Operators AFFE_CHAR_MECA and AFFE_CHAR_MECA_F

1 Drank

Affecter of the loadings and the boundary conditions on a mechanical model.

- For AFFE_CHAR_MECA, the values affected do not depend on any parameter and are defined by actual values.
- For AFFE_CHAR_MECA_F, the affected values are function of one or more parameters as a whole {INST, X, Y, Z}.

  These functions must be in particular defined beforehand by the call to one of the operators:

  - DEFI_CONSTANTE [U4.31.01],
  - DEFI_FONCTION [U4.31.02],
  - DEFI_NAPPE [U4.31.03],
  - CALC_FONC_INTERP [U4.32.01].

Table des Matières

2 ARETE_IMPO81 Syntaxe

```
CH  [char_meca] = AFFE_CHAR_MECA

          (  ♦  MODELE =mo   ,                                [model]

          ♦  | VERI_NORM=    /  "OUI',                      [DEFECT]
                             /  "NON',
             | LIAISON_XFEM= /  "NON',                      [DEFECT]
                             /  "OUI',
             | EVOL_CHAR=evch                               [evol_char]
             | ROTATION=         (Omega, rear, Br, Cr)         [l_R]
              | PRE_SIGM =       sigm                    /  [carte_sdaster]
                                                         /  [cham_elem]
             | PESANTEUR=_F      (see key word PESANTEUR       [§ 4.6])
             | DDL_IMPO=_F       (see key word    DDL_IMPO        [§ 4.9])
             | FACE_IMPO= _F     (see key word    FACE_IMPO       [§
4.10])
             | ARETE_IMPO= _F    (see key word    ARETE_IMPO      [§
4.45])
             | LIAISON_DDL=_F    (see key word    LIAISON_DDL     [§
4.11])
             | LIAISON_OBLIQUE=_F (see key word LIAISON_OBLIQUE  [§ 4.12])
             | LIAISON_GROUP=_F  (see key word    LIAISON_GROUP   [§
4.13])
             | LIAISON_MAIL=_F   (see key word    LIAISON_MAIL    [§
4.14])
             | LIAISON_CYCL=_F   (see key word    LIAISON_CYCL    [§
4.15])
             | FORCE_NODALE=_F   (see key word    FORCE_NODALE    [§
4.16])
             | LIAISON_SOLIDE=_F (see key word    LIAISON_SOLIDE  [§
4.17])
             | LIAISON_ELEM=_F   (see key word    LIAISON_ELEM    [§
4.18])
             | LIAISON_UNIF=_F   (see key word    LIAISON_UNIF    [§
4.19])
             | LIAISON_CHAMNO=_F (see key word    LIAISON_CHAMNO  [§
4.20])
             | CHAMNO_IMPO=_F    (see key word    CHAMNO_IMPO     [§
4.21])
             | LIAISON_INTERF=_F (see key word    LIAISON_INTERF  [§
4.22])
             | VECT_ASSE=_F      (see key word VECT_ASSE       [§ 4.23])
             | FORCE_SOL=_F      (see key word FORCE_SOL       [§ 4.24])
continuum  | FORCE_FACE=_F     (see      mot-cléFORCE_FACE     [§ 4.25])
             | FORCE_ARETE=_F    (see      mot-cléFORCE_ARETE     [§
4.26])
             | FORCE_CONTOUR=_F  (see      mot-cléFORCE_CONTOUR      [§
4.27])
             | FORCE_INTERNE=_F  (see      mot-cléFORCE_INTERNE      [§
4.28])
             | PRES_REP=_F       (see      mot-cléPRES_REP        [§
4.29])
             | EFFE_FOND=_F      (see      mot-cléEFFE_FOND          [§
4.30])
              | PRE_EPSI=_F          ( see key word     PRE_EPSI        [§
4.31])
beam shell   | FORCE_POUTRE=_F   (see      mot-cléFORCE_POUTRE       [§
4.32])
             | DDL_POUTRE =_F    (see      mot-cléDDL_POUTRE      [§
4.33])
             | FORCE_TUYAU=_F    (see      mot-cléFORCE_TUYAU     [§
4.34])
```

```
            | FORCE_COQUE=_F      (see       mot-cléFORCE_COQUE      [§ 4.35])
            | LIAISON_COQUE=_F    (see       mot-cléLIAISON_COQUE    [§ 4.36])
concrete    | RELA_CINE_BP=_F     (see       mot-cléRELA_CINE_BP     [§ 4.37])
electromechanical | FORCE_ELEC=_F (see       mot-cléFORCE_ELEC       [§ 4.38])
            | INTE_ELEC=_F        (see       mot-cléINTE_ELEC        [§ 4.39])
acoustic    | IMPE_FACE=_F        (see       mot-cléIMPE_FACE        [§ 4.40])
            | VITE_FACE=_F        (see       mot-cléVITE_FACE        [§ 4.41])
            | ONDE_FLUI=_F        (see       mot-cléONDE_FLUI        [§ 4.42])
            | ONDE_PLANE=_F       (see       mot-cléONDE_PLANE       [§ 4.43])
thermo-hydro | FLUX_THM_REP=_F    (see       mot-cléFLUX_THM_REP     [§ 4.44])

            ◊INFO   =        / 1,                        [DEFECT]
                             / 2,
      )
```

```
CH   [char_meca] = AFFE_CHAR_MECA_F

        (   ♦MODELE=mo        ,          [model]
            ♦   | DDL_IMPO=_F          (see    mot-cléDDL_IMPO          [§ 4.9])
                | FACE_IMPO=_F         (see    mot-cléFACE_IMPO         [§ 4.10])
                | LIAISON_DDL=_F       (see    mot-cléLIAISON_DDL       [§ 4.11])
                | LIAISON_OBLIQUE=_F   (see    mot-cléLIAISON_OBLIQUE   [§ 4.12])
                | LIAISON_GROUP=_F     (see    mot-cléLIAISON_GROUP     [§ 4.13])
                | FORCE_NODALE=_F      (see    mot-cléFORCE_NODALE      [§ 4.17])
                | LIAISON_SOLIDE=_F    (see    mot-cléLIAISON_SOLIDE    [§ 4.18])
                | LIAISON_UNIF=_F      (see    mot-cléLIAISON_UNIF      [§ 4.20])
continuum   | FORCE_FACE=_F            (see    mot-cléFORCE_FACE        [§ 4.25])
                | FORCE_ARETE=_F       (see    mot-cléFORCE_ARETE       [§ 4.26])
                | FORCE_CONTOUR=_F     (see    mot-cléFORCE_CONTOUR     [§ 4.27])
                | FORCE_INTERNE=_F     (see    mot-cléFORCE_INTERNE     [§ 4.28])
                | PRES_REP=_F          (see    mot-cléPRES_REP          [§ 4.29])
                | EFFE_FOND=_F         (see    mot-cléEFFE_FOND         [§ 4.30])
                | PRE_EPSI=_F          ( see key word  PRE_EPSI         [§ 4.31])
beam shell      | FORCE_POUTRE=_F      (see    mot-cléFORCE_POUTRE      [§ 4.32])
                | FORCE_TUYAU=_F       (see    mot-cléFORCE_TUYAU       [§ 4.34])
                | FORCE_COQUE=_F       (see    mot-cléFORCE_COQUE       [§ 4.35])
                | LIAISON_COQUE=_F     (see    mot-cléLIAISON_COQUE     [§ 4.36])
acoustic    | IMPE_FACE=_F             (see    mot-cléIMPE_FACE         [§ 4.40])
                | VITE_FACE=_F         (see    mot-cléVITE_FACE         [§ 4.41])
                | ONDE_PLANE=_F        (see    mot-cléONDE_PLANE        [§ 4.43])
                | FLUX_THM_REP=_F      (see    mot-cléFLUX_THM_REP      [§ 4.44])
                | VERI_NORM=     /  'OUI',                              [DEFAUT]
                                 /  'NON',
        )
```

3 General information

possible Error messages related to command AFFE_CHAR_MECA

It happens sometimes that an ordering of mechanical computation (MECA_STATIQUE, STAT_NON_LINE,…) stop in fatal error during the computation of the second elementary members due to the loadings defined in the AFFE_CHAR_MECA_xx commands. When the code stops during these elementary computations, important information of the error message is the name of the computation option required by the code.

The name of this option is in general unknown to the user and it is thus difficult for him to understand the message.

In the table below, one gives in with respect to the names of the computation options, the command name and of the key word factor which make it possible to activate this option.

Elementary computation option	Commande	Key word factor
CHAR_MECA_EPSI_F	AFFE_CHAR_MECA_F	PRE_EPSI
CHAR_MECA_EPSI_R	AFFE_CHAR_MECA	PRE_EPSI
CHAR_MECA_FF1D1D	AFFE_CHAR_MECA_F	FORCE_POUTRE
CHAR_MECA_FF1D2D	AFFE_CHAR_MECA_F	FORCE_CONTOUR
CHAR_MECA_FF1D3D	AFFE_CHAR_MECA_F	FORCE_ARETE
CHAR_MECA_FF2D2D	AFFE_CHAR_MECA_F	FORCE_INTERNE
CHAR_MECA_FF2D3D	AFFE_CHAR_MECA_F	FORCE_FACE
CHAR_MECA_FF3D3D	AFFE_CHAR_MECA_F	FORCE_INTERNE
CHAR_MECA_FFCO2D	AFFE_CHAR_MECA_F	FORCE_COQUE
CHAR_MECA_FFCO3D	AFFE_CHAR_MECA_F	FORCE_COQUE
CHAR_MECA_FLUX_F	AFFE_CHAR_MECA_F	FLUX_THM_REP
CHAR_MECA_FLUX_R	AFFE_CHAR_MECA	FLUX_THM_REP
CHAR_MECA_FORC_F	AFFE_CHAR_MECA_F	FORCE_NODALE
CHAR_MECA_FORC_R	AFFE_CHAR_MECA	FORCE_NODALE
CHAR_MECA_FR1D1D	AFFE_CHAR_MECA	FORCE_POUTRE
CHAR_MECA_FR1D2D	AFFE_CHAR_MECA_F	FORCE_CONTOUR
CHAR_MECA_FR1D3D	AFFE_CHAR_MECA	FORCE_ARETE
CHAR_MECA_FR2D2D	AFFE_CHAR_MECA	FORCE_INTERNE
CHAR_MECA_FR2D3D	AFFE_CHAR_MECA	FORCE_FACE
CHAR_MECA_FR3D3D	AFFE_CHAR_MECA	FORCE_INTERNE
CHAR_MECA_FRCO2D	AFFE_CHAR_MECA	FORCE_COQUE
CHAR_MECA_FRCO3D	AFFE_CHAR_MECA	FORCE_COQUE
CHAR_MECA_FRELEC	AFFE_CHAR_MECA	FORCE_ELEC
CHAR_MECA_PESA_R	AFFE_CHAR_MECA	PESANTEUR
CHAR_MECA_PRES_F	AFFE_CHAR_MECA_F	PRES_REP
CHAR_MECA_PRES_R	AFFE_CHAR_MECA	PRES_REP
CHAR_MECA_ROTA_R	AFFE_CHAR_MECA_F	ROTATION

4 Opérandes

4.1 Généralités on the operands

4.1.1 Deux categories of operands

Les operands under a key word factor are of two forms:

- operands specifying the geometrical entities on which the loadings are affected (key words GROUP_NO, GROUP_MA, etc…). The arguments of these operands are identical for the two operators,
- the operands specifying the affected values (DX, DY, etc…). The meaning of these operands is the same one for the two operators. The arguments of these operands are all of the real type for operator AFFE_CHAR_MECA and of the standard function (created in particular by one of operators DEFI_FONCTION, DEFI_NAPPE or DEFI_CONSTANTE) for operator AFFE_CHAR_MECA_F.
  This is true near with an exception: the argument of COEF_MULT for the key word factor LIAISON_DDL in AFFE_CHAR_MECA_F is obligatorily of real type.

