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.

Contents

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]
             ♦  /NOEUD           = node,                     [node]
                /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      = Hl,                       [R]
             ◊ NB_HARM_NONL      = /201,                     [DEFECT]
                                   /Hnl,                     [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 the node and the elastic thrust.
The value by default is 0,005 .

3.3.4 Operand NODE and GROUP_NO

◊ NODE
node is the name of the node on which non-linearity is.

◊ 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

Hl 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

Hnl 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 the node and the elastic thrust. The following condition Hnl>Hl 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.