Operator DEFI_SPEC_TURB

1 Goal

To define a spectrum of turbulent excitation. Various types of spectra are available:

- for the “tube bundles under transverse flow”, spectra of type “length of correlation”,
- for established uniform flows, parallel with plane or cylindrical structures circular, spectra of turbulence of boundary layer,
- spectrum of excitation defined by its decomposition on a family of functions of form by providing a matrix interspectrale and a list of associated functions of form. Concepts `tabl_intsp` and `function` must then be generated upstream,
- preset spectrum of turbulence, identified on the model `GRAPPE1` or `GRAPPE2`,
- spectrum of excitation associated with one or more specific forces and moments by providing a matrix interspectrale excitations (concept `tabl_intsp` in front of being generated upstream), the list of the nodes of application of these excitations, the nature of the excitation applied of each one of these nodes (force or moment) and directions of application of the excitations thus defined.
- spectrum of excitation defined by a set of complex analytical functions.

Product a concept of the type `spectrum`.

2 Syntax

```
spe [spectrum] = DEFI_SPEC_TURB  (

    ♦   /  SPEC_LONG_COR_1 =  _F (
                ♦   LONG_COR        =     lc,       [R]
                ♦  PROF_VITE_FLUI   =     profv,    [function, formula]
                ♦  VISC_CINE        =     eps ,        [R]
                              ),
       /  SPEC_LONG_COR_2 =   _F (
                ♦   LONG_COR        =     lc,       [R]
                ♦  PROF_VITE_FLUI   =     profv,    [function, formula]
                ◊  /  FREQ_COUP     =     0.1          [DEFECT]
                      PHI0          =     1.5D-3       [DEFECT]
                      BETA          =     2.7,         [DEFECT]
                   /  FREQ_COUP     =     frc          [R]
                      PHI0          =     phi0         [R]
                      BETA          =     beta,        [R]
                               ),
        /  SPEC_LONG_COR_3 =  _F (
                ♦   LONG_COR        =     lc,       [R]
                ♦  PROF_VITE_FLUI   =     profv,    [function, formula]
                ◊  /  FREQ_COUP     =     0.2          [DEFECT]
                      PHI0_1    =     5.D-3         [DEFECT]
                      BETA_1        =     0.5          [DEFECT]
                      PHI0_2        =     4.D-5        [DEFECT]
                      BETA_2        =     3.5 ,        [DEFECT]
                   /  FREQ_COUP     =     frc          [R]
                      PHI0_1        =     phi01        [R]
                      BETA_1        =     beta1        [R]
                      PHI0_2        =     phi02        [R]
                      BETA_2        =     beta2,    [R]
                               ),
        /  SPEC_LONG_COR_4 =  _F (
                ♦  LONG_COR         =     lc,       [R]
                ♦  PROF_VITE_FLUI   =     profv,    [function, formula]
                ♦  TAUX_VIDE        =     TV,       [R]
                ◊  /  BETA          =     2.           [DEFECT]
                      GAMMA         =     4. ,         [DEFECT]
                   /  BETA          =     beta         [R]
                      GAMMA         =     gamma,    [R]
                              ),
       /  SPEC_CORR_CONV_1 =  _F (
                ♦  LONG_COR_1       =     lc1,         [R]
                ◊  LONG_COR_2       =     lc2  ,       [R]
                ♦  VITE_FLUI        =     vflui,    [R]
                ◊  FREQ_COUP        =     FC,       [R]
                ◊  K                =  /  5.8D-3       [DEFECT]
                                       /  K,           [R]
                ♦  D_FLUI           =     dhyd,        [R]
                ♦  RHO_FLUI         =     rho_f,    [R]
                ◊  COEF_VITE_FLUI_A =     alpha,    [R]
                ◊  COEF_VITE_FLUI_O =     beta,        [R]
                ◊  METHOD        =  /  'GENERAL' [DEFECT]
                                       /   'CORCOS'
                                       /   'AU_YANG',
                              ),
```

```
      /   SPEC_CORR_CONV_2 =  _F (
              ♦  FUNCTION         =     fonc,        [function, formula]
              ♦  VITE_FLUI        =     vflui,    [R]
              ◊  FREQ_COUP        =     FC,       [R]
              ◊  COEF_VITE_FLUI_A =     alpha,    [R]
              ◊  COEF_VITE_FLUI_O =     beta,        [R]
              ◊  METHOD        =  /  'GENERAL' [DEFECT]
                                    /  'CORCOS'
                                    /  'AU_YANG',
                            ),

      /   SPEC_CORR_CONV_3 =  _F (
              ♦  TABLE_FONCTION   =     fonc,        [table_fonction]
                            ),

      /   SPEC_FONC_FORME =   _F (
              ♦  /  INTE_SPEC     =     int_spec, [interspectre]
                    FUNCTION      =     l_tab_fonc,  [l_table_fonction]
                 /  GRAPPE_1      =  /  'DEBIT_180'
                                     /  'DEBIT_300',
              ♦  GROUP_NO     =     gno,          [gnoeud]
              ♦  CARA_ELEM        =     will cara,          [cara_elem]
              ♦  MODEL            =     model,    [model]
                            ),

      /   SPEC_EXCI_POINT =   _F (
              ♦  /  INTE_SPEC     =     int_spec, [interspectre]
                    NATURE        =     l_nat,    [l_TXM]
                    ANGLE         =     l_theta,     [l_R]
                    GROUP_NO  =     l_gno,    [l_gnoeud]
                 /  GRAPPE_2      =  /  'ASC_CEN'
                                     /  'ASC_EXC'
                                     /  'DES_CEN'
                                     /  'DES_EXC',
                    RHO_FLUI      =     rho_f,    [R]
                    GROUP_NO  =     gno,          [l_gnoeud]
               ♦ CARA_ELEM        =     will cara,          [cara_elem]
               ♦ MODEL            =     model,    [model]
                            ),

   ◊  TITLE =   title,                             [TXM]

                            )
```