We will thus not distinguish in this document, except mention express of the opposite, two operators AFFE_CHAR_MECA and AFFE_CHAR_MECA_F.

4.1.2 Designation of the topological entities of assignment of the loadings

In a general way, the entities on which values must be affected are defined:

- by node and in this case:
  - maybe by operand GROUP_NO allowing to introduce a list of nodes groups: let us note that in certain cases a group of node should contain one node,
  - that is to say by the operand NODE allowing to introduce a list of nodes.
- by mesh and in this case:
  - either by GROUP_MA allowing to introduce a list of mesh groups,
  - or by MESH allowing to introduce a list of meshes.

4.1.3 Regulate of Pour

overload to define the field of assignment most simply possible, one uses **the rule of overload** defined in the document “Règles of overload” [U1.03.00] :
when various occurrences of the same key word factor exist, it is the last assignment which precedes.

The key words different factors always cumulate.

If for example, the made user:

```
FORCE_FACE (GROUP_MA='G1”, FX=12.)
PRES_REP  (GROUP_MA='G1”, PRES=13.)
```

and if the norm for $G1$ is directed according to X,

then all will occur as if one had made:

```
FORCE_FACE (GROUP_MA='G1", FX=25.)
```

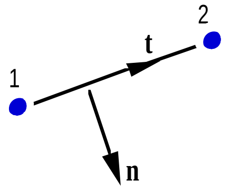
4.1.4 Structural elements, continuums

Pour the assignment of the distributed loadings on the elements with average layer (plate - shell) or with average fiber (beam, cable, bar) the key words factors are distinct from those used for the continuums.

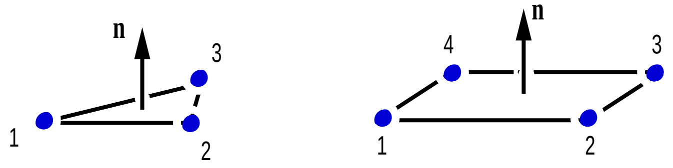
4.1.5 Norms and tangents with the Normal

meshes:

- `SEG2` or `SEG3` in `2D` (coordinated defined by `COOR_2D` in the mesh file in the Aster *format*). The norm n is such as (n,t) form a direct reference, t being carried by the segment directed by the first two nodes of the segment.

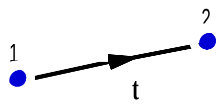


- `QUAD4`,..., `QUAD9`, `TRIA3`, `TRIA6` in `3D` (coordinated defined by `COOR_3D` in the mesh file in the Aster *format*). The directional sense of the norm n is that corresponding to the direct meaning of the description of the mesh.

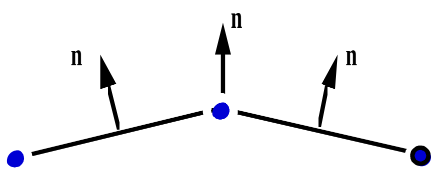


Tangents:

Can be specified only if the mesh is of type `SEG2` or `SEG3` in `2D`. The tangent is that defined by the segment directed by its first two nodes.



If `DNOR` (or `DTAN)` are specified, the norm (or the tangent) on a node is the average of the norms or the tangents of the meshes which have this joint node (except for the curved elements quadratic where the norm is correctly calculated in any point)



4.2 Opérande MODELE

```
♦MODELE=mo ,
```

Product concept by operator AFFE_MODELE where the types of finite elements affected on the mesh are defined.

4.3 Operand VERI_NORM

```
| VERI_NORM= / 'OUI' [DEFAUT]
             / 'NON'
```

Checking of the directional sense of the norms to the surface meshes in 3D (meshes of skin TRIA or QUAD) and linear in 2D (meshes of skin SEG). This relates to key words PRES_REP and FACE_IMPO 'DNOR'.
If a norm is not outbound, there is emission of an error message fatal.

To reorientate the meshes in order to have outgoing norms, operator MODI_MAILLAGE [U4.23.04] should be used key word ORIE_PEAU_2D and ORIE_PEAU_3D.

No checking is made on the shells. To check their directional sense, one also returns to operator MODI_MAILLAGE key word ORIE_NORM_COQUE.

4.4 Operand LIAISON_XFEM (AFFE_CHAR_MECA only)

```
| LIAISON_XFEM=/ 'NON' [DEFAUT]
               / 'OUI'
```

During a computation with method X-FEM [R7.02.12], the activation of the contact requires to add connections between the degrees of freedom of contact to observe condition LBB [R5.03.54]. These connections are automatically computed and introduced into the load when LIAISON_XFEM= is indicated'OUI'. It is thus necessary to create an additional expenditure, as on the following example, and to use it for any computation X-FEM with contact.

```
chxfem=AFFE_CHAR_MECA ( MODELE=modele ,
                        LIAISON_XFEM= 'OUI",
                      )
```

4.5 Opérande EVOL_CHAR (AFFE_CHAR_MECA only)

```
| EVOL_CHAR =evch ,
```

Loadings evolutionary in the time of the type "evol_char" produced by LIRE_RESU [U7.02.01] and containing fields of pressure, densities of volume force in 2D or 3D and densities of surface force in 2D or 3D.

4.6 Operand PESANTEUR (AFFE_CHAR_MECA only)

```
| PESANTEUR =_F ( ♦ / GRAVITE=G ,             [R]
                  ♦ / DIRECTION= (ap, LP, CP), [l_R]
                  ◊ / MAILLE=lma ,
[l_maille]
                    /GROUP_MA =lgma ,
[l_gr_maille]
                )
```

G represents the intensity of the field of gravity and vector DIRECTION specifies the direction and the meaning of application of the field. The loading which results from it is form:

$$\rho\, g \frac{\left(a_p \boldsymbol{i}+b_p \boldsymbol{j}+c_p \boldsymbol{k}\right)}{\sqrt{a_p^2+b_p^2+c_p^2}}$$

where $(\boldsymbol{i}, \boldsymbol{j}, \boldsymbol{k})$ is the total cartesian coordinate system.

ρ is the definite density like characteristic of the material (see operators DEFI_MATERIAU [U4.43.01] and AFFE_MATERIAU [U4.43.03]).

By default, this field applies to all models it. It is possible to restrict it with part of the model using the key words NETS and GROUP_MA, which specify the meshes to which the field applies.

Note:

It can exist U difference between the theoretical solution of computation of the weight of structure and the solution finite elements. That is due to the discretization of the problem.

In axisymmetric modelization, gravity is exerted only parallel to the axis of revolution Y.

When loading PESANTEUR is used with MECA_STATIQUE, Code_Aster calculates the nodal efforts by using the stiffness matrix of the element and displacements previously calculated (option EFGE_ELNO). One thus finds well the weight of structure where the conditions of blockings are imposed.

If loading PESANTEUR is used with STAT_NON_LINE, Code_Aster makes the sum of the nodal stresses starting from the stresses at Gauss points SIGM_ELGA. And that does not give the same thing as MECA_STATIQUE, because if one imposes, at the time of a STAT_NON_LINE, with a node at the same time of the conditions of displacement and force (here coming from gravity), these forces are not taken into account. The only way of finding the weight of structure is:
•To use MECA_STATIQUE
•Lors of a use with STAT_NON_LINE to make so that the finite elements, on which kinematical conditions are imposed, are of a sufficiently small size so that their weight is negligible in front of that of total structure.
•During a use of beam elements with STAT_NON_LINE, a solution is to duplicate the nodes on which the kinematical condition is imposed and to make for example a LIAISON_DDL between the 2 nodes or to use the discrete ones.

4.7 Operand ROTATION (AFFE_CHAR_MECA only)

```
|   ROTATION =_F   (      ♦VITESSE=omega           ,                [R]
                          ♦AXE=                  (rear, Br, Cr)  ,        [l_R]
                          ◊CENTRE       =    (X, there, Z),           [l_R]
                          ◊   /   MAILLE=lma               ,
[l_maille]
                              /GROUP_MA     =lgma  ,              [l_gr_maille]
                                 /   TOUT=         'OUI",
                  )
```

♦ VITESSE= Omega ,

Rotational speed

♦AXE= (rear, Br, Cr) ,

direction of the rotational axis which leads to:

$$\boldsymbol{\omega}=\omega \frac{\left(a_r \boldsymbol{i}+b_r \boldsymbol{j}+c_r \boldsymbol{k}\right)}{\sqrt{a_r^2+b_r^2+c_r^2}}$$

The loading which results from it is: $\rho(\omega \wedge \boldsymbol{OM}) \wedge \omega$ where $\boldsymbol{O}$ is the origin of the coordinates and $\boldsymbol{M}$ a point running of structure with ρ definite density like characteristic of the material (see operators `DEFI_MATERIAU` [U4.43.01] and `AFFE_MATERIAU` [U4.43.03]).

`◊CENTRE = (X, there, Z),`

If the center is not the origin (defect), one can specify its coordinates (x, y, z).

