K1_K2_K3` (keyword `FOND_FISS`), the lips must necessarily be stuck .

For the nonplane cracks 3D, the direction of propagation of the crack in any point of the bottom of crack is built in this operator and is used by the operator `CALC_G` [U4.82.03].

Currently, calculations of breaking process by `CALC_G`, `POST_K1_K2_K3` or other are not possible for defects 3D not plans and whose lips are separated.

3.3.1 Keyword CONFIG_INIT

The initial configuration is that described by the grid. The lips are:

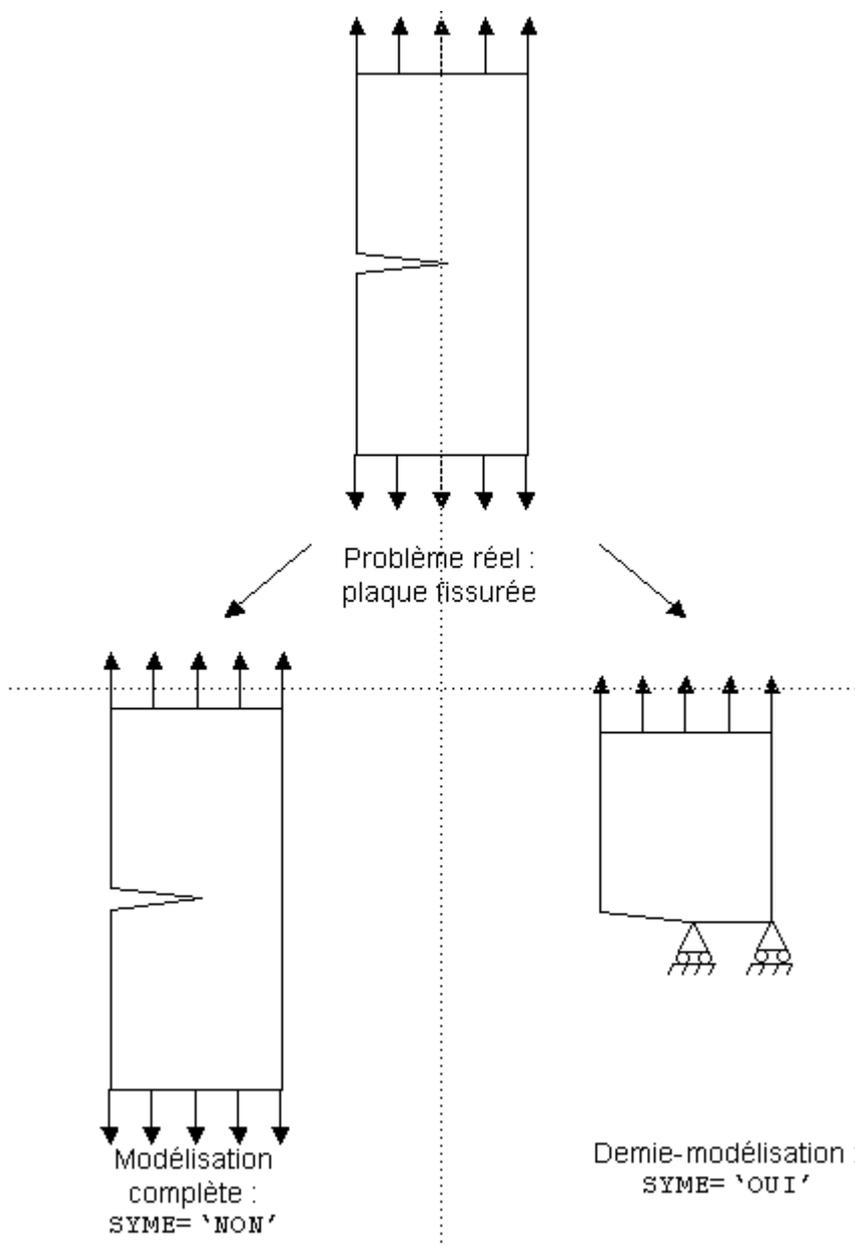
1. stuck if the angle between the 2 lips is lower or equal to 5°;
2. taken off in the contrary case.

Note: The calculation of the factors of intensity of the constraints with the operator `POST_K1_K2_K3` [U4.82.05] , or with the option `'K'` of the operator `CALC_G` [U4.82.03] , can be carried out only if `CONFIG_INIT='COLLEE'` .

