Operator **DYNA_ALEA_MODAL**

1. **Goal**

   This operator allows to calculate the matrix of spectral concentration of the answer of a linear structure under an excitation which one knows the matrix of spectral concentration (one says also interspectre excitation).

   The operator then provides the modal answer in the form of his spectral concentration (the interspectre of the answer).

   The produced concept is of type **interspectre**.
Syntax

dyalea [interspectre] = DYNA_ALEA_MODAL
(

    BASE_MODALE = _F (
        ♦ mode_meca = mode mec
        ♦ / ♦ NUME_ORDRE = order [l_I]
        ♦ / ♦ AMOR_REDUIT = amor [l_R]
        ♦ / ♦ BAND = (f1, f2) [l_R]
        ♦ / ♦ AMOR_UNIF = amor [R]
    )

    ♦ MODE_STAT = mosta [mode_meca]

    ♦ EXCIT = _F (  
        ♦ / ♦ DERIVATION = / 0 [DEFECT]  
        ♦ / ♦ SIZE = / 'DEPL_R' [DEFECT]  
        ♦ / ♦ INTE_SPEC = interexc [interspectre]

        ♦[NUME_VITE_FLUI = list_ind [l_I]
        ♦ / ♦ OPTION = / 'ALL' [DEFECT]  

        ♦ / ♦ MODAL = 'OUI'
        ♦ / ♦ NUME_ORDRE_I = noi [l_I]
        ♦ / ♦ NUME_ORDRE_J = noj [l_I]
        ♦ / ♦ NODE = list_noe [l_noeud]
        ♦ / ♦ NOM_CMP = list_comp [l_cmp]
        ♦ / ♦ MODAL = 'NOT' [DEFECT]
        ♦ / ♦ CHAM_NO = list_vass [l_cham_no_*]
        ♦ / ♦ MODAL = 'NOT' [DEFECT]
        ♦ / ♦ MODAL = 'YES'

        / ♦ NOEUD_I = noeudi [l_noeud]
        ♦ / ♦ NOEUD_J = noeudj [l_noeud]
        ♦ / ♦ NOM_CMP_I = cmpi [l_cmp]
        ♦ / ♦ NAME_CMP_J = cmpj [l_cmp]
        ♦ / ♦ NODE = list_noe [l_noeud]
        ♦ / ♦ NOM_CMP = list_comp [l_cmp]
        ♦ / ♦ MODAL = 'NOT' [DEFECT]
    )

)
◊ ANSWER = _F_.
   # order of derivation of the answer
   ◊ DERIVATION = / 0       [DEFECT]
          / 1
          / 2

   # possible limitation of calculation to the diagonal
   ◊ OPTION = / ‘ALL’       [DEFECT]
          / ‘DIAG’

   # frequential dicretisation for the answer
   ◊ ♦ FREQ_MIN = fmin       [R]
      ♦ FREQ_MAX = fmax       [R]
   ◊ NOT = not                [R]
   ◊ FREQ_EXCIT = / ‘WITH’   [DEFECT]
          / ‘WITHOUT’
   ◊ NB_POIN_MODE = / 50     [DEFECT]
           / N                [I]

   )
   ◊ TITLE = title           [l_Kn]
   ◊ INFORMATION = / 1       [DEFECT]
              / 2

);
3 Features

The operator DYNA_ALEA_MODAL allows to calculate the answer in the frequential field, on modal basis, of a structure subjected to an excitation represented by a matrix interspectrale (confer DEFI_INTE_SPEC [U4.36.02]).

The size excitation can be of ddl type imposed or effort associated with a deliberté degree. It can also correspond to sources of fluid excitation [R4.05.02].

The excitation can be given in form derived of a nature equal to 0.1 or 2 (displacement, speed or acceleration).

The operator REST_SPEC_PHYS [U4.63.22] allows to restore the response in displacement or effort the degrees of freedom "of observation" (couples node, component).

The matrix interspectrale of modal answer thus calculated can be reintroduced in a new calculation.

4 Operands

4.1 Keyword BASE_MODALE

♦ BASE_MODALE = _F (Keyword factor for the definition of the parameters of selection of the modal base of calculation.

4.1.1 Operand MODE_MECA

♦ MODE_MECA = modemec

modemec is the concept of the type mode_meca containing the dynamic modes.

