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## Operator POST\_ELEM

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### 1 Drank

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Compute of the quantities on whole or part of structure. The calculated quantities correspond to particular computation options of the affected modelization.

The currently available options are:

- computation of the mass, inertias and the position of the center of gravity,
- computation of potential energy,
- computation of kinetic energy,
- computation of the energy of dissipation (elements DKTG),
- computation of the work of the external forces,
- computation of the indicators of loss of proportionality of the loading in elastoplasticity,
- computation of the Yield-point load,
- computation of the stress of Weibull,
- computation of the growth rate of a spherical cavity (Rice - Tracey),
- computation of elastic strain energy and total energy,
- computation of the area of a hole in a 2D mesh,
- computation of the integral and the average of a field,
- computation of the distribution on the surface/volume of the value of one component of a field,
- computation of the extrema in space of a list of components of a field,
- computation of the norm of a field.

The turned over concept is an `array`.

## 2 Syntax

```
[array] = POST_ELEM      (
  # key word simple
  ◊   MODELE=mo           ,           [model]
  ◊           CHAM_MATER=chmater ,     [cham_mater]
  ◊           CARA_ELEM=carac  ,     [cara_elem]
  ◊   CHARGE=lcha        ,           / [l_char_meca]
                                     / [l_char_cine_meca]
                                     / [l_char_ther]
                                     / [l_char_acou]
  ◊   |   NUME_COUCHE=/numérique      ,           [I]
                                     /1 ,           [DEFAULT]
  |   |   NIVE_COUCHE=/              "INF",
                                     / "SUP",
                                     / "MOY",           [DEFAULT]
◊MODE_FOURIER=/nh              ,           [I]
                                     /0 ,           [DEFAULT]
"                               DEFORMED" ◊GEOMETRIE=/,
  ◆   /CHAM_GD            =cham      ,           [cham_no_DEPL_R]
                                     /           [cham_no_TEMP_R]
                                     /           [cham_elem_ENER_R]
  /RESULTAT              =resu      ,           [evol_elas]
                                     /           [evol_noli]
                                     /           [evol_ther]
                                     /           [evol_char]
                                     /           [mult_elas]
                                     /           [fourier_elas]
                                     /           [mode_meca]
                                     /           [dyna_trans]
                                     ◊/TOUT_ORDRE=' OUI ',
  /NUME_ORDRE            =l_nuor    ,           [l_I]
  /LIST_ORDRE            =l_ordr    ,           [listis]
  /NUME_MODE              =l_numo    ,           [l_I]
  /NOEUD_CMP              =l_nomo    ,           [l_Kn]
  /NOM_CAS                =l_nocas   ,           [l_Kn]
  //FREQ                  =l_freq    ,           [l_R]
  /LIST_FREQ              =lreel     ,           [listr8]
  //INST                  =l_inst    ,           [l_R]
  /LIST_INST              =lreel     ,           [listr8]
  ◊ / | CRITERE=/          "RELATIF",           [DEFAULT]
  |   | PRECISION=/prec    ,           [R]
                                     /1.0D-6 ,           [DEFAULT]
  /◆                       CRITERE=' ABSOLU',
  ◆   | PRECISION=prec     ,           [R]

# factor keywords
| MASS_INER      :   (see key word MASS_INER  [$ 3.9] )
| ENER_POT       :   (see key word ENER_POT   [$ 3.10])
| ENER_CIN       :   (see key word ENER_CIN   [$ 3.11])
| ENER_ELAS      :   (see key word ENER_ELAS  [$ 3.12])
| ENER_TOTALE    :   (see key word ENER_TOTALE [$ 3.13])
| WEIBULL        :   (see key word WEIBULL    [$ 3.14])
| RICE_TRACEY    :   (see key word RICE_TRACEY [$ 3.15])
| INDIC_ENER     :   (see key word INDIC_ENER  [$ 3.16])
| INDIC_SEUIL    :   (see key word INDIC_SEUIL [$ 3.17])
```

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

```
| CHAR_LIMITE : (see key word CHAR_LIMITE [$ 3.18])
| CARA_GEOM : (see key word CARA_GEOM [$ 3.19])
| CARA_POUTRE : (see key word CARA_POUTRE [$ 3.20])
| AIRE_INTERNE: (see key word AIRE_INTERNE [$ 3.21])
| TRAV_EXT : (see key word TRAV_EXT [$ 3.22])
| INTEGRALE : (see key word INTEGRALE [$ 3.23])
| MINMAX : (see key word MINMAX [$ 3.24])
| ENER_DISS : (see key word ENER_DISS [$ 3.25])
| VOLUMOGRAM: (see key word VOLUMOGRAM [$ 3.26])
| NORMALIZES : (see key word NORMALIZES [$ 3.27])
◇INFO=/1 [DEFAULT]
/2 ,
=ti ,
)
```

## 3 Operands

the operands `MODELS`, `CHAM_MATER`, `CARA_ELEM` and `CHARGE` are optional if `RESULTAT` is indicated, compulsory if it is `CHAM_GD` which is given.

### 3.1 MODEL operand

◇MODELE = Mo,

Name of the model on which is calculated the option. The name of the model is optional because it is contained in data structure `result`.

### 3.2 Operand CHAM\_MATER

◇CHAM\_MATER = chmater,

Material field associated with the model Mo, optional because contained in data structure `result`.

### 3.3 Operand CARA\_ELEM

◇CARA\_ELEM = carac,

the elementary characteristics `carac` necessary if there exists in the model structural elements (beam, plate, shell or discrete elements), optional because of being contained in data structure `result`.

### 3.4 Operand CHARGE

◇CHARGE = lcha,

List containing the concepts of the type `charges`, optimal because contained in data structure `result`.

### 3.5 Operands NUME\_COUCHE/NIVE\_COUCHE

◇NUMÉRIQUE\_COUCHE = numerical,

In the case of a multi-layer material, whole value ranging between 1 and the number of layers, necessary to specify the layer where one wishes to carry out elementary computation. By convention, layer 1 is the sub-base (according to the norm with the element) in the case of the shell elements mechanics or of thermal shell.

◇NIVE\_COUCHE =

For the numerical `layer` defined by `NUME_COUCHE`, makes it possible to specify the Y-coordinate where one wishes to carry out elementary computation:

"INF"	ordered lower of the layer	(skin interns),
"SUP"	ordered higher of the layer	(external skin),
"MOY"	ordered average of the layer	(average average by default).

### 3.6 Operand MODE\_FOURIER

◇MODE\_FOURIER =

Number of the harmonic of FOURIER: positive or null integer (default = 0).

## 3.7 Operand GEOMETRIE

◆ GEOMETRIE = "INITIALE", [DEFAULT]  
/ "DEFORMED",

Indicates if one works on the initial geometry or the deformed shape. In this last case, it is necessary to provide a field of displacements by CHAM\_GD or RESULTAT.

## 3.8 Operands CHAM\_GD/RESULTAT

options ENER\_POT and ENER\_CIN are calculated from a field at nodes or by elements existing or extracted from one result.

### 3.8.1 Operand CHAM\_GD

◆/CHAM\_GD = cham,

Name of a field (for options ENER\_POT and ENER\_CIN).

For the option ENER\_POT, it is necessary to provide a field of displacement or a field of temperature (see [§3.9]).

For the option ENER\_CIN, it is necessary to provide a velocity field (without providing frequency) or a field of displacements and a frequency (see [§3.9]).

### 3.8.2 Operand RESULTAT

/RESULTAT = resu,

Name of a result concept of the evol\_elas type, evol\_ther, mode\_meca, evol\_noli, mult\_elas, fourier\_elas or dyna\_trans.

Option ENER\_POT : evol\_elas , evol\_ther , mode\_meca , mult\_elas ,  
fourier\_elas evol\_noli or dyna\_trans .

Option ENER\_CIN : mode\_meca , evol\_elas , evol\_ther , evol\_noli , or  
dyna\_trans .

Option ENER\_ELAS and ENER\_TOTALE : evol\_noli, evol\_elas

### 3.8.2.1 Operands TOUT\_ORDRE / NUME\_ORDRE / NUME\_MODE / LIST\_ORDRE / NOEUD\_CMP / FREQ / LIST\_FREQ / INST / LIST\_INST / accuracy / CRITERE

See [U4.71.00].

