Operator POST_DYNA_ALEA

1 Drank

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

Computation of curves of brittleness from an array containing the results of a simulation of Monte Carlo
From an array [table_sdaster] containing information on the levels of excitation (in seismic analysis, one chooses the PGA in general) like on the failure or not of structure for this excitation, POST_DYNA_ALEA makes it possible to the model determine the parameters of a curve of brittleness according to 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 type interspectrum.
POST_DYNA_ALEA allows on functions selected in a concept of the type [interspectrum] to calculate statistical parameters: spectral moments, standard deviation, distribution of the peaks, center frequency.
The interspectral matrix 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 processing carried out.

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

2 Syntax

```
[table_sdaster] = POST_DYNA_ALEA

    (
      ♦/ FRAGILITE= _F (
                       ♦TABL_RESU      =  tabres              [table_sdaster]
                       ◊VALE    = list                    [l_R]
                       ◊LISTE_PARA    = laster               [listr8]
                       ◊AM_INI     =/AM0                      [R]
                                    /0.4                       [DEFAULT]
                       ◊BETA_INI   =/BETA0                 [R]
                                        /0.3                   [DEFAULT]

                       ◊FRACTILES     = fract                 [listr8]
                       ◊NB_TIRAGE     = nbt                   [I]
                          ),


          /INTE_SPEC = inter                                  [interspectrum]
          # INTE_SPEC is indicated:
             ◊TOUT_ORDRE=          "OUI'
             ◊DUREE               = duration                     [R]

             ♦/♦NUMÉRIQUE_ORDRE_I           = lnumi                 [l_Kn]
                   ♦NUMÉRIQUE_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              = "DIAG"

          ◊MOMENT    =lmom                                    [l_I]

      ◊INFO   =/1                                               [DEFAULT]
                /2

      ◊TITER  =titer                                          [l_Kn]

    );
```

3 Operands

3.1 Key word FRAGILITE

FRAGILITE =

mot_clé the FRAGILITE makes it possible to determine the parameters A_m and β (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 *Am* and β obtained. Option FRACTILES (optional) makes it possible 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]

One gives the name of the array [table_sdaster] which one must have creates before using CREA_TABLE [U4.33.02] . This array must have at least two columns with access keys (name of label of column): PARA_NOCI (it is the indicator 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.)

3.1.2 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 computation $(a_1, a_2, \ldots, a_n)$:
◊ . . . VALE = list [l_R]

or by giving the name of the concept of the listr8 type containing the list of the values:
◊ . . . LIST_PARA = list [listr8]

3.1.3 Operand AM_INI and BETA_INI

◊ . . AM_INI
◊ . . BETA_INI

One gives initial values of the parameters A_m and β to estimate (not starting for the algorithm of optimization).

3.1.4 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 by the method of rééchantillonnage (method known as of "bootstrap"). Operand FRACTILES makes it possible to give fractiles qu "one wishes to calculate.

◊ FRACTILES = fract [listr8]
By default, one draws as much D" samples "bootstrap" as one has data (it is the number N of simulation of Monte Carlo carried out as a preliminary and whose results are stored in array

TABL_RESU). Command NB_TIRAGE makes it possible nevertheless to decrease the number of pulling to be carried out:

◊ NB_TIRAGE = nbt [I]

It is necessary that *nbt* is lower or equal to 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 general case because the results are not very reliable.

3.2 Key word INTE_SPEC

♦INTE_SPEC = inter

inter is the name user of the interspectral matrix.

The interspectral matrix 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].

Note:

The spectral moments are defined like integrals of power spectral density (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 multiplies 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 consult of the command documentation DYNA_ALEA_MODAL [U4.53.22] for more information on the meaning of the parameters of the key word.

◊TOUT_ORDRE = "OUI'

All the interspectrums are taken into account.

One defines then the terms of the matrix whose functions will undergo the processing.

♦/♦NUMÉRIQUE_ORDRE_I = lnumi
♦NUMÉRIQUE_ORDRE_J = lnumj

When the autospectrums or the interspectrums are calculated on **the 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 autospectrum on mode 2,
- (3,1) corresponds to the interspectrum between mode 3 and mode 1.

lnumi and lnumj must contain the same number of terms.

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

When the autospectrums or the interspectrums are calculated on **the nodes** in a given direction:

- `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 autospectrum with the node $NO92$ in the direction DX,
- $(NO98\,DY, NO92\,DX)$ corresponds to the interspectrum 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.

```
/OPTION     = "DIAG"
```

computations are carried out on all the autospectrums of the matrix and only for these.

3.2.1 Key word DUREE

◊ DUREE = duration

If the key word `duration` is indicated, then one determines the average maximum as well as the factor of peak of the Gaussian steady stochastic process according to the formulas of Vanmarcke. `duration` then indicates the interval of time considered to estimate these quantities. By way of an example, in the frame of a seismic analysis, `duration` can be taken equal to the period of the strong phase of the seismic signal.

3.2.2 Operand MOMENT

◊MOMENT = lmom

`lmom` is the list of the orders of the spectral moments which will be calculated. By defaults, the 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 order higher than `4`. Example: `(5,7,8)`.

3.3 Operand INFO

◊INFO =

1	printing of the results requested.
2	like `1` but with more details.

3.4 Operand TITER

◊TITER = title

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

4 Results provided

4.1 Key word FRAGILITE

the parameters of the array in output are:

PARAMETERS	TYPE	DESCRIPTION
TITER	TXM	Titrates array
AM	R	Parameter A_m estimated by maximum of probability from original sample
BETA	R	Parameter β estimated by maximum of probability from original sample
PARA_NOCI	R	Values of the parameter of harmfulness for which one evaluates 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 Key word INTE_SPEC

For each function chosen in the interspectrum, POST_DYNA_ALEA stores in an array accessible by IMPR_TABLE [U4.91.03]

- the spectral moments
- from the statistical parameters (to be used if it is about an autospectrum):
  - standard deviations,
  - factor of irregularity,
  - median number of extrema a second,
  - many transitions by zero a second,
  - center frequency
  - the factor of peak according to the formula of Vanmarcke
  - the average maximum according to the formula of Vanmarcke

the parameters of this array are:

PARAMETERS	TYPE	DESCRIPTION
NUME_ORDRE_I	I	sequence number of modes i
NUME_ORDRE_J	I	sequence number of modes j
NOEUD_I	NO	Node i
NOEUD_J	NO	Node j
NOM_CMP_I	TXM	Name of the component to node i (DX, DY, DY)
NOM_CMP_J	TXM	Name of the component to 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	average number of extrema a second
NB_PASS_ZERO_P_S	R	many transitions by zero a second
FREQ_APPAR	R	center frequency
FACT_IRRE	R	factor of irregularity
MAX_MOY	R	Maximum layer
FACT_PIC	R	Factor of peak

If INFO = 1 one prints in the message file

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

5 Example

5.1 Key word FRAGILITE

Example of an array generated as a preliminary, by calling on CALC_TABLE, during the simulation of Monte Carlo (see also [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 computation 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,
                               ),),
                         TITER = "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 Key word INTE_SPEC

First example:

```
POSTALEA =POST_DYNA_ALEA (
                        INTE_SPEC= INTERS,
                        TOUT_ORDRE=' OUI',
                        OPTION=' DIAG'
                        )
```

Second example:

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