3.3.2 Keyword SYME

This keyword makes it possible to specify if modeling used takes account of a symmetry of the structure compared to the average plan of the lips of the crack (see Figure 3.1). If `SYME = 'YES'` , the value of the rate of refund of energy `G` (S) and those of the factors of intensity of the constraints corresponding to the mode of symmetry will be automatically multiplied by 2 and that of `G_Irwin` by 4 (see [U4.82.03] for `CALC_G` and [U4.82.05] for `POST_K1_K2_K3`).

If `SYME = 'YES'` and `CONFIG_INIT='COLLEE'` , definition of upper lip of the crack (`LEVRE_SUP`, §3.3.3) allows of knowing of which with dimensions of the bottom the crack is located.



3.3.3 Keyword LEVRE_SUP

◇ LEVRE_SUP =

The whole of the faces of the elements defines which are pressed on the upper lip of the crack. The whole of these faces is specified by the operands:

MYISLAND = Lmy list meshes.
GROUP_MA = L grma list of G roupe S meshes.

The meshes are thus surface if the model is 3D and linear if the model is 2D.

3.3.4 Keyword LEVRE_INF

◇ LEVRE_INF =

The whole of the faces of the elements defines which are pressed on the lip lower crack. If the crack is on a symmetry plane, this keyword should not be indicated.

The whole of these faces is specified by the operands:

MYISLAND = Lmy list meshes.
GROUP_MA = L grma list of G roupe S meshes.

The meshes are thus surface if the model is 3D and linear if the model is 2D.

3.3.5 Operand NORMAL

This operator is to be defined only in the case of a crack in the separated lips (CONFIG_INIT='DECOLLEE') . That relates to the cases of open defect or notch.

The keyword NORMAL is used to specify the normal vector with the plan of these lips, therefore with the crack itself. This vector is used in any point of the bottom of crack to determine the direction of propagation and thus supposes that the crack is plane. The normal is then not the normal with the lips, but with the plan of propagation (symmetry plane).

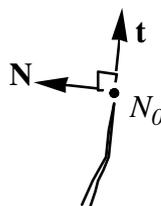
/ ◆ NORMAL = (Nx, Ny, Nz)

The keyword NORMAL allows to introduce the components Nx, Ny, Nz in the total reference mark of a normal \bar{N} with the plan of the crack with the following convention of direction:

- In 3D, $n = \Gamma_0 \wedge N$, where n is the normal external with the crack in the plan of the lips, Γ_0 is the bottom of crack directed (defined by the keyword FOND_FISS),
- in 2D, the normal \bar{N} is defined such as the reference mark (N_0, t, N) that is to say direct, with:

N_0 the node of the bottom of crack,

t direction of propagation of the crack.



In all the cases, \bar{N} is normalized automatically. It is necessary to give the three components of the vector even in 2D.

3.4 Operand `PREC_NORM`

This operand is useful only in the case 3D, before a calculation with `POST_K1_K2_K3` [U4.82.05].

The parameter `PREC_NORM` the precision used in the research of the nodes of the lips defines which are on normal directions at the bottom of crack: for the interpolation of the jumps of displacement, one indeed uses the nodes of which the distance D with the normal right-hand side at the bottom and passing by a node of this bottom checks:

$$d < \text{PREC_NORM} \cdot l_f$$

where l_f is the minimal distance between two successive nodes of the bottom of crack. To increase the value of `PREC_NORM` come down to increase the number of nodes potentially retained for the calculation of $\bar{\kappa}$ in `POST_K1_K2_K3`.

