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## Operator DEFI\_FLUI\_STRU

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### 1 Goal

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To define the characteristics necessary under investigation dynamic of a structure under flow. By the choice of one of the keywords factors, the user specifies the type of configuration "structure - flow" studied: tube bundle under transverse or axial flow, control rod, hulls coaxial. According to the type of configuration, the abundant data make it possible to realize downstream:

- a study of coupling fluid/structure: estimate of the coefficients of forces fluid-rubber bands and calculation of the new modal parameters of the structure using the operator `CALC_FLUI_STRU` [U4.66.02],
- projection on the modal basis under flow of one or several turbulent excitations defined by their (S) density (S) spectral (S): operators `DEFI_SPEC_TURB` [U4.44.31] and `PROJ_SPEC_BASE` [U4.63.14]. One can then calculate the response of the structure to the turbulent excitation, into temporal and frequential.

The operator "DEFI\_FLUI\_STRU" produced a concept of the type `type_flui_stru` intended to be used downstream by the operators `FONC_FLUI_STRU` [U4.35.02], `CALC_FLUI_STRU` [U4.66.02] or, indirectly, `PROJ_SPEC_BASE` [U4.63.14].

## 2 Syntax

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typeflui [type_flui_stru] = DEFI_FLUI_STRU (
  ♦ / FAISCEAU_TRANS = _F (
    ◇ COUPLING = / 'YES'
                  / 'NOT',
    ◇ CARA_ELEM = will cara,
    [cara_elem]
    ♦ PROF_VITE_FLUI = profv, [function, formula]
    ◇ PROF_RHO_F_INT = profrhoi, [function, formula]
    ◇ PROF_RHO_F_EXT = profrhoe, [function, formula]
    ◇ NOM_CMP = / 'DX', [KN]
                  / 'DY',
                  / 'DZ',
    ◇ COEF_MASS_AJOU = cm, [R]
    ◇ TYPE_PAS = / 'CARRE_LIGN'
                  / 'TRIA_LIGN',
    ◇ TYPE_RESEAU = tr, [I]
    ◇ UNITE_CA = / iu1, [I]
                  / 70, [DEFECT]
    ◇ UNITE_KA = / iu2, [I]
                  / 71, [DEFECT]
    ◇ NOT = not, [R]
    / ♦ CSTE_CONNORS = cste, [l_R]
        ♦ NB_CONNORS = Nb, [I]
        ♦ RHO_TUBE = rho, [R]
    ),
  / BUNCH = _F (
    ♦ COUPLING = / 'YES' [KN]
                  / 'NOT' ,
    ◇ GROUP_NO = grno, [grno]
    ◇ / ♦ GRAPPE_2 = / 'ASC_CEN' [KN]
                    / 'ASC_EXC'
                    / 'DES_CEN'
                    / 'DES_EXC' ,
    [cara_elem] ♦ CARA_ELEM = will cara,
    ♦ MODEL = model, [model]
    ♦ RHO_FLUI = rho_f, [R]
    ◇ COEF_MASS_AJOU= cm1 , [R]
    ),
  / FAISCEAU_AXIAL = _F (
    ♦ / GROUP_MA = l_grma, [l_gr_ma]
        / TRI_GROUP_MA = / 'racine*'
                          / '*racine*'
                          / '*racine',
    ♦ VECT_X = l_comp, [l_R]
    ♦ PROF_RHO_FLUI = profrho, [function]
    ♦ PROF_VISC_CINE = profvisc, [function]
  )
)

```

```

    ♦ / CARA_ELEM = will cara,
[cara_elem]
    / ♦ RAYON_TUBE = ray, [R]
      ♦ COOR_TUBE = l_coor, [1_R]
    ♦ GRAVITY = l_g, [1_R]
    ♦ ROUGHNESS = rug, [R]
    ♦ CARA_PAROI = will l_cara, [1_TXM]
    ♦ VALE_PAROI = l_vale, [1_R]
    ♦ ANGL_VRIL = alpha, [R]
    ♦ LONG_TYPG = lotg, [R]
    ♦ LARG_TYPG = latg, [R]
    ♦ EPAI_TYPG = etg, [R]
    ♦ RUGO_TYPG = rtg, [R]
    ♦ COEF_TRAI_TYPG = ctt, [R]
    ♦ COEF_DPOR_TYPG = cdt, [R]
    ♦ COOR_GRILLE = cg, [R]
    ♦ TYPE_GRILLE = tg, [I]
      ),
  / COQUE_COAX = _F(
    ♦ MASS_AJOU = / 'YES' [DEFECT]
      / 'NOT',
    ♦ GROUP_MA_INT = gr_ma_i, [gr_ma]
    ♦ GROUP_MA_EXT = gr_ma_e, [gr_ma]
    ♦ VECT_X = l_comp, [1_R]
    ♦ CARA_ELEM = will cara,
