
Macro-order MACR_SPECTRE

1 Goal

This macro-order allows calculation of a fast and effective postprocessing to determine the spectra of floor of any building after a seismic dynamic analysis.

It can for example be used after a transitory dynamic calculation of a building to the earthquake, where connections between the ground and the foundation raft in mono-support or multi-support are simulated by a stiffness of ground (DYNA_TRAN_MODAL [U4.53.21], transitory dynamic calculation on a reduced modal basis, calculated in relative reference mark, produced concept: `resu_gene`) or after calculations resulting from the coupling *Code_Aster - ProMiss3D* (CALC_MISS [U7.03.12], produced concept: `dyna_trans`) or following a nonlinear transitory dynamic resolution (DYNA_NON_LINE, concept `evol_noli`, and on the table of observation resulting from a calculation of this type).

This macro-order carries out successively:

- 1) the extraction of relative acceleration in one or more nodes of the grid in the concept result (`RECU_FONCTION` [U4.32.03]);
- 2) combination with the acceleration of ground to obtain absolute acceleration (`CALC_FONCTION` [U4.32.04]);
- 3) the calculation of the spectrum of answer of acceleration with several damping coefficients (`CALC_FONCTION` [U4.32.04]);
- 4) the function wraps relative displacement or acceleration corresponding to a given floor.
- 5) impression of the spectra envelope by floor and direction.
- 6) the creation of a table for the spectra envelope of all the floors.

For practical examples of implementation, the reader can refer to the cases tests `SDNL131` (postprocessing of an analysis of piping), `SDNV112` (Building of civil engineer under seismic request of standard multi-support) or with the tests `SDLX101`, `SDLX101`, `MISS01`, `MISS05` with calculation of coupling *Code_Aster - Miss3D*.

The macro-order produces a concept of the type `table_sdaster`.

2 Syntax

```
table_sdaster = MACR_SPECTRE (
  ## calculation of the spectrum of answer, seismic postprocessing of analysis
  ◇ GRID = my [grid]
  ◆ FLOOR = _F (
    ◆ NAME = floor [KN]
    ◇ / NODE = l_no [l_noeud]
    / GROUP_NO = l_gno [l_gr_noeud]
  )
  ◆ CALCULATION = / 'ABSOLUTE'
  / 'RELATIVE'
  ◆ NOM_CHAM = / 'ACCE'
  / 'DEPL'

  ## if NOM_CHAM = ' ACCE':
  ◆ AMOR_SPEC = l_amor [l_R]
  ◇ LIST_INST = linst [listr8]
  ◇ / FREQ = l_fr [l_R]
  / LIST_FREQ = lfreq [listr8]
  ◆ NORMALIZES = R [R]
  ◆ RESU = _F (
    ◆ / 'RESU_GENE' = tg [tran_gene]
    / 'TABLE' = [table_sdaster]
    / 'RESULT' = resu [dyna_trans]
    [evol_noli]

  ## if CALCULATION = ' RELATIF':
    ◆ ACCE_X = ac_x [function]
    ◆ ACCE_Y = ac_y [function]
    ◆ ACCE_Z = ac_z [function]

  ## if CALCULATION = ' ABSOLU':
    ◇ MULT_APPUI = 'YES'
  )
  ◇ IMPRESSION = _F (
    ◇ SORTING = / 'AMOR_SPEC' [DEFECT]
    / 'DIRECTION'
    ◇ FORMAT = / 'TABLE' [DEFECT]
    / 'XMGRACE'

  ## logical unit indicating the print file of the results :
    ◇ UNIT = / 29 [DEFECT]
    / U [I]

    ## if FORMAT = ' XMGRACE':
    ◇ PILOT = / 'POSTSCRIPT'
    / 'EPS'
    / 'MIF'
    / 'SVG'
    / 'PNM'
    / 'PNG'
    / 'JPEG'
    / 'Pdf'
    / 'INTERACTIVE'

    ◇ ALL = / 'NOT' [DEFECT]
    / 'YES'
  )
)
```

```
## if NOM_CHAM = ' DEPL':  
    ◇ LIST_INST      =      linst                [listr8]  
    ◇ RESU = _F (  
        ◇ / 'RESU_GENE' = tg                [tran_gene]  
        / 'RESULT' = resu                [dyna_trans,  
                                          [evol_noli]  
    ## if CALCULATION = ' ABSOLU':  
        ◇ DEPL_X =                de_x                [function]  
        ◇ DEPL_Y =                de_y                [function]  
        ◇ DEPL_Z =                de_z                [function]  
    )  
)
```

