

## Operator CALC\_MATR\_ELEM

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### 1 Goal

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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',  
'AMOR_MECA_ABSO', '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'
        )

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

        /  ♦ OPTION = 'RIGI_GEOM',
            ♦ MODEL = Mo,                                  [model]
            ◇ CARA_ELEM = caract,                          [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 = caract,                         [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]

        /  ♦ OPTION = 'MECA_GYRO',
            ♦ MODEL = Mo,                                  [model]
            ◇ CARA_ELEM = caract,                          [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 = caract,                          [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]

/   ◆ 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 'DP_ABSO' model $M_0$ and calculated starting from the mechanical characteristics $E$ , $\nu$ and $\rho$ 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 $M_0$ [U4.53.11].
'MASS_FLUI_STRU' *	MECHANICS	Mass of the elements of the model $M_0$ 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 $M_0$ .
'MASS_MECA_DIAG'	MECHANICS	Mass (diagonal) of the elements of the model $M_0$ .
'ONDE_FLUI'	MECHANICS	Acoustic impedance of the surface elements of the model $M_0$ 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 $M_0$ 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 $M_0$ .
'RIGI_MECA'	MECHANICS	Rigidity of the elements of the model $M_0$ .
	AFFE_CHAR_MECA	Matrix associated with the multipliers with Lagrange with <code>lchar</code> .
'RIGI_MECA_HYST'	MECHANICS	Hysteretic rigidity (complex) calculated by the multiplication by a complex number of simple rigidity [U2.06.03].
	AFFE_CHAR_MECA	Matrix associated with the multipliers with Lagrange with <code>lchar</code> .
'RIGI_ROTA'	MECHANICS	Rigidity of rotation of the elements of the model $M_0$

'RIGI_THER'	THERMICS	Rigidity of the elements of the model $M_0$ .
	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 $M_0$ .
'AMOR_ACOU'	ACOUSTICS	Damping of the elements of the model $M_0$ .
'MASS_ACOU'	ACOUSTICS	Mass of the elements of the model $M_0$ .
'RIGI_ACOU'	ACOUSTICS	Rigidity of the elements of the model $M_0$ .
	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 = $M_0$

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 meshes 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 meshes of the groups *lgma*. The operand is authorized only for the options of gyroscoy.

### 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 =

Elementary matrices of rigidity ('RIGI\_MECA') necessary to the calculation of the matrices of damping ('AMOR\_MECA') or of hysteretic rigidity ('RIGI\_MECA\_HYST') to see "Note of use of damping and hysteretic rigidity" [U2.06.03].

◇ 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

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### 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)
```