# Operator POST_DYNA_ALEA

## 1 Goal

POST_DYNA_ALEA allows to carry out two types of postprocessing at the conclusion of a stochastic calculation of dynamics:

**Calculation of curves of brittleness starting from a table containing the results of a simulation of Monte Carlo**
Starting from a table [table_sdaster] containing information on the levels of excitation (in seismic analysis, one chooses the PGA in general) and the variable of interest characterizing the failure or not structure, POST_DYNA_ALEA allows to determine the parameters of a curve of brittleness according to the model lognormale and to calculate values of this curve. The reader can consult [U2.08.05] for a more detailed description.

**Postprocessing statistically of the results of the interspectre type.**
POST_DYNA_ALEA allows on functions selected in a concept of the type [interspectre] to calculate statistical parameters: spectral moments, standard deviation, distribution of the peaks, centre frequency.
The matrix interspectrale can be obtained by various operators: LIRE_INTE_SPEC [U4.36.01], CALC_INTE_SPEC [U4.36.03], DEFI_INTE_SPEC [U4.36.02], DYNA_ALEA_MODAL [U4.53.22], DYNA_SPEC_MODAL [U4.53.23] or REST_SPEC_PHYS [U4.63.22]. One will refer to [R7.10.01] for the description of the treatments carried out.

This operator produces a table of the type table_sdaster printable by IMPR_TABLE [U4.91.03].

# 2 Syntax

```
[table_sdaster] = POST_DYNA_ALEA

    (
      ♦  / FRAGILITE= _F (
                      ♦  TABL_RESU  =  tabres              [table_sdaster]
                      ◊  VALE  = list                  [l_R]
                      ◊  LIST_PARA = laster               [listr8]
                      ♦  METHOD =         / 'EMV'
                                            / 'REGRESSION'
                      ◊  THRESHOLD  =   THRESHOLD                [R]

          if METHOD =         / 'EMV'

                      ♦  AM_INI  =    am0                 [R]
                      ◊  BETA_INI  =  /  beta0            [R]
                                      /  0.3              [DEFECT]
                      ◊  FRACTILES = fract                [listr8]
                      ◊  NB_TIRAGE = nbt                  [I]

                         ),


          / INTERSPECTRE= _F (
                      ♦  INTE_SPEC        = inter         [interspectre]
                      ◊  DURATION            = duration          [R]
                      ◊  FRACTILE       =    /tailcoat        [R]
                                             /0.5      [DEFECT]

                      ♦  /  ♦  NUME_ORDRE_I = lnumi                 [l_Kn]
                            ♦  NUME_ORDRE_J = lnumj                 [l_Kn]
                         /  ♦  NOEUD_I      = lnoeudi               [l_Kn]
                            ♦  NOEUD_J      = lnoeudj               [l_Kn]
                            ♦  NOM_CMP_I    = lcmpi                 [l_Kn]
                            ♦  NOM_CMP_J    = lcmpj                 [l_Kn]

                         /  OPTION          =/'ALL'
                                               / 'DIAG'

                      ◊  MOMENT =     lmom                        [l_I]
                         ),

      ◊  INFORMATION =    /  1                                  [DEFECT]
                       /  2

      ◊  TITLE =   title                                    [l_Kn]

    ) ;
```

# 3 Operands

## 3.1 Keyword BRITTLENESS

BRITTLENESS =

Mot_clé BRITTLENESS allows to determine the parameters $A_m$ and $\beta$ (median and standard deviation logarithmic curve) of a curve of brittleness according to the model lognormal [U2.08.05]:

$$P_{f|a}=\Phi\left(\frac{\ln(a/A_m)}{\beta}\right)$$

One can also calculate the values of the curve for the values of parameters *With*$_m$ and $\beta$ obtained. The option FRACTILES (optional) allows moreover to determine fractiles for the curve by a method of rééchantillonnage of the original sample which one informed in TABL_RESU.