3 Operands

The classical postprocessing of a seismic analysis in transitory dynamics consists in carrying out following calculations:

- The spectrum of floor obtained starting from absolute accelerations, for each direction X, Y, Z , calculated in a specified node of the grid (for example in the case of model "a skewer");
- The envelope of the spectrum of floor, calculated in some nodes of the same floor, for each direction X, Y, Z and H (maximum enters X and Y), (for example in the case of a structure of building 3D);
- Envelopes displacements of the structure compared to movements of ground.
- Three operators of Code_Aster can produce concepts `result` correspondent with transitory dynamic calculations:
 - DYNATRAN_MODAL [U4.53.21] produced a concept `resu_gene`, including the fields of acceleration and relative displacements. In this case, one must add accelerations of ground to obtain accelerations absolute, necessary to the calculation of the spectrum of floor.
 - CALC_MISS [U7.03.12] produced a concept `dyna_trans`, including the fields of acceleration and absolute displacements. In this case, accelerations are directly employed for the calculation of the spectrum of floor; conversely, the deduction of displacements of ground is obligatory (with being read with the order `LIRE_FONCTION` [U4.32.02] since a specific file given by its logical unit) to obtain relative displacements.
 - DYNANON_LINE [U4.53.01]. The treatment is then the same one as for the preceding point.

Here a general diagram of the calculation algorithm of this macro-order:

Buckle #1 on the floors

Buckle #2 on the nodes of floor

Buckle #3 on the 3 directions (X, Y, Z)

Buckle #4 on the results

- Recovery of the functions accelerations relating to the nodes: `RECU_FONCTION`
- If calculation of accelerations:
 - Combination or not with the function of acceleration of the ground:
`CALC_FONCTION/COMB`
 - Calculation of the spectrum of answer, with specified values of frequencies and damping with `CALC_FONCTION/SPEC_OSCI`
- If calculation of displacements (absolute displacements):
 - Displacements of ground are deduced to obtain relative displacements:
`CALC_FONCTION/COMB`.

End of the loop #4

- In the case of the calculation of accelerations:
 - calculation of the median value for a given node and a direction:
`CALC_FONCTION/COMB`
- In the case of the calculation of displacements:
 - recovery of the maximum one

End of the loop #3

- Impression of the spectrum of acceleration for each node and each direction X, Y, Z :
`IMPR_FONCTION`

End of the loop #2

- Envelopes of the spectrum of acceleration for a given floor, or maximum displacements
`CALC_FONCTION/ENVELOPPE`
- Envelopes of the spectrum of acceleration for each floor, each direction X, Y, Z, H
`IMPR_FONCTION`

End of the loop #1

The table produced by the macro-order has the following structure:

- in the case of calculation of displacement: the spectra envelope on each floor
- in the case of calculation of acceleration: the spectra envelope by floor and values of specified damping

3.1 Keyword GRID

This keyword corresponds to the grid read by the operator `LIRE_MAILLAGE` [U4.21.01].

This key word is optional. The knowledge of the grid is necessary only if the user uses the single-ended spanner word `GROUP_NO` key word factor `FLOOR`. Indeed as described in the preceding algorithm, the treatment is carried out on the nodes and if the user directly gives the name of the nodes present in the table the grid is not necessary.

3.2 Keyword FLOOR

This keyword is obligatory to define the names of the floors, where the spectra will be calculated. These names will be employés to select or filter the parameters of posting in the structure of table produced by the macro-order `table_sdaster`.

3.2.1 Operand NAME

This obligatory operand makes it possible to name the floor considered.

3.2.2 Operand NODE / GROUP_NO

This operand makes it possible to define the nodes (individually or by groups) component the floor where the spectra will be calculated. It is possible to inform `GROUP_NO` if the grid were indicated.

3.3 Keyword CALCULATION

This obligatory keyword makes it possible to define the nature of the transitory dynamic calculation employed for postprocessing: in the absolute reference mark (`'ABSOLUTE'`) or the relative reference mark (`'RELATIVE'`).

3.4 Keyword NOM_CHAM

This obligatory keyword makes it possible to define the nature of the field used: accelerations (`'ACCE'`) or displacements (`'DEPL'`).

3.5 Case NOM_CHAM = ' ACCE '

In this case, the user must provide the following data necessary for calculation of the spectrum of answer of acceleration: in the 3 directions X , Y , Z (vertical) and H (maximum horizontal value enters the values according to X and Y).

