# Data structures FOND_FISS

**Summarized:**

This document by the operator describes the data structure fond_fiss produced DEFI_FOND_FISS [U4.82.01] and used by the operators of fracture mechanics CALC_THETA [U4.82.02], CALC_G [U4.82.03] and POST_K1_K2_K3 [U4.82.05].

# 1 General information

an object of the fond_fiss `type` describes a crack tip of a mesh 3D or 2D (in this case, the crack tip is tiny room to a node). This concept is obligatorily produced by the operator `DEFI_FOND_FISS` [U4.82.01].

# 2 Relations with other data structures

a concept `fond_fiss` is defined on a mesh, via the entities `NOEUD, GROUP_NO, MESH, GROUP_MA` describing crack.

# 3 Tree structure of the data structure `fond_fiss`

```
fond_fiss  (K8)  :: =record

   ♦   ' .INFO'           :  SVK8

   #si the bottom is defined by only one nodes group or of meshes
   ◊   ' .FOND.NOEU': SVK8                    #SI

   the bottom is defined by a bottom sup and a bottom inf ◊
   ".FONDINF.NOEU  ": SVK8       ◊         '.
   FONDSUP.NOEU': SVK8 ♦      '  .FONDFISS

      ": SVR ♦"        .FOND.TYPE
   "  : SVK8 #SI              THE BOTTOM

   IS defined on auxiliary grid the ◊" .fondFISG
   ":  SVR #SI CONFIGURATION_

   INIT=' DECOLLEE" in DEFI_FOND_FISS ◊ ' .normale
   ": SVR  #SI CONFIGURATION_

   INIT=' COLLEE" in DEFI_FOND_FISS ◊ ' .basefond
   ":  SVR ◊"              .LTNO'   :
   CHAM_NO    ◊            '  .LNNO':
   CHAM_NO    ◊            '  .BASLOC
   ": CHAM_NO    ◊           "   .FOND.TAILLE
      _R': SVR ◊ '           .DTAN_ORIGINE

      ": SVR ◊"            .DTAN_EXTREMITE
      ": SVR #SI LEVRESUP

   is present in DEFI_FOND_FISS ◊" .levresup.mail
      ": SVK8 ◊" .SUPNORM.NOEU
   ": SVK8    #SI LEVRESUP        IS

   PRESENT in DEFI_FOND_FISS ◊" .levreinf.mail':
   SVK8    ◊ ' .INFNORM.NOEU'    :  SVK8
   CONTAINED  OF BASIC
```

# 4 JEVEUX objects ".INFO" : `Vector` (K8)

`containing` information on crack ".fond.noeu": vector (K8

| | | |
|---|---|---|
| ) CONTAINING | | the list of N the ordered nodes of the crack tip ".fondinf.noeu": vector (K8 |
| ) CONTAINING THE LIST | | of N the ordered nodes of the bottom and pertaining to the lower crack lip ".fondsup.noeu": vector (K8) containing |
| THE LIST | | of N the ordered nodes of the bottom and pertaining to the crack upper lip ".FONDFISS": vector of realities |
| CONTAINING | | the coordinates as well as the curvilinear abscisses of the nodes of the bottom. ".FONDFISG": vector of realities |
| CONTAINING | | the coordinates as well as the curvilinear abscisses of the nodes of the bottom on auxiliary grid. ".basefond": vector of 6*N real |
| CONTAINING | | the components of the vector of propagation of crack and the normal vector to the average plane of the lips locally to each node of the crack tip. ".normale": vector of 3 realities |
| CONTAINING | | the components of the norm to the plane of the lips $(n_x, n_y, n_z)$ (case of a crack planes) (see sign convention in [U4.82 .01 §3.4]) ".dtan_origine": vector of 3 realities |
| CONTAINING | | the components of the tangent to structure in the beginning of the crack tip, in the plane of the lips (see sign convention in [U4.82 .01 §3.5]) ".dtan_extremite": even thing |
| THAT .DTAN_ORIGINE | at | the end of crack tip ".BASLOC": field at nodes (CHAM_NO |
| ) CONTAINING | | the origin and the vectors of the local base to crack tip ".LTNO": field at nodes (CHAM_NO |
| ) SCALAR | | which contains for each node of the mesh the actual value of the level set tangent to crack. ".LTNO": field at nodes (CHAM_NO |
| ) SCALAR | | which contains for each node of the mesh the actual value of the level set norm to crack. ".levresup.mail": vector (K8) containing |
| THE LIST OF | | meshes of the upper lip of crack ".levreinf.mail": vector (K8) containing |
| THE LIST OF | meshes | of the lower lip of crack ".supnorm.noeu": vector (K8) containing |
| THE LIST OF THE NODES | | of the upper lip on the normal direction than the crack tip ".infnorm.noeu": vector (K8) containing |
| THE LIST OF THE NODES | of | the lip lower on the normal direction than crack tip ".FOND.TAILLE_R": vector of realities containing |
| FOR EACH | | node of the bottom, an estimate of the size according to the radial direction, of meshes which are connected to them. Contents of the objects of the sd_fond_fiss General information |