Limitations:

- **plane modelizations:** the rotational axis must be in the direction Oz (normal direction with the plane), the center can be unspecified.
- **axisymmetric modelizations and Fourier:** the rotational axis must be in the direction Oy, the center must be the origin (if not the loading is not axisymmetric).

Notice important:

> *One can vary in time rotational speed by breaking up rotation in a multiplicative way between spatial loading and evolution into time $\omega(t) = \omega_0 f(t)$, then by multiplying `the LOAD` by a multiplying function (key word `FONC_MULT`) in transient computation (`DYNA_TRAN_MODAL`, `DYNA_LINE_TRAN`, `DYNA_NON_LINE`). However, it is advisable to pay attention: the loading $\rho(\omega \wedge \boldsymbol{OM}) \wedge \omega$ being proportional to the square rotational speed $\omega(t)^2$, it is necessary to affect the square of the evolution in time $f(t)^2$, behind `FONC_MULT`.*

4.8 Operand PRE_SIGM (AFFE_CHAR_MECA only)

```
| PRE_SIGM =sigm ,
```

Word-key factor usable to apply a prestressing σ_{pre}. This loading makes it possible to apply average voluminal stresses, overall uniform (2D or 3D) with a voluminal field. The second computed elementary member will be $\int_{Ve} \sigma_{pre} : \varepsilon(v^*) dV_e$.

The stress field `sigm` is of standard card or `chamelem elga`. It can come from `CREA_CHAMP` or be computed in addition.

One should not confuse this prestressing with the initial stress σ_{ini} used into nonlinear, because this prestressing does not intervene directly in the statement of the constitutive law. This field of prestressings, is used like second member in the resolutions of `MECA_STATIQUE` and `STAT_NON_LINE`.

4.9 Key word DDL_IMPO

4.9.1 Drank

Word-key factor usable to impose, with nodes introduced by one (at least) of the key words: TOUT, NODE, GROUP_NO, MESH, GROUP_MA, one or more values of displacement (or certain associated quantities).

According to the name of the operator called, the values are provided directly (AFFE_CHAR_MECA) or via a concept function (AFFE_CHAR_MECA_F).

During a computation with method X-FEM, it is possible to impose the displacement of nodes nouveau riches. (AFFE_CHAR_MECA only). That is done in a usual way (although these nodes do not have a degree of freedom DX , DY or DZ).

Notice; if the required node is on the lips, then one imposes the condition of blocking on the nodes of the upper lips and lower.

4.9.2 Syntax

- for AFFE_CHAR_MECA

```
     |   DDL_IMPO=_F    ( ♦  /  TOUT=        'OUI”,
                             /NOEUD       =lno      ,      [l_noeud]
                             /GROUP_NO    =lgno  ,      [l_gr_noeud]
                             /MAILLE         =lma      ,      [l_maille]
                             /GROUP_MA    =lgma  ,      [l_gr_maille]
                          ♦  /  |  DX  =UX         ,      [R]
                                |  DY  =UY         ,      [R]
                                |  DZ  =UZ         ,      [R]
                                |  DRX =THETAX     ,   [R]
                                |  DRY =THETAY        ,   [R]
                                |  DRZ =THETAZ        ,   [R]
                                |  GRX =G       ,      [R]
                                |  PRES=p       ,      [R]
                                |  PHI =PHI        ,      [R]
                                |  TEMP=T       ,      [R]
                                |  PRE1=pr1        ,      [R]
                                |  PRE2=pr2        ,      [R]
                                   …
                                |  LAGS_C=lag   ,      [R]
                                |  V11=v11      ,      [R]
                                |  V12=v12      ,      [R]
                                |  V21=v21      ,      [R]
                                |  V22=v22      ,      [R]
                                |  PRES11=pres11,   [R]
                                |  PRES12=pres12,   [R]
                                |  PRES21=pres21,   [R]
                                |  PRES22=pres22,   [R]
                             /LIAISON  =     'ENCASTRE'
                     )
```

The exhaustive list of the degrees of freedom being able to be imposed is:

DX, DY, DZ, DRX, DRY, DRZ, GRX, PRES, PHI, TEMP, PRE1, PRE2, UI2, UI3, VI2, VI3, WI2, WI3, UO2, UO3, VO2, VO3, WO2, WO3, UI4, UI5, VI4, VI5, WI4, WI5, UO4, UO5, VO4, VO5, WO4, WO5, UI6, UO6, VI6, VO6, WI6, WO6, WO, WI1, WO1, GONF, CONNECTION, H1X, H1Y, H1Z, E1X, E1Y, E1Z, E2X, E2Y, E2Z, E3X, E3Y, E3Z, E4X, E4Y, E4Z, LAGS_C , V11, V12, V21, V22, PRES11, PRES12, PRES21, PRES22

* for AFFE_CHAR_MECA_F

```
    |   DDL_IMPO=_F    ( ♦  /   TOUT=         'OUI”,
                             /NOEUD          =lno       ,       [l_noeud]
                             /GROUP_NO       =lgno  ,       [l_gr_noeud])
                            /MAILLE          =lma       ,       [l_maille]
                            /GROUP_MA     =lgma  ,       [l_gr_maille]
                        ♦  /  |   DX=
                                  …                        [function]
                            /LIAISON      =   'ENCASTRE'
                     )
```

4.9.3 Operands

| DDL_IMPO

Toutes the specified values are defined in reference GLOBAL of definition of the mesh.

• DX = ux or uxf • DY = uy or uyf • DZ = uz or uzf	Valeur of the component of displacement in **translation** imposed on the specified nodes

Uniquement if the specified nodes belong to discrete elements of translation - rotation, **beam** or **shell**:

• DRX = θ X or θ xf • DRY = θ there or θ yf • DRZ = θ Z or θ zf	Valeur of the component of displacement in **rotation** imposed on the specified nodes

Uniquement if the specified nodes belong to beam elements "POU_D_TG" :

• GRX = G or gf	Valeur of the warping of the Uniquement

beam if the specified nodes belong to elements fluid or fluid structure:

• PRES = p or acoustic	PF Pressure in the fluid (modelization "3D_FLUIDE")
• PHI = ϕ or ϕ F	Potentiel of displacements of the fluid (modelizations "3D_FLUIDE" and "FLUI_STRU")

Uniquement if the specified nodes belong to surface elements free:

• DZ = uz or uzf	Déplacement imposed of the free face (modelization "2D_FLUI_PESA")
• PHI = ϕ or ϕ F	Potentiel of displacements of the fluid (modelization "2D_FLUI_PESA")

Uniquement if the specified nodes belong to elements THM:

• PRES= p	Pressure of interstitial fluid (modelizations "3D_JOINT_CT")
• TEMP= T	Temperature (modelizations "" with = 3D or AXIS or D_PLAN YYYY = THM or THHM or THH)
• PRE1= p1	capillary Pression or pressure of the liquid or the gas (modelizations "" with = 3D or AXIS or D_PLAN YYYY = THM or THHM or THH or HM or HHM)
• PRE2= p2	Pression of the gas (modelizations "" with = 3D or AXIS or D_PLAN YYYY = THH or THHM or HHM)

• LH1=0	Multiplicateur of lagrange hydraulic for the joined elements of type " _JHMS". Allows to neutralize the degrees of freedom at the edge of the joint if the solid mass of bearings is purely mechanical.

Only if the specified nodes belong to elements "PIPE".
These elements have 15 degrees of freedom of shell:

U : warping V, W : ovalization
I : "in plane" O : "out of planes"

Soit:

• UI2 VI2 WI2 UO2 VO2 WO2	Degrees of freedom related to the mode 2
• UI3 VI3 WI3 UO3 VO3 WO3	Degrees of freedom related to the mode 3
• WO WI1 WO1	Degrees of freedom of swelling and mode 1 on W

Uniquement if the specified nodes belong to elements "TUYAU_6M".

• UI4 VI4 WI4 UO4 VO4 WO4	Degrees of freedom related to the mode 4
• UI5 VI5 WI5 UO5 VO5 WO5	Degrees of freedom related to the mode 5
• UI6 VI6 WI6 UO6 VO6 WO6	Degrees of freedom related to the mode 6

Uniquement if the specified nodes belong to elements "XXX_INCO".

• GONF	Uniquement

swelling if the specified nodes belong to elements of regularization second gradient:

• V11 V12 V21 V22	Component of microscopic strain tensor
• PRES11 PRES12 PRES21 PRES22	Lagrange multipliers introduced for the mixed formulation

Uniquement if the specified nodes belong to elements of regularization second gradient microcomputer-dilation:

• GONF	Swelling
• PRES	Multiplicateur de Lagrange introduced for the mixed formulation

CONNECTION = "ENCASTRE'

Allows to embed nodes directly, i.e. to force to zero the degrees of freedom of translation and rotation. The other degrees of freedom are not modified.

4.9.4 Checks and recommendations

It is checked that the specified degree of freedom exists in this node for the elements assigned in the MODELE to the meshes which contain the node.

However, if the same boundary condition is specified twice by two calls to AFFE_CHAR_MECA (for example, with two values of imposed displacement), that led to a singular matrix.

If it is specified twice (or more) in only one call to AFFE_CHAR_MECA, the rule of overload applies and an alarm message (indicating the overload) is transmitted.

4.10 Key word FACE_IMPO

4.10.1 Drank

Word-key factor usable to impose, with all the nodes of a face defined by a mesh or a mesh group, one or more values of displacement (or certain associated quantities).
According to the name of the operator called, the values are provided directly (`AFFE_CHAR_MECA`) or via a concept `function` (`AFFE_CHAR_MECA_F`).