## 3.9 Key word MASS\_INER

### 3.9.1 Drank

Key word factor making it possible to calculate the mass, inertias and the center of gravity. This option allows computation on each element of the following characteristics: ( $\rho$  indicating the density defined in DEFI\_MATERIAU [U4.43.01] by ELAS or ELAS\_FO).

$$\text{Mass: } m = \int_v \rho dv$$

$$\text{Center of gravity: } x_G = \frac{1}{m} \int_v x \rho dv; y_G = \frac{1}{m} \int_v y \rho dv; z_G = \frac{1}{m} \int_v z \rho dv$$

Tensor of inertia at the center of gravity  $G$  in the total reference of description of mesh:

$$\begin{aligned} I_{xx}(G) &= \int_v \left( (y - y_G)^2 + (z - z_G)^2 \right) \rho dv & I_{xy}(G) &= \int_v (x - x_G)(y - y_G) \rho dv \\ I_{yy}(G) &= \int_v \left( (x - x_G)^2 + (z - z_G)^2 \right) \rho dv & I_{xz}(G) &= \int_v (x - x_G)(z - z_G) \rho dv \\ I_{zz}(G) &= \int_v \left( (x - x_G)^2 + (y - y_G)^2 \right) \rho dv & I_{yz}(G) &= \int_v (y - y_G)(z - z_G) \rho dv \end{aligned}$$

Then calculates by "summation" the quantities relating to total structure.

The principal tensor of inertia made up of the eigenvalues of the matrix of inertia is calculated, as well as the 3 Eulerian angles associated with the principal reference with inertia. These components are noted in the array:

IX\_PRIN\_G IY\_PRIN\_G IZ\_PRIN\_G ALPHA BETA GAMMA.

#### Foot-note

*[This option is active only on the volume elements and not on the edge elements.]*

### 3.9.2 Syntax

```
| MASS_INER =_F (
|
|   ◆/TOUT           = ' OUI',
|     /MAILLE       =l_maille ,           [l_maille]
|     /GROUP_MA    =lgrma ,             [l_gr_maille]
|   ◇ORIG_INER=    (xp, YP [, zp]),      [l_R]
|     ),
```

#### simple Key words: (see [§2])

```
◇ MODELE=mo , [model]
◇CHAM_MATER =chmater , [cham_mater]
◇CARA_ELEM =carac , [cara_elem]
◇ | NUME_COUCHE =
| | NIVE_COUCHE =
◇MODE_FOURIER =
◇GEOMETRIE =
| ◆/CHAM_GD =
```

```

        /RESULTAT =
    ◇ CHARGE =                [char_meca]
                                / [char_ther]
                                / [char_acou]
    
```

## Foot-note

*For the key word factor `MASS_INER`, the model and the material field are compulsory if `RESULTAT` and `CHAM_GD` are absent.*

### 3.9.3 Operands

```

    ◆GEOMETRIE = "INTIALE", [DEFAULT]
                / "DEFORMED",
    
```

Indicates if one works on the initial geometry or the deformed shape. In this last case, it is necessary to provide a field of displacements by `CHAM_GD` or `RESULTAT`.

```

    ◆/TOUT = ' OUI ',
    
```

On all structure.

```

    /MAILLE = l_maille,
    
```

On a list of meshes.

```

    / GROUP_MA =lgrma ,
    
```

On a list of mesh group.

```

    ◇ORIG_INER = (xp, YP [, zp]), [l_R]
    
```

Not compared to which the tensor of inertia will be calculated.

The tensor of inertia at the point  $P$  of coordinates  $(x_P, y_P, z_P)$  is obtained starting from the tensor inertia at the center of gravity  $G$ , mass  $m$  of structure and coordinates from  $G$  the formulas:

$$\begin{aligned}
 I_{xx}(P) &= I_{xx}(G) + m x_{PG}^2 \\
 I_{yy}(P) &= I_{yy}(G) + m y_{PG}^2 \\
 I_{zz}(P) &= I_{zz}(G) + m z_{PG}^2 \\
 I_{xy}(P) &= I_{xy}(G) + m x_{PG} y_{PG} \\
 I_{xz}(P) &= I_{xz}(G) + m x_{PG} z_{PG} \\
 I_{yz}(P) &= I_{yz}(G) + m y_{PG} z_{PG}
 \end{aligned}$$

with

$$\begin{aligned}
 x_{PG} &= x_G - x_P \\
 y_{PG} &= y_G - y_P \\
 z_{PG} &= z_G - z_P
 \end{aligned}$$

## 3.10 Key word ENER\_POT

### 3.10.1 Drank

Key word factor allowing to calculate:

- the potential energy of deformation due to the equilibrium starting from displacements, in linear mechanics of the continuums (thermoelasticity 2D and 3D):

$$EPOT = \frac{1}{2} \int_{\text{élément}} \varepsilon(\mathbf{U}) \cdot \mathbf{A} \varepsilon(\mathbf{U}) dv - \int_{\text{élément}} \varepsilon(\mathbf{U}) \cdot \mathbf{A} \varepsilon^{th}(\mathbf{T}) dv + \frac{1}{2} \int_{\text{élément}} \varepsilon^{th}(\mathbf{T}) \cdot \mathbf{A} \varepsilon^{th}(\mathbf{T}) dv$$

where  $\mathbf{A}$  the elasticity tensor,

- the potential energy of deformation due to the equilibrium starting from displacements indicates, in linear mechanics for the structural elements:

$$EPOT = \frac{1}{2} \mathbf{U}^T \mathbf{K}_e \mathbf{U} - \mathbf{U}^T \mathbf{B}^T \mathbf{A} \varepsilon^{th} + \frac{1}{2} \varepsilon^{th} \mathbf{A} \varepsilon^{th}$$

where  $\mathbf{K}$  the stiffness matrix Foot-note indicates:

*In any rigor, the potential energy of a structure is the opposite of these quantities.*

- the energy dissipated thermally with the equilibrium in linear thermal starting from the temperatures (cham\_no\_TEMP\_R):

$$W_{th} = -\frac{1}{2} \int_{\Omega} \nabla T \cdot \mathbf{K} \cdot \nabla T d\Omega$$

**Note :**

*In the first both cases, one must give a field of displacement behind operand RESULTAT or CHAM\_GD . In the last case a field of temperature.*

### 3.10.2 Syntax

```
| ENER_POT =_F (
                                ♦/TOUT=' OUI',
                                /MAILLE           =l_maille      , [l_maille]
                                /GROUP_MA         =lgrma         , [l_gr_maille]
                                )
```

**simple Key words: (see [S2])**

```
♦MODELE=mo                      , [model]
♦CHAM_MATER=chmater              , [cham_mater]
♦CARA_ELEM=carac                 , [cara_elem]
♦ | NUMÉRIQUE_COUCHE=
  | NIVE_COUCHE=
♦MODE_FOURIER=
♦ /CHAM_GD                       =
  /RESULTAT                       =
♦ CHARGE                          = CH, / [char_meca]
                                   / [char_ther]
                                   / [char_acou]
```

#### Foot-note

*For factor key word the ENER\_POT , the model, the material field and possibly the field of characteristics of structural elements are compulsory compulsory (except if RESULTAT is provided) to determine as a preliminary the fields of energy by elements.*

### 3.10.3 Operands

```
♦/TOUT=' OUI',
On all structure.

/MAILLE           = l_maille,
On a list of meshes.

/ GROUP_MA=lgrma ,
On a list of mesh group.
```



## 3.10.4 Count produced

the array contains, for each time, the values of energy and the percentage on the locus concerned:

INST	PLACE	ENTITE	TOTAL	POUR_CENT
5.50000E+00	MY	TOUT	4.00093E+12	1.00000E+02
5.50000E+00	GMA1	GROUP_MA	2.71323E+11	6.78151E+00

## 3.11 Key word ENER\_CIN

### 3.11.1 Drank

Key word factor making it possible to calculate the kinetic energy from a velocity field or a field of displacement and of a frequency.

If a velocity field were given  $E_c = \frac{1}{2} V^T M V$ .

If one gave a field of displacement and a frequency  $E_c = \frac{1}{2} \omega^2 U^T M U$ .

### 3.11.2 Syntax

```

| ENER_CIN =_F (
|   ◇ OPTION=/'
|                                     "MASS_MECA",           [DEFAULT]
|                                     / "MASS_MECA_DIAG",
|   ◆ /TOUT                          = ' OUI',
|     /MAILLE                         =l_maille           ,           [l_maille]
|     /GROUP_MA                       =lgrma              ,           [l_gr_maille]
|                                     )
    
```

#### simple Key words: (see [§2])

```

◇ MODELS                             =mo,                [model]
◇ CHAM_MATER=chmater                  ,                   [cham_mater]
◇ CARA_ELEM=carac                     ,                   [cara_elem]
◇ |   NUME_COUCHE=
◇ |   NIVE_COUCHE=
◇ MODE_FOURIER=
◆ /CHAM_GD=
  /RESULTAT                           =
◇ CHARGE=                             CH,                / [char_meca]
|                                     / [char_ther]
|                                     / [char_acou]
    
```

#### Foot-note 1

For factor key word the ENER\_CIN, the model, the material field and possibly the field of characteristics of structural elements are compulsory (except if RESULTAT is provided) to determine as a preliminary the fields of energy by elements.