[cara_elem]
    ♦ MATER_INT = mater_i, [to subdue]
    ♦ MATER_EXT = mater_e, [to subdue]
    ♦ RHO_FLUI = rho_f, [R]
    ♦ VISC_CINE = visco, [R]
    ♦ ROUGHNESS = rug, [R]
    ♦ PDC_MOY_1 = cde, [R]
    ♦ PDC_DYN_1 = cdep, [R]
    ♦ PDC_MOY_2 = cds, [R]
    ♦ PDC_DYN_2 = cdsp, [R]
      ),
  ♦ INFORMATION = / 1 [DEFECT]
    / 2, [I]
)

```

## 3 Operands

### 3.1 Keyword FAISCEAU\_TRANS

◆ / FAISCEAU\_TRANS

Keyword factor allowing to characterize a configuration of type “tube bundle under transverse flow”. If the study is based on the definition of several zones of excitation, one needs as many occurrences of the keyword factor FAISCEAU\_TRANS that zones.

◇ COUPLING = 'YES' or 'NOT'

Indicator of type text specifying the taking into account or not forces elastic fluid -. This operand must appear in at least one of the occurrences of the keyword factor FAISCEAU\_TRANS, and can be omitted in the others.

◇ CARA\_ELEM = will cara

Concept of the type [cara\_elem] allowing to provide all the relative data to the geometry of the elements of the structure: useful for the estimate of the hydraulic diameter. This operand must appear in at least one of the occurrences of the keyword factor FAISCEAU\_TRANS, and can be omitted in the others.

◆ PROF\_VITE\_FLUI = profv

Concept of the type [function] allowing to provide the profile adimensionné transverse speed along the tube. The parameter of the function is the curvilinear X-coordinate. This operand must appear in all the occurrences of the keyword factor FAISCEAU\_TRANS.

◇ PROF\_RHO\_F\_INT = profrhoi

Concept of the type [function] allowing to provide the profile of density of the fluid interns with the tube, along the tube. The parameter of the function is the curvilinear X-coordinate. This operand must appear in at least one of the occurrences of the keyword factor FAISCEAU\_TRANS, and can be omitted in the others.

◇ PROF\_RHO\_F\_EXT = profrhoe

Concept of the type [function] allowing to provide the profile of density of the external fluid to the tube, the tube. The parameter of the function is the curvilinear X-coordinate. This operand must appear in at least one of the occurrences of the keyword factor FAISCEAU\_TRANS, and can be omitted in the others.

◇ NOM\_CMP = 'DX' or 'DY' or 'DZ'

Indicator of type text [TXM] specifying the direction according to which act the turbulent forces fluid-rubber bands and/or forces. This operand must appear in at least one of the occurrences of the keyword factor FAISCEAU\_TRANS, and can be omitted in the others.

◇ COEF\_MASS\_AJOU = cm

Value of the coefficient of added mass cm. This operand, if it is used, can be defined only in one of the occurrences of the keyword factor FAISCEAU\_TRANS, and can be omitted in the others.

◇ CSTE\_CONNORS = cste

List of two realities defining the interval of the constants of Connors for the method of the same name (see R4.07.04).

◇ RHO\_TUBE = rho

Density of the tube for the method of Connors

- ◇ NB\_CONNORS = Nb, [I]  
Number of points of discretization inside the interval defined by the keyword CSTE\_CONNORS presented above.
  
- ◇ / ◇ TYPE\_PAS = 'CARRE\_LIGN' or 'TRIA\_LIGN'  
Indicator of type text [TXM] allowing to specify the type of step of the beam, defined by the arrangement of the tubes the ones compared to the others and by the direction of the flow compared to the beam. This operand can appear only in one of the occurrences of the keyword factor FAISCEAU\_TRANS, and can be omitted in the others.  
  - 'CARRE\_LIGN' = not square line.
  - 'TRIA\_LIGN' = not triangular line.