3 Operands

3.1 Keywords SPEC_LONG_COR_n

The definition of a spectrum of excitation of type "length of correlation" can be done only by only one occurrence of one of the keywords factors SPEC_LONG_COR_n, corresponding to a zone of the tube defined beforehand by the function indicated in the operand PROF_VITE_FLUI order DEFI_FLUI_STRU [U4.25.01]. Profile speed associated with this zone, pointed out here under the operand PROF_VITE_FLUI, must be identical to that well informed in DEFI_FLUI_STRU [U4.25.01]. The use of spectra of excitation of type "length of correlation" is limited to the configuration "tube bundle under transverse flow" (keyword factor FAISCEAU_TRANS of the operator DEFI_FLUI_STRU [U4.25.01]).

To carry out a calculation with several zones of excitation, it is necessary to define as many spectra as there are zones. The contributions of the various spectra can be then added when the excitation is projected on modal basis by the order PROJ_SPEC_BASE [U4.63.14]. However, it is not possible in this order to combine spectra of type "length of correlation" with spectra of another type (SPEC_CORR_CONV_n, SPEC_FONC_FORME or SPEC_EXCI_POINT).

The four spectra standard "length of correlation" have definite values by default. The definition of new coefficients is delicate, in particular with regard to the model 3 for which there exist conditions of connection between the lines determined by the coefficients.

The general analytical form of models 1 to 4 is the following one:

$$S(s_1, s_2, f_r) = S(f_r) \cdot \exp\left(\frac{-|s_2 - s_1|}{\lambda_c}\right)$$

with:

$S(s_1, s_2, f_r)$	interspectre adimensional of turbulence between two points of curvilinear X-coordinates (s_1, s_2) ;
$S(f_r)$	autospectre of turbulence;
$\exp\left(\frac{-\|s_2 - s_1\|}{\lambda_c}\right)$	function of space correlation and λ_c length of correlation.

The spectrum is defined according to a reduced frequency f_r (Strouhal number). For a tube under transverse flow, the expression of f_r is the following one:

$$f_r = \frac{f \cdot de}{V_g}$$

f is the dimensioned frequency, de the diameter external of the tube V_g and the average transverse speed of the fluid along the structure, which will be recovered in the operator PROJ_SPEC_BASE [U4.63.14] via the concept [melasflu] product by the operator CALC_FLUI_STRU [U4.66.02].

3.1.1 Analytical expression of the spectra of the type SPEC_LONG_COR_1

♦ / `SPEC_LONG_COR_1`

Keyword factor corresponding to the first model of spectrum with length of correlation.