#### Foot-note 2

When one wishes to calculate energy by using the diagonal mass (to be in coherence with the option that one chose in the elementary computation of the mass matrixes), one can specify "MASS\_MECA\_DIAG" behind key key OPTION (nonavailable in 2D). By default one uses the complete mass matrix.

### 3.11.3 Operands

◆ /TOUT=' OUI',

On all structure.

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

```

/MAILLE          = l_maille,
    On a list of meshes.

/ GROUP_MA=lgrma ,
    On a list of mesh group.
    
```

### 3.11.4 Count produced

the array contains, for each time, the values of energy and the percentage on the locus concerned:

INST	PLACE	ENTITE	TOTAL	POUR CENT
5.50000E+00	MY	TOUT	4.00093E+12	1.00000E+02
5.50000E+00	GMA1	GROUP_MA	2.71323E+11	6.78151E+00

## 3.12 Key word ENER\_ELAS

### 3.12.1 Goal

Makes it possible to calculate elastic strain energy for each time  $t$  after an elastic design or elastoplastic, on the topological selection chosen by the user.

The user can carry out this postprocessing from a result concept of the evol\_noli type or evol\_elas. In the case of a concept evol\_noli, computation carried out depends on the choice of strain made during computation.

- In small strains (DEFORMATION = PETIT or DEFORMATION = PETIT\_REAC), computation is carried out starting from the stress field of Cauchy SIEF\_ELGA by the statement of Hooke:

$$E^e(t) = \frac{1}{2} \int_v \sigma(t) D^{-1} \sigma(t) dv$$

where  $D$  the operator of elasticity represents.

- in multiplicative large deformations (DEFORMATION = SIMO\_MIEHE), computation is carried out starting from the jacobian  $J$  of the gradient of transformation and the specific measurement of elastic strain  $\bar{\mathbf{b}}^e$  of SIMO\_MIEHE (see R5.03.21):

$$E^e(t) = \int_v \left[ \frac{1}{2} \frac{E}{3(1-2\nu)} \left( \frac{1}{2} (J^2(t) - 1) - \ln J(t) \right) + \frac{1}{2} \mu (tr \bar{\mathbf{b}}^e(t) - 3) \right] dv$$

In the presence of thermal, a specific correction is carried out in order to as well as possible gum the effects of this one on the jacobian. This specific correction is detailed in R5.03.21

- in large deformations logarithmic curves (DEFORMATION = GDEF\_LOG), computation is carried out starting from the specific stress field  $T$  (see R5.03.24) by the statement:

$$E^e(t) = \frac{1}{2} \int_v T(t) D^{-1} T(t) dv$$

### 3.12.2 Syntax

```

| ENER_ELAS =_F (
|   ♦/TOUT          = ' OUI',
|   /MAILLE         =l_maille , [l_maille]
|   /GROUP_MA       =lgrma   , [l_gr_maille]
| )
    
```

**simple Key words: (see [§2])**

```

◇ MODELE=mo , [model]
◇ CHAM_MATER=chmater , [cham_mater]
  ◇ CARA_ELEM=carac , [cara_elem]
◇ | NUMÉRIQUE_COUCHE=
  | NIVE_COUCHE=
◇ MODE_FOURIER=
◆ RESULTAT=
◇ CHARGE= / [char_meca]
           / [char_ther]
           / [char_acou]
    
```

### 3.12.3 Operands

```

◆ /TOUT = ' OUI',
    On all structure.

/MAILLE = l_maille,
    On a list of meshes.

/ GROUP_MA = lgrma,
    On a list of mesh group.
    
```

### 3.12.4 Count produced

the array contains, for each time, the values of total energy and possibly of the energy of membrane, of the energy of bending, the energy of shears and the energy of membrane-flexure coupling on the locus concerned:

INST	PLAC E	ENTITE	TOTAL	MEMBRANE	BENDING	SHEARS	COUPL_MF
1.00000E+00	MY	TOUT	4.00093E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.00000E+00	GMA1	GROUP_MA	2.71323E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00

energies of membrane, bending, shears and membrane-flexure coupling are available when the locus contains shell elements or of shell. The energy of shears and membrane-flexure coupling are calculated only when the result concept is of evol\_elas type, if they are not put at 0.

## 3.13 Key word ENER\_TOTALE

### 3.13.1 Drank

Key word factor making it possible to calculate total strain energy for the elements of continuums 2D or 3D.

For behaviors VMIS\_ISOT\_LINE or VMIS\_ISOT\_TRAC (isotropic hardening), energy is calculated starting from the stress fields, of local variables and the material:

$$E^T = E^{el} + E^p = \frac{1}{2} \int_v \sigma^T A^{-1} \sigma dv + \int_v \left( \int_0^p R(q) dq \right) dv$$

$P$  being cumulated equivalent plastic strain.

With option SIMO\_MIEHE, this energy applies to two models VMIS\_ISOT\_LINE or VMIS\_ISOT\_TRAC :

$$E^T = \int_{V_0} \left( \rho_0 \Psi + \int_0^t \Delta d\tau \right) dv$$

where  $\Psi$  and  $\Delta$  are respectively the free energy and the potential of dissipation,  $V_0$  initial volume. For more accuracy, to see [R5.03.21].

For the other behaviors, energy is obtained by incremental integration:

$$E^T = \int_v \left( \int_0^t \sigma \cdot d\varepsilon \right) dv$$

Incremental integration by the method of the trapezoids implies:

- that the discretization in time is sufficiently fine,
- that the initial stresses and strains are null,
- and that computation is required as from the first time of computation.

### 3.13.2 Syntax

```
| ENER_TOTALE = _F (
  ♦ /TOUT           = ' OUI',
  /MAILLE           = l_maille , [l_maille]
  /GROUP_MA        = lgrma , [l_gr_maille]
)
```

**simple Key words: (see [§2])**

```
◇ MODELE=mo , [model]
◇ CHAM_MATER=chmater , [cham_mater]
  ◇ CARA_ELEM=carac , [cara_elem]
◇ | NUMÉRIQUE_COUCHE=
  | NIVE_COUCHE=
◇ MODE_FOURIER=
♦ RESULTAT=
◇ CHARGE=ch , / [char_meca]
/ [char_ther]
/ [char_acou]
```

### 3.13.3 Operands

```
♦ /TOUT = ' OUI',
    On all structure.

/MAILLE = l_maille,
    On a list of meshes.

/ GROUP_MA = lgrma,
    On a list of mesh group.
```

### 3.13.4 Count produced

the array contains, for each time, the values of total energy and possibly of the energy of membrane and the energy of bending on the locus concerned:

INST	PLACE	ENTITE	TOTAL	MEMBRANE	BENDING
1. 0 0000E+00	MY	TOUT	4.00093E+12	0.00E+00	0.00E+00
2.0 0000E+00	GMA1	GROUP_MA	2.71323E+11	0.00E+00	0.00E+00

## 3.14 Key word WEIBULL

### 3.14.1 Drank

Key word allowing for each defined time, the computation of the elementary field of the power *m-ième* of the stress of Weibull whose statement on the mesh *K* is given, without taking into account of the plastic strain, by:

$$\sigma_w^m(K) = \frac{1}{V_{ref}} \int_{K_p} \sigma_1^m dK_p$$

and, with taking into account of the plastic strain by:

$$\sigma_w^m(K) = \frac{1}{V_{ref}} \int_{K_p} \sigma_1^m \exp\left(\frac{-m}{2} \varepsilon_1^p\right) dK_p$$

$K_p$  of the mesh indicate the part  $K$  which plasticized, i.e., the part of  $K$  where the cumulated plastic strain exceeds a certain threshold;  $\sigma_1$  represent the maximum principal stress and  $\varepsilon_1^p$  represents the maximum principal plastic strain.

Material parameters  $m$ ,  $V_{ref}$  and the threshold of plasticity are defined in `DEFI_MATERIAU` by behavior model `WEIBULL` (cf [R7.02.06]).

Once determined this elementary field, the option calculates by "summation" the stress of Weibull of a field  $D$  for each definite time:

$$\sigma_w(D) = \left( C \sum_{K \in D} \sigma_w^m(K) \right)^{\frac{1}{m}}$$

where  $C$  is a coefficient intended for the taking into account of symmetries (case Bi and three-dimensional) and thickness (in the two-dimensional case) of structure containing the field  $D$  (key word `COEF_MULT`).

The probability of fracture of the field  $D$  is then calculated by:

$$P_w(D) = 1 - \exp\left(-\frac{\sigma_w^m}{\sigma_u^m}\right)$$

The parameter "forced of cleavage"  $\sigma_\mu$  is also defined in behavior model `WEIBULL`.

Lastly, the preceding statements of the stress of Weibull and the probability of fracture are valid only in the case of a way of monotonic loading. This kind of postprocessing can nevertheless also be applied to a way of more general loading, including when the stress of cleavage depends on the temperature (behavior model `WEIBULL_FO`). The statements of the stress of Weibull and the probability of fracture are then different (cf [R7.02.06]).

