Operator CALC_MATR_ELEM

1 Goal

To calculate elementary matrices which one will be able to assemble by the order ASSE_MATRICE.

The possible options of calculations are:

'AMOR_ACOU', 'MASS_MECA', 'RIGI_FLUI_STRU', 'RIGI_ROTA', 'AMOR_MECA',
'MECA_GYRO', 'MASS_MECA_DIAG', 'RIGI_GEOM', 'RIGI_THER',
'MASS_THER', 'IMPE_MECA','RIGI_MECA', 'MASS_ACOU', 'ONDE_FLUI',
'RIGI_MECA_HYST', 'MASS_FLUI_STRU', 'RIGI_ACOU','RIGI_GYRO'

Product a structure of data of the type matr_elem_*.

2 Syntax

```
mel    [matr_elem_*] = CALC_MATR_ELEM

          (      /  ♦  OPTION = 'RIGI_MECA',
                    ♦  MODEL = Mo,                          [model]
                    ♦  CHAM_MATER =     chmat,              [cham_mater]
                          ◊  CARA_ELEM =      caract ,            [cara_elem]
                    ◊  MODE_FOURIER =   /  nh  ,            [I]
                                        /  0   ,            [DEFECT]
                    ◊  LOAD =    l_char ,                [l_char_meca]
                    ◊  CALC_ELEM_MODELE =  /  'YES'  ,      [DEFECT]
                                           /  'NOT'
                    ◊  GROUP_MA = lgma,                     [l_gr_maille]


                 /  ♦  OPTION =  /  'MASS_MECA',
                                 /  'MASS_MECA_DIAG',
                    ♦  MODEL = Mo,                          [model]
                    ◊  CHAM_MATER = chmat,                  [cham_mater]
                    ◊  LOAD = tank  ,                       [char_meca]
                    ◊  CARA_ELEM =caract,                   [cara_elem]
                    ◊  GROUP_MA = lgma,                     [l_gr_maille]

                 /  ♦  OPTION = 'RIGI_GEOM',
                    ♦  MODEL = Mo,                          [model]
                    ◊  CARA_ELEM = carac,                   [cara_elem]
                    ♦  SIEF_ELGA = sig  ,                   [cham_elem]
                    ◊  MODE_FOURIER =   /  nh  ,            [I]
                                        /  0   ,            [DEFECT]

                 /  ♦  OPTION = 'RIGI_ROTA',
                    ♦  MODEL = Mo,                          [model]
                    ♦  CHAM_MATER = chmat,                  [cham_mater]
                    ♦  LOAD = l_char,                       [l_char_meca]

                 /  ♦  OPTION = 'AMOR_MECA',
                    ♦  MODEL = Mo,                          [model]
                    ♦  |      CARA_ELEM = carac   ,        [cara_elem]
                       |  ♦   RIGI_MECA = rigiel  ,        [matr_elem_DEPL_R]
                          ◊   MASS_MECA = massel  ,        [matr_elem_DEPL_R]
                    ♦  CHAM_MATER = chmat,                  [cham_mater]
                    ◊  LOAD = tank,                     [char_meca]
                    ◊  GROUP_MA = lgma,                     [l_gr_maille]

                 /  ♦  OPTION = 'MECA_GYRO',
                    ♦  MODEL = Mo,                          [model]
                    ◊  CARA_ELEM = carac   ,                [cara_elem]
                    ♦  CHAM_MATER = chmat,                  [cham_mater]
                    ◊  LOAD = tank,                     [char_meca]
                    ◊  GROUP_MA = lgma,                     [l_gr_maille]

                 /  ♦  OPTION = 'RIGI_GYRO' ,
                    ♦  MODEL = Mo,                          [model]