### 3.1.1 Operand TABL_RESU

♦ TAB_RESU = tabres [table_sdaster]

The name of the table is given [table_sdaster] that one must have creates before using CREA_TABLE [U4.33.02] . This table must have at least two columns with access keys (name of label of column): PARA_NOCI (it is the indicate fract = 0.5 ur characterizing the level of the excitation) and DEFA (the values of this column are 0 if one did not observe a failure or 1 if there were failure) or REQUEST (values of the real variable of interest characterizing the failure or the damage, called too *seismic request* in my literature).

### 3.1.2 Operand METHOD

♦ METHOD = / 'EMV'
/ 'REGRESSION'

One chooses between the two methods for calculation of the curve of brittleness lognormale: EMV for the estimate by maximum of probability or REGRESSION for the linear regression. One finds more details on these two methods in documentation [U2,08.05] . If one chooses REGRESSION , then the table tabres must contain a column REQUEST informing the seismic request (variable of interest like the drift transistor, a maximum constraint,…) and it is necessary to inform the threshold of failure via the keyword THRESHOLD .

### 3.1.3 Operand THRESHOLD

◊ THRESHOLD = THRESHOLD [R]

If the table TAB_RESU a column contains REQUEST , then it is necessary to inform the threshold of this variable from which the structure is considered failing.

### 3.1.4 Operands LIST_PARA and VALE

One can give a list of realities, values for which one evaluates the curve of brittleness.

This can be done in the form of a list containing the values of calculation $(a_1, a_2, \ldots, a_n)$ :
◊ ... VALE = list [l_R]

or by giving it name of the concept of the type listr8 containing the list of the values:

◊ ... LIST_PARA = list [listr8]

### 3.1.5 Operand AM_INI and BETA_INI

♦ .. AM_INI
◊ .. BETA_INI

If one chose METHOD ='EMV', then it is requirement of Donner an initial value for the estimate of the parameter $A_m$ and it is advised to give an initial estimate for $\beta$ (points of starting for the algorithm of optimization).

### 3.1.6 Operands FRACTILES and NB_TIRAGE

These operands must be indicated if one wishes to determine fractiles or confidence intervals more precisely for the curve of brittleness estimated by the method of the maximum of probability ('EMV'). The method of rééchantillonnage (known as also "bootstrap" in the Anglo-Saxon literature) is used for that. The operand FRACTILES allows to give the fractiles that one wishes to calculate.

◊ FRACTILES = fract [listr8]

By default, one as many draws samples "bootstrap" than one has data (it is the number $N$ of simulation of Monte Carlo carried out as a preliminary and whose results are stored in the table TABL_RESU). The order NB_TIRAGE allows nevertheless to decrease the number of pulling to be carried out:

◊ NB_TIRAGE = nbt [I]

It is necessary that *nbt* either inferior or equalizes with the number of values in TABL_RESU ( $nbt \leq N$ ). This functionality makes it possible to reduce the computing time but is disadvised in the case general because the results are not very reliable.

## 3.2 Keyword INTERSPECTRE

### 3.2.1 Operand INTE_SPEC

♦ INTE_SPEC = inter

inter is the name user of the matrix interspectrale.

The matrix interspectrale can be obtained by various operators: LIRE_INTE_SPEC [U4.36.01], CALC_INTE_SPEC [U4.36.03], DEFI_INTE_SPEC [U4.36.02], DYNA_ALEA_MODAL [U4.53.22], DYNA_SPEC_MODAL [U4.53.23] or REST_SPEC_PHYS [U4.63.22].

**Notice** :

*The spectral moments are defined like integrals of the spectral concentration of power (DSP):*

$$\lambda_i = \int_{-\infty}^{+\infty} |\omega|^i S_{XX}(\omega)\, d\omega = 2\int_{0}^{+\infty} \omega^i S_{XX}(\omega)\, d\omega$$

*Thus, if the DSP is given for the positive frequencies only, POST_DYNA_ALEA multiply by 2 the integrals of the DSP calculated for $\omega > 0$. In addition, the DSP are defined according to the natural frequency $f = 2\pi\omega$ ( $Hz$ ) in POST_DYNA_ALEA. The following formulas are used [cf R7.010.01]:*

$$S_{\mathbf{xx}}(f) = \int_{-\infty}^{+\infty} R_{XX}(\tau)\, e^{-2i\pi f \tau}\, d\tau ;$$

$$S'_{\mathbf{xx}}(\omega) = \frac{1}{2\pi} S_{\mathbf{xx}}(f)$$

The reader is invited to to consult the documentation of the order DYNA_ALEA_MODAL [U4.53.22] pour more information on the direction of the parameters of the keyword.