4.10.2 Syntax

- for `AFFE_CHAR_MECA`

```
  |  FACE_IMPO=_F  ( ♦  /  MAILLE=lma            ,        [l_maille]
                        /GROUP_MA      =lgma  ,           [l_gr_maille]
                     ◊SANS_MAILLE=lma1          ,         [l_maille]
                     ◊SANS_GROUP_MA=lgma1          ,      [l_gr_maille]
                     ◊SANS_NOEUD=lno1          ,          [l_noeud]
                           SANS_GROUP_NO=lgno1    ,       [l_gr_node]
                     ♦  /  |  DX=ux       ,               [R]
                           |  DY=uy       ,               [R]
                           |  DZ=uz       ,               [R]
                           |  DRX=        θ X,            [R]
                           |  DRY=        θ there,        [R]
                           |  DRZ=        θ Z,            [R]
                           |  GRX=g          ,            [R]
                           |  PRES=p      ,               [R]
                           |  PHI=phi        ,            [R]
                           |  TEMP=T      ,               [R]
                           |  PRE1=pr1       ,            [R]
                           |  PRE2=pr2       ,            [R]
                        /  |  DNOR=un        ,            [R]
                           |  DTAN=ut        ,            [R]
  )
```

- for `AFFE_CHAR_MECA_F`

```
  |  FACE_IMPO=_F  ( ♦  /  MAILLE=lma            ,        [l_maille]
                        /GROUP_MA      =lgma  ,           [l_gr_maille]
                     ◊SANS_MAILLE=lma1          ,         [l_maille]
                     ◊SANS_GROUP_MA=lgma1          ,      [l_gr_maille]
                     ◊SANS_NŒUD=lno1          ,           [l_noeud]
                           SANS_GROUP_NO=lgno1    ,       [l_gr_node]
                     ♦  /  |  DX=uxf          ,           [function]
                           |  DY=uyf          ,           [function]
                           |  DZ=uzf          ,           [function]
```

```
                                   |  DRX=xf      θ ,          [function]
                                   |  DRY=yf      θ ,          [function]
                                   |  DRZ=zf      θ ,          [function]
                                   |  GRX=gf        ,
       [function]
                                   |  PRES=pf       ,
       [function]
                                   |  PHI=f       ϕ ,          [function]
                                   |  TEMP=Tf       ,
       [function]
                                   |  PRE1=pr1f   ,            [function]
                                   |  PRE2=pr2f   ,            [function]
                                 / |  DNOR=un       ,
       [function]
                                   |  DTAN=ut       ,
       [function])
```

4.10.3 Opérandes

```
◊SANS_MAILLE=lma1              ,           [l_maille]
◊SANS_GROUP_MA=lgma1           ,           [l_gr_maille]
◊SANS_NŒUD=lno1                ,           [l_noeud]
◊SANS_GROUP_NO=lgno1           ,           [l_gr_noeud]
```

Indique which one wants to omit the nodes of the lists lma1, lgma1, lno1, lgno1, of the list lma or lgma.

Example:
```
FACE_IMPO = (  _F (   GROUP_MA =Gauche,
                      DX =0, DY =0),
               _F (   GROUP_MA =Haut,
                      SANS_GROUP_MA =Gauche,
                      DNOR =0),)
```

the meaning of the 2nd occurrence of FACE_IMPO is: "for all the nodes of Haut except those which belong on the left, DNOR=0 ".

This makes it possible not to have redundant boundary conditions.

```
♦  /  |  DX   =
      |  DY   =
      |  DZ   =
      |  DRX  =
      |  DRY  =
      |  DRZ  =
      |  GRX  =
      |  PRES=
      |  PHI  =
      |  TEMP=
      |  PRE1=
      |  PRE2=
```

Les components, imposed on all the nodes belonging to the specified meshes, are defined in **reference** GLOBAL of definition of the mesh.

The sides considered are made up:

- either of TRIA3, TRIA6, QUAD4, QUAD8, QUAD9 in dimension 3,

- or of SEG2 or SEG3 in dimension 2 (the face is reduced on a board).

Note:

*The components of displacement in rotation DRX, DRY, DRZ can intervene only on nodes which belong to beam elements or of **shell** (see DDL_IMPO [§4.10]),*

component GRX on beam elements "POU_D_TG",

components PRES and PHI on elements of modelizations "3D_FLUIDE" and "FLUI_STRU" , components DZ and PHI on elements of modelization "2D_FLUI_PESA".
Components TEMP, PRE1, PRE2 on elements of modelizations THM.

```
/    |    DNOR =
     |    DTAN =
```

Les imposed components are defined according to the norm or the tangent with a mesh (**local coordinate system**).
DNOR : normal component (see [U4.44.01 §4.1]),
DTAN : tangential component (see [U4.44.01 §4.1]).

4.11 Key word LIAISON_DDL

4.11.1 Drank

Word-key factor usable to define a linear relation between degrees of freedom of two or several nodes.

According to the name of the operator called, the values are provided directly (AFFE_CHAR_MECA) or via a concept function (AFFE_CHAR_MECA_F).

4.11.2 Syntax

- for AFFE_CHAR_MECA

```
LIAISON_DDL=_F (    ♦  /  NOEUD=lno        ,           [l_noeud]
                       /GROUP_NO    =lgno  ,           [l_gr_noeud]
                    ♦DDL=lddl        ,                  [l_K8]
                    ♦COEF_MULT=i        α ,             [l_R]
                    ♦COEF_IMPO=         β ,             [R]
               )
```

- for AFFE_CHAR_MECA_F

```
LIAISON_DDL=_F (    ♦  /  NODE    =lno            ,    [l_noeud]
                       /GROUP_NO  =        lgno,   [l_gr_noeud]
                    ♦DDL=lddl        ,                  [l_K8]
                    ♦  /             COEF_MULT=i   α  ,    [l_R]
                       /COEF_MULT_FONC     =if α  ,    [l_fonction]
                    ♦COEF_IMPO=f                   β  ,    [function]
               )
```

4.11.3 Opérandes

GROUP_NO or NODE : list nodes $N_i \quad (i=1,r)$ ordered in a natural way:

- in the order of the list of nodes groups, and for each nodes group, in the order of definition of the group by GROUP_NO,
- in the order of the list of nodes for NODE.

D.O.F. : list degrees of freedom $U_i \quad (i=1,r)$ of r texts to be taken in the documentation of the simple quantities [U2.01.04]

COEF_MULT : list $\alpha_i \quad (i=1,r)$ coefficients (of real type for AFFE_CHAR_MECA **and** AFFE_CHAR_MECA_F).

COEF_MULT_FONC : list $\alpha_i \quad (i=1,r)$ coefficients of type function of the geometry only for AFFE_CHAR_MECA_F.

COEF_IMPO : coefficient β for AFFE_CHAR_MECA, function of time for AFFE_CHAR_MECA_F.

The following kinematical condition will be applied: $\sum_{i=1}^{r} \alpha_i U_i = \beta$

4.11.4 Component precautions of

4.11.4.1 use in rotation

Les components of displacement in rotation `DRX, DRY, DRZ` can intervene only in combinations only **assigned** to nodes which belong to discrete elements of translation-rotation, **beam** or **shell** (see `DDL_IMPO` : cf [§4.10]).

4.11.4.2 Linear relation between the degrees of freedom of the same node

Dans this case particular, one will repeat behind the key word `NODE` the name of the node as many times as there are degrees of freedom in the relation. Example: to impose $U_x = U_y$ on the node $N1$, one will write:

```
LIAISON_DDL =_F   ( NODE       =     ("N1", "N1"),
                    D.O.F.       =    ("DX", "DY"),
                    COEF_MULT =    (1. , -1.),
                    COEF_IMPO =0  .,                        )
```

4.11.4.3 linear Relation between nodes groups

It is important to note that to an occurrence of the key word factor `LIAISON_DDL` corresponds one and only one linear relation.

If one wants to impose the same relation between 2 nodes groups `GRN01` and `GRN02` (even node U_x displacement with node for example) **one cannot write** :

```
LIAISON_DDL = _F    ( GROUP_NO   =    ("GRNO1", "GRNO2"),
                      D.O.F.       =    ("DX"   "DX"),
                      COEF_MULT =    (1. , -1.),
                      COEF_IMPO =0  .,                        )
```

Cette writing has meaning only if `GRNO1` and `GRNO2` contain each one one node. It will be necessary in the case above to clarify each linear relation, node by node, or to use `LIAISON_GROUP` [§4.14] which makes it possible to condense the writing of same linear relations between two nodes groups as screw - with - screw.

4.11.4.4 Multiplying coefficients geometry dependent

Pour `AFFE_CHAR_MECA_F,` one can re-enter of the multiplying coefficients geometry dependent with `COEF_MULT_FONC`. Nevertheless, these coefficients are computed starting from the initial geometry, it does not have there a possible reactualization into nonlinear.

4.12 Key word LIAISON_OBLIQUE

4.12.1 Drank

Word-key factor usable to apply, with nodes or nodes groups, the same component value of displacement definite per component in an unspecified oblique coordinate system.
According to the name of the operator called, the values are provided directly (`AFFE_CHAR_MECA`) or via a concept `function` (`AFFE_CHAR_MECA_F`).

4.12.2 Syntax

- for `AFFE_CHAR_MECA`

```
|   LIAISON_OBLIQUE =_F  ( ♦  /  NODE    =no      ,      [node]
                              /GROUP_NO  =gno     ,      [gr_noeud]
                          ♦  |  DX  =UX              ,      [R]
                             |  DY  =UY              ,      [R]
                             |  DZ  =UZ              ,      [R]
                             |  DRX =X         θ  ,      [R]
                             |  DRY =Y         θ  ,      [R]
                             |  DRZ =z         θ  ,      [R]
                           ♦  ANGL_NAUT =      (α,β,γ),    [l_R]
                       )
```

- for `AFFE_CHAR_MECA_F`

```
ILIAISON_OBLIQUE  =_F   ( ♦  /  NODE    =no      ,      [node]
                              /GROUP_NO  =gno     ,      [gr_noeud]
                          ♦  |  DX  =uxf             ,
[function]
                             |  DY  =uyf             ,
[function]
                             |  DZ  =uzf             ,
[function]
                             |  DRX =xf        θ,      [function]
                             |  DRY =yf        θ,      [function]
                             |  DRZ =zf        θ,      [function]
                          ♦ANGL_NAUT   =      (α,β,γ),    [l_R]
                       )
```

4.12.3 Opérandes

| `LIAISON_OBLIQUE`

• `DX` = `ux` or `uxf` • `DY` = `uy` or `uyf` • `DZ` = `uz` or `uzf`	Valeur of the component of displacement in translation in the oblique coordinate system imposed on the specified nodes

Uniquement if the specified nodes belong to discrete elements of translation - rotation, beam or shell.

• `DRX` = θ `X` or θ `xf` • `DRY` = θ `there` or θ `yf` • `DRZ` = θ `Z` or θ `zf`	Valeur of the component of displacement in rotation in the oblique coordinate system imposed on the specified nodes

♦ANGL_NAUT = (α, β, γ),

Les nautical angles (α, β, γ) defined in **degrees**, are the angles making it possible to pass from reference GLOBAL of definition of the coordinates of the nodes to an unspecified oblique coordinate system (see AFFE_CARA_ELEM [U4.42.01]).

