

Macro-order MACR_ASCOUF_CALC

1 Goal

To carry out the thermomechanical analysis of the elbow whose grid was conceived with the macro order MACR_ASCOUF_MAIL. **Lengths of the grid produced by MACR_ASCOUF_MAIL are in millimetres**, it is necessary to take of it account in the units of the characteristics material and the loading.

The principal stages of the macro order are:

- assignment of the model by the order AFFE_MODELE,
- assignment of materials by the order AFFE_MATERIAU,
- assignment of the characteristics of the discrete elements by the order AFFE_CARA_ELEM,
- definition of the boundary conditions of embedding of type beam with the connection 3D_POUTRE by the order AFFE_CHAR_MECA,
- definition of the mechanical loading (pressure, basic effect, torque of effort) by the order AFFE_CHAR_MECA,
- definition of the thermal loading (temperature of fluid, coefficient of exchange) by the order AFFE_CHAR_THER_F,
- realization of linear thermal calculation and linear mechanical calculation or not linear by the orders THER_LINEAIRE and STAT_NON_LINE,
- realization of the post treatment by the orders CALC_THETA, CALC_G, POST_RELEVE_T or POST_RCCM
- impression of postprocessing by the orders IMPR_RESU, IMPR_TABLE.

2 Syntax

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resu [evol_noli] = MACR_ASCOUF_CALC
(
  ◆ TYPE_MALLAGE = / 'HEALTHY' , [TXM]
                  / 'FISS_COUDE' ,
                  / 'FISS_AXIS_DEB' ,
                  / 'SOUS_EPAIS_COUDE' ,
  ◆ GRID = my , [grid]
  ◆ MODEL = CO ("modmec") , [TXM]
  ◇ CHAM_MATER = CO ("chmat") , [TXM]
  ◇ CARA_ELEM = CO ("carael") , [TXM]
  ◇ FOND_FISS = CO ("fonfiss") , [TXM]
  ◇ RESU_THER = CO ("resuth") , [TXM]
  ◆ AFFE_MATERIAU = _F ( ◆ / ALL = 'YES' ,
                        / GROUP_MA = / 'ELBOW' , [TXM]
                        / 'BOWL' ,
                        ◆ MATER = chechmate , [to
subdue]
                        ◇ TEMP_REF = / 0. , [DEFECT]
                        / tref , [R]
                        ) ,
  ◇ PRES_REP = _F ( ◆ NEAR = near , [R]
                  ◇ EFFE_FOND_P1 = / 'YES' , [DEFECT]
                  / 'NOT' ,
                  ◇ PRES_LEVRE = / 'YES' ,
                  / 'NOT' , [DEFECT]
                  ◇ FONC_MULT = fmult , / [function]
                  / [formula]
                  ) ,
  ◇ EXCHANGE = _F ( ◇ COEF_H = H , / [function]
                  / [formula]
                  ◇ TEMP_EXT = chtex , / [function]
                  / [formula]
                  ) ,
  ◇ TORS_P1 = _F ( ◆ | FX = fx , [R]
                  | FY = fy , [R]
                  | FZ = fz , [R]
                  | MX = MX , [R]
                  | MY = my , [R]
                  | MZ = mz , [R]
                  ◇ FONC_MULT = fmult , / [function]
                  / [formula]
                  )
  ◆ | BEHAVIOR = _F ( ◆ RELATION = / 'ELAS' ,
                    / 'ELAS_VMIS_TRAC' ,
                    ) ,
  ◇ SOLVEUR = (see the document [U4.50.01])
  ◇ NEWTON = (see the document [U4.51.03])