♦ `LONG_COR = lc`

Length of correlation.

♦ `PROF_VITE_FLUI = profv`

Name of the profile speed corresponding to the zone where is applied the turbulent excitation.

♦ `VISC_CINE = eps`

Kinematic viscosity of the fluid.

$$S(f_r)=\frac{\Phi_0}{\left[1-\left[\frac{f_r}{f_{rc}}\right]^{\beta/2}\right]^2+4e^2\left[\frac{f_r}{f_{rc}}\right]^{\beta/2}}$$

with: $\Phi_0=\Phi_0(R_e)$ polynomial of the 5ième degree.

$\beta=\beta(R_e)$

$\varepsilon=\varepsilon(R_e)$

$f_{rc}=0{,}2$

If $1{,}5.10^4<R_e\leq 5.10^4$:

$$\Phi_0=1{,}3.10^{-4}\left[20{,}42-14.10^{-4}R_e-9{,}81.10^{-8}R_e^2+11{,}97.10^{-12}R_e^3 -35{,}95.10^{-17}R_e^4+34{,}69.10^{-22}R_e^5\right]$$

If $R_e>5.10^4$: $\Phi_0=38{,}6075$

If $R_e\leq 3{,}5.10^4$ — $\varepsilon=0{,}7 \quad \beta=3$

If not if $3{,}5.10^4<R_e\leq 5{,}5.10^4$ — $\varepsilon=0{,}3 \quad \beta=4$

If not — $\varepsilon=0{,}6 \quad \beta=4$

3.1.2 Analytical expression of the spectra of the type SPEC_LONG_COR_2

/ `SPEC_LONG_COR_2`

Keyword factor corresponding to the second model of spectrum with length of correlation.

♦ `LONG_COR = lc`

Length of correlation.

♦ `PROF_VITE_FLUI = profv`

Name of the profile speed corresponding to the zone where is applied the turbulent excitation.

◊ / `FREQ_COUP = frc`

Reduced frequency of cut.

```
 PHI0 = phi0
BETA = beta
```

Coefficients of the spectrum.

Note:

If the user informs one of these operands, it must obligatorily inform the two others, in order to have coherent values.
If the user does not inform any of the three operands, the values by default are used.

$$S(f_r)=\frac{\Phi_0}{1+\left[\frac{f_r}{f_{rc}}\right]^{\beta}}$$

The values of the parameters by default are: $\Phi_0=1{,}5.10^{-3}$, $\beta=2{,}7$, $f_{rc}=0{,}1$

3.1.3 Analytical expression of the spectra of the type `SPEC_LONG_COR_3`

/ `SPEC_LONG_COR_3`

Keyword factor corresponding to the third model of spectrum with length of correlation.

♦ `LONG_COR = lc`

Length of correlation.

♦ `PROF_VITE_FLUI = profv`

Name of the profile speed corresponding to the zone where is applied the turbulent excitation.

◊ / `FREQ_COUP = frc`

Reduced frequency of cut.

```
 PHI0_1 = phi01
BETA_1 = beta1
PHI0_2 = phi02
BETA_2 = beta2
```

Coefficients of the spectrum.

Note:

The five operands must be used simultaneously. If one is indicated, the others also owe the being.
The values by default are used when the user did not inform any of the five operands.

$$S(f_r)=\frac{\Phi_0}{f_r^\beta} \text{ with } \begin{cases}\Phi_0=\Phi_0(f_{rc})\\ \beta=\beta(f_{rc})\end{cases} \text{ where } f_{rc}=0{,}2$$

If $f_r \le f_{rc}$ $\Phi_0=5.10^{-3}$ $\beta=0{,}5$
If not $\Phi_0=4.10^{-5}$ $\beta=3{,}5$

3.1.4 Analytical expression of the spectra of the type `SPEC_LONG_COR_4`

/ `SPEC_LONG_COR_4`

Keyword factor corresponding to the fourth model of spectrum with length of correlation.

♦ `LONG_COR = lc`

Length of correlation.

♦ `PROF_VITE_FLUI = profv`

Name of the profile speed corresponding to the zone where is applied the turbulent excitation.

♦ `TAUX_VIDE = TV`

Rate of vacuum (diphasic flow).

◊ / `BETA = beta`
`GAMMA = gamma`

Coefficients of the spectrum.