# 5 .INFO Vector of K8 length

## 5.1 3: V (1) contains

### 5.1.1

the value of key word CONFIG_INIT
of DEFI_FOND_FISS: "DECOLLEE" or "COLLEE " V ( 2) contains the value of key word SYME of
DEFI_FOND_FISS: "OUI' or "NON" V (3) specifies if the bottom is opened or closed
: "OUVERT" or "FERME" Description of the entities of the crack tip

## 5.2 the list of the names of the ordered nodes of the crack tip

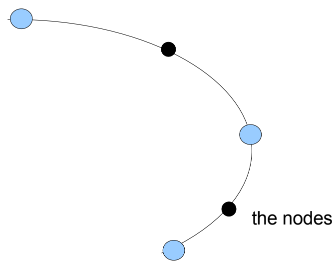
is given either by: vector .FOND.NOEUD if the crack tip
- is simple vectors .FONDINF.NOEUD and .FONDSUP.NOEUD
- if the crack tip is double . The bottom is simple if it consists of a set of

contiguous nodes in an element. The bottom is double if it consists of two
sets distinct from contiguous nodes in an element. Each node of a group is colocalisé with a node of the second group. .FOND.NOEUD This vector contains all

### 5.2.1 the nodes describing

the crack tip. These nodes constitute the intersection of the nodes of the lips lower and higher. In the quadratic case, the convention of

the scheduling of the nodes is not the same one as in the connexity of meshes. In other words, this one does not take account owing to the fact that the node is top or not. For example, if the nodes, and are nodes tops, vector $N_a$ .FOND $N_c$ $N_e$ .NOEU will be: N1NaNcNbNdNe .FONDINF.NOEUD This vector contains
$(N_a, N_b, N_c, N_d, N_e,)$




### 5.2.2 describing

the crack tip and pertaining to the lower lip. No node is common to .FONDSUP.NOEU. .FONDSUP.NOEUD This vector contains the nodes

### 5.2.3 describing

the crack tip and pertaining to the upper lip. No node is common to .FONDINF.NOEU. .FONDFISS vector .FONDFISS is a vector

### 5.2.4 of realities

containing the coordinates of the nodes of the crack tip. The points are ordered according to the order given in .FOND.NOEUD in the case of a simple bottom or .FONDSUP .NOEU in the case of a double bottom , so that a curvilinear abscisse can be defined.
If NFON is the number of nodes of the crack tip
, then the length of vector .FONDFISS is 4xNFON. For each point of the crack tip
, the first 3 components correspond to the 3 coordinates (in 3D) of the point, and the fourth component is its curvilinear abscisse. This structure N" is not modified in 2D.
However one uses only the first 2 components, because neither the curvilinear abscisse
nor the last geometrical component are relevant in 2D. In 3D, when the bottom is closed,
the last
point is equal to the first. The last 4 terms of vector .FONDFISS are then identical to the 4 first . .FONDFISG vector .FONDFISG is a vector

### 5.2.5 of realities

containing the coordinates of the nodes of the crack tip defined on auxiliary grid. If
NFON is the number of nodes of the crack tip
on auxiliary grid, then the length of vector .FONDFISG is 4xNFON. For each point of the crack tip , the first 3 components correspond to the 3 coordinates (in 3D) of the point, and the fourth component is its curvilinear abscisse. This structure is created only when
one uses the methods Upwind or Simplex in 3D for the update of level sets. .TYPE This type is worth the character string:

### 5.2.6 "NOE2"

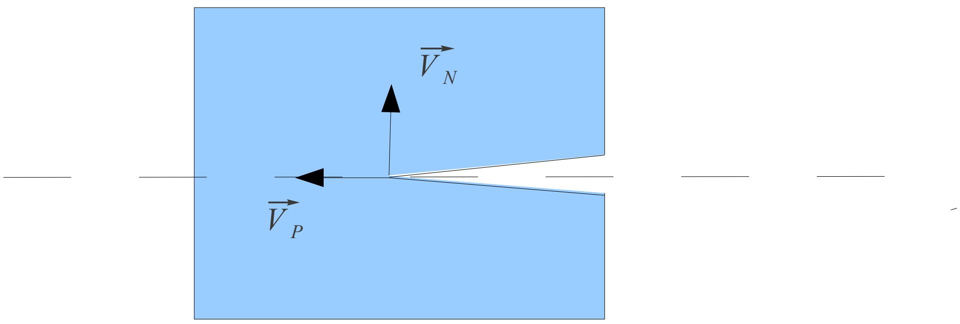
or "SEG2" if meshes connected

- to the crack tip are all linear. "NOE3" or "SEG3" if not Description of the references
- related to crack tip

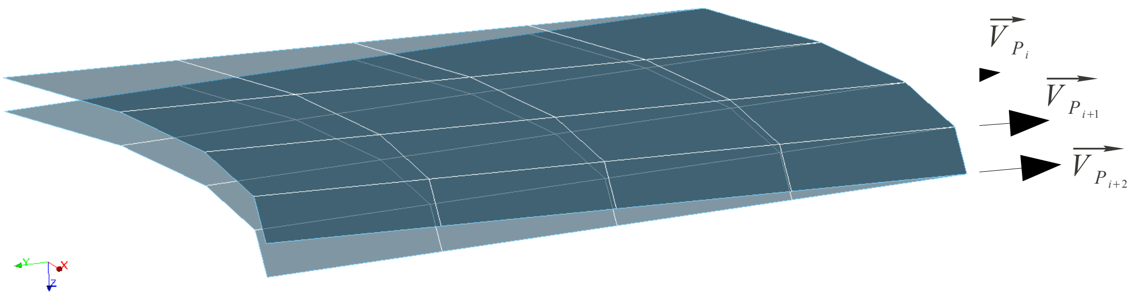
## 5.3 .BASEFOND In 2D, vector .BASEFOND

### 5.3.1 consist

of 6 real components . The three first are those of the vector of propagation of crack. The three last constitute the norm $\vec{V}_P$ formulated. In 3D, vector .BASEFOND consists $\vec{V}_N$



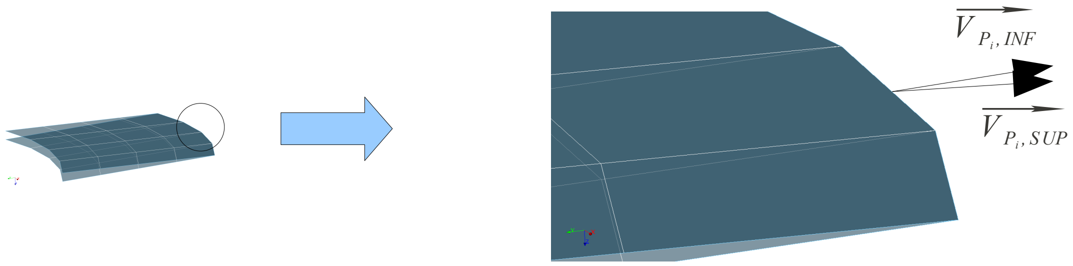
of 6 real components `per` node of the crack tip. For each node, the first three components are those $N_i$ of the local vector of propagation formulated with the crack tip and the three following $\vec{V}_{P_i}$ those of the normal vector to the average plane of crack formulated. Initially, the local bases $\vec{V}_{N_i}$




are built by couple of top nodes in crack tip in other words by segment which one will note. For each face containing and pertaining $E_i$ to the upper lips and lower $E_i$ , one calculates the orthogonal vector with and in the plane of the face and the normal vector $E_i$ with the face. Thus, we obtain two couples of vectors: (,) for the upper face (,) for the lower

- $\vec{V}_{P_i,SUP}$ $\vec{V}_{N_i,SUP}$ face. The vectors
- , $\vec{V}_{P_i,INF}$ $\vec{V}_{N_i,INF}$ have even meaning: they are directed

such as $\vec{V}_{N_i,SUP}$ $\vec{V}_{N_i,INF}$ the trihedron (,) that is to say direct with vector directed according to $\vec{V}_{P_i,SUP}$ $\vec{V}_{E_i}$ $\vec{V}_{N_i,SUP}$ the scheduling of $\vec{V}_{E_i}$ the nodes of the bottom. formulate formula the local base is calculated