4.12.4 Checking

One checks that the specified degree of freedom exists in this node for the elements assigned in the MODELE to the meshes which contain the node.

4.12.5 Limitation

Dans an occurrence of the key word factor, one can introduce for time one node or one nodes group containing one node.

4.13 Key word LIAISON_GROUP

4.13.1 Drank

Word-key factor usable to define the same linear relation between certain degrees of freedom of couples of nodes, these couples of nodes being obtained while putting in opposite two lists of meshes or nodes [§4.14.5].

According to the name of the operator called, the values are provided directly (AFFE_CHAR_MECA) or via a concept function (AFFE_CHAR_MECA_F).

4.13.2 Syntax

- for AFFE_CHAR_MECA

```
LIAISON_GROUP=_F  ( ♦  /  ♦  /  MAILLE_1=lma1       ,    [l_maille]
                             /GROUP_MA_1      =lgma1 ,
[l_gr_maille]
                          ♦  /  MAILLE_2=lma2       ,    [l_maille]
                             /GROUP_MA_2      =lgma2 ,
[l_gr_maille]

                       /  ♦ /NOEUD_1         =lno1  ,    [l_noeud]
                            /GROUP_NO_1      =lgno1 ,    [l_gr_noeud]
                          ♦ /NOEUD_2         =lno2  ,    [l_noeud]
                            /GROUP_NO_2      =lgno2 ,    [l_gr_noeud]

                    ◊  /            SANS_NOEUD=lno      ,
[l_noeud]
                       /SANS_GROUP_NO           =lgno  ,
[l_gr_noeud]

                    ♦   DDL 1 =  /   | "DX",
                                     | "DY",
                                     | "DZ",
                                     | "DRX",
                                     | "DRY",
                                     | "DRZ",
                                 /  "DNOR",
                    ♦   DDL 2 =  /   | "DX",
                                     | "DY",
                                     | "DZ",
                                     | "DRX",
                                     | "DRY",
                                     | "DRZ",
                                 /  "DNOR",

                    ♦   COEF_MULT_1=            α1i  ,       [l_R]
                    ♦   COEF_MULT_2=            α2i  ,       [l_R]
                    ♦   COEF_IMPO=                β  ,          [R]
                    ◊SOMMET=                   'OUI",
                    ◊CENTRE=lr                        ,
[l_R]
                    ◊ANGL_NAUT=lr                ,          [l_R]
                    ◊TRAN=lr                     ,          [l_R]
                 )
```

- for AFFE_CHAR_MECA_F

```
LIAISON_GROUP=_F  ( ♦  /  ♦  /  MAILLE_1=lma1       ,    [l_maille]
                                /GROUP_MA_1      =lgm
[l_gr_maille]
                             ♦  /  MAILLE_2=lma2       ,    [l_maille]
                                /GROUP_MA_2      =lgma2 ,    [l_gr_maille]
                          /  ♦  /NOEUD_1         =lno1  ,    [l_noeud]
                                /GROUP_NO_1      =lgno1 ,    [l_gr_noeud]
                             ♦  /NOEUD_2         =lno2  ,    [l_noeud]
                                /GROUP_NO_2      =lgno2 ,    [l_gr_noeud]
                    ◊  /           SANS_NOEUD=lno       ,    [l_noeud]
                       /SANS_GROUP_NO           =lgno   ,    [l_gr_noeud]
                    ♦   DDL_1=       /  |   'DX",
                                     |   'DY",
                                     |   'DZ',
                                     |   'DRX',
                                     |   'DRY',
                                     |   'DRZ',
                                  /   "DNOR",
                    ♦   DDL_2=       /  |   'DX',
                                     |   'DY',
                                     |   'DZ',
                                     |   'DRX',
                                     |   'DRY',
                                     |   'DRZ',
                                  /  "DNOR",
                    ♦   COEF_MULT_1=1i       α ,             [l_R]
                    ♦   COEF_MULT_2=2i       α ,             [l_R]
                    ♦COEF_IMPO=f             β  ,
[function]
                    ◊SOMMET=                'OUI',
                    ◊CENTRE=lr                   ,             [l_R]
                    ◊ANGL_NAUT=lr               ,            [l_R]
                    ◊TRAN=lr                    ,            [l_R]
                    )
```

4.13.3 Opérandes

/ ♦ / GROUP_MA_1 =
/MAILLE_1 =

These operands define the first list of meshes in relation (noted Γ_1).

♦ / GROUP_MA_2 =
/MAILLE_2 =

These operands define the second list of meshes in relation (noted Γ_2).

♦ / GROUP_NO_1 =
/NOEUD_1 =

These operands define the first list of nodes in relation.

♦ / GROUP_NO_2 =
/NOEUD_2 =

These operands define the second list of nodes in relation.

The two lists must have the same length.

◊ / `SANS_GROUP_NO =`
/`SANS_NOEUD =`

These operands make it possible to remove list of the couples of nodes as screw - with - screw [§4.14.5] all the couples of which at least one of the nodes belongs to the list of nodes described by these operands.
That makes it possible to avoid the accumulation of linear relations on the same node during various repetitions of the key word factor `LIAISON_GROUP,` which leads most of the time to a singular matrix.

♦`DDL_1 (_2) =`

the argument of `DDL 1` or `_2` must be a list of texts taken among (`DX', "DY", "DZ", "DRX", "DRY", "DRZ")` or `"DNOR"`.

♦`COEF_MULT_1` (resp. `COEF_MULT_2) =`

Liste of realities dimensioned exactly with the number of degrees of freedom declared in `DDL 1` (resp. `DDL 2`) corresponding to the multiplying coefficients of the linear relation.

♦`COEF_IMPO =`

Coefficient of blocking of the linear relation:

β : reality for `AFFE_CHAR_MECA`
βf : function for `AFFE_CHAR_MECA_F`

Les operands `CENTRE` / `ANGL_NAUT` / `TRAN` make it possible to define a virtual transformation (rotation and/or translation) approximate Γ_1 in Γ_2 order to ensuring the bijectivity of the function opposite [§4.14.5].
The command carries out initially rotation, then the translation.

◊`CENTRE=` coordinated centre of rotation (in the total reference)
◊`ANGL_NAUT=` nautical angles defining rotation (in degrees)
◊`TRAN=` component of the vector Remarques

translation:

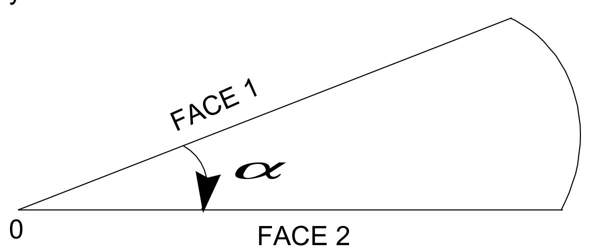
- *It is checked that the degrees of freedom specified in these operands exist for each node of the elements assigned in `the MODELE` to the meshes which contain the node,*
- *to use argument `"DNOR"` , it is compulsory to have declared edges using meshes and which the computation of a norm on this meshes is possible.*

◊`SOMMET = 'OUI'`

When the edge meshes are quadratic (thus `SEG3`) the use of `SOMMET: "OUI"` forces the algorithm of pairing to associate the tops of `the SEG3` with other tops, and the mediums of `the SEG3` in other mediums. In the case of fine meshes, that makes it possible in certain cases to avoid the problems of conflicts of opposite.

4.13.4 Example of use

One wants to impose a cyclic condition of repetitivity (even normal displacement) between face 1 and face 2 of the geometry below:



Let us suppose that FACE1 (respectively FACE2) is made up of the list of meshes lma1 (resp. lma2).

One wants to write the following linear relations:

$\forall N_i^1$ node of the face 1 of opposite N_i^2

$\boldsymbol{u}.\boldsymbol{n}\left(N_i^1\right)=\boldsymbol{u}.\boldsymbol{n}\left(N_i^2\right) \qquad \forall i=1,\ldots,$ *nbno*

where nbno is the number of nodes of face 1 (and of face 2).

The data of LIAISON_GROUP will be written:

```
LIAISON_GROUP=_F  (  MAILLE_1=lma1        ,
                     MAILLE_2=lma2        ,
                     DDL_1=             'DNOR',
                     DDL_2=             'DNOR',
                     COEF_MULT_1=1      .,
                     COEF_MULT_2=-1        .,
                     COEF_IMPO=0          ,
                     CENTRE=               (X0, Y0, Z0),
                     ANGL_NAUT=            ( α , 0. , 0.),
                  )
```

4.13.5 Determination of the couples of nodes in opposite

Elle are in the same way made that in AFFE_CHAR_THER.

Initially, one draws up the two lists of nodes to be put in opposite (IE to be paired), for each occurrence of the key word factor LIAISON_GROUP :

- for key words GROUP_NO_1 and GROUP_NO_2, they are the nodes setting up the nodes groups,
- for key words GROUP_MA_1 and GROUP_MA_2, they are the nodes of the meshes setting up the mesh groups.

The redundancies being eliminated, the two lists of nodes obtained must have the same length.

The determination of the couples of nodes in opposite is done in several stages:

- for each node $N1$ of the first list, one seeks the node image $N2=f(N1)$ of the second list. If f is not injective (a node $N2$ is the image of two distinct nodes $N1$ and $N1'$), the following error message is transmitted:

```
<F> <MODELISA8_85> CONFLICT IN WITH RESPECT TO NODES
LE NODE N2 IS LE WITH RESPECT TO THE NODES N1 AND N1'
```

- for each node $N2$ of the second list, one seeks the node image $N1=g(N2)$ of the first list. If g is not injective (a node $N1$ is the image of two distinct nodes $N2$ and $N2'$), the following error message is transmitted:

```
<F> <MODELISA8_85> CONFLICT IN WITH RESPECT TO NODES
LE N1 NODE IS LE WITH RESPECT TO THE NODES N2 AND N2'
```

- it is checked that $g=f^{-1}$, i.e. the couples obtained by the stages a) and b) are the same ones (one wants to have a bijection f between the two lists of nodes). If f is not surjective, the following error message is transmitted:

```
<F> <MODELISA8_88> CONFLIT DANS LES VIS-À-VIS GENERES
SUCCESSIVEMENT A PARTIR DES LISTES LIST1 AND LIST2
   LE NODE DE LA PREMIERE LISTE N1 EST the IMAGE Of AUCUN NODE PAR
CORRESPONDANCE INVERSE
```

Pour a given N node, one calls node image $f(N)$ the node of the other list of nodes which carries out the minimum of distance with N. To facilitate pairing, in particular in the case of particular geometries (where the borders Γ_1 and Γ_2 could “almost” result one from the other by the composition of a translation and of a rotation), one makes it possible to make a virtual geometrical transformation of the first nodes group (translation and rotation before calculating the distances (key words TRAN, CENTRE and ANGL_NAUT).