Note:

If the user informs one of these two operands, it must obligatorily inform the other.
If none of the two operands is indicated, the values by default are used.

$$S(f_r)=\frac{\Phi_0}{(f_r)^\beta(\rho_v^\gamma)} \text{ with } \begin{cases}\Phi_0=\frac{1}{6{,}8.10^{-2}}\cdot 10^\Phi\\ \Phi=A.\tau_v^{0,5}-B.\tau_v^{1,5}+C.\tau_v^{2,5}-D.\tau_v^{3,5}\end{cases}$$

τ_v indicate the rate of vacuum;
$A=24{,}042\,;B=-50{,}421\,;C=63{,}483\,;D=33{,}284$

The values by default of the exhibitors are $\beta=2$ and $\gamma=4$.

ρ_v is the volume throughput: $\rho_v=\rho_m\times V=\sum_{i=N_d}^{N_f}\rho_e\frac{(x_i)}{N_n}\times V$

where V indicate the speed of the fluid for which the fluid study of interaction - structure was conducted and N_n the number of points taken into account over the excited length. The speed of the fluid will be recovered in the operator `PROJ_SPEC_BASE` [U4.63.14] via the concept `[melasflu]` product by the operator `CALC_FLUI_STRU` [U4.66.02].

3.2 Keywords `SPEC_CORR_CONV_n`

The keywords factors `SPEC_CORR_CONV_1` and `SPEC_CORR_CONV_2` allow respectively to define spectra of turbulence of boundary layer and a function of the unspecified frequency. `SPEC_CORR_CONV_3` leave to the user the whole control of the definition of the inter-spectrum, by using analytical functions gathered in a table.

Theoretical precise details:

- In the case of a plane structure subjected to a parallel turbulent flow, which one wishes to know the spectral response with this excitation, the model of correlation of `CORCOS` introduced a function of correlation between two points x and x' on the plane structure, type

$$r(\omega, x, x') = \exp\left(\frac{-|x-x'|}{\lambda_1}\right) \times \exp\left(\frac{-|y-y'|}{\lambda_2}\right) \times \cos\left(\frac{\omega(x-x')}{U_c}\right)$$

In the basic model of `CORCOS`, one has $\begin{cases} \lambda_1 = \dfrac{1}{k_L} \text{ avec } k_L = 0{,}1 \,.\, \dfrac{\omega}{U_c} \\ \lambda_2 = \dfrac{1}{k_T} \text{ avec } k_T = 0{,}55 \,.\, \dfrac{\omega}{U_c} \end{cases}$

x is the axis parallel with the flow.
y is the axis perpendicular to the flow.

U_c is the convective speed of the swirls. It is allowed that it represents between 60 and 70% the speed of the fluid. By default, one goes it equal to 65% faster of the fluid.

- In the case of a circular cylindrical structure subjected to an axial flow, the model of correlation of `AU_YANG` introduced a function of correlation between two points defined by:

$$r(\omega, x, x') = \exp\left(\frac{-|x-x'|}{\lambda_1}\right) \times \cos\left(\frac{\omega(x-x')}{U_c}\right) \times \exp\left(-R\frac{|\theta-\theta'|}{\lambda'}\right) \times \cos\left(\frac{\omega R(\theta-\theta')}{U'_c}\right)$$

  - θ and θ' correspond to the angular positions of the two points of the cylinder to correlate,
  - x and x' indicate the dimensions of the points to correlate,
  - R is the ray of the cylinder,
  - U_c is the axial convective speed of the swirls: it is equal to the product of the coefficient axial speed by the speed of the fluid,
  - U'_c orthoradiale is convective speed swirls: it is equal to the product of the coefficient speed orthoradiale by the speed of the fluid,
  - λ and λ' are the lengths of correlation according to the axis and the direction orthoradiale respectively.

- The correlation `GENERAL` is a function of the type

$$r(\omega, \mathbf{x}, \mathbf{x}') = \exp\left(\frac{-\|\mathbf{x}-\mathbf{x}'\|}{\lambda}\right) \times \cos\left(\frac{\omega\|\mathbf{x}-\mathbf{x}'\|}{U_c}\right)$$

  - $\mathbf{x}$ and $\mathbf{x}'$ are the vectors locating the positions of the two points to be correlated,
  - U_c is the convective speed of the swirls,
  - λ is the length of correlation.