4.1.2 Operands NUME_ORDRE / AMOR_REDUIT

/ NUME_ORDRE = lordre

lordre is the list of the sequence numbers of the modes of the concept modemec actually taken into account in LE calculation. Example: (2,3,4).

AMOR_REDUIT = lamor

lamor is the list of reduced modal depreciation corresponding to the modes selected. The number of elements of the list is equal to the number of elements of lordre. Example: (0.05,0.05,0.02). This keyword is usable only with NUME_ORDRE.

4.1.3 Operands BAND / AMOR_UNIF

/ BAND = (f1 f2)

The dynamic modes taken into account will be those of modemec whose frequency is in the band (f1 f2)

AMOR_UNIF = amor

For each mode selected, damping is equal to amor. This keyword is usable only with BAND.
4.2 Operand **MODE_STAT**

◊ **MODE_STAT = mosta**

Concept of the type `mode_meca` containing the static modes necessary to calculation.

This keyword is necessary only in the case of a seismic calculation multi-supports where the excitation is done on degrees of freedom (i.e. when the keyword **SIZE** under the keyword factor **EXCIT** is worth ‘DEPL_R’).

4.3 **Keyword EXCIT**

◊ **EXCIT = _F**

Keyword factor defining all the parameters relating to the excitation.

Keywords **DERIVATION**, **SIZE** and **MODAL** define the type of excitation.

Keywords **INTE_SPEC**, **NUME_VITE_FLUI**, **NUME_ORDRE_I**, **NUME_ORDRE_J**, **NOEUD_I**, **NOEUD_J**, **NOM_CMP_I** and **NOM_CMP_J** define the interspectre of excitation.

4.3.1 Operand **DERIVATION**

◊ **DERIVATION =**

When the size of the excitation is of imposed ddl type (‘DEPL_R’), this keyword makes it possible to describe if the interspectre of excitation must be regarded as a displacement, a speed or an acceleration imposed. The user specifies then 0, 1 or 2.

This keyword is optional. By default, it is equal to 0.

Note:

In the case of a seismic calculation, the excitation is often an acceleration. This keyword must then be equal to 2.

4.3.2 Operand **SIZE**

◊ **SIZE =**

This keyword makes it possible to say if the excitation is of imposed ddl type (‘DEPL_R’), imposed effort (‘EFFO’), source of flow-volume (‘SOUR_DEBI_VOLU’), source of flow - mass (‘SOUR_DEBI_MASS’), source of pressure (‘SOUR_PRESS’) or fluid source of force (‘SOUR_FORCE’).

This keyword is optional. By default, it is equal to ‘DEPL_R’ and the excitation is of ddl type of displacement imposed in all the cases except in the case of supports represented by assembled vectors (keyword **CHAM_NO**).

4.3.3 Operands **INTE_SPEC** and **NUME_VITE_FLUI**

These keywords define L (be) interspectre (S) of excitation.

◊ **INTE_SPEC = interexc**

`interexc` is the concept of the type `interspectre` containing the whole of the matrices interspectrales (matrices of spectral concentration) of excitation. He is taken into account such as he is defined in the function associated with the concept, i.e. in particular which one does not interpret a possible folding up of spectrum.

For a function defined by:

\[ f \in [f_1, f_2]; \tilde{S}(f) \] given
One will interpret:

\[ f < f_1 : S(f) = 0 \]

\[ f \in [f_1, f_2] : S(f) = \tilde{S}(f) \text{ donné} \]

\[ f > f_2 : S(f) = 0 \]

If the loop of frequency \([f_1, f_2]\) must be reproduced for the negative frequencies, it is necessary:

- that is to say to give the whole of the spectrum on the axis of realities,
- that is to say to apply a coefficient 2 to the value of the DSP, possible skirting, since the spectral concentrations are supposed to be symmetrical in the calculations carried out by the order DYNA_ALEA_MODAL.

The parameters necessary of the table are:

1) if one index parameters of the table by sequence numbers: ‘NUME_ORDRE_I’ [I], ‘NUME_ORDRE_J’ [I], ‘FUNCTION’ [K24]

2) if not: ‘NŒUD_I’ [K8], ‘NŒUD_J’ [K8], ‘NOM_CMP_I’ [K8], ‘NOM_CMP_J’ [K8], ‘FUNCTION’ [K24].

This table can be generated by the operators: DEFI_SPEC_MODAL, LIRE_INTE_SPEC or CALC_INTE_SPEC. The reader is invited to consult the documentation of the order TEST_FONCTION [U4.92.02] for more information on the direction of the parameters.

\[ \text{NUME_VITE_FLUI} = nk \]

nk is the sequence number the speed of the fluid associated with interexc.