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◇ CONVERGENCE = (see the document [U4.51.03])
◇ RECH_LINEAIRE= (see the document [U4.51.03])
◆ INCREMENT = (see the document [U4.51.03])
◇ ENERGY = _F ( )
◇ THETA_3D = _F ( ◆ R_INF = R, [R]
                  ◆ R_SUP = R, [R]
                  ),
◇ IMPRESSION = _F ( ◇ FORMAT = / 'RESULT', [DEFECT]
                    / 'ASTER' ,
                    / 'CASTEM' ,
                    ◇ NIVE_GIBI = / 3,
                    / 10, [DEFECT]
                    ◇ FORMAT = 'IDEAS',
                    ◇ VERSION = / 4,
                    / 5, [DEFECT]
                    ),
◇ IMPR_TABLE = _F ( ◆ / TOUT_PARA = 'YES',
                    / NOM_PARA = | 'TRESCA_MEMBRANE',
                    | 'VERYCA_MFLE',
                    | 'TRESCA',
                    | 'SI_LONG',
                    | 'SI_RADI',
                    | 'SI_CIRC',
                    # If TOUT_PARA = 'YES' or if NOM_PARA contains
                    # 'SI_LONG' ou/et 'SI_RADI' ou/et 'SI_CIRC'
                    ◆ ANGLE =  $\alpha$ , [R]
                    ◆ / POSI_ANGUL = beta, [R]
                    / POSI_CURV_LONGI = sl, [R]
                    ◆ R_CINTR = Rc, [R]
                    # Finsi
                    ◇ TRANSFORM = / 'TUBE', [TXM]
                    / 'ELBOW', [DEFECT]
                    )
◇ TITLE = tx , [KN]
◇ INFORMATION = / 1 ,
[DEFECT] / 2 , [I]
)
```

3 Operands

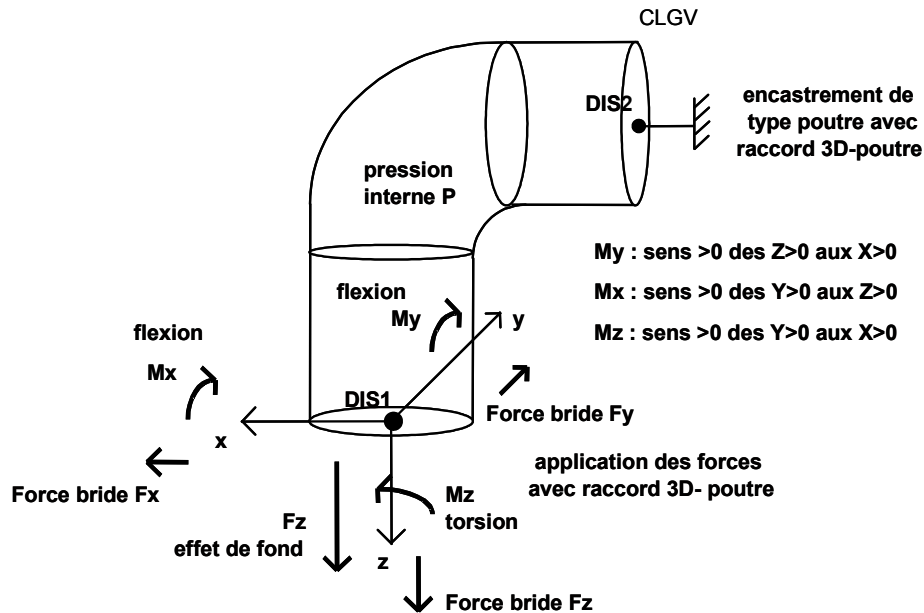


Figure 3-a: Loading and boundary conditions applicable on the elbow

3.1 Keyword TYPE_MALLAGE

Allows to recall which is the type of grid produced by MACR_ASCOUF_MAIL :

- ◆ TYPE_MALLAGE =
 - / 'HEALTHY' : calculation is carried out on a tube or bends healthy.
 - / 'FISS_COUDE' : calculation is carried out on a tube or bends comprising a crack (breaking process).
 - / 'SOUS_EPAIS_COUDE' : calculation is carried out on a tube or bends with one or more under-thicknesses.
 - / 'FISS_AXIS_DEB' : calculation is carried out on a tube or bends comprising an emerging axisymmetric crack.

To do calculations on a bottom of crack closed, it is thus necessary to indicate 'FISS_AXIS_DEB' like type of grid.

Note:

If a crack is defined in the model (FISS_COUDE or FISS_AXIS_DEB), a checking of the interpenetration of the lips is carried out for all the steps of time. If an interpenetration is detected, a message of alarm is transmitted to announce it. It is pointed out that the contact is not taken into account in calculation. The rate of refund of energy G is thus positive including where the crack tends to be closed, which can lead to results too much penalizing.

3.2 Operand GRID

- ◆ GRID = my

Here the grid used is specified. This grid is resulting from the macro-order MACR_ASCOUF_MAIL.

3.3 Operand MODEL

◆ MODEL = CO ("modmec")

Keyword used to name the mechanical model for a later use apart from the macro-order.

3.4 Operand CHAM_MATER

Keyword used to name the structure of data of the type `cham_mater` produced by the order `AFFE_MATERIAU`, for a later use apart from the macro-order.