**Note :**

*For the key word factor `WEIBULL`, the model and the material field are compulsory (except if `RESULTAT` is present).*

Advice of use of this model is given in documentation [U2.05.08].

### 3.14.2 Syntax

```
| WEIBULL = _F (
|
|     /MAILLE                =l_maille      ,      [l_maille]
|     /GROUP_MA             =lgrma         ,      [l_gr_maille]
|     /OPTION=/'           "SIGM_ELGA",      [DEFAULT]
|
|     /CORR_PLAST=/'       "SIGM_ELMOY",
|
|     /COEF_MULT=/'        "OUI",
|
|     /                      "NON",          [DEFAULT]
|
|     /                      coeff,          [R]
|
|     /1 . . ,              [DEFAULT]
|
| )
```

*Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.*

**simple Key words: (see [S2])**

```

◇ MODELE=mo , [model]
◇ CHAM_MATER=chmater , [cham_mater]
◇ CARA_ELEM=carac , [cara_elem]
◇ | NUME_COUCHE=
  | NIVE_COUCHE=
◇ MODE_FOURIER=
◆ /CHAM_GD =
  /RESULTAT =
◇ CHARGE = / [char_meca]
              / [char_ther]
              / [char_acou]
    
```

### 3.14.3 Operands

#### 3.14.3.1 Operand OPTION

◇/OPTION = "SIGM\_ELGA",

the value of the elementary field associated with the mesh  $K$  is obtained by integration by squaring with Gauss points of the statement  $\frac{1}{V_p} \int_{K_p} \sigma_1^m dK$ .

/ OPTION = "SIGM\_ELMOY",

the value of the elementary field associated with the mesh  $K$  is obtained from the maximum principal value of the tensor  $\frac{1}{V_p} \int_{K_p} \sigma dK$  whose value is approached by squaring with Gauss points.

#### 3.14.3.2 Operand CORR\_PLAST

◇/CORR\_PLAST = "OUI",

the stress field of Weibull is evaluated with taking into account of the plastic strain.

/CORR\_PLAST = "NON",

the stress field of Weibull is evaluated without taking into account of the plastic strain.

#### 3.14.3.3 Operand COEF\_MULT

/COEF\_MULT = value,

the default value of this coefficient is 1.0 .

The following table, in which the thickness is noted  $e$  , indicates typical values of the coefficient  $C$  according to the type of symmetry:

- **simple symmetry** : the symmetry plane of the mesh passes by the plane of the default and the default is entirely with a grid,
- **double symmetry** : the symmetry plane of the mesh also passes by the plane of the default but only one half of the default is with a grid.

	3D and 3D_SI	AXIS and AXIS_SI	D_PLAN and SIMPLE	D_PLAN_SI
C_PLAN	2	$4\pi$	$2e$	$2e$
DOUBLE	4	without object	without object	without object
NON	1	$2\pi$	$e$	$e$

#### Values of the multiplying coefficient of symmetry-thickness

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

### 3.14.4 Counts produced

the array contains, for each time, the values of the stress of Weibull, the probability of fracture and the power  $m - i\grave{e}me$  of the stress of Weibull on the locus concerned:

INST	ENTITE	SIGMA_WEIBULL	PROBA_WEIBULL	SIGMA_WEIBULL ** M
1. 0 0000E+00	TOUT	2.49298E+02	0.00E+00	3.32096E+57
2.0 0000E+00	TOUT	2.50473E+02	0.00E+00	3.71756E+57

## 3.15 Key word RICE\_TRACEY

### 3.15.1 Drank

This option allows, for each time of defined  $t_n$  computation, the computation of the growth rate  $\frac{R(t_n)}{R_0}$  of a spherical cavity compared to a field  $D(R(t_n))$  and  $R_0$  respectively indicate the radius running and the initial radius of the cavity). The law of evolution of Rice-Tracey is expressed by the relation:

$$\frac{d}{dt} \log\left(\frac{R}{R_0}\right) = 0.283 \text{Signe}\left(\frac{\sigma_M}{\sigma_{eq}}\right) \exp\left(\left|\frac{2\sigma_M}{2\sigma_{eq}}\right|\right) \frac{d\varepsilon_{eq}^p}{dt}$$

( $\sigma_M = \frac{1}{3} \text{Trace}(\sigma)$  ;  $\sigma_{eq}$  indicate the equivalent stress of von Mises and  $\varepsilon_{eq}^p$  indicates the equivalent strain of von Mises).

### 3.15.2 Syntax

```
| RICE_TRACEY = _F (
  ♦ /TOUT= "OUI",
    /MAILLE = l_maille, [l_maille]
    /GROUP_MA = lgrma, [l_gr_maille]
  ♦ OPTION=/ "SIGM_ELGA", [DEFAULT]
    / "SIGM_ELMOY",
  ♦ LOCAL=/ "OUI", [DEFAULT]
    / "NON",
  )
```

#### simple Key words: (see [§2])

```
♦ MODELE=mo , [model]
♦ CHAM_MATER=chmater , [cham_mater]
♦ CARA_ELEM=carac , [cara_elem]
♦ | NUME_COUCHE=
  | NIVE_COUCHE=
♦ MODE_FOURIER=
♦ /CHAM_GD =
  /RESULTAT =
♦ CHARGE= CH, / [char_meca]
  / [char_ther]
  / [char_acou]
```

### 3.15.3 Operands

#### 3.15.3.1 Operand OPTION

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

◇OPTION=/ "SIGM\_ELGA", [DEFAULT]

the elementary fields of the stresses and plastic strains are used in their representations with Gauss points.

/ "SIGM\_ELMOY",

the elementary fields of the stresses and plastic strains are realized compared to Gauss points before being used.

### 3.15.3.2 Operand LOCAL

◇LOCAL=/ "OUI", [DEFAULT]

the model of Rice-Tracey is integrated on each mesh  $K$  of the field  $D$  and result consists of the maximum value obtained on the group of meshes of the field.

/ "NON",

the fields of triaxiality  $\frac{\sigma_M}{\sigma_{eq}}(t_n)$  and variation of plastic strain  $\Delta \varepsilon_{eq}^p(t_n)$  are calculated on

each mesh. Then, their respective averages, balanced by the volume of meshes of the field, are given. Finally, the model of Rice-Tracey is integrated on these realised values.

### 3.15.3.3 Operands TOUT / GROUP\_MA / MESH

the fields of computation  $D$  are specified by:

/TOUT = "OUI",

Only one field is defined, it coincides with the group of structure.

/GROUP\_MA = lgrma,

Each definite mesh group of the list lgrma a field of computation.

/MAILLE = l\_maille,

Each mesh of the list l\_maille definite a field of computation.

### 3.15.4 Count produced

the array contains, for each time, the values of the growth rate of a spherical cavity and volume concerned on the locus concerned:

INST	PLACE	TX CROIS CAVITES	VOLUME CONCERNE
1.0 0000E+00	MA101	1.00000E+00	3.75000E+00
2.0 0000E+00	MA101	1.00000E+00	6.23719E-01

## 3.16 Key word INDIC\_ENER

### 3.16.1 Drank

Key word factor making it possible to calculate a total indicator of loss of proportionality of the loading in elastoplasticity, founded on the density of energy. This indicator is described in detail in the document [R4.20.01].

One points out his function and his statement. This indicator is intended to detect so during the history of structure and until current time  $T$ , and for a zone of structure chosen by the modelisator, there was loss of proportionality of the loading (i.e it acts to have a total measurement of the change of the principal directions of the stress tensor for each point of the zone defined by the user). This indicator is usable only for models whose material presents an isotropic hardening and whose elements are isoparametric 2D or 3D. This



indicator has as a statement: where

$$I = \frac{1}{V} \int_V \left( 1 - \frac{\Psi}{\Omega} \right) dv$$

: is

- $V$  the volume of the field defined by the user, is
- $\Psi$  the density of total elastic strain energy associated with curve of tension if the nonlinear elastic material were considered.  
 More exactly its statement is the following one: where

$$\Psi = \frac{1}{2} K \cdot tr^2(\varepsilon) + \frac{2\mu}{3} \varepsilon_{eq}^2 \quad si \quad \sigma_{eq} < R(p)$$

$$\Psi = \frac{1}{2} K \cdot tr^2(\varepsilon) + \frac{R^2(p)}{6\mu} + \int_0^p R(s) ds \quad si \quad \sigma_{eq} = R(p)$$