### 4.3.4 Operands NUME_ORDRE_I, NUME_ORDRE_J, NODE, NOM_CMP, CHAM_NO and MODAL

These keywords bind the terms of () the interspectre (S) of excitation and the points of excitation for a modal excitation or when the parameters of the table were subscripted by sequence numbers.

\[ / \] / \[ NUME_ORDRE_I = noi1, noi2. \]

\[ / \] / \[ NUME_ORDRE_J = noj1, noj2,… \]

These lists of sequence number are paired two by two in order to determine the term of the matrix interspectrale given.

\[ / \] / \[ NODE = list_noe \]

This keyword makes it possible to specify the nodes where the multispectral excitation will be applied. Example (‘N1’, ‘N5’, ‘N7’).

For all the types of sizes of excitation, except for the sources of pressure and the sources of force, list_noe as many terms contains as there are couples of indices defining of the interspectres of excitation.

In the case of sources of pressure or sources of force, with each source is associated a dipole, i.e. two points of application. list_noe then has twice more terms than there are couples of indices defining of the interspectres.

\[ / \] / \[ NOM_CMP = list_cmp \]

This keyword makes it possible to specify the components to which the spectral excitation multi - will be applied. Example (‘CLOSE’ ‘DRZ’ ‘PHI’).

These components must of course correspond to degrees of freedom of the nodes of supports.

In all the cases, list_cmp the same number of elements has as list_noe.

For the fluid sources, it is the degree of freedom ‘CLOSE’ who is excited.
MODAL = ‘NOTʼ [DEFECT]
The excitation is not modal in this case.

/  ♦  ♦  CHAM_NO = list_vass

When this keyword is present, each support of excitation is a definite vector before assembled in the command file. list_vass the list of the assembled vectors contains holding place of supports. The associated exiting size is ‘EFFO’. It is recommended that L’ intensity associated with the effort which one imposes by this skew is given by the interspectre: the assembled vector is primarily used to define a function of form support of a spectrum of power in effort. It is thus standardized.

This option makes it possible to affect a spectrum of power of effort on a function of form.

In all the cases, list_vass as many terms contains as there are couples of indices defining of the interspectres.

/  ♦  ♦  MODAL = ‘YES’

The presence of ‘YES’ under this keyword implies that the interspectre of excitation is regarded as a modal excitation.

4.3.5 Operands NOEUD_I, NOEUD_J, NOM_CMP_I and NOM_CMP_J

These keywords bind the terms of () the interspectre (S) of excitation and the points of excitation when the parameters of the table were subscripted by physical data made up by the couple (Node - Component).

/  ♦  ♦  NOEUD_I  =  ndi1, ndi2,…
  ♦  ♦  NOM_CMP_I  =  cmpi1, cmpi2,…
  ♦  ♦  NOEUD_J  =  ndj1, ndj2,…
  ♦  ♦  NOM_CMP_J  =  cmpj1, cmpj2,…

These lists of sequence number are paired two by two in order to determine the term of the matrix interspectrale given. The length of the preceding lists must correspond to the number of excitations imposed on the structure.

/  ♦  ♦  NRNOEUD  =  list_noe  [l_noeud]
  ♦  ♦  NOM_CMP  =  list_comp  [l_comp]

These two keywords have the same meaning as in [§4.3.4].

MODAL = ‘NOTʼ [DEFECT]
The excitation is not modal in this case.

4.4 Keyword ANSWER

/  ♦  ANSWER = _F ( 

Keyword factor for the definition of all the parameters concerning the answer.

The three following keywords describe the type of the answer.

4.4.1 Operand DERIVATION

/  ♦  DERIVATION =

This keyword has the same direction as for the keyword factor EXCIT [§4.3.1].

4.4.2 Operand OPTION
4.4.3 Operands FREQ_MIN / FREQ_MAX / NOT / FREQ_EXCIT / NB_POIN_MODE

These keywords are used to describe the frequential discretization in which the answer will be given.

- **FREQ_MIN** = fmin
- **FREQ_MAX** = fmax
- **NOT** = not

fmin and fmax are the two terminals of the interval of frequency. not is the minimum step of discretization.

