

Operator `MODE_NON_LINE`

1 Goal

The operator `MODE_NON_LINE` allows to calculate a non-linear mode of an autonomous conservative linear system equipped with localised non-linearities of shock.

The initial condition perhaps a linear mode or a non-linear mode allowing to use the results of a former calculation. Non-linearities are defined in the operator.

This operator produces a concept of the type `table_container`.

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2 Syntax

```

resu_out [table_container] = MODE_NON_LINE (
  ◊ reuse = resu_out,

  ◆ MATR_MASS = M, [matr_asse_depl_r]
  ◆ MATR_RIGI = K, [matr_asse_depl_r]

  ◆ ETAT_INIT = _F (,
    ◆ /MODE_LINE = mode_line, [mode_meca]
    /MODE_NON_LINE = resu_in, [table_container]
    ◊ NUME_ORDRE = num_ordr, [I]
    ◊ DIR_EVOLUTION = /-1, [DEFECT]
    /1,
    ◊ COEF_AMPL = ampl, [R]
  ),

```

the keyword factor SHOCK is necessary only if the keyword MODE_LINE is present:

```

◊ SHOCK = _F (
  ◆ GAME = game, [R]
  ◆ RIGI_NOR = alpha, [R]
  ◊ PARA_REGUL = /0.005, [DEFECT]
    /eta, [R]
  ◆ GROUP_NO = grno, [group_no]
  ◆ OBSTACLE = /'PLAN',
    /'BI_PLAN',
    /'CERLCE',

```

only associated Keywords for OBSTACLE = 'CIRCLE' :

```

◊ ORIG_OBST = /(0. , 0. , 0.), [DEFECT]
    /(orgx, orgy, orgz) [l_R]
  ◆ NOM_CMP = /('DX', 'DY'),
    /('DY', 'DZ'),
    /('DX', 'DZ'),

```

only associated Keywords for OBSTACLE = 'PLAN' or 'BI_PLAN':

```

  ◆ NOM_CMP = /'DX',
    /'DY',
    /'DZ',

```

```

  ◆ RESOLUTION = _F (
    ◊ METHOD = /'EHMAN',

```

only associated Keywords for 'EHMAN' :

```

    [DEFECT]
  ◆ NB_HARM_LINE = H1, [R]
  ◆ NB_HARM_NONL = /201, [DEFECT]
    /Hn1, [R]
  ◆ NB_BRANCHE = will nbra, [I]
  ◆ NB_PAS_MAN = npas, [I]
  ◊ NB_ORDRE_MAN = /20, [DEFECT]
    /nordre, [I]
  ◊ PREC_MAN = /1.E-9, [DEFECT]
    /eps_man, [R]
  ◊ PREC_NEWTON = /1.E-8, [DEFECT]
    /eps_man, [R]
  ◊ ITER_NEWTON_MAXI = /15, [DEFECT]
    /iter_newt, [R]
  ◊ CRIT_ORDR_BIFURCATION = /3, [DEFECT]
    /crit_bif, [I]
  ◊ RESI_RELA_BIFURCATION = /1.E-4, [DEFECT]

```

```
), /eps_bif, [R]
),
    ◇ INFORMATION = /1,
[DEFECT]
    /2,
)
```

3 Operands

3.1 Keyword `MATR_MASS` and `MATR_RIGI`

◇ `MATR_MASS`

Real, symmetrical assembled matrix of type `[matr_asse_depl_r]`.

◇ `MATR_RIGI`

Real, symmetrical assembled matrix of type `[matr_asse_depl_r]`.

3.2 Keyword `ETAT_INIT`

◇ `ETAT_INIT`

Under this keyword factor, one can inform a periodic solution to initialize the calculation algorithm of the non-linear modes.

3.2.1 Operand `MODE_LINE`

◇ `MODE_LINE`

Structure of the type `mode_meca` exit of a calculation with the operator `CALC_MODES`. This keyword is not valid if the keyword `MODE_NON_LINE` is present.

3.2.2 Operand `MODE_NON_LINE`

◇ `MODE_NON_LINE`

Structure of the type `table_container` exit of a calculation with the operator `MODE_NON_LINE`. This keyword is not valid if the keyword `MODE_LINE` is present.

3.2.3 Operand `NUME_ORDRE`

◇ `NUME_ORDRE`

If the keyword `MODE_LINE` is present then `num_ordr` indicate the sequence number of the linear clean mode resulting from `mode_line` chosen to initialize the algorithm.

If the keyword `MODE_NON_LINE` is present then `num_ordr` indicate the sequence number of the periodic solution resulting from `resu_in` chosen to initialize the algorithm.

3.2.4 Operand `DIR_EVOLUTION`

◇ `DIR_EVOLUTION`

If 1 then one goes in the same direction as the first calculated tangent vector.

If -1 then one goes in the contrary direction to the first calculated tangent vector.

The value by default is -1.

3.2.5 Operand `COEF_AMPL`

◇ `COEF_AMPL`

`ampl` is the maximum amplitude given to the periodic solution selected to initialize the algorithm.

This value is useful when one initializes with a linear clean mode, where the maximum amplitude must be small so that the algorithm converges.