3.5.1 Operand AMOR_SPEC

This obligatory operand makes it possible to define the values of the damping coefficient reduces employed in the calculation of the spectral response. See also `CALC_FONCTION` [U4.32.04], keyword `SPEC_OSCI`.

3.5.2 Operand LIST_INST

This operand optional makes it possible to specify the list, produced by `DEFI_LIST_REEL` [U4.34.01], defining all the steps of time for the transitory calculation of dynamics.

3.5.3 Operand **FREQ / LIST_FREQ**

```
/ ◇ FREQ = L_FR  
    L_FR = (f1, f2, f3, ...) Fr. frequencies.  
/ ◇ LIST_FREQ = LFREQ  
    List of frequencies defined beforehand by a concept listr8.
```

This operand optional makes it possible to define the values of frequencies, to see too `CALC_FONCTION` [U4.32.04], keyword `SPEC_OSCI`.

3.5.4 Operand **NORMALIZES**

```
◇ = R NORMALIZES
```

The spectrum of answer will be standardized by the value r (value of pseudo-acceleration). The calculations are done in most case in Units of the International System (USI) and the histories of accelerations are often given in unit m/s^2 . The spectra of answers are generally given with $g=9.81m/s^2$.

Thus, this obligatory operand `NORMALIZES` can be used as conversion ratio of units between calculated accelerations and the spectrum of answer, see too `CALC_FONCTION` [U4.32.04], keyword `SPEC_OSCI`.

3.5.5 Keyword **RESU**

This obligatory keyword makes it possible to specify the names of the concepts results where nodal accelerations are considered.

The possible values are:

```
/ 'RESU_GENE' = TG [TRAN_GENE]
```

if postprocessing is carried out starting from a concept `DYNA_TRAN_MODAL` [U4.53.21] (transitory dynamics on a reduced modal basis). However, this result must be calculated in the relative reference mark

or:

```
/ 'RESULT' = RESU [DYNA_TRANS]  
[EVOL_NOLI]
```

if postprocessing is carried out starting from a transitory result of dynamics (coming for example from `CALC_MISS` [U7.03.12], produced concept: `dyna_trans` or of `DYNA_NON_LINE`, produced concept: `evol_noli`).

or:

```
/ 'TABLE' = [TABLE_SDASTER]
```

if postprocessing is carried out starting from a table containing the results to read. Typically, a table of observation deduced from a transitory calculation of dynamics.

3.5.6 Case **CALCULATION = ' RELATIF '**

```
◇ ACCE_X = /AC_X [FUNCTION]  
◇ ACCE_Y = /AC_Y [FUNCTION]  
◇ ACCE_Z = /AC_Z [FUNCTION]
```

In this case, the user must provide the function of acceleration of ground, definite on the same list of moments, in each direction of space, in order to combine them with relative accelerations to calculate absolute accelerations.

3.5.7 Case **CALCULATION = ' ABSOLU '**

```
◇ MULT_APPUI = 'YES'
```

In this case, the user can specify if it is about a modeling in multi-support. By default, this one is a modeling in mono-support. Modeling in multi-support is realizable only when the concept result is of type `resu_gene`.

3.6 Keyword **IMPRESSION**

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This optional keyword makes it possible to specify the nature of the results to print (spectra, envelopes). The exits will be according to the directions 'X', 'Y', 'Z', 'H' and values of damping.

3.6.1 Operand SORTING

This optional keyword makes it possible to specify the nature of the curves to be printed sorted according to: the value of the damping coefficient ('AMOR_SPEC') or space direction ('DIRECTION').

3.6.2 Operand FORMAT

This optional keyword makes it possible to specify the format of impression of the curves: by impression with the format table ('TABLE') or in form readable by the software Xmgrace ('XMGRACE'). The scale of the X-coordinates (frequencies) is logarithmic curve.

3.6.3 Operand UNIT

◇ UNIT = U

Logical unit of the file in which the results are written (whole ranging between 10 and 90). The unit by default is 29. This number of unit must be coherent with the statement made in the interface astk for the file in question.

3.6.4 Case FORMAT = ' XMGRACE '

For more details, to see the documentation of the order IMPR_FONCTION [U4.33.01].

3.6.5 Operand ALL

This operand optional TOUT=' OUI ' can be used to print all the spectrum calculated) the exit of the loop #4: median values with each node, for all the directions and all the values of damping.