For each occurrence of the key word factor LIAISON_GROUP, one thus builds the list of the new couples in opposite. When all the occurrences were swept, one removes list the couples in double.

Note:

In the couples of nodes in opposite, the order of the nodes is important. So for the first occurrence of LIAISON_GROUP , a node N belonged to the first nodes group and a node M with the second group of node, and that for the second occurrence of LIAISON_GROUP , it is the reverse, one will obtain at the conclusion of pairing the couples (N, M) and (M, N). They will not be eliminated during detection of the redundancies; on the other hand, the matrix obtained will be singular. Thus, one advises to keep same logic during the description of edges as screw - with - screw.

4.14 Key word LIAISON_MAIL

4.14.1 Drank

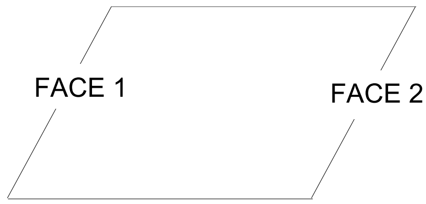
Word-key factor usable to define linear relations making it possible "to restick" two "edges" of a structure.

The characteristic of this key word (compared to LIAISON_GROUP for example) is to make it possible to bind displacements of unconstrained nodes on the mesh. The meshes of FACE1 and FACE2 can be incompatible.

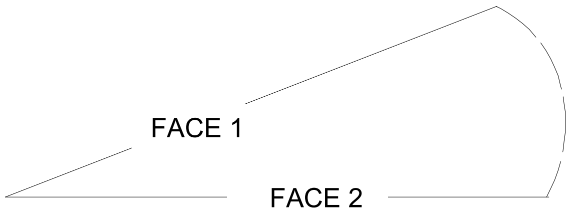
Note: The experiment showed that for computations of periodic homogenisation, the results are much more precise if the 2 sides have compatible meshes (i.e the meshes of FACE1 and FACE2 are superposable modulos a isometry).

Examples:

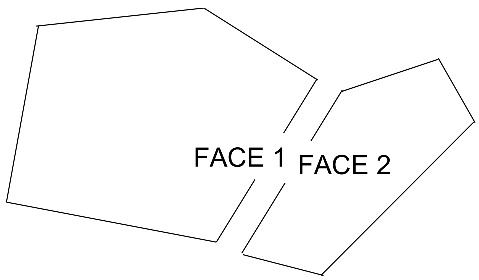
a) a condition of interval (study of a cell of homogenisation)



b) a cyclic condition of repetitivity



c) a condition of simple resticking



Dans the continuation of this paragraph, one will speak about the face "slave" (FACE2) and about the face "Master" (FACE1).

The "resticking" of the 2 sides will be done by writing of linear relations between the degrees of freedom of the 2 sides.

Displacements of the nodes of the face slave will be connected to displacements of their projections on the face Master. For each node of the face slave, one will write 2 (in 2D) or 3 (in 3D) linear relations.

If FACE1 and FACE2 are not geometrically confused but that there exists a isometry (rotation + translation) between the two, the user must define this isometry (that which transforms FACE2 into FACE1).

An application of this functionality is for example the resticking of a mesh formed by linear elements $(P1)$ on another quadratic mesh $(P2)$. In this case it is rather advised to choose like face “slave” the quadratic face.

4.14.2 Syntax (in AFFE_CHAR_MECA only)

```
LIAISON_MAIL=_F      (
   ◊TYPE_RACCORD=           /  "MASSIF"                        [DEFECT]
                            /  "SHELL"
                            /  "COQUE_MASSIF"
                            /  "MASSIF_COQUE"

   ♦  |        GROUP_NO_ESCL=lgno2    ,
[l_gr_noeud]
      |        NOEUD_ESCL=lno2     ,                          [l_noeud]
      |        GROUP_MA_ESCL=lgma2    ,
[l_gr_maille]
      |        MAILLE_ESCL=lma2    ,                          [l_maille]
   ♦  |        GROUP_MA_MAIT=lgma1    ,
[l_gr_maille]
      |        MAILLE_MAIT=lma1    ,                          [l_maille]

   # if TYPE_RACCORD = "MASSIF":
   ◊◊    |  ♦CENTRE=            (xc, yc, [zc]),             [l_R]
            ♦ANGL_NAUT=         (alpha, [beta, gamma]),        [l_R]
         |  ♦TRAN=           (tx, ty, [tz]),               [l_R]
      ◊♦DDL_MAIT=              'DNOR',
         ♦DDL_ESCL=            'DNOR',

   # if TYPE_RACCORD = "COQUE_MASSIF":
   ♦EPAIS=epais                ,                             [l_R]
      CHAM_NORMALE=chanor      ,                          [cham_no]

   ◊ELIM_MULT=                 /  "NON",                     [DEFECT]
                            /  "OUI",
            )
```

4.14.3 Opérandes

4.14.3.1 Choix of surface slave and surface Master

the principle of connection is to eliminate the slaves degrees of freedom by writing them like linear relations from the main degrees of freedom. There is a certain symmetry in the problem and one could believe that one can choose randomly who will be the Master and who will be the slave.

Actually, it is necessary to be attentive on two particular items:

- Syntax is not symmetric: side slave, the user must specify the nodes "to be welded", whereas main side, it must give meshes. Moreover, the meshes Masters are (for time) of a topological dimension with what would be natural. For example, for a mesh 2D, surfaces to be restuck are lines, and one could expect that the meshes Masters are segments. The code expects surface meshes (quadrangles and triangles).
- It is preferable (from a mechanical point of view) to choose like surface slave surface with a grid most finely. In the same way that when 2 sheets are welded, it is to better multiply the weld points.

4.14.3.2 TYPE_RACCORD

This key word makes it possible to choose the type of the linear relations which one will write to eliminate the degrees of freedom from the slave nodes.

- If `TYPE_RACCORD='MASSIF'`, the nodes are supposed to carry degrees of freedom of translation (`DX, DY, DZ`). If the user does not specify `DDL_MAIT='DNOR'`, one will write (for example in 2D), 2 linear relations for each slave node: one to eliminate its `"DX"`, the other to eliminate its `"DY"`.

- If TYPE_RACCORD='SHELL', the nodes are supposed to carry degrees of freedom of translation (DX, DY, DZ) and degrees of freedom of rotation (DRX, DRY, DRZ). One will write 6 linear relations to eliminate the 6 degrees of freedom from each slave node.

- If TYPE_RACCORD='MASSIF_COQUE' , the slave nodes are supposed "massive" (translations: DX, DY, DZ) and the master nodes are supposed of standard "shell" (3 translations and 3 rotations).

The degrees of freedom of translation of the slave nodes are eliminated by writing that they are equal to the translations of the "main" point in opposite. The translations of the main point are computed as if the small segment of norm to the shell remained rigid.

- If TYPE_RACCORD='COQUE_MASSIF', the slave nodes are supposed of standard "shell" (6 degrees of freedom: DX, DY, DZ, DRX, DRY, DRZ) and the master nodes are supposed of "massive" type (DX, DY, DZ).

The degrees of freedom of translation of the slave nodes are eliminated by writing that they are equal to the translations of the "main" point in opposite.
The degrees of freedom of rotation of the slave nodes are eliminated by writing that they are equal to rotations of the "main" point in opposite (A). Rotations of the point A are calculated starting from the translations of two other points $A1$ and $A2$ located at $+h/2$ and $-h/2,$ if h is a normal vector with the shell and of which the length is the thickness of the shell (see key words EPAIS and CHAM_NORMALE).

4.14.3.3 GROUP_NO_ESCL / NOEUD_ESCL / GROUP_MA_ESCL / MAILLE_ESCL

Ces key words make it possible to define all the nodes of the face slave. One takes all the nodes specified by key words GROUP_NO_ESCL and NOEUD_ESCL more all the nodes carried by the meshes specified by key words GROUP_MA_ESCL and MAILLE_ESCL.

Note:

When one wants to restick only normal displacements of the sides (cf key words DDL_MAIT and DDL_ESCL), it is necessary to be able to determine the normal direction of the sides. The normal direction is computed on the face slave. It is thus necessary in this case to use key words GROUP_MA_ESCL and MAILLE_ESCL with meshes of the type "facets".

4.14.3.4 GROUP_MA_MAIT / MAILLE_MAIT

Ces key words make it possible to define the group of the meshes where they with respect to the nodes of the face slave will be sought.

Caution:

In 3D, one should not give meshes of surface, but the voluminal meshes adjacent with the face. The specified meshes are "candidates" for the search of the points opposite. One can give too much of it, that is not awkward.

In the same way, in 2D, the meshes "Masters" must be surface (QUAD, TRIA) and nonlinear

4.14.3.5 CENTRE / ANGL_NAUT / TRAN

Ces key words make it possible to define the geometrical transformation (rotation and/or translation) making it possible to pass from the face main slave to the face.

If these key words are absent, it is that the geometrical transformation is "the identity" i.e. the sides Master and slave are geometrically confused.

It should be noted that the program carries out initially rotation and then the translation. Caution: the meaning of the transformation is slave towards Master.

4.14.3.6 DDL_MAIT / DDL_ESCL

If one wants to restick only normal displacements with the sides, it is necessary to specify:
DDL_MAIT=   'DNOR'

DDL_ESCL= 'DNOR'

Note:

The normal direction is computed on the face slave (it is necessary to give meshes of breakage). This normal direction is transformed by the possible rotation of the geometrical transformation to determine the normal direction on the face Master.

4.14.3.7 Remarks

key word LIAISON_MAIL is made in theory to connect 2 surfaces disjoined a priori. Sometimes it is not the case and a slave node can belong to the one of the meshes Masters. The linear relation that the problem seeks to write becomes a tautology ($X=X$), which leads to a null pivot during factorization.

To avoid this problem, one does not write the relations connecting a slave node to his mesh Master if:

- this node belongs to the connectivity of the mesh
- key words CENTRE, ANGL_TRAN , TRAN were not used

It is necessary to be conscious that for each occurrence of LIAISON_MAIL, one connects TOUS the main slave nodes to the meshes even if the distances from projection are important (one emits however alarms in this case).