3.5 Operand CARA_ELEM

Keyword used to name the structure of the type `cara_elem` produced by the order `AFFE_CARA_ELEM`, for a later use apart from the macro-order.

3.6 Operand FOND_FISS

Keyword used to name the concept of the type `fond_fiss` product by the order `DEFI_FOND_FISS`, for a later use apart from the macro-order.

3.7 Operand RESU_THER

Keyword used to name the result of linear thermal calculation (concept `evol_ther`), for a later use apart from the macro-order.

3.8 Keyword AFFE_MATERIAU

Keyword factor allowing to affect various materials on the grid. The characteristics of material are to be defined with the order `DEFI_MATERIAU` upstream of the macro-order.

Note:

In the event of elbow with under-thickness, the postprocessing carried out at the conclusion of calculation claims the definition of a working stress (keywords factor 'RCCM' / 'RCCM_FO' of `DEFI_MATERIAU`) for material constituting the elbow .

3.8.1 Operand GROUP_MA

◆ / ALL = 'YES'

This keyword makes it possible to affect on all the meshes of the grid.

/ GROUP_MA

This keyword makes it possible to affect the groups of meshes according to:

ELBOW group of meshes corresponding to the part bends and the right ends,

BOWL group of meshes corresponding to an end of type bowl (cf macro-order `MACR_ASCOUF_MAIL`).

3.8.2 Operand MATER

◆ MATER

Name of the material (cf orders `DEFI_MATERIAU`) that one wants to affect.

3.8.3 Operand TEMP_REF

◇ TEMP_REF

Temperature of reference for which there is no thermal deformation (cf orders `AFFE_MATERIAU`).

3.9 Keyword PRES_REP

3.9.1 Operand NEAR

◆ NEAR = near

One indicates here the value of the pressure which applies to the internal skin of the elbow and the ends.

This pressure is also used to calculate the tractive effort representing the basic effect which the taking into account is automatically assured (cf orders AFFE_CHAR_MECA keyword EFFE_FOND).

The value of this effort is: $T_{fond} = pres \times \frac{R_i^2}{R_e^2 - R_i^2}$

3.9.2 Operand EFFE_FOND_P1

◇ EFFE_FOND_P1

Allows to activate or not the application of the evoked basic effect [§3.11.1] of this document. By default EFFE_FOND_P1 is worth 'YES'.

3.9.3 Operand PRES_LEVRE

◇ PRES_LEVRE

Allows to activate or not the application of the pressure, evoked with [§3.11.1] of this document, on the lips of the crack when this one emerges in internal skin. By default PRES_LEVRE is worth 'NOT'.

Caution not to use PRES_LEVRE = 'YES' that for the cracks which emerge in internal skin.

3.9.4 Operand FONC_MULT

◇ FONC_MULT = fmult

Multiplying function of the loading (pressure plus basic effect). By default: $f = 1$. This one is to be defined upstream macro-order thanks to the order DEFI_FONCTION or FORMULA.

3.10 Keyword EXCHANGE

Keyword factor making it possible to apply conditions of exchange to the skin interns elbow (cf orders AFFE_CHAR_THER_F) and to carry out a linear thermal calculation (THER_LINEAIRE) precondition to mechanical calculation. For thermics, one uses the solvor and the parameter theta by default. The initial temperature is determined by a stationary calculation. The initial temperature is worth the temperature of the fluid at the initial moment (cf operand TEMP_EXT).

3.10.1 Operand COEF_H

◇ COEF_H = H

Value of the coefficient of exchange on the skin interns elbow given in the form of function of time.

This one is to be defined macro-order thanks to the orders upstream DEFI_FONCTION or FORMULA.

3.10.2 Operand TEMP_EXT

◇ TEMP_EXT = chtex

Value of the temperature of the fluid inside the elbow given in the form of function of time.

This one is to be defined macro-order thanks to the orders upstream DEFI_FONCTION or FORMULA.

3.11 Keyword TORS_P1

◇ TORS_P1 =

The keyword TORS_P1 allows to apply a torque of effort. This torque applies to the node of beam P1 (indicated DIS1 on the Figure 3-a).

In order to block the rigid movements of body, one blocks the six degrees of freedom of the node of beam P2 located at the center of the section CLGV.

3.11.1 Operands FX, FY, FZ, MX, MY, MZ

Components FX, FY, FZ, MX, MY, MZ torque of the efforts must be provided in the reference mark of the grid. At least one of the components must be indicated.