  
- ◆ TYPE\_RESEAU = tr  
Whole indicator strictly lower than 1000 and positive defining the experimental configuration for which the coefficients of coupling used for the study were obtained [bib1]. This operand must appear in all the occurrences of the keyword factor FAISCEAU\_TRANS.

## Note:

*"tr" must appear in two files "cd.70" and "ck.71" which makes it possible to describe the evolution of damping and the stiffness added by the flow according to the fallback speed  $V_r$ , the latter being calculated starting from speed inter-tubes.*

*The files "cd.70" and "ck.71" are read by the logical units 70 and 71. They have both the following structure:*

**Line 1 of the file:** many correlations present in the whole of the file (whole)

**\*\*\* then, for each one of these correlations, a block made up of \*\*\***

**Line 1 of the block:** type of step of the network associated with the correlation (1 if TYPE\_PAS= "CARRE\_LIGN", 2 if TYPE\_PAS= "TRIA\_LIGN")

**Line 2 of the block:** tr (whole well informed on the level of the operand "TYPE\_RESEAU")

**Line 3 of the block:** nbplages (many contiguous beaches fallback speed on which added damping and the stiffness were interpolated by the user in polynomial form)

**Line 4 of the block:** nbplages real, followed by two real A and B; the nbplages the first realities correspond to the values fallback speed - ordinates by order ascending - lower limits of the contiguous nbplages; two realities A and B are respectively smallest and largest values fallback speed for which added damping and the stiffness were in experiments given on a test bench in thermohydraulic similarity; they thus delimit the beach fallback speeds inside which the correlation can be interpolated starting from the values identified on test bench. In general, one thus chooses the first of the real nbplages equal to A and the last of the real nbplages equal to B.

**Nbplages following lines:** each line corresponds to the polynomial interpolation of the correlation of damping or the stiffness added in the beach

considered, the first beach fallback speeds extending between the first and the second of the real nbplages. On each line, 11 coefficients are to be informed. These coefficients are them  $(\alpha_i)_{1 \leq i \leq 11}$  defining the polynomial used for the interpolation in the beach considered. Thus, for the example,  $C_d$  indicating the damping added by the flow. The expression which will be taken by it into account according to the fallback speed is the following one  $V_r$  (the expression for the added stiffness is similar):

$$C_d(V_r) = \sum_{i=1}^{11} \alpha_i V_r^{(i-4)}$$

Following line: a line allowing to delimit the blocks associated with each correlation, in general of the form: " \*\*\*\*\* "

\*\*\* fine of the block \*\*\*

If there are other correlations, Line 1 of the block corresponding to the following correlation.

On the basis of number certain of tests, EDF worked out and validated a set of correlations fluid-rubber bands allowing to simulate the damping and the stiffness added to a structure by a flow. Supply of these correlations in the shape of two files of one format in conformity with that specified Ci high will be studied on a case-by-case basis according to the request.

◇ UNITE\_CA = iu1

Number of the logical unit in which is written the file "cd.70" the depreciation added by the flow.

◇ UNITE\_KA = iu2

Number of the logical unit in which is written the file "cd.71" stiffnesses added by the flow.

◇ NOT = not

Step value reduced of the beam: report enters, on the one hand the distance between centres between 2 close tubes, and on the other hand the diameter external of the tubes. This operand can appear only in one of the occurrences of the keyword factor FAISCEAU\_TRANS, and can be omitted in the others.

## 3.2 Keyword BUNCH

◆ / BUNCH

Keyword factor allowing to characterize a configuration of type "control rod".

◆ COUPLING = 'YES' or 'NOT'

Indicator of type text [TXM] specifying the taking into account of the forces fluid-rubber bands.

The coupling fluid-rubber band, if he is taken into account, utilizes the adimensional coefficients of forces fluid-rubber bands identified on model GRAPPE2, which are used to represent a resulting force and a moment [bib2].

If COUPLING = 'YES', it is necessary to inform the following operands obligatorily, except for COEF\_MASS\_AJOU who remains optional.

◇ / ◆ GRAPPE\_2 = 'ASC\_CEN' or 'ASC\_EXC' or 'DES\_CEN' or 'DES\_EXC'

Four possible choices corresponding to the various experimental configurations for which the coefficients of forces fluid-rubber bands were identified:

- flow Ascending stem of Centered order;
- flow Ascending stem of Offset order;
- flow Descendant stem of Centered order;
- flow Descendant stem of Offset order.