                    ◊  CARA_ELEM = carac   ,                [cara_elem]
                    ♦  CHAM_MATER = chmat,                  [cham_mater]
                    ◊  LOAD = tank,                     [char_meca]
```

```
                    ◊  GROUP_MA = lgma,                    [l_gr_maille]

                  /  ♦  OPTION = 'RIGI_MECA_HYST',
                     ♦  MODEL = Mo,                        [model]
                     ♦  CHAM_MATER = chmat,                [cham_mater]
                     ♦  LOAD = l_char,                     [l_char_meca]
                     ♦  RIGI_MECA = rigiel  ,              [matr_elem_DEPL_R]
                     ◊  GROUP_MA = lgma,                   [l_gr_maille]

                  /  ♦  OPTION = 'RIGI_THER',
                     ♦  MODEL = Mo,                        [model]
                     ♦  CHAM_MATER = chmat,                [cham_mater]
                     ◊  CARA_ELEM = carac,                 [cara_elem]
                     ◊  MODE_FOURIER =   /  nh  ,          [I]
                                         /  0   ,          [DEFECT]
                     ◊  CHARGE=      lchar,                [l_char_ther]

                  /  ♦  OPTION = 'FARMHOUSE_THER',
                     ♦  MODEL = Mo,                        [model]
                     ♦  CHAM_MATER = chmat,                [cham_mater]
                     ◊  CARA_ELEM = carac,                 [cara_elem]
                     ◊  MODE_FOURIER =   /  nh  ,          [I]
                                         /  0   ,          [DEFECT]

                  /  ♦  OPTION = 'RIGI_ACOU',
                     ♦  MODEL = Mo,                        [model]
                     ♦  CHAM_MATER = chmat,                [cham_mater]
                     ◊  LOAD = lchar,                  [l_char_acou]

                  /  ♦  OPTION =  /   'MASS_ACOU',
                                  /   'AMOR_ACOU',
                     ♦  MODEL = Mo,                        [model]
                     ♦  CHAM_MATER = chmat,                [cham_mater]

                  /  ♦  OPTION = 'RIGI_FLUI_STRU',
                     ♦  MODEL = Mo,                        [model]
                     ♦  CARA_ELEM = carac   ,              [cara_elem]
                     ♦  CHAM_MATER = chmat  ,              [cham_mater]
                     ◊  LOAD = l_char,                     [l_char_meca]

                  /  ♦  OPTION = 'MASS_FLUI_STRU',
                     ♦  MODEL = Mo,                        [model]
                     ♦  CARA_ELEM = carac   ,              [cara_elem]
                     ♦  CHAM_MATER = chmat  ,              [cham_mater]

                  /  ♦  OPTION =      /   'IMPE_MECA',
                                      /   'ONDE_FLUI',
                     ♦  MODEL = Mo,                        [model]
                     ♦  LOAD = lchar,                  [l_char_meca]
                     ♦  CHAM_MATER = chmat  ,              [cham_mater]

                  ◊  INST =         /  tps,               [R]
                                    /  0.0,               [DEFECT]
                  ◊  INCR_INST =    /  incr_tps,          [R]
                                    /  0.0,               [DEFECT]
            )

      If OPTION 'AMOR_ACOU'          then       [*]          PRES_C
```