It would be an error to write:

```
LIAISON_MAIL =  (   _F (GROUP_MA_ESCL='GE', GROUP_MA_MAIT ='GM1'),
                    _F (GROUP_MA_ESCL='GE', GROUP_MA_MAIT ='GM2'))
```

by thinking that the program will sort in GE the nodes close to $\mathrm{GM1}$ and those close to $\mathrm{GM2}$.
In this example, the nodes of GE will be eliminated 2 times and one can expect a problem of null pivot during factorization.

The user must write:

```
LIAISON_MAIL =  _F (GROUP_MA_ESCL='GE', GROUP_MA_MAIT= (“GM1', “GM2'))
```

4.14.3.8 CHAM_NORMALE = chnor, EPAIS = thick

Ces two words key are compulsory if TYPE_RACCORD = “COQUE_MASSIF”.
Thick is the thickness of the shell on the level of connection (presumedly constant).
Chnor is a field with the nodes which contains the direction of the norm to the shell on the “main” nodes of the meshes.
The field chnor can be obtained by the command:

```
CHNOR = CREA_CHAMP (TYPE_CHAM = “NOEU_GEOM_R”, OPERATION = “NORMAL”,
                    MODELE = MODEL, GROUP_MA = “GMCOQU”)
```

4.14.3.9 ELIM_MULT= “OUI” / “NON” [DEFAUT]

This key word is used to solve the difficulty which can arise when several surfaces adjacent slaves are restuck (i.e which have one or more common nodes).

Let us imagine for example that one writes (in 2D):

```
LIAISON_MAIL= (
         _F (GROUP_MA_ESCL='LIGNE_AB”,  GROUP_MAIT=…)
         _F (GROUP_MA_ESCL='LIGNE_BC”,  GROUP_MAIT=…)
```

If the user forces ELIM_MULT='OUI', the program will treat each occurrence of independent LIAISON_MAIL of way. The node B , pertaining to LIGNE_AB and LIGNE_BC will be eliminated 2 times and it is unfortunately probable that computation will stop during the factorization of the matrix with the message “Pivot almost no one…” because the linear relations generated by LIAISON_MAILLE are redundant.

Most of the time, defect (ELIM_MULT='NON') is the good choice. The only case where the user could use ELIM_MULT='OUI' is that of the use of key word DDL_ESCL='DNOR' because so in the 2 occurrences, normal "the slaves" are not the same ones, elimination is not redundant.

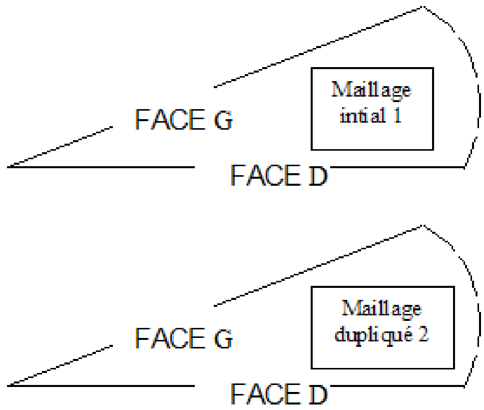
4.15 Key word LIAISON_CYCL

4.15.1 Drank

Word-key factor usable to define the linear relations making it possible to impose conditions of cyclic symmetry with taking into account of a phase shift. It is mainly dedicated to being used in the restrictive frame of dynamic computation with cyclic symmetry.

The characteristic of this key word (with the image of `LIAISON_MAIL`) is to make it possible to bind displacements of unconstrained nodes on the mesh. The meshes of $FACEG$ and $FACED$ can be incompatible.

The cyclic condition of repetitivity applied in the frame of the dynamics is based on the method of duplication of mesh. The operator thus leaves on the postulate that the initial mesh of a sector is duplicated in two meshes identical to the image of the following figure.



In the continuation of this paragraph, one will speak about the face "slave" and the face "Master". The "resticking" of the 2 sides will be done by writing of linear relations between the degrees of freedom of the 2 sides.

Displacements of the nodes of the face slave will be connected to displacements of their projections on the face Master. For each node of the face slave, one will write 2 (in 2D) or 3 (in 3D) linear relations.

If $FACEG$ and $FACED$ are not geometrically confused but that there exists a isometry (rotation + translation) between the two, the user must define this isometry (that which transforms $FACEG$ into $FACED$).

Note:

An application of this functionality is for example the resticking of a mesh formed by linear elements $(P1)$ on another quadratic mesh $(P2)$. In this case it is rather advised to choose like face "slave" the quadratic face.

The statement of the condition of cyclic symmetry for a phase shift AND element β given and while regarding G as the application interface slave is the following one:

$$\begin{bmatrix} q_g^1 \\ q_g^2 \end{bmatrix} = \begin{bmatrix} \cos\beta & \sin\beta \\ -\sin\beta & \cos\beta \end{bmatrix} \begin{bmatrix} q_d^1 \\ q_d^2 \end{bmatrix}$$

In order to write the linear relations making it possible to take into account this condition, it is necessary to give **two** occurrences of the key word factor `LIAISON_CYCL` :

- The first makes it possible to bind the degrees of freedom of the face G of mesh 1 with the face D of the same mesh and the face D of mesh 2. The coefficients ($\cos\beta$ and $\sin\beta$) must be indicated by key words `COEF_MAIT1`, `COEF_MAIT2`.
- The second makes it possible to bind the degrees of freedom of the face G of mesh 2 with the face D of the same mesh and the face D of mesh 1. The coefficients ($-\sin\beta$ and $\cos\beta$) must be indicated by key words `COEF_MAIT1`, `COEF_MAIT2`.

4.15.2 Syntax (in `AFFE_CHAR_MECA` only)

```
LIAISON_CYCL=_F      (
    ♦ | GROUP_NO_ESCL=lgno2          ,                 [l_gr_noeud]
      | NOEUD_ESCL=lno2            ,                 [l_noeud]
      | GROUP_MA_ESCL=lgma2          ,
[l_gr_maille]
      | MAILLE_ESCL=lma2           ,                 [l_maille]
    ♦ | GROUP_MA_MAIT1=lgma1         ,
[l_gr_maille]
      | MAILLE_MAIT1=lma1            ,                 [l_maille]
      | GROUP_MA_MAIT2=lgma2         ,
[l_gr_maille]
      | MAILLE_MAIT2=lma1            ,                 [l_maille]
    ◊ |  ♦ CENTRE=           (xc, yc, [zc]),           [l_R]
         ♦ ANGL_NAUT=         (alpha, [beta, gamma]),      [l_R]
      |  ♦ TRAN=           (tx, ty, [tz]),           [l_R]
    ◊ |  ♦ COEF_MAIT1=      α ,                     [R]
      |  ♦  COEF_MAIT2  =   β ,                     [R]
      |  ♦  COEF_ESCL   =   χ ,                     [R]
    ◊ ♦ DDL_MAIT=          'DNOR',
      ♦ DDL_ESCL=          'DNOR',
               )
```

4.15.3 Operands

4.15.4 `GROUP_NO_ESCL / NOEUD_ESCL / GROUP_MA_ESCL / MAILLE_ESCL`

Ces key words make it possible to define all the nodes of the face slave. One takes all the nodes specified by key words `GROUP_NO_ESCL` and `NOEUD_ESCL` more all the nodes carried by the meshes specified by key words `GROUP_MA_ESCL` and `MAILLE_ESCL`.

Note:

> *When one wants to restick only normal displacements of the sides (cf key words `DDL_MAIT` and `DDL_ESCL`), it is necessary to be able to determine the normal direction of the sides. The normal direction is computed on the face slave. It is thus necessary in this case to use key words `GROUP_MA_ESCL` and `MAILLE_ESCL` with meshes of the type "facets".*

4.15.5 `GROUP_MA_MAIT1 / MAILLE_MAIT1`

Ces key words make it possible to define the group of the meshes Masters of the mesh 1 (or 2) where will be sought they with respect to the nodes of the face slave of mesh 1 or 2.

Caution:

In 3D, one should not give meshes of surface, but the voluminal meshes adjacent with the face. The specified meshes are “candidates” for the search of the points opposite. One can give too much of it, that is not awkward.

In the same way, in 2D, the meshes “Masters” must be surface (`QUAD`, `TRIA`) and nonlinear

4.15.6 GROUP_MA_MAIT2 / MAILLE_MAIT2

Ces key words make it possible to define the group of the meshes of 1 (or 2) where will be sought they with respect to the nodes of the face slave of mesh 1 or 2.

Caution:

> *In 3D, one should not give meshes of surface, but the voluminal meshes adjacent with the face. The specified meshes are "candidates" for the search of the points opposite. One can give too much of it, that is not awkward.*

In the same way, in 2D, the meshes "Masters" must be surface (QUAD, TRIA) and nonlinear

4.15.7 CENTRE / ANGL_NAUT / TRAN

Ces key words make it possible to define the geometrical transformation (rotation and/or translation) making it possible to pass from the face main slave to the face.

If these key words are absent, it is that the geometrical transformation is "the identity" i.e. the sides Master and slave are geometrically confused.

It should be noted that the program carries out initially rotation and then the translation. Caution: the meaning of the transformation is slave towards Master.

4.15.8 COEF_MAIT1 / COEF_MAIT2 / COEF_ESCL

Ces key words make it possible to define the coefficients of the linear relation to apply, in the case of cyclic symmetry they is the cosine and sines the angle phase shift AND element considered. These coefficients must thus be coherent with the definition of the application interfaces Masters and slaves. Coefficient COEF_ESCL makes it possible to pass a coefficient in front of the slaves degrees of freedom.

For example:

$$\text{COEF\_ESCL}\left(q_g^1\right)=\left[\text{COEF\_MAIT1}\times\text{COEF\_MAIT2}\right]\begin{bmatrix}q_d^1\\q_d^2\end{bmatrix}=\left[\cos\beta\cdot\sin\beta\right]\begin{bmatrix}q_d^1\\q_d^2\end{bmatrix}$$

4.15.9DDL_MAIT / DDL_ESCL

If one wants to restick only normal displacements with the sides, it is necessary to specify:

```
DDL_MAIT=     'DNOR'
DDL_ESCL=     'DNOR'
```

Note:

> *The normal direction is computed on the face slave (it is necessary to give meshes of breakage). This normal direction is transformed by the possible rotation of the geometrical transformation to determine the normal direction on the face Master.*

4.16 Key word FORCE_NODALE

4.16.1 Drank

Word-key factor usable to apply, with nodes or nodes groups, nodal forces, definite component by component in reference `GLOBAL` or an oblique coordinate system defined by three nautical angles.