### 3.2.2 Operand S NUME_ORDRE_I, NUME_ORDRE_J

♦ / ♦ NUME_ORDRE_I = lnumi
♦ NUME_ORDRE_J = lnumj

These keywords make it possible to define the terms of the matrix whose functions will undergo the treatment.

When the autospectres or the interspectres are calculated on **modes** :

- lnumi is the list of the sequence numbers of the modes 'I'. Example: (2,3,1).
- lnumj is the list of the numbers of odre modes 'I. Example: (2,1,4)

The indices are appairés according to the same row.

- (2.2) corresponds to the autospectre on mode 2,
- (3.1) corresponds to the interspectre between mode 3 and mode 1.

lnumi and lnumj must contain the same number of terms.

### 3.2.3 Operands NOEUD_I, NOEUD_J, NOM_CMP_I, NOM_CMP_J

♦ / ♦ NOEUD_I = lnoeudi
♦ NOEUD_J = lnoeudj
♦ NOM_CMP_I = lcmpi
♦ NOM_CMP_J = lcmpj

When the autospectres or the interspectres are calculated on **nodes** in a direction givenE:

- lnoeudi is the list of the nodes according to "I" : $(NO92, NO95, NO98)$
- lnoeudj is the list of the nodes according to "J" : $(NO92, NO92, NO92)$
- lcmpi is the list of the components according to "I" : $(DX, DX, DY)$
- lcmpj is the list of the components according to "J" : $(DX, DX, DX)$

The nodes and components are appairés according to the same row:

- $(NO92\,DX, NO92\,DX)$ corresponds to the autospectre with the node $NO92$ in the direction $DX$,
- $(NO98\,DY, NO92\,DX)$ corresponds to the interspectre between the node $NO92$ in the direction $DX$ and the node $NO95$ in the direction $DY$.

lnoeudi, lnoeudj, lcmpi and lcpmj must contain the same number of terms.

### 3.2.4 Operand OPTION

♦ / OPTION = 'ALL'
Calculations are carried out on the whole of the interspectres of the matrix.
/ OPTION = 'DIAG'

Calculations are carried out on the whole of the autospectres of the matrix and only for these.
fract = 0.5

### 3.2.5 Keyword DURATION and FRACTILE

◊ DURATION = duration
If the keyword duration is informed, then one determines the maximum médian or very other fractile as well as the factor of peak of the Gaussian stationary stochastic process according to the

formulas of Vanmarcke. duration then indicate the interval of time considered to estimate these quantities. By way of an example, within the framework of a seismic analysis, duration can be taken equal to the duration of the strong phase of the seismic signal.

◊ FRACTILES = fract [listr8]
Allows to define the fractile considered for the calculation of the maximum.
By default, one takes fract = 0.5, which corresponds to the median of the maximum one.

### 3.2.6 Operand MOMENT

◊ MOMENT = lmom

lmom is the list of the orders of the spectral moments which will be calculated. By default, spectral moments of orders 0, 1, 2, 3 and 4 are always calculated. It is thus advisable to mention in this list the moments of a nature higher than 4. Example: (5,7,8).

## 3.3 Operand INFORMATION

◊ INFORMATION =

| | |
|---|---|
| 1 | impression of the results requested. |
| 2 | like 1 but with more details. |

## 3.4 Operand TITLE

◊ TITLE = title

title is the title of calculation. It will be printed at the top of the results. See [U4.03.01].