3.2.1 Definition of a spectrum of turbulence of boundary layer

/ SPEC_CORR_CONV_1

Keyword factor corresponding to the first model of spectrum of pressure with length of correlation and speed of convection of the swirls in the fluid.

♦ LONG_COR_1 = lc1

First length of correlation (along the axis parallel with the flow) for the method of AU_YANG. Length of correlation of the method GENERAL.

◊ LONG_COR_2 = lc2

Second length of correlation for the method of AU_YANG.

♦ VITE_FLUI = vflui

Speed of the fluid skirting the studied structure.

◊ FREQ_COUP = FC

Cut-off frequency of the spectrum. In the case of the method of CORCOS, the value is used $f_c = 10 \frac{U}{d}$ (see notations below) by default.

◊ K = K

Constant giving the amplitude of the spectrum of pressure.
By default, k is worth $5,8 10^{-3}$ in units IF.

♦ D_FLUI = dhyd

Hydraulic diameter entering the expression of the amplitude of the spectrum of pressure.

♦ RHO_FLUI = rho_f

Density of the fluid.

◊ COEF_VITE_FLUI_A = alpha

Coefficient the convective speed of the swirls in the axial direction (direction of the flow) for the methods of CORCOS, of AU_YANG.

◊ COEF_VITE_FLUI_O = beta

Coefficient the convective speed of the swirls in the direction orthoradiale with the cylinder, for the method of AU_YANG.

◊ METHOD = 'GENERAL' or 'CORCOS' or 'AU_YANG'

Method of correlation determined by the type of the structure which one wants to study the vibrations generated by turbulence.
By default, method GENERAL is used.

Note:

In the case of the method of CORCOS , one uses for LONG_COR_1 and LONG_COR_2 lengths of correlation of the basic model (see [§3.2]).
The spectrum of pressure used is of the type $S_p(\omega) = K^2 (\rho U^2)^2 d^3$ *if* $f \leq f_c$ *and* $0 \text{ pour } f > f_c$.
K *indicate the constant of the model, well informed under the operand* K *. For the model of CORCOS ,* K *is in experiments given and is worth* $K = 5,8 . 10^{-3} s^{1/2} m^{-3/2}$ *;*
ρ *is the density of the fluid, well informed under the operand RHO_FLUI ;*
U is the speed of the fluid, well informed under the operand VITE_FLUI ;
D is the hydraulic diameter, well informed under the operand D_FLUI .

3.2.2 Definition of a spectrum of turbulence of a function of the unspecified frequency

/ `SPEC_CORR_CONV_2`

Keyword factor allowing to define a spectrum of unspecified pressure function of the frequency.

♦ `FUNCTION = fonc`

Concept of type function defining the spectrum of pressure according to the frequency, produced by one of the operators `DEFI_FONCTION` [U4.31.02], `CALC_FONCTION` [U4.32.04] or `CALC_FONC_INTERP` [U4.32.01].

♦ `VITE_FLUI = vflui`

Speed of the fluid skirting the studied structure.

◊ `FREQ_COUP = FC`

Cut-off frequency beyond which the function defining the spectrum of pressure is regarded as worthless.

◊ `COEF_VITE_FLUI_A = alpha`

Coefficient the convective speed of the swirls in the axial direction (direction of the flow).

◊ `COEF_VITE_FLUI_O = beta`

Coefficient the convective speed of the swirls in the direction orthoradiale with the cylinder, for the method of `AU_YANG`.

◊ `METHOD = 'GENERAL'` or `'CORCOS'` or `'AU_YANG'`

Method of correlation determined by the type of the structure which one wants to study the vibrations generated by turbulence.
By default, method `GENERAL` is used.

3.2.3 `SPEC_CORR_CONV_3` : definite unspecified spectrum analytically

/ `SPEC_CORR_CONV_3`

Keyword factor allowing to define a spectrum on the basis of analytical function.

♦ `TABLE_FONCTION = table`

Concept of the function table type containing the analytical formulas defining the spectrum.

Example of use: one wishes to describe the efforts of pressure induced by an axial flow along a fuel pin in the shape of a spectrum of type "length of correlation" and describing:

- on the one hand decrease of turbulent energy downstream from the grid,
- in addition the dephasing of with the convection of turbulence with the flow.