3.7 Case NOM_CHAM = ' DEPL '

In this case, the user must give the following data necessary for calculation of the envelope of displacement: in the 3 directions X , Y , Z (vertical) and H (maximum horizontal value according to X and Y).

3.7.1 Operand LIST_INST

This operand makes it possible to specify the list, resulting from DEFI_LIST_REEL [U4.34.01], defining all the steps of time of the dynamic transient for the calculation of displacement wraps.

3.7.2 Keyword RESU

This obligatory keyword makes it possible to specify the names of the concept result in which nodal accelerations are extracted. The operand associated can be:

/ 'RESU_GENE' = TG [TRAN_GENE]

if postprocessing is carried out starting from a concept DYNA_TRAN_MODAL [U4.53.21] (transitory dynamics on a reduced modal basis). However, this result must be calculated in the relative reference mark.

or:

/ 'RESULT' = RESU [DYNA_TRANS]
[EVOL_NOLI]

if postprocessing is carried out starting from a transitory result of dynamics (coming for example from LIRE_MISS3D [U7.02.31], produced concept: DYNA_TRANS or of DYNA_NON_LINE, produced concept: evol_noli).

or:

/ 'TABLE' = [TABLE_SDASTER]

if postprocessing is carried out starting from a table containing the results to read. The table perhaps produced by:

- a transitory calculation of dynamics and to come from a table of observation. In this case the name of the columns of the table are ('INST', 'NODE', 'NOM_CHAM', 'NOM_CMP', 'VALE') with 'NOM_CHAM'=' ACCE' .
- any order producing a table. In this case the name of the columns of the table are obligatorily ('INST', 'NODE', 'NOM_CHAM', 'DX', 'DY', 'DZ') with 'NOM_CHAM'=' ACCE ' .

3.7.3 Case CALCULATION = ' ABSOLU '

- ◆ DEPL_X = /DE_X [FUNCTION]
- ◆ DEPL_Y = /DE_Y [FUNCTION]
- ◆ DEPL_Z = /DE_Z [FUNCTION]

In this case, it is necessary to introduce the functions of displacement of the ground, definite on the same list of moments, in each direction of space, in front of being deduced from absolute displacements in order to obtain relative displacements.

4 Examples

The following examples illustrate the calculation of a spectrum of acceleration, as well as the calculation of the envelope of displacements:

```
TAB=MACR_SPECTRE (
  GRID = E-MAIL,
  FLOOR = _F (NAME = 'TOP', GROUP_NO = ('GTOP1',)),),
  NOM_CHAM = 'ACCE',
  CALCULATION = 'ABSOLUTE',
  AMOR_SPEC = L_AMOR_S,
  FREQ = L_FREQ,
  NORMALIZES = 9.81,
  RESU= (_F (RESU_GENE = RESUGENE,)),)

TAB2=MACR_SPECTRE (
  GRID = MA1,
  FLOOR = (
    _F (NAME = 'NIV1', GROUP_NO = ('N4_NIV1', 'N5_NIV1', 'N6_NIV1',
    'N7_NIV1',)),),
    _F (NAME = 'NIV8', GROUP_NO = ('N4_NIV8', 'N5_NIV8', 'N6_NIV8',
    'N7_NIV8',)),),
  ),
  NOM_CHAM = 'DEPL',
  CALCULATION = 'RELATIVE',
  LIST_INST = LIST,
  RESU= (
    _F (RESU_GENE = TRAN_GE1,)),
    _F (RESU_GENE = TRAN_GE2,)),
    _F (RESU_GENE = TRAN_GE3,)),
  ),)

TAB3=MACR_SPECTRE (
  GRID = MA1,
  FLOOR = (
    _F (NAME = 'NIV1', GROUP_NO = ('N4_NIV1',)),),
    _F (NAME = 'NIV8', GROUP_NO = ('N4_NIV8', 'N5_NIV8',)),),
  ),
  NOM_CHAM = 'ACCE',
  CALCULATION = 'ABSOLUTE',
  AMOR_SPEC = L_AMOR_S,
  LIST_FREQ = L_FREQ,
  RESU= (_F (RESULT = DYNAT_K1,)),
    _F (RESULT = DYNAT_K2,)),
    _F (RESULT = DYNAT_K3,)),),
  IMPRESSION = _F (FORMAT = 'TABLEAU', UNIT = 16,))
)
```

One can also refer to the case test SDNV112A for another example of use.