: is

- $K$  the modulus of compressibility, is
- $\mu$  the shear coefficient of Lamé, is
- $R(p)$  the threshold of curve of tension associated with the cumulated plastic strain,  $p$  is
- $\Omega$  the density of strain energy defined by: one

$$\Omega(t) = \int_0^t \sigma \cdot \dot{\varepsilon} d\tau$$

can break up into  $\Omega(t)$  an elastic part and a plastic part: with

$$\Omega(t) = \Omega_{elas}(t) + \Omega_{plas}(t)$$

: Note:

$$\Omega_{elas}(t) = \frac{1}{2} \sigma \cdot \varepsilon^{elas}$$

$$\Omega_{plas}(t) = \int_0^t R(p) dp$$

If

|one has,  $\Omega(t)=0$  one poses.  $I=0$  Syntax

## 3.16.2 |INDIC\_ENER

```
= _F (♦
/TOUT=          "OUI" , /MAILLE
              = l_maille , [l_maille          ] /GROUP_MA
              = lgrma , [l_gr_maille         ] )
              simple
```

**Key words: (see [§2]) ♦**

```
MODELS      =mo      , [model              ] ♦
CHAM        _MATER=chmater , [cham_mater        ] ♦
CHARGE      =ch      , / [char_meca          ] / [
                          char_ther ] / [
                          char_acou ] ♦
RESULTAT=resu , [evol_noli          ] Operands
```

### 3.16.3

the indicator is calculated on the field defined by the key keys: /

TOUT = " OUI", On all the elements of the model Mo . /

MESH = l\_maille , On the list l\_mesh of meshes of the model Mo . /

GROUP \_MA= lgrma , On the list lgrma of the mesh groups of the model Mo . Count

### 3.16.4 produced

the array contains, for each time, the value of the total indicator of loss of proportionality of the loading in elastoplasticity on the locus concerned: INST

PLACE	INDIC ENER	1
. 0 0000E+00 MY	4.77299	E-02 2.0
0000E+00 MY	3.33763	E-02 Key word

## 3.17 INDIC\_SEUIL Drank

### 3.17.1 Key word

factor making it possible to calculate a total indicator of loss of proportionality of the loading in elastoplasticity. This

indicator makes it possible on the one hand to know, on average about the zone considered, if the tensor of the stresses and that of plastic strains have the same directions and if the plastic threshold is reached at current time, and on the other hand so during the history the plastic strain changed direction. This

indicator has as a statement: where

$$I = \frac{1}{V} \int_V \left( 1 - \frac{\sigma \cdot \varepsilon^p}{R(p) \cdot p} \right) dv$$

: is

- $V$  the volume of the field defined by the user, is
- $\sigma$  the tensor of the stresses at time running, is
- $\varepsilon^p$  the tensor of plastic strains at time running, is
- $R(p)$  the function of hardening (with where  $R(o) = \sigma_y$  is  $\sigma_y$  the elastic limit). i.e it is the threshold of curve of tension associated with the cumulated plastic strain. is  $p$
- $p$  the cumulated plastic strain. Note:

If

| one has, one  $R(p) \cdot p = 0$  poses.  $I = 0$  The scalar product

is associated  $\sigma \cdot \varepsilon^p$  with the norm within the meaning of von Mises. This indicator is standardized and has a value ranging between 0 and 1. It is

null if the loading preserved its character proportional in each point of throughout  $\nabla$  the past history. This indicator is described in detail in the document [R4.20.01]. Syntax

### 3.17.2 INDIC\_SEUIL

```
= _F (♦/TOUT
= ' OUI' , /MAILLE
=l_maille , [l_maille ] /GROUP_MA
=lgrma , [l_gr_maille ] ) simple
```

**Key words: (see [§2]) ♦ MODELS**

```
=mo, [model ] ♦ CHAM
MATER=chmater , [cham_mater ] ♦ CHARGE
=ch,/[ char_meca ]/[tank
_ther ]/[tank
_acou ] ♦RESULTAT
= resu , [evol_noli ] Operands
```

### 3.17.3 the indicator

is calculated on the field defined by the key keys: /TOUT

```
= "OUI" , On all the
elements of the model Mo. / MESH
```

```
= l_maille , On
the list l_maille of meshes of the model Mo. / GROUP
```

```
_MA= lgrma , On
the list lgrma of the mesh groups of the model Mo. Count
```

### 3.17.4 produced the array

contains, for each time, the value of the total indicator of loss of proportionality of the loading in elastoplasticity on the locus concerned: INST

PLACE	INDIC SEUIL	1. 0
0000E+00 MY 4.77299		E-02 2.0 0000
E+00 MY 3.33763		E-02 Key word

## 3.18 CHAR\_LIMITE Drank Postprocessing

### 3.18.1

of the computation of the Yield-point load [R7.07.01 §2.3]. This factor key word the computation of the Yield-point load of a structure by a kinematical approach allows. Its employment requires as a preliminary to have carried out a nonlinear computation (see operator STAT\_NON\_LINE [U4.51 .03]) well informed by the key word RESULTAT and whose characteristics are the following ones: constitutive law

- NORTON\_HOFF , increasing

- list of times of computation corresponding to values of regularization of the model of NORTON\_HOFF which tend towards 1 (in practice, one recommends to be limited to the times ranging between 1 and 2 which do not lead to too long computations while making it possible to obtain a higher limit of the sufficiently precise Yield-point load), loading
- (unit) controlled corresponding to the loading compared to which one seeks to estimate the Yield-point load, continuation method being TYPE = "ANA\_LIM", possibly
- a constant loading whose it is then necessary imperatively to point out the existence by the key word CHAR\_CSTE = "OUI". Operator

POST\_ELEM then produces an array which gives for each time of computation, i.e. for increasingly weak regularizations, a limit higher CHAR\_LIMI\_SUP of the Yield-point load supported by structure. Moreover, in the absence of constant loading, CHAR\_CSTE = "NON", THE ARRAY also contains an estimate CHAR\_LIMI\_ESTIM of a lower limit of the Yield-point load. On the other hand, if a constant loading is present, CHAR\_CSTE = "OUI", such an estimate of the lower limit is not available any more but the array then contains power PUIS\_CHAR\_CSTE of the constant loading in the velocity field solution of the problem. A detailed example of computation of Yield-point load is provided in [U2.05.04]. Syntax

### 3.18.2 |CHAR\_LIMITE

```
=_F (◇CHAR
_CSTE=/ "NON" , [DEFAULT ]/"OUI'
, ) simple
```

**Key words: (see [§2]) ◇ MODELS**

```
=mo, [ model ] ◇ CHAM
- MATER=chmater , [cham_mater] ◇ RESULTAT
- =resu, [ evol_noli ] ◇ CARA
- _ELEM=carac , [cara_elem ] ◇ MODE
- FOURIER=nh, [I ] ◇ CHARGE
=ch,/[ char_meca ]/[tank
_ther ]/[tank
_acou ] Operands
```

### 3.18.3 ◇CHAR

```
_CSTE = "NON" , [DEFAULT ]/"OUI'
, Key word
```

indicating if the loading is constant or not constant (default value). Count

### 3.18.4 produced the array

contains, if CHAR\_CSTE = "OUI" : INST

CHAR	LIMI_SUP PUIS	CHAR_CSTE 1. 0
0000E+00	E+01 -2.50000	E-01 2.0 0000
1.46838		
E+00 1.46838	E+01 -2.50000	E-01 the array

contains, if CHAR\_CSTE = "NON" : INST

CHAR	LIMI_SUP CHAR	LIMI_ESTIM 1. 0
0000E+00	E+01 -2.50000	E-01 2.0 0000
1.46838		
E+00 1.46838	E+01 -2.50000	E-01 Key word

## 3.19 CARA\_GEOM Drank CARA\_GEOM

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

## 3.19.1

is used by macro\_commande MACR\_ CARA\_POUTRE [U4.42 .02] to compute: the geometrical characteristics (center of inertia, main moments of inertia) of a section of beam with a grid in elements of continuous medium 2D. Syntax

## 3.19.2 |CARA\_GEOM

```
= _F (♦/TOUT
= ' OUI' , /GROUP_MA
    =lgma, [ l_gr_maille ] /MAILLE
    =lma, [ l_maille ] ♦SYME
_X=/ "OUI" , /"NON
    ", [DEFAULT ] ♦SYME
_Y=/ "OUI" , /"NON
    ", [DEFAULT ] ♦ORIG
_INER= (xp, YP), [l_R] ) single-ended spanner
```

Keys: (see [§2]) ♦ MODELS

```
= Mo, [ model ] ♦ CHAM
- MATER= chmater , [cham_mater] ♦ CHARGE
= CH,/ [char_meca ]/[tank
    _ther ]/[tank
    _acou ] Operands
```

## 3.19.3 Operands

### 3.19.3.1 TOUT /GROUP\_MA /MESH Define

the place of computation. One can calculate in particular characteristics for a set of meshes, defined by GROUP\_MA or MESH . Operands

### 3.19.3.2 SYME\_X /SYME\_Y Taken

into account of a symmetry compared to or with  $X$  (or  $Y$  both). The mesh provided by the user corresponds then to half of the section (or the quarter). Operand