4 Examples

4.1 Whole crack defined by various types of entities in 3D

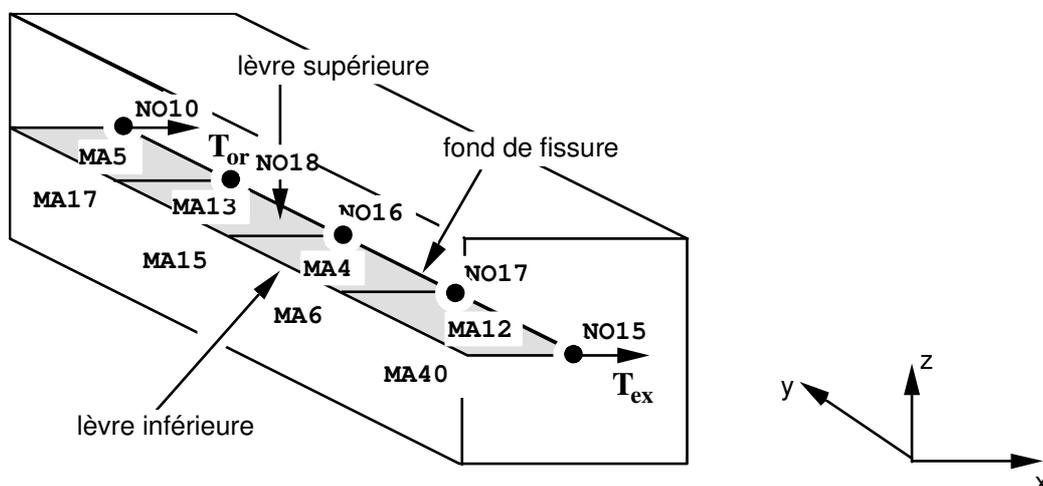
The bottom of crack is defined by one group of meshes, the upper lip by a list of meshes, the lower lip by a list of groups of meshes.

```
Fiss1 = DEFI_FOND_FISS (GRID = my,
                        FOND_FISS = _F (GROUP_NO = ('GMFOND'),
                        LEVRE_SUP = _F (GROUP_MY = ('GM123')),
                        LEVRE_INF = _F (GROUP_MA = ('GRM1','GRM2')),
                        )
```

with the following groups defined in the grid `my` :

```
GRN1: {N010 N018}          GRN2: {N018 N016 N017}
GRN3: {N017 N015}
GRM123: {MA5, MA13, MA4, MA12}
GRM1: {MA17 MA15 MA6}    GRM2: {MA40}
```

The bottom of crack is made up here group of meshes `GMFOND` connecting `Lbe` nodes `N010`, `N018`, `N016`, `N017`, `N015` in an ordered way.



4.2 Use of the operand NORMAL (plane crack DECOLLEE in 3D)

```
fiss = DEFI_FOND_FISS ( GRID          = my,
                        FOND_FISS = _F (GROUP_NO='GMFOND',
                        CONFIG_INIT=' DECOLLEE',
                        NORMAL       = (0. , 0. , - 1.)),
                        )
```

The normal is defined N with the plan of the crack.

Direction n normal at the bottom of crack in the plan of the lips of the crack is determined by

$$n = \Gamma_0 \wedge N \cdot$$

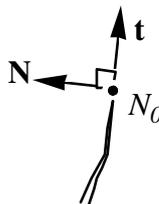
4.3 Crack in 2D

The bottom of crack is defined by the node N10 grid my. This node east constitutes the single node of the group GN10 The groups of the meshes of the lips are noted respectively GMSUP and GMINF. The crack can be defined is starting from the normal:

```
fiss = DEFI_FOND_FISS ( GRID = my,
                        FOND_FISS = _F (GROUP_NO = 'GN10'),
                        CONFIG_INIT = 'DECOLLEE',
                        NORMAL = (- 1. , 1. , 0.)),
                        )
```

maybe starting from the meshes of the lips:

```
fiss = DEFI_FOND_FISS ( GRID = my,
                        FOND_FISS = _F (GROUP_NO = 'GN10'),
                        LEVRE_SUP = 'GMSUP',
                        LEVRE_INF = 'GMINF',
                        )
```



4.4 Fund of crack closed with scheduling of nodes

```
fiss = DEFI_FOND_FISS ( GRID          = my,
                        FOND_FISS = _F (TYPE_FOND=' FERME',
                        GROUP_MA=' GMA',
                        GROUP_NO_ORIG = 'NO',
                        GROUP_MA_ORIG = 'GMA2'      ),
                        CONFIG_INIT = 'DECOLLEE',
                        NORMAL       = (0. , 0. , - 1.)),
                        )
```

with GMA: {MA1, MA2, MA3,...}, GMA2: {MA2}

The normal is defined \underline{N} with the plan of the crack. Direction \underline{n} normal at the bottom of crack in the plan of the lips of the crack is determined by $\underline{n} = \underline{\Gamma}_o \wedge \underline{N}$.

The order of declaration of the meshes in the list does not have any importance. The operator checks that the node NO belongs well to the mesh MA2 and that the whole of the meshes segments provided form well a closed related curve. The order of the nodes in the produced concept will be that given by the arrow of the drawing below, on the basis of NO .