◆ GROUP\_NO = grno

Identifier of the node where the force and the moment are applied resulting representing the action from the forces fluid-rubber bands.

◆ CARA\_ELEM = will cara

Concept of the type [cara\_elem] providing all the relative data to the geometry of the elements of the structure: useful for the estimate of the diameter of the stem of order. This concept brings inter alia the relative information to the orientations of the elements.

◆ MODEL = model

Concept of the type [model] providing the relative information to the types of the elements of the structure.

◇ COEF\_MASS\_AJOU = cm1

Value of the coefficient of mass added due to the local containment of the stem of order to the level of the plate of housing. If the modal water characteristics at rest of the structure were calculated with the equivalent density.

$$\rho_{eq} = \alpha \frac{\pi D^2}{4S} \rho_{eau} + \rho_{poutre}$$

The coefficient `cm1` of mass added due to local containment to the level of the plate of housing is given by the relation:

$$cm1 = \frac{\pi \left( \frac{D}{2H} - \alpha \right)}{2}$$

where  $D$  indicate the diameter external of the stem;  $S$  is the surface of the cross-section of the tube and  $H$  represent the thickness of the fluid film on the level of containment.

#### Note:

*When the user does not inform the operand `COEF_MASS_AJOU`, `cm1` is estimated automatically using this expression with  $\alpha = 1$ .*

◆ RHO\_FLUI = rho\_f

Value of the density of the fluid surrounding the structure.

### 3.3 Keyword FAISCEAU\_AXIAL

◆ / FAISCEAU\_AXIAL

Keyword factor allowing to characterize a configuration of standard “the tube bundle under axial flow” [bib2].

**Note:**

*If the study is carried out using a representation of the complete beam, one authorizes only one occurrence for this keyword factor.*

*If the study is based on a simplified representation, one needs as many occurrences as there are tubes in the simplified beam. Each tube of the simplified beam defines a class of equivalence for the tubes of the real beam. The characteristics of the tubes of the real beam for the same class of equivalence (common ray, positions) are the object of an occurrence of the keyword factor.*

*To be able to use a simplified representation of the beam, it is necessary that the modal base calculated in air is equivalent to the modal base in air complete of the real beam; each tube of the simplified beam must thus be a tube equivalent to each class of real tubes. For example, for a class of  $N$  real tubes, of Young modulus  $E$  and of density  $\rho$ , a possible equivalent tube is characterized by a Young modulus  $NE$  and a density  $N\rho$ .*

◆ / GROUP\_MA = l\_grma

If the study relates to the complete beam: list of the groups of meshes corresponding to the tubes of the beam (concepts of the type [group\_ma]).

If the study is based on a simplified representation: the use of this operand is obligatory and excludes the recourse to TRI\_GROUP\_MA. One expects a concept of the type [group\_ma] corresponding to the one of the equivalent tubes of the simplified beam.

/ TRI\_GROUP\_MA = 'racine\*' or '\*racine\*' or '\*racine'

Argument of type text [TXM] defining the root of the names of the groups of meshes corresponding to the tubes of the beam. The use of this operand is licit only if the study is carried out using a representation of the complete beam. The root can be a prefix, an intermediate character string or a suffix.

◆ VECT\_X = l\_comp

List of three realities giving the components of the directing vector of the beam in the total reference mark. The beam having to be directed according to one of the axes of the total reference mark, only three sets of components are acceptable: (1.,0.,0.), (0.,1.,0.) or (0.,0.,1.). This operand is obligatory if the study relates to the complete beam, and must appear at least in one of the occurrences of the keyword factor if the study is based on a simplified representation.

◆ PROF\_RHO\_FLUI = profrho

Concept of the type [function] defining the profile of density of the fluid surrounding the tubes. The parameter of the function is the coordinate of space corresponding to the axis of the total reference mark directing the tube bundle. This operand is obligatory if the study relates to the complete beam, and must appear at least in one of the occurrences of the keyword factor if the study is based on a simplified representation.

◆ PROF\_VISC\_CINE = profvisc

Concept of the type [function] defining the kinematic profile of viscosity of the fluid surrounding the tubes. The parameter of the function is the coordinate of space corresponding to the axis of the total reference mark directing the tube bundle. This operand is obligatory if the study relates to the complete beam, and must appear at least in one of the occurrences of the keyword factor if the study is based on a simplified representation.