### 3.19.3.3 ORIG\_INER Makes it possible

compared to give the punctual coordinates to which will be calculated the geometrical characteristics [U4.42.02]. Count

## 3.19.4 produced cf [U

4.42.02] §3.2 Key word

## 3.20 CARA\_POUTRE Drank Remark

### 3.20.1

**This key word**

| is not intended to be called directly by the user. CARA\_POUTRE

is used exclusively by macro-command MACR\_ CARA\_POUTRE [U4.42 .02] to compute: the mechanical characteristics (constant of torsion, radius of torsion, constants of shears, position of the shear center, warping constant) of a section with a grid in elements 2D. Its employment

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requires the preliminary call of many commands, specific to each calculated option. The operands will thus not be here detailed. For more detail one will refer to MACR\_CARA\_POUTRE [U4.42 .02].  
 Syntax

### 3.20.2 |CARA\_POUTRE

```

= _F (♦/
    TOUT=' OUI'
    _MA=lgma,
    _MA_INTE=lgma_inte
CARA
    GEOM=tab,
LAPL
    _ PHI=, [evol
    _ PHI_Y=, [evol
LAPL_PHI_Z
    =, [evol
    =rt,
        LIAISON=/
            "HINGE
            ",/"ENCASTREMENT
            ", ♦LONGUEUR
=L, [R ] ♦
=mat, [ to subdue
= "CARA_TORSION
            ",/"CARA_CISAILLEMENT
            ",/"CARA_GAUCHI
            ",) single-ended spanner
    ] ♦GROUP
    , [l_gr_maille
    ] ♦
    [ tabl
    _cara_geom] ♦
    _ther] ♦ LAPL
    _ther] ♦
    _ther] ♦RT
    ♦
    MATERIAU
    ] ♦OPTION
    "/,"CARA_CISAILLEMENT
    "/,"CARA_GAUCHI
    ",) single-ended spanner
    ] ♦
    ] ♦CHAM
    ] ♦CHARGE
    ]/[tank
    _ther ]/[tank
    _acou ] produced
    
```

Keys: (see [§2]) ♦ MODELS

```

=mo, [
MATER=chmater
=ch,/[
    model
    , [cham_mater
    char_meca
    ] ♦CHAM
    ] ♦CHARGE
    ]/[tank
    _ther ]/[tank
    _acou ] produced
    
```

### 3.20.3 Array cf [U

4.42.02] §3.2 Key word

## 3.21 AIRE\_INTERNE Drank Key word

### 3.21.1

factor allowing the computation of the area of a hole in a 2D mesh from his contour. Syntax

### 3.21.2 |AIRE\_INTERNE

```

= _F (♦ GROUP_MA_BORD = lgma) simple
    
```

Key word: ♦MODELE = Mo, [model ] Operand

### 3.21.3 ♦GROUP

\_MA\_BORD = lgma, List  
 of mesh groups of edge delimiting hole (SEG2 or SEG3) Counts

### 3.21.4 produced the array

contains, for each mesh group of edge, the area of hole and the length of his contour. GROUP\_MA

AREA	LONGUEUR	GMA1
3.14128	E-02 6.28303	E-01 GMA 2
3.14128	E-02 6.28303	E-01 Key word

## 3.22 TRAV\_EXT Drank Key

### 3.22.1 \_clé

factor making it possible to calculate the real work of external forces TRAV\_REEL or elastic TRAV\_ELAS such as below definite: éq 3.22

$$\text{TRAV\_REEL} = \int_{t_0}^t \int_{\Omega} \sigma \cdot \dot{\varepsilon} = \int_{t_0}^t F_{\text{int}} \cdot \dot{U} \quad .1-1 \text{ éq 3.22}$$

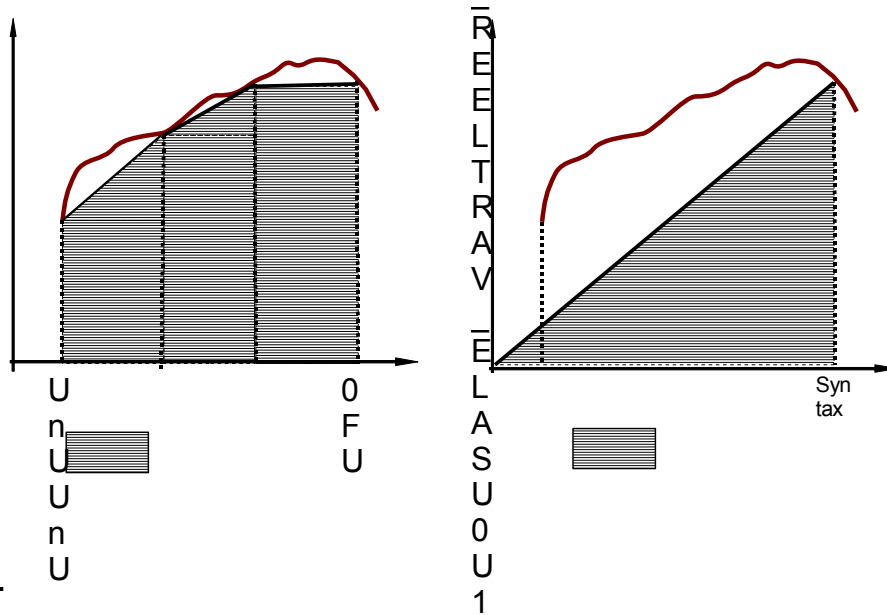
$$\text{TRAV\_ELAS} = \frac{1}{2} \int_{\Omega} \sigma \cdot \varepsilon = \frac{1}{2} F_{\text{int}} \cdot U \quad .1-2 \text{ The computation}$$

is carried out on the basis of SD result, well informed under the key word RESULTAT , for which the nodal forces, i.e. the internal forces, were beforehand calculated by the operator CALC\_CHAMP , option "FORC\_NODA " [U4.81 .04]. In the case of real work, initial time corresponds  $t_0$  to the first time filed in the SD result; integration in time is carried out by a method of trapezoids: The two

$$\begin{aligned} \text{TRAV\_REEL} &= \sum_{i=0}^{n-1} \int_{t_i}^{t_{i+1}} F(U(t_i)) \cdot U(t_i) dt = \sum_{i=0}^{n-1} \int_{U_i}^{U_{i+1}} F(Z) dZ \approx \frac{1}{2} \sum_{i=0}^{n-1} (U_{i+1} - U_i)(F_{i+1} + F_i) \\ &\approx \frac{1}{2} \sum_{i=0}^{n-1} (U_{i+1} \cdot F_{i+1} + U_{i+1} \cdot F_i - U_i \cdot F_{i+1} - U_i \cdot F_i) \end{aligned}$$

quantities TRAV\_REEL and WK. \_ELAS are calculated for each time filed in the SD result. These quantities

can graphically be interpreted on the response curve force-displacement of structure (provided that the force is dual displacement, for example the pressure and volume in the case of a cavity under pressure). FTRAV



### 3.22.2 TRAV\_EXT

= \_F ( ) simple

Key word: ♦RESULTAT

```
= resu/[evol_elas      ]/[evol
      _noli]/[dyna
      _trans] Name of
```

data structure result of computation. Count

### 3.22.3 produced the array

contains, for each time, elastic work and the real work of the external forces. INST

TRAV_	ELAS TRAV_	REEL 0.00000
E+00 1.16070	E+00 1.16070	E+00 1.00000
E+00 4.64279	E+00 4.64279	E+00 INTEGRAL

## 3.23 Operand Goal Makes it possible

### 3.23.1

TOUT to calculate the integral of a component of a field on a field defined by the key words, GROUP\_MA , MESH . One produces an array containing the value of the integral as well as the average (equal to the integral divided by volume). Syntax

### 3.23.2 |INTEGRALE

```
=_F (♦/
TOUT = ' OUI' , /MESH
      =l_maille , [l_maille ]/GROUP
      _MA=lgrma , [l_gr_maille ] ♦NOM
      _CHAM= field , [kN] ♦NOM
      _CMP= cmp , [ kN] ♦DEJA
      _INTEGRE= /"OUI" /"NON
```

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.