- **FREQ_EXCIT** = / 'WITH' / 'WITHOUT'

If the user gives the argument 'WITH' under the keyword FREQ_EXCIT, then the frequencies of the excitation are integrated into the discretization of the answer (option by default). If it gives the argument 'WITHOUT', they will be ignored. This keyword is put at 'WITHOUT' in the event of presence of the keyword FREQ_MIN.

- **NB_POIN_MODE** = N [defect = 50]

The answer is refined towards Eigen frequencies in order to ensure a good description of the answer towards peaks.

The keyword NB_POIN_MODE the number of steps of frequency per Eigen frequency taking into account makes it possible to define. By default, there is 50 pas by Eigen frequency. This keyword is not taken into account if FREQ_MIN is given.

Each function of the interspectre will have by default a mode of interpolation of the type 'LINÉAIRE' and a mode of prolongation out of field of discretization of the type 'EXCLUDED'.

4.5 Operand TITLE

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

4.6 Operand INFORMATION

- **INFORMATION** =

  Specify the options of impression on the file MESSAGE.

  1 pas d’impression
5 Produced table

The parameters of the produced table are described in the table below:

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TYP E</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOM_CHAM</td>
<td>K16</td>
<td>name of the field (&quot;DEPL_GENE&quot;)</td>
</tr>
<tr>
<td>OPTION</td>
<td>K16</td>
<td>name of the option (&quot;ALL&quot; or &quot;DIAG&quot;)</td>
</tr>
<tr>
<td>DIMENSION</td>
<td>I</td>
<td>dimension</td>
</tr>
<tr>
<td>NUME_VITE_FLUI</td>
<td>I</td>
<td>sequence number of the matrix interspectrale of modal answer</td>
</tr>
<tr>
<td>VITE_FLUIDE</td>
<td>R</td>
<td>corresponding speed of fluid</td>
</tr>
<tr>
<td>NUME_ORDRE_I</td>
<td>K8</td>
<td>Indices of the sequence numbers $i$ and $j$ allowing to define a term of the matrix interspectrale</td>
</tr>
<tr>
<td>NUME_ORDRE_J</td>
<td>K8</td>
<td></td>
</tr>
<tr>
<td>FUNCTION</td>
<td>K24</td>
<td>name of the function of modal answer corresponding at the end of the matrix defined by NUME_ORDRE_x</td>
</tr>
</tbody>
</table>

6 Useful remarks for the use

- **Need for a static and standard mode of dynamic modes:**
  
  In the case of excitation in imposed displacement, the dynamic modes are calculated in blocked supports and the presence of the static mode is obligatory.

  In the other cases, the dynamic modes are calculated in free supports, and the presence of a static mode is not justified any more.

  The dimension of the matrix interspectrale is given by the sum of the static modes and the dynamic modes (if it there of a) taken into account.

  Thus, for a structure with five dynamic modes, excited in displacement by two supports, the dimension of the matrix interspectrale of modal answer is 7.

  If the excitation is given in imposed force, there are no static modes and the dimension of the matrix interspectrale is 5.

- **Use of the keyword MODAL under the keyword factor EXCIT:**

  In the case of use of the keyword MODAL under the keyword factor EXCIT to directly introduce the matrix of modal spectral concentration like excitation, it is necessary to give again under the keywords EXCIT BASE_MODALE and MODE_STAT all the arguments which had been used to create this modal matrix interspectrale (nodes and degrees of freedom supports).

7 Phase of checking

The coherence of the data is checked:

- many modal depreciation = many modes selected.
- number of nodes of supports equal to the component count (for the excitation).
- many couples of indices retained in the interspectre excitation = number of supports or many points of excitation.
- in the case of sources of pressure: number of nodes supports equal to twice the number of couples of indices retained in the interspectre of excitation.
- the presence of one mode_meca is checked in the cases of excitation by a size of the type DEPL_R.
8 Example

```
DYNALEA1=DYNA_ALEA_MODAL (  
    BASE_MODALE=_F (  
        MODE_MECA = FREQ1,  
        NUME_ORDRE = 1,  
        AMOR_REDUIT = 0.05),  
    MODE_STAT=MODESTA1,  
    EXCIT=_F (DERIVATION = 2,  
        INTE_SPEC = INTEREXC,  
        NUME_ORDRE_I = 1,  
        NUME_ORDRE_J = 1,  
        NODE = 'P1',  
        NOM_CMP = 'DX'),  
    REPONSE=_F (DERIVATION = 2),
    )
```

• \( f_{max} \geq f_{min} \)