3.11.2 Operand FONC_MULT

◇ FONC_MULT = fmult

Multiplying function of the loading TORS_P1. By default: $f = 1$. This one is to be defined macro-order thanks to the orders upstream DEFI_FONCTION or FORMULA.

3.12 Keyword BEHAVIOR

◆ RELATION =

Type of elastic relation of behavior used to carry out mechanical calculation with STAT_NON_LINE :

'ELAS'	linear elastic behavior,
'ELAS_VMIS_TRAC'	nonlinear elastic behavior of Von Mises with nonlinear isotropic work hardening.

3.13 Keyword SOLVEUR

One defines the solver retained for mechanical calculation. The syntax of this keyword common to several orders is described in the document [U4.50.01]. It is used only for mechanical calculation.

3.14 Keyword NEWTON

Specify the characteristics of the method of resolution of the nonlinear incremental mechanical problem. The syntax of this keyword is described in the document [U4.51.03]. It is used only for mechanical calculation.

3.15 Keyword CONVERGENCE

Specify the convergence criteria of mechanical calculation. The syntax of this keyword is described in the document [U4.51.03]. It is used only for mechanical calculation.

3.16 Keyword RECH_LINEAIRE

Specify the linear mode of research of the solver. The syntax of this keyword is described in the document [U4.51.03]. It is used only for mechanical calculation.

3.17 Keyword INCREMENT

Defines the time intervals taken in the incremental method during a linear or mechanical calculation thermal nonlinear. The steps of times used for calculations thermics and mechanics are identical. The syntax of this keyword is described in the document [U4.51.03].

3.18 Keyword ENERGY

This keyword makes it possible to activate the calculation of the assessment of energy and its posting during mechanical calculation (see the document [R4.09.01]). This assessment is stored in the table of name `PARA_CALC` from where it can be extracted using the order `RECU_TABLE` [U4.71.02].

3.19 Keyword THETA_3D

This keyword, usable for postprocessing in breaking process, is used to define the crown for the field theta in order to calculate the rate of refund of energy G total and $G(s)$ room (cf orders `CALC_G` [U4.82.03]). Fields *thêta* and $G(s)$ are smoothed by polynomials of Legendre of degree 4, except for the axisymmetric cracks (smoothing with the functions of Lagrange form). This keyword is répétable as many times as one wants. The choice of several couples of rays makes it possible to check the stability of the method.

The contact is not taken into account in calculation, but a message of alarm is transmitted if the two lips of the crack interpenetrate. In this case, the rate of refund of energy G will remain positive including where the crack tends to be closed, which can lead to results too much penalizing.

3.19.1 Operand R_INF

◆ `R_INF = R [R8]`

Allows to indicate the lower value of the ray at a peak of crack in order to calculate the rate of refund of energy G .

3.19.2 Operand R_SUP

◆ `R_SUP = R [R8]`

Allows to indicate the higher value of the ray at a peak of crack in order to calculate the rate of refund of energy G .

3.20 Keyword IMPRESSION

3.20.1 Operand FORMAT

◇ `FORMAT`

Allows to specify the format of impression of the result and/or grid. By default the format is `'RESULT'`. If one wishes to print the grid, the format should be used `'ASTER'` and to put a file of the type `mast` as a result in the profile of study.

3.20.2 Operand VERSION

◇ `VERSION`

If and only if the operand `FORMAT` is worth `'IDEAS'`. This operand makes it possible to specify the version of the Ideas software. By default `VERSION` is worth 5.

3.20.3 Operand `NIVE_GIBI`

◇ `NIVE_GIBI`

If and only if the operand `FORMAT` is worth `'CASTEM'`. This operand makes it possible to specify the level of the software GIBI in which the grid will be printed. By default `NIVE_GIBI` is worth 10.

3.21 Keyword `IMPR_TABLE`

This keyword makes it possible to activate the impression of the tables of results for postprocessing on the ligaments concerning the elbows with under-thickness.

3.21.1 Operand `TOUT_PARA`

`TOUT_PARA = 'YES'`

Impression of all the values of the parameters of the table. The impression contains the elements enumerated below, in the order where they are described.

For the ligaments representing the under-thickness and those contained in the section including the center the under-thickness (ligaments `CIRxx`, `LONxx`, `PCENxx`, `INTRx`, `EXTRx`, `FGAUx`, `FDROx`, `EGAx`, `EXDRx`, `INDRx`, `INGAx`):

- Ligament where the membrane stress (named `PM`) is maximum.