" ) simple

**Key words: (see [§2]) ♦ MODELS**

```
=mo, [model ] ♦CHAM
_MATER=chmater , [cham_mater] ♦ /CHAM_GD
=cham, [ cham_gd ]/RESULTAT
=resu, [ result ] # selection
```

of times computation to see

TOUT\_ORDRE , NUME\_ORDRE, LIST\_ORDRE, INST, LIST\_INST in [U4.71 .00] Operands

### 3.23.3 ♦/TOUT

```
= ' OUI' , On all
structure. /MAILLE
```

```
= l_maille , On
a list of meshes. /GROUP
```

```
_MA=lgrma , On
a list of mesh group. ♦ DEJA_INTEGRE
```

```
=/" OUI' /"NON
" is useful
```

only for the constant cham\_ elem by element. In this case, this key word is compulsory and is used to differentiate the really constant fields from the fields integrated on the element (like energies potential or kinetic for example). This distinction is important for the computation of the integral because one does not make the same "sum". Count

### 3.23.4 produced the array

contains, for each time, the integral and the average: INST

INTE	NEAR MOYE	NEAR 0.00000
E+00 1.16070	E+00 1.16070	E+00 1.00000
E+00 4.64279	E+00 4.64279	E+00 Operand

## 3.24 MINMAX Goal Makes it possible

### 3.24.1

to calculate the extremums in space of a list of components of a field, for all the times specified on a field defined by the key words TOUT, GROUP\_MA . One produces an array containing the value of the min, the max, and their localization: name of the mesh and of the Gauss point, name of the node . Syntax

### 3.24.2 MINMAX

```
= _F ( ♦ /TOUT
= ' OUI' , /GROUP_MA
=lgrma , [l_gr_maille ] ♦ MODELS
=mo, [model ] ♦ /CHAM_GD
=cham, [ cham_gd ] /RESULTAT
=resu, [ result ] NOM_CHAM
= # selection
of times computation to see
```

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

TOUT\_ORDRE , NUME\_ORDRE, LIST\_ORDRE, INST, LIST\_INST in [U4.71 .00] ♦ NOM\_CMP  
 =lcmp) Operands

### 3.24.3 ♦ /TOUT

= ' OUI' , Computation  
 of the extremums on all structure. /GROUP

\_MA=lgrma , Computation  
 of the extremums on a list of mesh group. Count

### 3.24.4 produced to It array

contains, for each time, the values of the max, min for each component like their localization:  
 CHAM\_GD

INSTS	MAX_EPXX	MA_MAX	_EPXX PT_MAX	_EPXX EPMAX
0.0		E+02 M121	4 MIN	_EPXX
6.90232				

MA_MIN	_EPXX PT_MIN	_EPXX
E+00 M1080	1 Key word	0.00000

## 3.25 ENER\_DISS Goal Makes it possible

### 3.25.1

to calculate the energy of dissipation (integral on the field of the density of energy DISS\_ELGA calculated by CALC\_CHAMP ). This option is for time computable only in the following case:  
 element

- DKTG and constitutive law GLRC\_DM Syntax

### 3.25.2 |ENER\_DISS

```
=_F (♦/TOUT
    = ' OUI' , /MAILLE
    =l_maille , [l_maille] /GROUP_MA
    =lgrma , [l_gr _maille]) simple
```

#### Key words: (see [§2]) ♦ MODELS

```
=mo, [model ] ♦CHAM
_MATER=chmater , [cham_mater] ♦CARA
_ELEM=carac , [cara_elem ] ♦|NUMERICAL
_COUCHE= |NIVE
_COUCHE= ♦ RESULTAT
= ♦ CHARGE
=/[tank _meca ]/[tank
_ther ]/[tank
_acou ] Operands
```

### 3.25.3 ♦/TOUT

```
= ' OUI' , On all
structure. /MAILLE

= l_maille , On
```

a list of meshes. /GROUP\_MA  
 = lgrma , On  
 a list of mesh group. Count

### 3.25.4 produced the array

contains, for each time, the values of the energy of dissipation and possibly of the energy of damage and the energy of plasticity on the locus concerned: INST

PLACE	ENTITE	TOTAL	ENDO	PLAS	1. 0
0000E+00 MY TOUT		4.00093	E+12 0.00E	+00 0.00E	+00 2.0 0000
E+00 GMA1	GROUP MA	2.71323	E+11 0.00E	+00 0.00E	+00 Operand

## 3.26 VOLUMOGRAM Goal Makes it possible

### 3.26.1

to calculate the distribution on the surface or volume of the value of a component of a field at various times on a field defined by the key words TOUT or GROUP\_MA . One produces an array containing: limits

- of the intervals defined by the values maximum minimum and of the component and amongst intervals wished, the percentage
- of structure corresponding to each interval. Notice

#### the number

of intervals is defined by the user, the limits are determined by Code\_Aster in the following way: That is to say

the number  $n$  of intervals, and the  $V_{min}$  extreme  $V_{max}$  values of the component. That is to say

the length  $p=(V_{max}-V_{min})/n$  of each interval. The intervals are: Syntax

$[V_{min}, V_{min} + p], [V_{min} + p, V_{min} + 2p], \dots, [V_{min} + (n-1)p, V_{max}]$

### 3.26.2 VOLUMOGRAM

```
=_F (♦/
TOUT = ' OUI' , /GROUP
      _MA=grma, [ gr_maille ] ♦TYPE
      _MAILLE= /"2D " ,/"3D"
              , ♦NOM
      _CHAM= field , [kN] ♦NOM
      _CMP= cmp , [ kN] ♦BORNE
      = (bmin , bmax), [l_R] ♦NORME
      = /"RELATIF " [default ]/"ABSOLU
        " ♦NB
      _INTERV= /5 [ default ] /nb_int
                ) simple
```

#### Key words: (see [§2]) ♦ MODELS

```
=mo, [model ] ♦CHAM
_MATER=chmater , [cham_mater] ♦ /CHAM_GD
      =cham, [ cham_gd ]/RESULTAT
      =resu, [ result ] # selection
```

of times computation to see  
 TOUT\_ORDRE , NUME\_ORDRE, LIST\_ORDRE, INST, LIST\_INST in [U4.71 .00] Operands

### 3.26.3 ♦/TOUT

```
= ' OUI' , On all
structure. /GROUP

    _MA=lgrma , On
a mesh group. ♦ TYPE_MAILLE

    Makes it possible
to filter according to the mesh size. ♦NB

    _INTERV= /5 [ default ] /nb_int
Many
desired intervals ♦NORME

= /"RELATIF " [default ]/"ABSOLU
" With
NORM = ' RELATIF', the results displayed in column DISTRIBUTION of the produced
array are percentages (between 0 and 100) of calculated total volume. With
NORM = ' ABSOLU', one does not make this adimensionnalisation and the displayed
results are the effective volumes, interval by interval, expressed in the unit defined by the
mesh. ♦BORNE

= (bmin , bmax), [l_R] Allows
to limit the values of the fields used for the computation of the volumogram. Count
```

### 3.26.4 produced the array

contains the limits of the intervals and the percentage of structure corresponding to each interval. INST

NOM_CMP	GROUP_MA	BORNE_IN F	BORNE_SUP	DISTRIBUTION	1. 0
0000E+00 M11	GAUCHE	-9.99990	E-07 -8.99947	E-07 1.95000	E+01 1. 0
0000E+00 M11	GAUCHE	-8.99947	E-07 -7.99947	E-07 2. 000	00E+0 1 1. 0
0000E+00 M11	GAUCHE	-7.99947	E-07 - 6 . 99947	E-07 2. 0	5 0 00E+0 1 Operand

## 3.27 NORMALIZES Goal Makes it possible

### 3.27.1

TOUT to calculate the norm of a field on a field defined by the key words, GROUP\_MA , MESH for elements continuums only. Currently, only the norm is calculated. One  $L_2$  produces an array containing the norm of the field. Syntax

### 3.27.2 |=\_F

```
NORMALIZES (♦TYPE
    _NORM=' L2', [ kN] ♦/
TOUT = ' OUI' , /MESH
    =l_maille , [l_maille ]/GROUP
```

*Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.*

```

        _MA=lgrma , [l_gr_maille ] ◇TYPE
    _MAILLE=/ "2D" , [kN]/ "3D
        " , ◆NOM
    _CHAM=champ , [kN] #Si CHAM_GD
    is well informed ◇COEF
    _MULT=coef , [ l_R] ) simple
    
```

**Key words: (see [§2]) ◇MODELE**

```

    =mo, [model ] ◇CHAM
    _MATER=chmater , [cham_mater] ◆/
    CHAM _GD=cham, [ cham_gd ]/RESULTAT
    =resu, [ result ] # selection
    
```

of times computation to see  
 TOUT\_ORDRE , NUME\_ORDRE, LIST\_ORDRE, INST, LIST\_INST in [U4.71 .00] Operands

### 3.27.3 ◆/TOUT

= ' OUI' , On all  
 structure. /MAILLE

= l\_maille , On  
 a list of meshes. /GROUP

\_MA=lgrma , On  
 a list of mesh group. ◇ TYPE\_MAILLE

Makes it possible  
 to filter according to the mesh size. ◆/

CHAM \_GD=cham, [ cham\_gd ] the accepted  
 fields cham is fields DEPL, TEMP, NEUT\_R , FLUX, SIEF and EPSI . ◇ COEF

\_ MULT=coef, Makes it possible  
 to give a list of real coefficients to balance the components of a field of the type NEUT\_R. If  
 this  
 list is not indicated, these coefficients are put at 1. If  
 the size of this list is lower than the number of components of the field, this list is supplemented by  
 zero values. Count