'AMOR_MECA'	DEPL_R
'MECA_GYRO'	DEPL_R
'RIGI_GYRO'	DEPL_R
'IMPE_MECA'	DEPL_R
'MASS_ACOU'	PRES_C
'MASS_FLUI_STRU'	DEPL_R
'MASS_MECA'	DEPL_R
'MASS_MECA_DIAG'	DEPL_R
'ONDE_FLUI'	DEPL_R
'RIGI_ACOU'	PRES_C
'RIGI_FLUI_STRU'	DEPL_R
'RIGI_GEOM'	DEPL_R
'RIGI_MECA'	DEPL_R
'RIGI_MECA_HYST'	DEPL_C
'RIGI_ROTA'	DEPL_R
'RIGI_THER'	TEMP_R
'MASS_THER'	TEMP_R

3 Operands

3.1 Operand OPTION

♦ OPTION =

The table which follows gives the list of the matrices calculated by an option as well as the type of element to which the option applies.

This kind of element is given either by the name of the phenomenon having made it possible to define the model, or by the name of the operator having produced the concept load.

Option	Phenomenon or operator	Matrix
'AMOR_MECA'	MECHANICS	Damping of the elements calculated by linear combination of rigidity and the mass [U2.06.03] or by direct assignment for the discrete elements. Damping of the elements of absorbing border pertaining to specific modelings '3D_ABSO' or 'D_PLAN_ABSO' model Mo and calculated starting from the mechanical characteristics E , ν and ρ affected material.
'MECA_GYRO'	MECHANICS	Gyroscopic damping [R5.05.07]
'RIGI_GYRO'	MECHANICS	Gyroscopic stiffness [R5.05.07]
'IMPE_MECA'	MECHANICS	Acoustic impedance of the surface elements belonging to modelings '3D_FLUIDE' or '2D_FLUIDE' model Mo [U4.53.11].
'MASS_FLUI_STRU'*	MECHANICS	Mass of the elements of the model Mo with taking into account of the fluids external and intern with the structure and coefficient of containment.
'MASS_MECA'	MECHANICS	Mass of the elements of the model Mo.
'MASS_MECA_DIAG'	MECHANICS	Mass (diagonal) of the elements of the model Mo.
'ONDE_FLUI'	MECHANICS	Acoustic impedance of the surface elements of the model Mo belonging to modelings '3D_FLUIDE' and '2D_FLUIDE'. This impedance corresponds to the influence of a harmonic incidental wave of pressure [U4.53.11].
'RIGI_FLUI_STRU'*	MECHANICS	Rigidity of the elements of the model Mo with taking into account of the fluids external and intern with the structure and coefficient of containment.
'RIGI_GEOM'	MECHANICS	Geometrical rigidity of the elements of the model Mo.
'RIGI_MECA'	MECHANICS	Reality part of the Rigidity of the elements of the model Mo.
	AFFE_CHAR_MECA	Matrix associated with the multipliers with Lagrange with lchar.
'RIGI_MECA_HYST'	MECHANICS	Rigidity complexes elements of the model. Calculée by the multiplication by a complex number of rigidity reality [U2.06.03] or by assembly of the realities parts and imaginary of rigidity of a viscoelastic material.
	AFFE_CHAR_MECA	Matrix associated with the multipliers with Lagrange with lchar.

'RIGI_ROTA'	MECHANICS	Rigidity of rotation of the elements of the model Mo
'RIGI_THER'	THERMICS	Rigidity of the elements of the model Mo.
	AFFE_CHAR_THER	Rigidity coming from the conditions of exchange from lchar.
	AFFE_CHAR_THER	Matrix associated with the multipliers with Lagrange with lchar.
'MASS_THER'	THERMICS	Mass of the elements of the model Mo.
'AMOR_ACOU'	ACOUSTICS	Damping of the elements of the model Mo.
'MASS_ACOU'	ACOUSTICS	Mass of the elements of the model Mo.
'RIGI_ACOU'	ACOUSTICS	Rigidity of the elements of the model Mo.
	AFFE_CHAR_ACOU	Matrix associated with the multipliers with Lagrange with lchar.

The marked options * relate to the resorption of software FLUSTRU:

These two options: 'RIGI_FLUI_STRU' and 'MASS_FLUI_STRU' allow to calculate the matrices of mass and rigidity (and thus a modal base) for a structure of beam (SEG2) bathed by an external fluid. The relation of behavior of material must be ELAS_FLU.

3.2 Operands MODEL / CHAM_MATER / CARA_ELEM

♦ MODEL = Mo

This operand is used to indicate the elements for which must be carried out elementary calculations: it is pointed out that the finite elements for the majority are defined in the model.

There are two exceptions:

1) Elements of dualisation of the conditions of DIRICHLET, i.e. elements allowing to impose conditions on the degrees of freedom of displacement in mechanics, degrees of freedom of temperature in thermics and degrees of freedom of pressure in acoustics.
2) Nodal loading elements.

These elements are defined in the concepts of the type char_meca, char_ther or char_acou.

One must thus provide the argument l_char for the calculation of the elementary matrices of rigidity: RIGI_MECA, RIGI_THER, RIGI_ACOU, RIGI_MECA_HYST.

◊ CHAM_MATER = chmat

Name of the material field where the characteristics of materials of the elements are defined.

This argument is **almost always necessary**.

In practice, one can do some:

- for the discrete elements whose elementary matrices are defined in the concept cara_elem. See AFFE_CARA_ELEM [U4.42.01],
- for the calculation of rigidities due to the dualisation of the boundary conditions.