- ◆ / CARA\_ELEM = will cara  
Concept of the type [cara\_elem] providing all the relative data to the geometry of the elements of the structure: ray of each tube. This concept is to be provided only if the study relates to the complete beam.
- / ◆ RAYON\_TUBE = ray  
Ray of the tubes of the real beam for the same class of equivalence. This operand is used only if the study is based on a simplified representation.
- ◆ COOR\_TUBE = l\_coor  
List of the coordinates of the centers of the tubes of the real beam pertaining to the same class of equivalence. This operand is used only if the study is based on a simplified representation.
- ◇ GRAVITY = l\_g  
List of four realities laying the standard and down the direction of the vector gravity  $\mathbf{g}$  in the total reference mark. It is necessary to provide in the order the data  $(g, a_p, b_p, c_p)$  such as:

$$\mathbf{g} = g \frac{a_p \mathbf{X} + b_p \mathbf{Y} + c_p \mathbf{Z}}{\sqrt{a_p^2 + b_p^2 + c_p^2}}$$

The values by default are:  $g = 9.81$  ;  $a_p = 0$  . ;  $b_p = 0$  . ;  $c_p = -1$  .

- ◆ RUGO\_TUBE = rug  
Value of the absolute roughness of the walls of the tubes, being used for the estimate of the coefficient of axial friction. This operand is obligatory if the study relates to the complete beam, and must appear at least in one of the occurrences of the keyword factor if the study is based on a simplified representation. A characteristic value for a smooth steel is  $10^{-5}$  meter.
- ◆ CARA\_PAROI = will l\_cara  
List of arguments of type text [TXM] giving the names of the geometrical characteristics of the enclosure wrapping the beam. The licit arguments are the following:
  - 'YC' , 'ZC' and 'R' in the case of a circular enclosure: 'YC' , 'ZC' coordinates of the center in any plan  $x = x_0$  along the axes of the total reference mark perpendicular to the beam and ordered such as (X, Y, Z) that is to say direct if X is the axis of the total reference mark directed according to the beam. 'R' ray.
  - 'YC' , 'ZC' , 'HY' and 'HZ' in the case of a rectangular enclosure: 'YC' , 'ZC' coordinates of the center in any plan  $x = x_0$  . 'HY' , 'HZ' dimensions on the sides of the enclosure parallel respectively with the directions Y and Z.
- ◆ VALE\_PAROI = l\_vale  
List of realities giving the values of the geometrical characteristics, in correspondence with the list of the names received for CARA\_PAROI.
- ◇ ANGL\_VRIL = alpha  
Swing angle (in degrees) around the directing axis of the beam for a rectangular enclosure. This operand is obligatory if one defines a rectangular enclosure by CARA\_PAROI and VALE\_PAROI. It is prohibited in the case of a circular enclosure.

## Note:

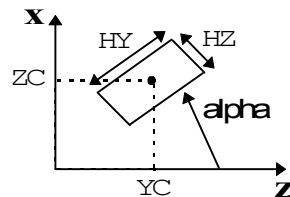
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Operands `CARA_PAROI` and `VALE_PAROI` are obligatory when the study relates to the complete beam. When the study is based on a simplified representation, these operands must appear together in at least one of the occurrences of the keyword factor `FAISCEAU_AXIAL`. The operand `ANGL_VRIL` must also be present under the same occurrence if a rectangular enclosure is defined.

### Example:

Total reference mark  $(x, y, z)$  beam axis  $y$



### Note:

If the study is carried out with the taking into account of the grids of the tube bundle, the user must inform each of the eight operands which follow. It is pointed out that the geometry of a grid is a prismatic network at square base. It can exist several types of grid; for example, grids of end and grids of mixture in the fuel assemblies. The grids of the same type are characterized by identical dimensions and coefficients.

◇ `LONG_TYPG = l_hg`

List of realities giving the lengths of each type of grid of the tube bundle. The length of a grid is its dimension according to the direction of the beam.

