
Operator CALC_AMOR_MODAL

1 Drank

To create a list of modal dampings calculated according to the rule of the RCC-G. The computation is carried out in postprocessing of the modal computation of a structure of type building of which to erase it rests on a soil modelled by springs.

The principle of computation is based on weighting by the rates of potential energy (compared to total energy) of reduced dampings affected by mesh groups constitutive of structure (by way of parameters of entry of the array of potential energy created by `POST_ELEM`) and of the depreciation radiated in the soil, by degree of freedom, functions of the frequency [bib1] [bib2].

There is also the alternative possibility to directly create a list of modal dampings by calculated frequency of a concept of the `mode_meca` type. This list depends at the same time on the values of the frequencies of the mode and the coefficients intervening in the statement of the damping of Rayleigh.

The list created is usable thereafter in command `DYNA_TRAN_MODAL` [U4.53.21] behind key word `LIST_AMOR`.

Product a concept of the `listr8` type.

2 Syntax

```

listr8 [listr8] =CALC_AMOR_MODAL (

/◆ENER_SOL=      _F ( ◆MODE_MECA=mod      ,
[mode_meca]

    ◇ METHODE=/      "DEPL",      [DEFAULT]
      /      "RIGI_PARASOL",
    ◆KX=kx      ,      [R]
    ◆ KY=ky      ,      [R]
    ◆ KZ=kz      ,      [R]
    ◇   ◆ KRX=krx      ,      [R]
        ◆ KRY=kry      ,      [R]
        ◆ KRZ=krz      ,      [R]

    # If METHODE=' DEPL':
      ◆ GROUP_NO_RADIER=      l_grno,      [l_group_no]

    # If METHODE=' RIGI_PARASOL':
      ◆GROUP_MA_RADIER=      l_grma,      [l_group_ma]
      ◆/FONC_GROUP=      l_fonc,      [l_fonction]
      /      COEF_GROUP=      l_coef,      [l_R]
      ◆ /      GROUP_NO_CENTRE=      grno,      [group_noeud]
      /NOEUD_CENTRE      = node,      [node]
      /COORD_CENTRE      = (X, there, Z),      [l_R]
    ),
◆AMOR_INTERN = _F (
    ◆ ENER_POT=      epot,      [table_sdaster]
    ◆GROUP_MA=      l_grma,      [l_group_ma]
    ◆AMOR_REDUIT=      l_amor,      [l_R]
    ),
◆AMOR_SOL=      _F (
    ◇AMOR_REDUIT =      0. ,      [DEFAULT]
      /amor,      [R]
    ◆FONC_AMOR_GEO =l_f_amor ,      [l_fonction]
    ◇HOMOGENE =      "OUI",      [DEFAULT]
      /"NON",
    ◇SEUIL =      0.3,      [DEFAULT]
      /threshold,      [R]
    ),
/◆AMOR_RAYLEIGH = _F ( ◆MODE_MECA=mod      ,      [mode_meca]
    ◆AMOR_ALPHA=alpha      ,      [R]
    ◆ AMOR_BETA=beta      ,      [R]
    ),
)

```

3 Operands

3.1 Key word ENER_SOL

This key word factor used only one times serves to introduce the data necessary to computation of potential energy into the soil per degree of freedom for all the frequencies as a concept of the mode_meca type.

3.1.1 Operand METHODE

This operand makes it possible to define the méthode de calcul of energy in the soil by frequency.

With value "DEPL", one calculates energy starting from the displacements realised on the nodes of the basemat for each mode: $E = \frac{1}{2} \sum_{i=1,6} k_i U_i^2(fr)_i$, where them k_i KX represent the 6 components, KY, KZ, KRX, KRY and KRZ of the total stiffness within the competences of soil (cf [§3.1.3]).

With value "RIGI_PARASOL", one calculates energy starting from the forces realised on the nodes of the basemat for each mode: $E = \frac{1}{2} \sum_{i=1,6} \frac{F_i^2}{k_i}(fr)_i$.

The forces with the nodes with this method are given starting from the values of stiffness distributed with the nodes under erasing it as by option RIGI_PARASOL of the command AFFE_CARA_ELEM [U4.42.01].

3.1.2 Operand MODE_MECA

Makes it possible to introduce the concept of the mode_meca type containing the frequencies of computation of potential energy.

3.1.3 Operands KX / KY / KZ / KRX / KRY / KRZ

Represent the values of the components total stiffness within the competences of soil.

Intervene in the computation of the terms $k_i \cdot U_i^2, i=1, NCmp$,

$NCmp$ (3 or 6) is the number of components determined by the presence or the absence of operands KRX, KRY, KRZ used (if they are it) obligatorily together. $NCmp$ and the number of dds increased by the nodes of the basemat can be different.