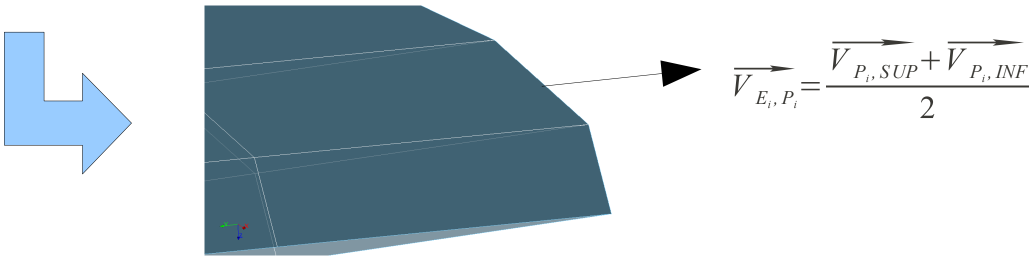


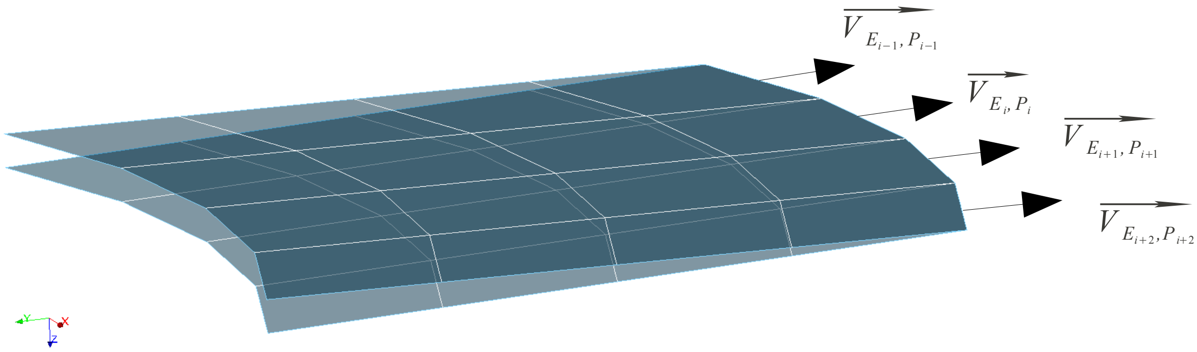

of the vectors obtained. In other words, the vector of propagation locally at the segment is calculated by the following statement: formulate $E_i$ and the normal vector locally at the segment

$$\vec{V}_{E_i,P_i}=\frac{\vec{V}_{P_i,SUP}+\vec{V}_{P_i,INF}}{2}$$

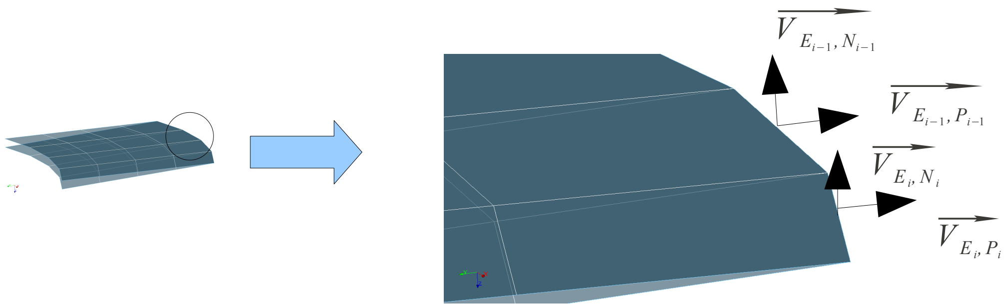
is calculated by the following statement: formuleformule $E_i$ formula formulates Thus, one obtains