◇ `LARG_TYPG = l_dg`

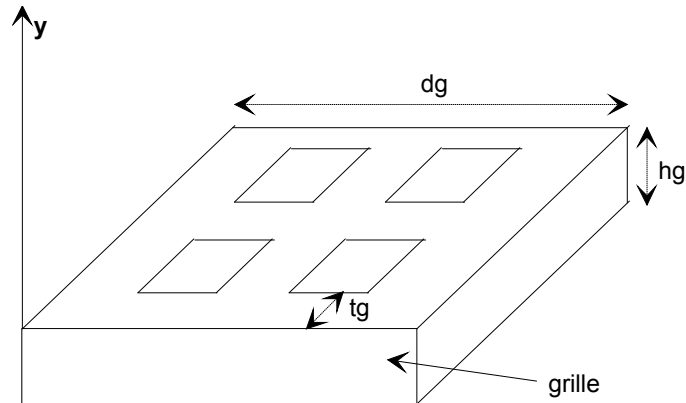
List of realities giving the widths of each type of grid. The width of a grid is its dimension in the plan perpendicular to the beam axis (i.e. the length of with dimensions of the network).

◇ `EPAIS_TYPG = l_tg`

List of realities giving the thicknesses of each type of grid. What is called thickness of grid, it is the thickness of the network constituting the grid in a section perpendicular to the beam axis.

## Example of grid:

Total reference mark  $(x, y, z)$  beam axis  $y$



◇ RUGO\_TYPG = l\_rugg

List of realities giving the height of roughness of each type of grid. These roughnesses are used for the estimate of the coefficient of axial friction of each grid.

◇ COEF\_TRAI\_TYPG = l\_cdg

List of realities giving the coefficient of drag of each type of grid. These coefficient of drags make it possible to calculate the efforts of trail exerted by each grid on the axial flow of the fluid.

◇ COEF\_DPOR\_TYPG = l\_cpg

List of realities giving the slope (with worthless incidence) of the coefficient of bearing pressure of each type of grid, which one supposes slightly tilted. These coefficients make it possible to calculate the efforts of bearing pressure exerted by each grid on the flow of the fluid.

◇ COOR\_GRILLE = l\_zg

List of the coordinates  $y$  (along the beam axis) of the points of discretization of each grid. These coordinates correspond to the points mediums (with mid-length) of the grids.

◇ TYPE\_GRILLE = l\_itypg

List of entirieties defining the type of each grid.

## 3.4 Keyword COQUE\_COAX

◆ / COQUE\_COAX

Keyword factor allowing to characterize a configuration made up of two coaxial cylindrical hulls separated by an annular game in which a fluid [bib2] runs out.

◇ MASS\_AJOU = 'YES' or 'NOT'

Indicator of type text [TXM] by which the user specifies the taking into account or not effects of added mass, besides the effects of added damping and stiffness.

◆ GROUP\_MA\_INT = gr\_ma\_i

Identifier of the group of meshes (concept of the type [group\_ma]) corresponding to the internal hull.

◆ GROUP\_MA\_EXT = gr\_ma\_e

Identifier of the group of meshes (concept of the type [group\_ma]) corresponding to the external hull.

- ◆ `VECT_X = l_comp`  
List of three realities giving the components of the directing vector of the axis of revolution of the two hulls in the total reference mark. The axis of revolution of the hulls having to be one of the axes of the total reference mark, only three sets of components are acceptable: (1.,0.,0.) , (0.,1.,0.) or (0.,0.,1.) .
- ◆ `CARA_ELEM = will cara`  
Concept of the type [`cara_elem`] bringing all the geometrical characteristics of the elements.
- ◆ `MATER_INT = mater_i`  
Concept of the type [`to subdue`] bringing all the physical sizes characteristic of material constitutive of the internal structure.
- ◆ `MATER_EXT = mater_e`  
Concept of the type [`to subdue`] bringing all the physical sizes characteristic of material constitutive of the external structure.
- ◆ `RHO_FLUI = rho_f`  
Density of the fluid.
- ◆ `VISC_CINE = visco`  
Kinematic viscosity of the fluid.
- ◆ `ROUGHNESS = rug`  
Absolute roughness of wall of the hulls. A characteristic value for a smooth steel is  $10^{-5}$  meter.
- ◆ `PDC_MOY_1 = cde`  
Stationary part (average) of the singular loss ratio of load of entry.
- ◆ `PDC_DYN_1 = cdep`  
Non stationary part (dynamic) of the singular loss ratio of load of entry.
- ◆ `PDC_MOY_2 = cds`  
Stationary part (average) of the singular loss ratio of load of exit.
- ◆ `PDC_DYN_2 = cdsp`  
Non stationary part (dynamic) of the singular loss ratio of load of exit.