3.1.4 Operand GROUP_NO_RADIER

This operand is related to value "DEPL" of operand METHODE.

List nodes groups constituting to erase it structure posed on the soil. One calculates thereafter the displacement realised in these nodes U of components U_i for each mode calculated of frequency fr in order to be able to determine energy in the soil by d.o.f. and frequency: $\frac{1}{2} k_i \cdot U_i^2(fr)$.

3.1.5 Operand GROUP_MA_RADIER

This operand is related to value "RIGI_PARASOL" of operand METHODE.

List mesh groups constituting to erase its structure posed on the soil. Allows to calculate the force realised with the nodes of these meshes F of components F_i for each mode calculated of frequency fr in order to determine energy in the soil by d.o.f. and frequency: $\frac{1}{2} \frac{F_i^2}{k_i}(fr)$.

3.1.6 Operand FONC_GROUP / COEF_GROUP / GROUP_NO_CENTRE / NOEUD_CENTRE / COOR_CENTRE

These operands are also related to value "RIGI_PARASOL" of operand METHODE.

These are the same ones as in option RIGI_PARASOL of the command AFFE_CARA_ELEM [U4.42.01]. They also make it possible to obtain the values of stiffness distributed with the nodes under erasing it being used to determine the nodal forces by mode then their average F of component F_i .

An operand chosen among FONC_GROUP / COEF_GROUP makes it possible to determine weightings, real functions of the X-coordinate or, each mesh group constitutive of the basemat. The formulas remain with the choice of the user. By default, one considers that the function of distribution is constant and unit, i.e. that each surface is affected same weight [bib2].

One thus needs as many terms in the corresponding list than in the list of the mesh groups given by operand GROUP_MA_RADIER.

An operand chosen among GROUP_NO_CENTRE / NOEUD_CENTRE / COOR_CENTRE makes it possible to provide either the central node of the basemat by a nodes group of only one name or a single name of node, or directly its coordinates.

3.2 Key word AMOR_INTERNE

Used only one times at the same time as key word ENER_SOL.

The contribution to the reduced damping of each mode is established from the distribution of potential energy in structure for the mode considered. This distribution is obtained using command POST_ELEM [U4.81.22] starting from the concept of the mode_meca type (cf [§3.1.1]) which produces an array.

The parameters of entry of this array are names of mesh groups, defined by the user according to the distributions of material damping in structure.

3.2.1 Operand ENER_POT

Name of the array of potential energy produced by the command POST_ELEM [U4.81.22].

The parameters necessary of the array are:

Parameters	Type	Description
NUME_ORDRE	I	Sequence number
FREQ	R	Frequency at the sequence number NUME_ORDRE
PLACE	K8	associated geometrical Entity: it can be a question of all structure, of a set of meshes or of mesh groups
POUR_CENT	R	Rate of potential energy compared to total energy

For more information on the meaning of the parameters, the reader is invited to consult of the command documentation POST_ELEM [U4.81.22].

3.2.2 Operand GROUP_MA

the list of names of mesh groups from which one will point in the array defined by ENER_POT (cf [§3.2.1]).

It is imperative that this list contains all the mesh groups constitutive of structure and that those had well their energy calculated in the array defined by ENER_POT. It will be considered that for each mode the sum of energies passing by the preceding mesh groups will be equal to energy total minus that passing by springs of soil and distributed starting from key word ENER_SOL.

If the user indicates a name of mesh group whose energy was not calculated in the array defined by ENER_POT, it will have an alarm but not stop. It is thus well with him to check the conformity of the mesh groups of the array and those of the list in key word AMOR_INTERNE.

3.2.3 Operand AMOR_REDUIT

the list of the actual values of material damping corresponding, term for term, with the list of names of mesh groups defined by GROUP_MA (cf [§3.2.2]).

3.3 Key word AMOR_SOL

Used only one times at the same time as key word ENER_SOL.

It makes it possible to determine the contribution of geometrical damping due to the reflection of the elastic waves. These directional values of damping are obtained by interpolating for each calculated eigenfrequency the geometrical functions of damping $\frac{\text{Im}(K(\omega))}{2 \text{Re}(K(\omega))}$ (cf § [3.3.1]) where $K(\omega)$ is the complex impedance of the soil determined using one of the software MISS3D, CLASSI or PARASOL:

$$amor(\omega_i) = \left[\omega_i, \frac{\text{Im}(K(\omega_i))}{2 \text{Re}(K(\omega_i))} \right]$$

3.3.1 Operand FONC_AMOR_GEO

Defines the list of functions of the frequency of geometrical depreciation, one by d.o.f. (3 or 6).