The length of correlation, and the auto--spectrum depend on the frequency. The analytical formulation suggested is the following one:

$$S_f(\underline{r_1},\underline{r_2},\omega)=\begin{cases} S_x=\exp\left(-\frac{|\underline{r_2}-\underline{r_1}|}{\lambda_{cx}(\omega)}\right).\exp\left(j\omega\frac{z_2-z_1}{U_c}\right)S_f(\underline{r_1},\underline{r_1},\omega) \\ S_y=\exp\left(-\frac{|\underline{r_2}-\underline{r_1}|}{\lambda_{cy}(\omega)}\right).\exp\left(j\omega\frac{z_2-z_1}{U_c}\right)S_f(\underline{r_1},\underline{r_1},\omega)\end{cases}$$

$\underline{r_1}$ and $\underline{r_2}$ are the vectors locating the positions of the two points to be correlated, z is the direction parallel with the axis of the pencil. One can also add, if it is wished, a term of correlation between the efforts according to x and y.
The spectrum above is defined in the CAS-test sdll148b with correlated efforts. One proposes here modeling with décorrélés efforts (not of term cross SXY and SYX). In this CAS-test the pencil is directed according to direction Y.

```
SXX = FORMULA (NOM_PARA= ('X1', 'Y1', 'Z1', 'X2', 'Y2', 'Z2',
'FREQ'),
              VALE_C=' exp (- FREQ/freq0) *
                       exp (distance (X1, Y1, Z1, X2, Y2, Z2) /correl
(FREQ))*
                      complex (cos (2*pi*FREQ* (Y2 there 1) /Uc),
                              sin (2*pi*FREQ* (Y2 there 1) /Uc))',)

SYY =…

# INTER-SPECTRE WITH EFFORTS X AND THERE DECORRELES
INTESPEC=CRÉA_TABLE (LISTE= (_F (LISTE_K= ('SXX', 'SYY'),
                              PARA=' FONCTION_C'),
                            _F (LISTE_K= ('DX', 'DY'),
                              PARA=' NUMÉRIQUE_ORDRE_I'),
                            _F (LISTE_K= ('DX', 'DY'),
                              PARA=' NUMÉRIQUE_ORDRE_J'),),
                    TYPE_TABLE=' TABLE_FONCTION',
                    FLUID TITRE=' EXCITATION TURBULENTE');

SPECTRE1=DEFI_SPEC_TURB (SPEC_CORR_CONV_3=_F (TABLE_FONCTION =
                                                       INTESPEC),);
```

The function outdistances was defined in python and gives the distance between two points of respective coordinates $(x_{1,}y_{1,}z_1)$ and $(x_{2,}y_{2,}z_2)$. The function correl depends exponentially on the frequency.

3.3 Keyword SPEC_FONC_FORME

/ SPEC_FONC_FORME

Keyword factor allowing to define a spectrum of excitation by its decomposition on a family of functions of form.

♦ / INTE_SPEC = int_spec

Concept of the type interspectre defining a matrix interspectrale excitation. This concept can be produced by the operator LIRE_INTE_SPEC [U4.36.01] after reading of the matrix interspectrale on external file.

FUNCTION = l_tab_fonc

List of concepts of the type `table_fonction` defining the family of functions of form associated with each mode. For each mode, a table is informed containing 2 functions of form in the 2 orthogonal directions with the axis of the telegraphic structure.

/ `GRAPPE_1 = 'DEBIT_180'` or `'DEBIT_300'`

Two possible choices corresponding to the flows for which the excitation `GRAPPE1` was identified.

♦ `GROUP_NO= gno`

Group containing the node of application of the excitation.

♦ `CARA_ELEM = will cara`

Concept of the type `cara_elem` product by the operator `AFFE_CARA_ELEM` [U4.42.01], defines the affected geometrical characteristics in the elements of the structure.
The geometrical characteristics are necessary to the estimate of the hydraulic diameter. Moreover, the concept of the type `cara_elem` bring the relative information to the orientations of the elements.

♦ `MODEL = model`

Concept of the type `model` product by the operator `AFFE_MODELE` [U4.41.01], defines the types of elements assigned to the meshs of the structure.