# 4 Provided results

## 4.1 Keyword BRITTLENESS

The parameters of the table at exit are:

| PARAMETERS | TYPE | DESCRIPTION |
|---|---|---|
| TITLE | TXM | Title of the table |
| AM | R | Parameter $A_m$ estimated by maximum of probability starting from the original sample |
| BETA | R | Parameter β estimated by maximum of probability starting from the original sample |
| PARA_NOCI | R | Values parameter of harmfulness for which one evaluates the curves |
| PFA | R | Values of the curve of brittleness (parameters AM and BETA) |
| FRACTILES | R | Values of the curves for the fractile $f$ |

## 4.2 Keyword INTE_SPEC

For each function chosen in the interspectre, POST_DYNA_ALEA store in a table accessible by IMPR_TABLE [U4.91.03]

- spectral moments
- statistical parameters (to be used if it is about a autospectre):
  - standard deviation,
  - factor of irregularity,
  - median number of extrema a second,
  - many passages by zero a second,
  - centre frequency
  - the factor of peak according to the formula of Vanmarcke
  - the average maximum according to the formula of Vanmarcke

The parameters of this table are:

| PARAMETERS | TYPE | DESCRIPTION |
|---|---|---|
| NUME_ORDRE_I | I | sequence number of the modes $i$ |
| NUME_ORDRE_J | I | sequence number of the modes $j$ |
| NOEUD_I | NO | Node $i$ |
| NOEUD_J | NO | Node $j$ |
| NOM_CMP_I | TXM | Name of the component to the node $i$ $(DX, DY, DY)$ |
| NOM_CMP_J | TXM | Name of the component to the node $j$ $(DX, DY, DY)$ |
| LAMBDA_00 | R | spectral moment of order 0 |
| LAMBDA_01 | R | spectral moment of order 1 |
| LAMBDA_02 | R | spectral moment of order 2 |
| LAMBDA_03 | R | spectral moment of order 3 |
| LAMBDA_04 | R | spectral moment of order 4 |
| VARIATION | R | standard deviation |
| NB_EXTREMA_P_S | R | median number of extrema a second |
| NB_PASS_ZERO_P_S | R | many passages by zero a second |
| FREQ_APPAR | R | centre frequency |
| FACT_IRRE | R | factor of irregularity |
| MAX_MOY | R | Average maximum |
| FACT_PIC | R | Factor of peak |

If INFORMATION = 1 one prints in the file MESSAGE

- the name user of the table,
- the two indices (2 nodes or 2 modes) of the selected function,
- the type of calculated result,
- options of calculations selected or taken by default,
- values of the selected functions.

# 5 Example

## 5.1 Keyword BRITTLENESS

Example of a table generated as a preliminary, by calling on CALC_TABLE, during the simulation of Monte Carlo (see too [U2.08.05]):

```
#TABLE_SDASTER
 PARA_NOCI        DEFA
  5.00000E-01          1
  4.50000E-01          0
  3.00000E-01          0
  3.00000E-01          1
  1.50000E-01          0
  2.50000E-01          0
  9.00000E-01          1
  4.00000E-01          1
       ⋮               ⋮
```

Example of the calculation of a curve of brittleness:

```
      TAB_POST=POST_DYNA_ALEA (FRAGILITE= (_F (TABL_RESU=TAB1,
                                LIST_PARA=lr,
                                AM_INI  =0.3,
                                BETA_INI=0.1,
                                FRACTILE = (0.0, 0.05, 0.5, 0.95, 1.0),
                                NB_TIRAGE =50,
                               ),),
                          TITLE = 'curve 1',
                          INFO=2,);
```

In this example, one carries out a rééchantillonnage ( $N = nbtr = 50$ ) to estimate the fractiles of the curve 5%,50% (median) and 95% and one determines the envelopes (100% and 0%).

## 5.2 Keyword INTERSPECTRE

First example:

```
POSTALEA =POST_DYNA_ALEA (INTERSPECTRE = _F ( INTE_SPEC= INTERS,
                                              OPTION=' DIAG'
                                            )
                         )
```

Second example:

```
POSTALEA=POST_DYNA_ALEA (INTERSPECTRE = _F (INTE_SPEC=INTERS,
                                            NOEUD_I=' N1',
                                            NOM_CMP_I=' DX',
                                            NOEUD_J=' N1',
                                            NOM_CMP_J=' DX',
                                           )
                         )
```