$$\vec{V}_{E_i,N_i}=\frac{\vec{V}_{N_i,SUP}+\vec{V}_{N_i,INF}}{2}$$

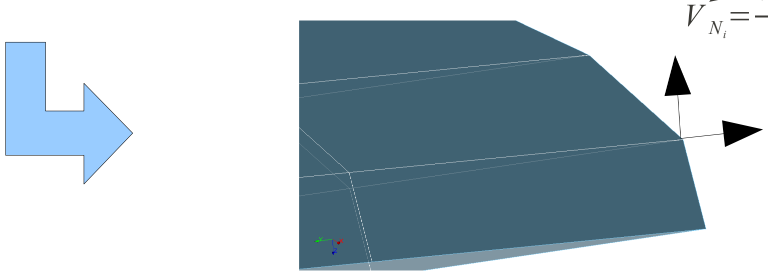



in crack tip. In the second time, the local base of a top node




is calculated as being the arithmetic mean of the components vectors of the bases of the related elements in this node. For the nodes-TOPS placed at the ends, one defers the bases calculated to the elements ends. In 3D, when the bottom is closed , the last



$$\overrightarrow{V_{N_i}}=\frac{\overrightarrow{V_{E_i,N_i}}+\overrightarrow{V_{E_{i+1},N_{i+1}}}}{2}$$

$$\overrightarrow{V_{P_i}}=\frac{\overrightarrow{V_{E_i,P_i}}+\overrightarrow{V_{E_{i+1},P_{i+1}}}}{2}$$

point is equal to the first. The last 4 terms of vector .BASEFOND are then identical to the 4 first . .NORMALE This vector contains 3 realities which constitute

### 5.3.2

the components formulated norm with the plane of the lips (case $(n_x, n_y, n_z)$ a crack planes) (see sign convention in [U4.82.01 §3.4]) .DTAN.ORIGINE This vector contains 3 realities which

### 5.3.3 constitute

the components of the tangent to structure in the beginning of the crack tip, in the plane of the lips (see sign convention in [U4.82.01 §3.5]). In the case of symmetry compared to the average plane of crack and thus of indetermination of the meaning of propagation of crack, this information is used to define the meaning. .DTAN.EXTREMITE This vector contains 3 realities

### 5.3.4 which constitute

the components of the tangent to structure in the beginning of the crack tip, in the plane of lips (see sign convention in [U4.82.01 §3.5]) .LTNO and .LNNO concept .LTNO (resp. .LNNO

### 5.3.5 ) is a field at nodes

(CHAM_NO ) scalar which contains for each node of the mesh the actual value of the level set tangent (resp. norm) with crack. .BASLOC concept .BASLOC is a field at nodes

### 5.3.6

(CHAM_NO) with 9 real components (in 3D). It contains the origin and the vectors of the Local Base to the crack tip. For each node, the first three components are the coordinates of the project of the node on the bottom, which corresponds at the origin of the local base. The three following components are the coordinates of the 1st vector of the base: vector of direction of propagation. This vector will be noted GRLT. The three last components are cordonnées of the 2nd vector of the base: normal vector on the surface of crack, directed lower lip towards the upper lip if LEVRE_SUP is defined in DEFI_FOND_FISS. This vector will be noted GRLN. The 3rd vector of the base is not stored, because it is determined easily as being the cross product of the first 2 vectors. V =.BASLOC (I); V (1) Coordinated according to formula

of the project

| | |
|---|---|
| of | node I on the bottom V $x$ according to formula of the project |
| of | node I on the bottom V $y$ according to formula of the project |
| of | node I on the bottom V $z$ according to formula of the 1st vector |
| | of the local base V (5 $x$ according to formula of the 1st vector |

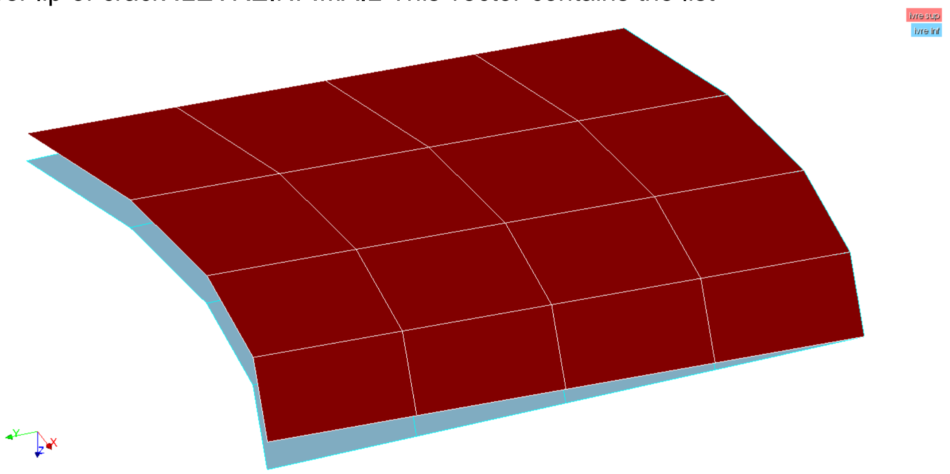
of the local base V (6 $y$ according to formula of the 1st vector
of the local base V (7 $z$ according to formula of the 2nd vector
of the local base V $x$ according to formula of the 2nd vector
of the local base V $y$ according to formula of the 2nd vector
local base In $z$ has only 2 components according to