### 3.27.4 produced the array

contains the type of the norm (L2 currently) and its value: GROUP\_MA

TYPE	NORM	VALE	NORM	GMA1
L2	4.64719		E-03	GMA 2
L2	2.71323		E -02	Operand

## 3.28 TITER ◊ TITER

=ti, Title

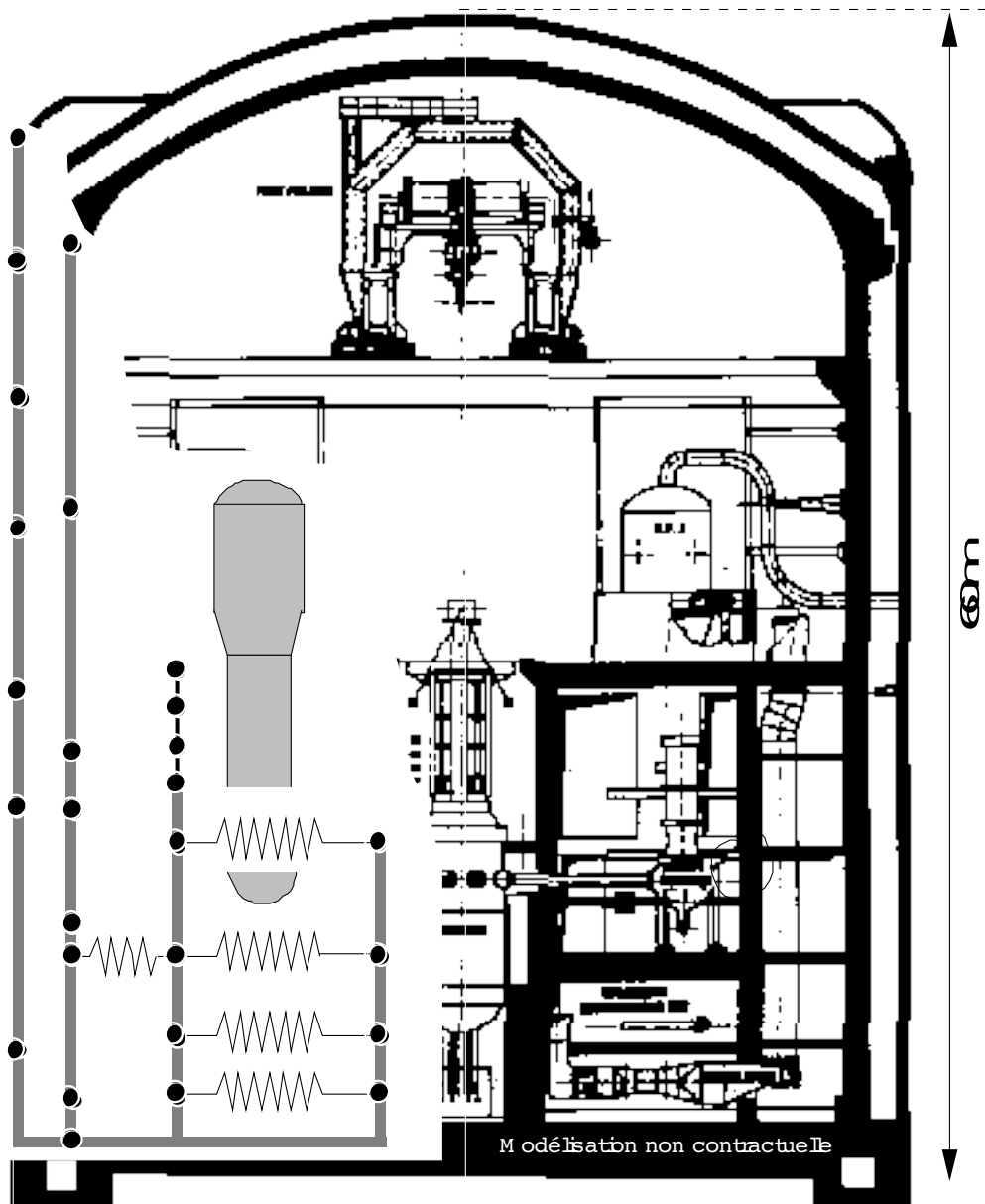
attached to the product concept by this operator [U4.03.01]. Operand

## 3.29 INFO ◊ INFO

= 1, [ DEFAULT ]/2,  
Parameter  
of printing. Example

## 4 the example

which follows applies to the computation of total quantities to a dynamic modelization of a building engine. Are modelled: the external enclosure, the interior enclosure, internal structures, the well of tank. The modelization



of a half building is realized by beam elements, discrete elements representing connections on the ground, the additional masses and the connections between nodes. It is

on this model of beams that operator POST\_ELEM will calculate : mass

- of structure, coordinates
- of the center of gravity, the tensor
- of inertia, the potential energy

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- of certain modes and its distribution in structure, the kinetic energy
- of certain modes and its distribution in structure. Computation

## 4.1 of the mass, the center of gravity and inertias for

- all structure (TOUT = "OUI") for
- the mesh group containing the beams (GROUP\_MA = "pou\_d\_t") for
- the mesh group containing connections on the ground (GROUP\_MA = "liai\_sol") for
- the mesh group containing the additional masses (GROUP\_MA = "masses") for
- the mesh group containing connections between nodes (GROUP\_MA = "liai\_noe")  
Orders

### massestr

```
= POST_ELEM (MODELE=stickmod, CHAM_MATER
             = chmater, CARA_ELEM
             = caraelem, MASS_INER
             = _F (GROUP_MA= (" pou_d_t", "liai_sol", "masses
                             ", "liai_noe"), TOUT=
             "OUI',), TITER
             = ' mass, center of gravity and inertias of the
structure'); Computation
```

## 4.2 of the potential energy of modes 1,2 and 7 for

- all structure (TOUT = "OUI") for
- the mesh group containing the beams (GROUP\_MA = "pou\_d\_t") for
- the mesh group containing connections on the ground (GROUP\_MA = "liai\_sol") for
- the mesh group containing the additional masses (GROUP\_MA = "masses") for
- the mesh group containing connections between nodes (GROUP\_MA = "liai\_noe") for
- meshes (MESH = "E101" with "E2601") for
- meshes (MESH = "ELN1" with "ELN5") Orders

### enerpot

```
= POST_ELEM (RESULTAT = modes, MODELS
             = stickmod, NUME_MODE
             = (1,2,7,), CHAM_MATER
             = chmater, CARA_ELEM
             = caraelem, ENER_POT
             = _F (TOUT = "OUI', GROUP_MA
                 = (" pou_d_t", "liai_sol", "masses
                   ", "liai_noe"), MESH
             = ("E101" , "E201", "E301", "E401", "E501", "E601", "E701
               ", "E801", "E901", "E1001", "E1101", "E1201
               ", "E1301", "E1401", "E1501", "E1601", "E1701
               ", "E1801", "E1901", "E2001", "E2101", "E2201
               ", "E2301", "E2401", "E2501", "E2601", "ELN1
               ", "ELN2", "ELN3", "ELN4", "ELN5"),), TITER
             = "potential energies of modes 1,2 and 7",)
Computation
```

## 4.3 of the kinetic energy of modes 1,2 and 7 for

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.



- all structure (TOUT = "OUI") for
- the mesh group containing the beams (GROUP\_MA = "POU\_D\_T") for
- the mesh group containing connections on the ground (GROUP\_MA = "LIAI\_SOL") for
- the mesh group containing the additional masses (GROUP\_MA = "MASSES") for
- the mesh group containing connections between nodes (GROUP\_MA = "LIAI\_NOE") for
- meshes (MESH = "MAS1" with "FARMHOUSE 27 ") for
- meshes (MESH = "E2001 ", "E2101 ", "E2201 ") Orders

## enercin

```
= POST_ELEM (RESULTAT=      modes, MODELS
                  = stickmod, NUME_
                  MODE= (1,2,7,), CHAM_
                  MATER= chmater, CARA_
                  ELEM= caraelem, ENER_
                  CIN= _F (TOUT=  "OUI", GROUP
                              _MA= ("pou_d_t", "liai_sol", "masses
                                     ", "liai_noe"), MESH
= ("MAS1" , "MAS2", "MAS3", "MAS4", "MAS5", "MAS6", "MAS7
   ", "MAS8", "MAS9", "MAS10", "MAS11", "MAS12", "MAS13
   ", "MAS14", "MAS15", "MAS16", "MAS17", "MAS18",
"MAS19
   ", "MAS20", "MAS21", "MAS22", "MAS23", "MAS24",
"MAS25
   ", "MAS26", "MAS27", "E2001", "E2101", "E2201"),),
TITER
= "kinetic energies  of modes 1,2 and 7",)
```