**Note:**

- 1) *The values of the various average and dynamic singular loss ratios of load are given, in complements, for various usual geometrical configurations of entry and exit (see hereafter [§6]).*
- 2) *By convention, a mean velocity of flow positive means that the flow is done in the direction growing of the parameter of space along the axis of revolution of the structures. Contrary, a mean velocity of flow negative means that the flow is done in the direction decreasing of the parameter of space. The sign mean velocity of flow thus fixes the positions of entry and exit. So that there is no ambiguity on these positions, one will take care in `CALC_FLUI_STRU [U4.80.03]` to define a beach of the same speeds signs.*
- 3) *Model `MOCCA_COQUE` used for the resolution of the coupling fluid-structure requires, for each mode selected, to identify the order of hull on the deformation.*  
*Orders of hull  $k_i$  identifiable are such as:  $k_i \leq \frac{N}{2}$  where  $NR$  indicates the number of nodes of the grid on a circumference, i.e at a fixed altitude. Orders of hull  $k_i$  precisely identified are such as  $k_i \leq \frac{N}{4}$ , with the same one definition for  $N$ .*

One advises to use a grid with at least 20 nodes on the circumferences of the hulls.  
A minimum number of 8 nodes is necessary.

## 3.5 Keyword INFORMATION

◇ INFORMATION = 1 or 2

Level of impression.

If INFORMATION = 2 one prints the characteristics of the configuration in the file MESSAGE.

If INFORMATION = 1 pas d' impression.

## 4 Complements concerning the configurations of the type “tube bundles under transverse flow”

### 4.1 Definition of the characteristics of the beam

Four operands TYPE\_PAS, TYPE\_RESEAU, NOT and COEF\_MASS\_AJOU are optional. No value is taken by default. At the time of the definition of these characteristics, three use potential is given:

- TYPE\_PAS, TYPE\_RESEAU and NOT are present. COUPLING = 'YES'  
The forces fluid-rubber bands will be taken into account during a dynamic calculation. The coefficient of added mass is calculated according to the step and of the type of step.
- TYPE\_PAS, TYPE\_RESEAU, NOT and COEF\_MASS\_AJOU are present. COUPLING = 'YES'  