The value by default is 1 .

3.3 Keyword `SHOCK`

◇ `SHOCK`

Under this keyword factor, one informs the physical configuration and parameters corresponding to the non-linearity of shock which one wants to impose.

3.3.1 Operand `GAME`

◆ `GAME`

`game` is the distance between the node and the elastic thrust on which this one can return in contact.

3.3.2 Operand `RIGI_NOR`

◆ `RIGI_NOR`

`alpha` is the stiffness of the elastic thrust.

3.3.3 Operand `PARA_REGUL`

◆ `PARA_REGUL`

`eta` is the parameter allowing to regularize the law of behavior which governs the relation between node and elastic thrust.

The value by default is 0,005 .

3.3.4 Operand `GROUP_NO`

◆ `GROUP_NO`

`grno` is the name of the group of node on which non-linearity is. It should be noted that `grno` must contain one node.

3.3.5 Operand `OBSTACLE`

◆ `OBSTACLE`

Three possibilities:

'`PLAN`' who corresponds to a unilateral elastic thrust.

'`BI_PLAN`' who corresponds to a bilateral elastic thrust.

'`CIRCLE`' who corresponds to an elastic thrust of circular form.

3.3.6 Operand `ORIG_OBST`

◆ `ORIG_OBST`

This keyword is available only if `OBSTACLE = 'CIRCLE'` . It defines the Cartesian coordinates of the center of the circle in the local reference mark whose origin is the node of shock.

3.3.7 Operand `NOM_CMP`

◆ `NOM_CMP`

If `OBSTACLE = 'PLAN'` , or `OBSTACLE = 'BI_PLAN'` then this keyword indicates on which axis, '`DX`', '`DY`' or '`DZ`' , the thrust is.

If `OBSTACLE = 'CIRCLE'` , then this keyword indicates in which plan the thrust is.

Oxy plan: ('`DX`' , '`DY`') ,

Oyz plan: ('`DY`' , '`DZ`') ,

Oxz plan: ('`DX`' , '`DZ`')

3.4 Keyword `RESOLUTION`

◆ `RESOLUTION`

Under this keyword factor, one informs the type of algorithm and the parameters associated. The methods available are to be declared under the operand `METHOD`.

3.4.1 Operand `METHOD`

◆ `METHOD`

Choice of the calculation algorithm of the non-linear modes. The only currently available algorithm is '`EHMAN`' corresponding to the combination of the method of balancing harmonic (`HEY`) and

digital asymptotic method (MAN), as well as an algorithm of Newton. This last makes it possible to make sure of the convergence of the algorithm.

3.4.2 Operand `NB_HARM_LINE`

◆ `NB_HARM_LINE`

`H1` is the number of harmonics used to develop in the shape of a series of Fourier the variables of displacements.

3.4.3 Operand `NB_HARM_NONL`

◇ `NB_HARM_NONL`

`Hn1` is the number of harmonics used to develop in the shape of a series of Fourier the functions representative of the laws of behavior who govern the relation between node and elastic thrust. The following condition $H_{n1} > H1$ must be respected.
The value by default is 201 .

3.4.4 Operand `NB_BRANCHE`

◆ `NB_BRANCHE`

`will nbra` is the number of branches calculated by the MAN.

3.4.5 Operand `NB_PAS_MAN`

◆ `NB_PAS_MAN`

`npas` is the step of discretization of the branches calculated by the MAN.

3.4.6 Operand `NB_ORDRE_MAN`

◇ `NB_ORDRE_MAN`

`nordre` is the number of discretization of the branches calculated by the MAN.
The value by default is 20 .

3.4.7 Operand `PREC_MAN`

◇ `PREC_MAN`

`eps_man` is the tolerance of algorithm MAN.
The value by default is 1.E-9 .

3.4.8 Operand `PREC_NEWTON`

◇ `PREC_NEWTON`

`eps_newt` is the tolerance of the algorithm Newton.
The value by default is 1.E-8 .

3.4.9 Operand `ITER_NEWTON_MAXI`

◇ `PREC_NEWTON`

`iter_newt` is the iteration count maximum of the algorithm Newton.
The value by default is 15 .

3.4.10 Operand `CRIT_ORDR_BIFURCATION`

◇ `CRIT_ORDR_BIFURCATION`

`crit_bif` is the number of coefficients of the whole series resulting from the MAN. One carries out the analysis of junction on these points.
The value by default is 3 .

3.4.11 Operand `RESI_RELA_BIFURCATION`

◇ `RESI_RELA_BIFURCATION`

`eps_bif` is the tolerance of the criterion which makes it possible to rule on the presence or not of a junction.
The value by default is 1.E-4 .

3.5 Keyword `SOLVEUR`

◇ `SOLVEUR`

The syntax of this keyword common to several orders is described in the document [U4.50.01].

3.6 Keyword `INFORMATION`

◇ `INFORMATION`

Entirety allowing to specify the level of impression in the file `MESSAGE` .

If `INFO=1`, one announces only the number of the calculated branch.

If `INFO=2`, one also displays the relative error of the last point of the branch. As well as the error for each possible iteration of Newton. And finally, the energy and the frequency of the first and the last point of the branch.