◊ INST = tps

The argument tps is used when the material characteristics or the loadings depend on time. A rather frequent case is that of a mechanical material depend on the temperature which it even depends on time.

◊ INCR_INST = incr_tps

The argument incr_tps is used for the option 'MASS_THER'. Caution! This value must be different from zero because the calculation of the thermal mass uses a factor which introduces incr_tps with the denominator!

◊ CARA_ELEM = carac

Elementary characteristics carac are necessary if there exists in the model of the elements of beam, hull or of the discrete elements or if a reference mark of anisotropy were defined on solid elements (keyword SOLID MASS order AFFE_CARA_ELEM).

3.3 Operand LOAD

◊ LOAD = tank

This operand has several distinct functions:

1) To allow the calculation of the matrices of elementary rigidity corresponding to the dualisation of certain boundary conditions of Dirichlet,
2) For the option 'IMPE_MECA' : to give the value of the acoustic impedance of the meshs of the edge,
3) For the option 'ONDE_FLUI' : to give the value of the pressure of the incidental wave,
4) For the option 'IHGI_ROTA' : to give the value of the rotation imposed on the model.

3.4 Operand MODE_FOURIER

◊ MODE_FOURIER = / nh
/ 0 [DEFECT]

Positive or null entirety indicating the harmonic of Fourier on whom one calculates the elementary matrices.

3.5 Operand CALC_ELEM_MODELE

◊ CALC_ELEM_MODELE = / 'YES' [DEFECT]
/ 'NOT'

This operand makes it possible to calculate the elementary matrix of rigidity only associated with the macronutrients with the model ('NOT'). By default, the matrix is calculated on the whole of the model ('YES').

3.6 Operand GROUP_MA

◊ GROUP_MA = lgma,
This operand makes it possible to calculate the elementary matrices only on the meshs of the groups lgma. The operand is authorized for the options of gyroscopy, RIGI_MECA, RIGI_MECA_HYST, AMOR_MECA, MASS_MECA, MASS_MECA_DIAG and MASS_FLUI_STRU.

3.7 Operand SIEF_ELGA (option 'RIGI_GEOM')

♦ SIEF_ELGA = sig

The stress field sig given for the calculation of the option 'RIGI_GEOM' must be calculated in theory with the option 'SIEF_ELGA' (stress field at the points of Gauss of the elements) (cf orders CALC_CHAMP [U4.81.04]). The theory of linear buckling indeed supposes a theory of small elastic displacements.

3.8 Operands RIGI_MECA and MASS_MECA (options 'AMOR_MECA' and 'RIGI_MECA_HYST')

♦ RIGI_MECA =

Real part of the melementary atrices of rigidity ('RIGI_MECA') necessary to the calculation of the matrices:

- of damping ('AMOR_MECA')
- DE hysteretic rigidity by total damping hysteretic ('RIGI_MECA_HYST') to see "Note of use of damping and hysteretic rigidity" [U2.06.03].
- of rigidity complexes for viscoelastic materials, the option 'RIGI_MECA_HYST' calculation the ima partGinaire of the elementary matrix of rigidity and assembles it with the reality part passed in argument of the option.

◊ MASS_MECA =

Elementary matrices of mass ('MASS_MECA' or 'MASS_MECA_DIAG') necessary to the calculation of the matrices of damping ('AMOR_MECA').

Notice :

For the option 'RIGI_MECA_HYST' , the result of calculation will contain besides the hysteretic rigidity of the elements of the model, the matrix associated with the multipliers of Lagrange induced by the dualisation with the outputs.

4 Examples of calculations with CALC_MATR_ELEM

4.1 Geometrical matrix of rigidity for the buckling of Euler

```
rigigeom = CALC_MATR_ELEM (   OPTION = ' RIGI_GEOM', MODEL = Mo,
                              CARA_ELEM = carac   ,  SIEF_ELGA = chsig)
```

4.2 Matrix of “mass” in acoustics

```
massacou = CALC_MATR_ELEM (   OPTION = ' MASS_ACOU', MODEL = Mo,
                              CHAM_MATER = chmat  )
```

4.3 Matrix of rigidity in mechanics

```
rigibloc = CALC_MATR_ELEM (   OPTION = ' RIGI_MECA', LOAD = ch_bloc)
```