formula and formula, is 6 components for $x$ . $y$ is one node with `the crack tip`, therefore all the nodes of the mesh and the have the same project on the crack tip same vectors GRLT and GRLN. Description of lips .LEVRESUP .MAIL `This` vector

## 5.4 contains the list

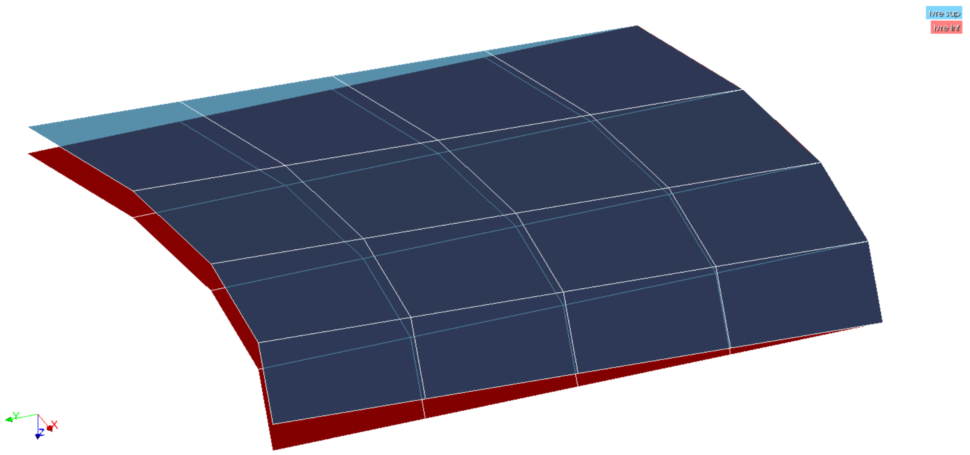
### 5.4.1 of meshes of

the upper lip of crack .LEVREINF.MAIL This vector contains the list




### 5.4.2 of meshes of

the lower lip of crack .SUPNORM.NOEU This vector contains the list of




### 5.4.3 the nodes of

the upper lip on the normal direction than the crack tip. .INFNORM.NOEU This vector contains the list of

### 5.4.4 the nodes of

the lower lip on the normal direction with the crack tip. .FOND.TAILLE_R This vector contains for each

### 5.4.5 node of

the bottom, an estimate of the maximum size according to the direction of propagation, of meshes which are connected to them. These sizes are ordered according to the order of the nodes given in .FOND.NOEU. One notes formula the vector of propagation of

the local $\overrightarrow{V_{P_i}}$ to the node of the bottom and formula the ème edge connected to the node $N_i$ $\vec{a}_{ij}$ each $j$ node of the bottom, one projects $N_i$
the edges on the vector of $N_i$ direction of propagation $\vec{a}_{ij}$ . The maximum size formulates meshes connected $\overrightarrow{V_{P_i}}$ to is the maximum $T_i$ of the absolute values $N_i$ of its projections. In other words, the size is equal to, where is the number of edges $T_i$ connected to

$$T_i = \max_{1 \leq j \leq Nb_{arêtes,i}} \left( \left| \vec{a}_{ij} . \overrightarrow{V_{P_i}} \right| \right)$$

the node $Nb_{arêtes,i}$ . The edges must form an angle lower $N_i$

than with the vector of direction of propagation $70°$ formulated to be projected there. In the contrary $\overrightarrow{V_{P_i}}$ they are ignored. For a node, if no edge checks this condition $N_i$ , an alarm is emitted and the size formulated is null. When the elements connected $T_i$ to the crack tip

are quadratic, the segments of the crack tip contain a node in their medium. For each one of these segments, the size of mesh allotted to its medium node, is the average of the sizes calculated with its nodes tops.