The forces fluid-rubber bands will be taken into account during a dynamic calculation. The coefficient of added mass is defined by the user.
- COEF\_MASS\_AJOU is present. COUPLING = 'NOT'  
Only the added mass due to the fluid is taken into account (not coupling).

## 5 Complements concerning the configurations “coaxial cylindrical hulls”

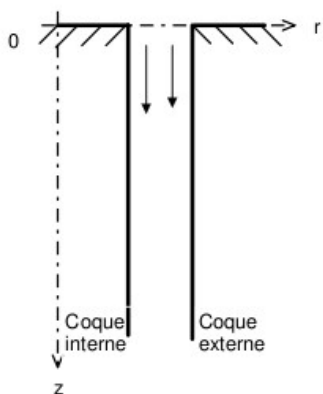
One provides hereafter the values of the singular loss ratios of load for some particular geometrical configurations of input-output.

### 5.1 Singular loss ratios of load of entry

Configuration (1)

$$cde = 0,5$$

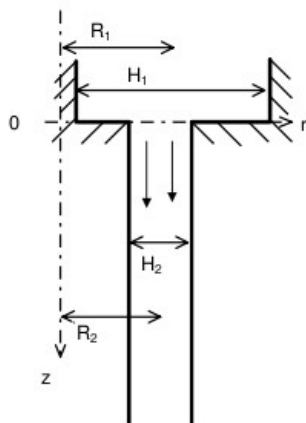
$$cdep = 0$$



Configuration (2)

$$cde = 0,5 \left( 1 - \frac{R_2 H_2}{R_1 H_1} \right)$$

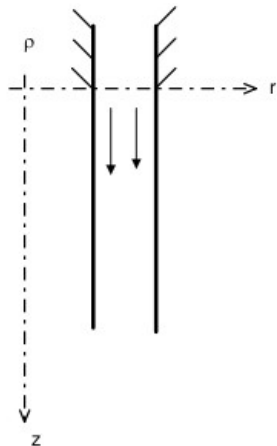
$$cdep = 0$$



Configuration (3)

$$cde=0$$

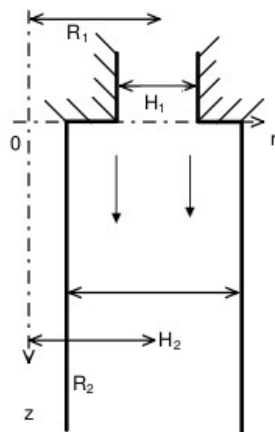
$$cdep=0$$



Configuration (4)

$$cde = \left(1 - \frac{R_1 H_1}{R_2 H_2}\right)^2 \left(\frac{R_2 H_2}{R_1 H_1}\right)^2 = \left(\frac{R_2 H_2}{R_1 H_1} - 1\right)^2$$

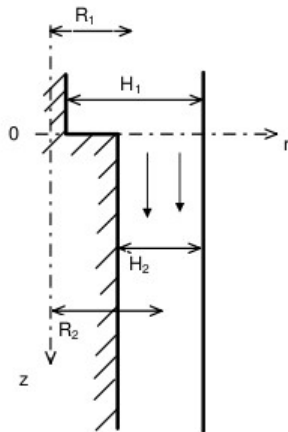
$$cdep=0$$



Configuration (5)

$$cde = 0,5 \left( 1 - \frac{R_2 H_2}{R_1 H_1} \right)$$

$$cdep = \frac{cde}{H_1}$$

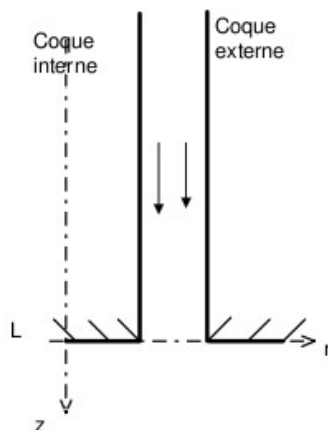


## 5.2 Singular loss ratios of load of exit

Configuration (1)

$$cds = 1$$

$$cdsp = 0$$

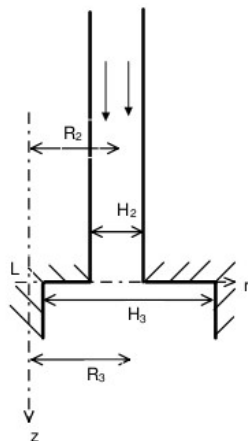




Configuration (2)

$$c_{ds} = \left(1 - \frac{R_2 H_2}{R_3 H_3}\right)^2$$

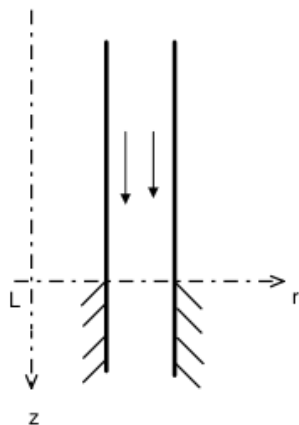
$$c_{dsp} = 0$$



Configuration (3)

$$c_{ds} = 0$$

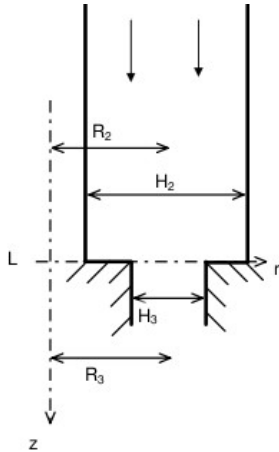
$$c_{dsp} = 0$$



Configuration (4)

$$c ds = 0,5 \left( 1 - \frac{R_3 H_3}{R_2 H_2} \right) \left( \frac{R_2 H_2}{R_3 H_3} \right)^2$$

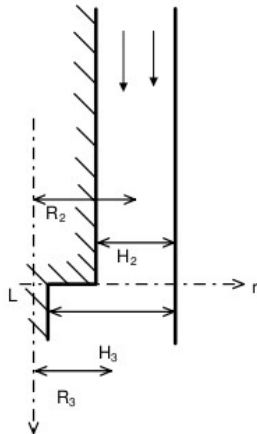
$$cdsp = 0$$



Configuration (5)

$$c ds = 0,5 \left( 1 - \frac{R_2 H_2}{R_3 H_3} \right)^2$$

$$cdsp = \frac{-2 c ds}{H_3}$$



## 6 Bibliography

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- 1) NR. GAY: Flustru Version 2.0 - general Presentation. Note of use - source FORTRAN of the software. Technical note EDF/DER HT-32/93.05A.
- 2) L. PEROTIN, MR. LAINET: Integration of various models of excitations fluid-rubber bands in *Code\_Aster* : specifications HT-32/96/014/A.