3.3.2 Operand AMOR_REDUIT

Correction in the computation of geometrical damping due to the reduced material damping of the soil.

Note:

The value of reduced damping is necessary if the impedance of the soil is produced by PARASOL. One then affects the complete value of the reduced material damping of the soil. If the impedance of the soil is produced by MISS3D, this value is necessary only if the soil is homogeneous (see operand HOMOGENE [§3.3.3]) and into this case one introduces the half-value of the reduced material damping of the soil.

3.3.3 Operand HOMOGENE

If the soil is homogeneous ("OUI"), one 0.5 balances the computation of geometrical damping by the factor. Then if the impedance of the soil is produced by MISS3D and only if the soil is homogeneous ("OUI"), one must introduce for operand AMOR_REDUIT (cf [§3.3.2]) the half-value of the reduced material damping of the soil. Nothing is introduced when the impedance of the soil is produced by MISS3D if the soil is not homogeneous ("NON").

3.3.4 Operand SEUIL

Value defined in the RCC-G [bib1] (0.3 per default) for the threshold beyond which one truncates possibly modal damping. This threshold operates after the possible preceding corrections.

3.4 Key word AMOR_RAYLEIGH

Used only one times other than key word ENER_SOL. This key word makes it possible to calculate a list of damping modal by calculated frequency of a concept of the mode_meca type. This list depends at the same time on the values of the frequencies of the mode $freq_i$ and the coefficients intervening in the statement of the damping of Rayleigh.

3.4.1 Operand MODE_MECA

Makes it possible to introduce the concept of the mode_meca type containing the frequencies from which one will calculate modal damping.

3.4.2 Operands AMOR_ALPHA / AMOR_BETA

Represent the values respectively of the components α and β intervening in the statement of the damping of Rayleigh starting from the operators of stiffness and mass: $C = \alpha K + \beta M$.

Then for each calculated frequency $freq_i$ of the concept of the mode_meca type *mod* associated with a pulsation $\omega_i = 2\pi freq_i$ one obtains an equivalent modal damping:

$$\xi_i = \frac{1}{2} \left(\alpha \omega_i + \frac{\beta}{\omega_i} \right)$$

4 Bibliography

(1)RCC-G: Rules of design and construction of the nuclear islands REFERENCE MARK. EDF - Direction of the Equipment Edition July 1988

(2)Fe. Seismic WAECKEL Response by transient analysis [R4.05.01]

5 Example of use

the use of CALC_AMOR_MODAL requires the computation of the eigen modes of structure on springs of soil in the form of a concept of the mode_meca type and a concept of the table_sdaster type of these modes calculated by means of command POST_ELEM [U4.61.04].

The following example is extracted from test SDLL109B.

```
# CALCUL OF THE MODAL QUANTITIES -----
MODE0=MODE_ITER_SIMULT ( MATR_RIGI=RIGIDITE,
                        MATR_MASS=MASSE,
                        CALC_FREQ=_F ( OPTION = "PLUS_PETITE",
                                      DIM_SOUS_ESPACE = 125,
                                      NMAX_FREQ = 33) )

MODE0=NORM_MODE (reuse=MODE0, MODE=MODE0, NORME=' TRAN_ROTA',
                MASS_INER=MASSESTR )

EPOT=POST_ELEM (MODELE=STICKMOD,
               RESULTAT=MODE0,
               CHAM_MATER=CHAMPMAT, CARA_ELEM=CARA_ELE,
               MASS_INER= (_F (GROUP_MA= ("MASSES", "LIAI_SOL", "LIAI_NOE",
                                           "POU_D_T"),),),
               _F (TOUT=' OUI',),),)

#
FT=DEFI_FONCTION ( NOM_PARA=' FREQ',
                  VALE= (0. , 0.0,10 . , 0.3,30. , 1.5,100. , 1.5,))

#
FR=DEFI_FONCTION ( NOM_PARA=' FREQ',
                  VALE= (0. , 0.0,10 . , 0.05,30. , 0.75,100. , 0.75,))

L_AMOR=CALC_AMOR_MODAL (
  ENER_SOL=_F (MODE_MECA = MODE0,
              GROUP_NO_RADIER = "P1",
              KX = 6.295E11, KY = 6.295E11, KZ = 6.864E11,
              KRX = 3.188E14, KRY = 3.188E14, KRZ = 3.2E14),
  AMOR_INTERNE=_F (
    ENER_POT = EPOT,
    GROUP_MA = ("POU_D_T", "MASSES", "LIAI_NOE"),
    AMOR_REDUIT = (0.07, 0.07,0.02,)),
  AMOR_SOL=_F (
    FONC_AMOR_GEO = (FT, FT, FT, FR, FR, FR),
    HOMOGENE = "NON")
)
```