- Ligament where the constraint of membrane-inflection at the origin of the segment (named `PMB`) is maximum.
- Ligament where the constraint of membrane-inflection at the end of the segment (named `PMB`) is maximum.
- Ligament where the average radial constraint (named `SIXX`) is maximum.
- Ligament where the average longitudinal constraint (named `SIYY`) is maximum.
- Ligament where the average circumferential constraint (named `SIZZ`) is maximum.
- Node and ligament where the constraint of Tresca (named `TRESCA`) is maximum.

For the same ligaments as previously but also those contained in the median sections of the elbow and interface with ends (ligaments `xxxxMI`, `xxxxTU`, `xxxxGV`):

- List of the values of the membrane stress (named `PM`) for each ligament.
- List of the values of the constraint of membrane-inflection at the origin of the segment (named `PMB`) for each ligament.
- List of the values of the constraint of membrane-inflection at the end of the segment (named `PMB`) for each ligament.
- List of the values of average radial constraint (named `SIXX`) for each ligament.
- List of the values of average longitudinal constraint (named `SIYY`) for each ligament.
- List of the values of average circumferential constraint (named `SIZZ`) for each ligament.
- List of the constraints of Tresca (named `TRESCA`) on each node of each ligament.

3.21.2 Operand `NOM_PARA`

`NOM_PARA = para`

Allows to choose a parameter list among the whole of the possible ones:

`'TRESCA'`, `'TRESCA_MEMBRANE'`, `'TRESCA_MFLE'`, `'SI_LONG'`, `'SI_RADI'`, `'SI_CIRC'`.

Note:

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

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This remark is valid for [§3.23.1] and [§3.23.2].

The constraints are given in the local reference mark of the section containing the ligament:

- *the radial constraint 'SI_RADI' corresponds in the file RESULT with SIXX,*
- *the longitudinal constraint 'SI_LONG' corresponds in the file RESULT with SIYY,*
- *the circumferential constraint 'SI_CIRC' corresponds in the file RESULT with SIZZ.*

The calculation of these constraints in local reference mark requires the carryforward of the parameters α , R_c , β or s_l and TRANSFORM defined in the macro-order of grid.

3.21.3 Operand ANGLE

◆ ANGLE = α

Value of the angle of the elbow in degrees. Here it is necessary to give the same value as in the macro-order MACR_ASCOUF_MAIL (cf [U4.CF.10, §4.3.1]).

3.21.4 Operand R_CINTR

◆ R_CINTR = R_c

Value of the ray of bending of the elbow. Here it is necessary to give the same value as in the macro-order MACR_ASCOUF_MAIL (cf [U4.CF.10, §4.3.2]).

3.21.5 Operand POSI_CURV_LONGI

◆ / POSI_CURV_LONGI = s_l

Value of the longitudinal position of the center under-thickness given by the curvilinear X-coordinate along the axis of the elbow on the external skin of this one, counted positively starting from the interface with the P1 end length l_{tube_p1} . Here it is necessary to give the same value as in the macro-order MACR_ASCOUF_MAIL (cf [U4.CF.10, §4.4.5]).

3.21.6 Operand POSI_ANGUL

/ POSI_ANGUL = β

Value of the longitudinal position of the center under-thickness given by the angle in degrees formed by the section containing this one and the section to the interface with the end length l_{tube_p1} . Here it is necessary to give the same value as in the macro-order MACR_ASCOUF_MAIL (cf [U4.CF.10, §4.4.6]).

3.21.7 Operand TRANSFORM

◆ TRANSFORM = / 'TUBE',
/ 'ELBOW', [DEFECT]

Allows to define the type of transformation applied in the macro-order of grid. Here it is necessary to give the same value as in the macro-order MACR_ASCOUF_MAIL (cf [U4.CF.10, §4.4.6]).

3.22 Operand TITLE

Title of the structure of data result. See [U4.50.01].

3.23 Operand INFORMATION

◆ INFORMATION =

Indicate the level of impression of the results of the operator,

- 1: no impression,
- 2: relative information impression with the grid.

The impressions are done in the file 'MESSAGE'.

To have the detail of the operators called by the macro-order in the file message, it is necessary to specify `IMPR_MACRO=' OUI '` in the order `BEGINNING`.