Note:

1) *The length of application L is characterized in an intrinsic way by the field of definition of the functions of form associated with the excitation. The enforcement zone is centered around the node of application.*
2) *The turbulent excitation being able to be developed in a way correlated in the two orthogonal directions with the axis of the telegraphic structure (axis x), the functions of form are a priori vectors with two components (according to y and z).*
, For each mode, two functions of form are thus defined (a following y and a following z) on the interval $(0;L)$. The functions then passed in a table_fonction to the operator `DEFI_SPEC_TURB`*. (cf CAS-test sdll116a)*

3.4 Keyword `SPEC_EXCI_POINT`

/ `SPEC_EXCI_POINT`

Keyword factor allowing to define a spectrum of excitation associated with one or more specific forces and moments.

♦ / `INTE_SPEC = int_spec`

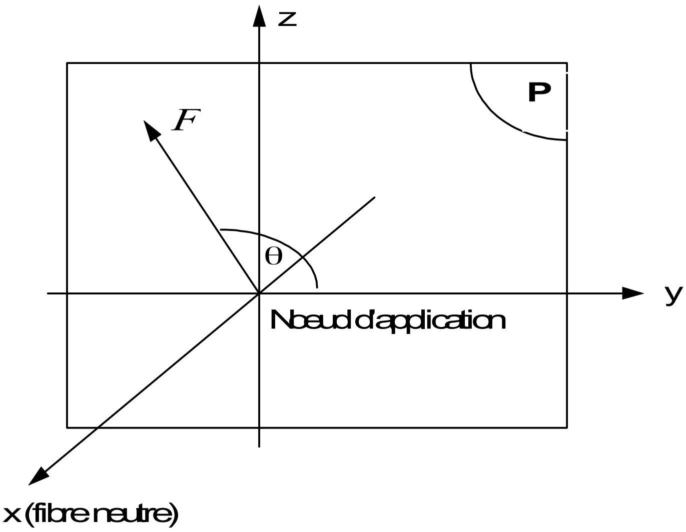
Concept of the type `interspectre` defining a matrix interspectrale specific excitations. This concept can be produced by the operator `LIRE_INTE_SPEC` [U4.56.01] after reading of the matrix interspectrale on external file.

`NATURE = l_nat`

List of arguments of type text defining the nature of the excitation of each node of application. The licit arguments are '`FORCE`' or '`MOMENT`'.

`ANGLE = l_theta`

List of the angles defining the directions of the vectors forces and moments of each node of application (see diagram).



The vector force is directed in the plan P orthogonal with neutral fibre. In this plan, the azimuth θ give the direction of the vector. The angles must be given in **degrees**.

/GROUP_NO = l_gno

List of the groups containing the nodes of application of the excitation.

Note:

> *The matrix interspectrale has as a dimension the number of forces and specific moments applied. The diagonal terms of this matrix characterize the autospectres of these excitations.*
> *The lists defining the nodes of application, the nature and the direction of the imposed excitations must thus be ordered in accordance with the structure of the matrix interspectrale of excitations.*

/ 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 excitation GRAPPE2 was 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.

The excitation GRAPPE2 is characterized by a specific force and a moment applied in the same node, in a homogeneous way in the two orthogonal directions with the axis of the telegraphic structure.

RHO_FLUI = rho_f

Density of the fluid surrounding the structure.

GROUP_NO= gno

Group containing the node of application of the excitation GRAPPE2.

Note:

> *When one resorts to a spectrum GRAPPE2 preset, the list of nodes waited under the operand GROUP_NO is reduced to only one element (only one node of application).*

♦ `CARA_ELEM = will cara`

Concept of the type `cara_elem` product by the operator `AFFE_CARA_ELEM` [U4.42.01], defines the affected geometrical characteristics in the elements of the structure.
The geometrical characteristics are necessary to the estimate of the hydraulic diameter. Moreover, the concept of the type `cara_elem` bring the relative information to the orientations of the elements.

♦ `MODEL = model`

Concept of the type `model` product by the operator `AFFE_MODELE` [U4.41.01], defines the types of elements assigned to the meshs of the structure.

4 Bibliography

1) NR. GAY, T. FRIOU: Resorption of software FLUSTRU in *Aster* HT-32/93/002/B

2) L. PEROTIN, MR. LAINET: Integration of a model general of turbulent excitation in *Code_Aster* : specifications HT-32/96/003/A