According to the name of the operator called, the values are provided directly (`AFFE_CHAR_MECA`) or via a concept `function` (`AFFE_CHAR_MECA_F`).

4.16.2 Syntax

- for `AFFE_CHAR_MECA`

```
FORCE_NODALE=_F   ( ♦  |  NODE     =lno     ,              [l_noeud]
                       |  GROUP_NO =lgno    ,
[l_gr_noeud]
                    ♦  |  FX=fx               ,              [R]
                       |  FY=fy               ,              [R]
                       |  FZ=fz               ,              [R]
                       |  MX=mx               ,              [R]
                       |  MY=my               ,              [R]
                       |  MZ=mz               ,              [R]
                    ◊  ANGL_NAUT=           ( α , β , γ )    [l_R]
                  ),
```

- for `AFFE_CHAR_MECA_F`

```
FORCE_NODALE=_F   ( ♦  |  NODE     =lno     ,              [l_noeud]
                       |  GROUP_NO =lgno    ,              [l_gr_noeud]
                    ♦  |  FX=fxf              ,
[function]
                       |  FY=fyf              ,
[function]
                       |  FZ=fzf              ,
[function]
                       |  MX=mxf              ,
[function]
                       |  MY=myf              ,
[function]
                       |  MZ=mzf              ,
[function]
                    ◊ANGL_NAUT=             ( α _f, β  _f, γ  _f),
[l_fonction]
                  ),
```

4.16.3 Opérandes

`fx, fy, fz, MX, my, mz`
or `fxf, fyf, fzf, mxf, myf, mzf`

Valeurs of the components of the nodal forces applied to the specified nodes. These nodal forces will come to be superimposed on the nodal forces resulting, possibly, other loadings. Into axisymmetric, the values correspond to a sector of 1 radian (divide the real loading by 2π).

(α, β, γ)
or (α _f, β _f, γ _f)

Liste of the 3 angles, in degrees, which define the oblique coordinate system of application of the nodal forces (the last angles of the list can be omitted if they are null). The nautical angles make it possible to pass from the total reference of definition of the coordinates of the mesh to an unspecified oblique coordinate system (see operator AFFE_CARA_ELEM [U4.42.01]). By defect the angles are identically null and thus the components of forces are defined in reference GLOBAL.

4.17 Key word LIAISON_SOLIDE

4.17.1 Drank

Word-key factor making it possible to modelize an indeformable part of a structure.

One imposes linear relations between the degrees of freedom of the nodes of this indeformable part so that relative displacements between these nodes are null and one imposes possibly displacements on the values resulting from the translation and/or rotation.

These nodes are defined by the mesh groups, the meshes, the nodes groups or the list of nodes to which they belong.

4.17.2 Syntax

- for AFFE_CHAR_MECA and AFFE_CHAR_MECA_F

```
LIAISON_SOLIDE =_F   (
                       ♦  /  MAILLE=lma            ,   [l_maille]
                          /GROUP_MA    =lgma      ,    [l_gr_maille]
                          /NOEUD       =lno       ,    [l_noeud]
                          /GROUP_NO    =lgno      ,    [l_gr_noeud]
                       ◊NUMÉRIQUE_LAGR     = /  "NORMAL",  [DEFECT]
                                             /  "APRES",
                        ◊ |  ♦  CENTRE=       (xc, yc, [zc]  ,   [l_R]
                             ♦ANGL_NAUT=   (alpha, [beta, gamma]),   [l_R]
                          |  ♦TRAN=        (tx, ty, [tz]),   [l_R]
                       ◊DIST_MIN=dmin              ,   [R]
      ),
```

4.17.3 Opérandes

◊NUMÉRIQUE_LAGR :

- If "NORMAL", the two Lagrange multipliers associated with the relation will be such as the first will be located before all the terms implied in the relation and the second after, in the assembled matrix.
- If "APRES", the two Lagrange multipliers associated with the relation will be located after all the terms implied in the relation, in the assembled matrix.

  This choice has the advantage of having an assembled matrix whose overall dimension is weaker but has the disadvantage to be able to reveal a singularity in the matrix.

  Note:

  In a general way, one imposes:

  - *in 2D* $(nb_{ddl} \times nb_{noeud} - 3)$ *relations*
  - *in 3D* $(nb_{ddl} \times nb_{noeud} - 6)$ *relations*

  where

- nb_{ddl} *is the number of degrees of freedom per node,*
- nb_{noeud} *is the number of nodes of the list given after* `LIAISON_SOLIDE`

since a solid is determined by the position of one of its points and a reference in this point.

Relations are written by taking the vectorial formula representing a rigid body motion into small rotations:

$$\vec{u}(M)=\vec{u}(A)+\vec{\Omega}(A)\wedge\overrightarrow{AM}$$

where A *is an arbitrary node of solid.*

◊CENTRE / ANGL_NAUT / TRAN :

These key words make it possible to define the geometrical transformation (rotation and/or translation) making it possible to determine the displacements imposed on structure.

If these key words are absent, imposed displacements are null.

It is currently disadvised using key words CENTRE and ANGL_NAUT.

TRAN= (tx, ty, [tz]) : components of the translation imposed on structure.

◊DIST_ MIN : dmin

This key word is used to define a distance (in the units of the mesh) below which one considers that the points of the mesh are confused. This distance is also used to determine points so are aligned, i.e. if they are in a cylinder of diameter lower than $dmin$.
By default $dmin=0.001*armin$, where $armin$ is the smallest edge of the mesh.

4.18 Key word LIAISON_ELEM

4.18.1 Drank

By calling “massive part” a piece of structure modelized with isoparametric elements 3D, this key word factor makes it possible to modelize the connection:

- of a massive part with a part beam [R3.03.03] or a pipe section [R3.08.06],
- of a shell part with a part beam [R3.06.03] or a pipe section [R3.08.06].

This key word also makes it possible to connect edge of a structure 2D with a beam or a discrete element.

The goal of this functionality is not to give an account of the scales length between the parts to be connected but to allow a simplification of the modelization as a substitute a massive or surface part by a beam part for example.

The connection is treated by forcing linear relations between the degrees of freedom of the nodes of the junction of the two parts to be connected, without imposing superfluous relations.

4.18.2 Syntax (AFFE_CHAR_MECA only)

```
LIAISON_ELEM =_F (
   ♦  /  OPTION=            /  “3D_POU”,
                         /  “3D_TUYAU”,
                         /  “COQ_POU”,
                         /  “COQ_TUYAU”,
                         /  “PLAQ_POUT_ORTH”,
                         /  “2D_POU”,
   # beginning conditionoption    == “PLAQ_POUT_ORTH”
   ◊EXCENT_POUTRE=          /  “NON”,
                         /  “OUI”,                           [DEFAUT]
   # fine condition
   # beginning conditionoption    == “COQ_POU” or
                       option == “COQ_TUYAU” or
                       option == “3D_TUYAU”
   ◊AXE_POUTRE=             (X, there, Z),
       [l_R]
   will ◊CARA_ELEM=cara                   ,
          [cara_elem]
   # end condition
   ♦  /  MAILLE_1=lma1       ,                             [l_maille]
      /GROUP_MA_1      =lgma1 ,                          [l_gr_maille]
    ♦ /NOEUD_2         =lno2  ,                             [l_noeud]
       /GROUP_NO_2     =lgno2 ,                          [l_gr_noeud]
   ◊NUMÉRIQUE_LAGR=            /  “NORMAL”,
       [DEFECT]
                         /  “APRES”,
   ◊ANGL_MAX=               /  1. ,
       [DEFAUT]
                         /angl  ,                                [R]
),
```

4.18.3 Opérandes of option “3D_POU”

♦OPTION = “3D_POU”

Cette option makes it possible to connect a massive part 3D with a part modelized with beams of Euler or Timoshenko.

```
♦  /  MAILLE_1=
   /GROUP_MA_1      =
```

These operands define the surface meshes of the massive part modelizing the trace of the section of the beam on this massive part. This meshes must be affected by finite elements of sides of elements 3D before.

♦ `/NOEUD_2 =`
`/GROUP_NO_2 =`

These operands define the node of the beam to be connected to the massive part. Thus if NOEUD_2 `is used`, one should give one node and if GROUP_NO_2 `is used`, one should give one group, the aforementioned containing one node.

Precaution for use:

The massive part must be with a grid with quadratic elements because the coefficients of the relations to be imposed are numerically integrated geometrical quantities. So that these integrals are evaluated correctly, it is necessary to have quadratic elements.

Note:

A connection between a massive part 3D and a beam part requires six linear relations.

4.18.4 Operands of the option "2D_POU"

♦`OPTION = "2D_POU"`

Cette option makes it possible to connect a surface part 2D to a part modelized with a beam of Euler or discrete.

♦ `/ MAILLE_1=`
`/GROUP_MA_1 =`

These operands define the edge meshes of part 2D to be connected to element 1D.

♦ `/NOEUD_2 =`
`/GROUP_NO_2 =`

These operands define the node of the beam to be connected to the surface part. Thus if NOEUD_2 `is used`, one should give one node and if GROUP_NO_2 `is used`, one should give one group, the aforementioned containing one node.

Precaution for use:

The surface part must be with a grid with quadratic elements because the coefficients of the relations to be imposed are numerically integrated geometrical quantities. So that these integrals are evaluated correctly, it is necessary to have quadratic elements.

4.18.5 Operands of option "COQ_POU"

Cette option makes it possible to connect a part with a grid in shell with a beam part.

♦`AXE_POUTRE =`

Permet to define the axis of the beam to be connected, whose end is `lno2` or `lgno2` (1 only node).

♦`CARA_ELEM = will cara`

Concept created by command `AFFE_CARA_ELEM`, containing the geometrical characteristics of the shell.

♦ `/ MAILLE_1 =`
`/GROUP_MA_1 =`

These operands define the edge meshes of the part with a grid in shells (the edge meshes are thus `SEG2` or `SEG3` following the selected modelization). This meshes must be affected by edge finite elements of shells before.

♦ `/NOEUD_2 =`
`/GROUP_NO_2 =`

These operands define the node of the beam to be connected to the shell part. Thus if NOEUD_2 `is used` one should give one node, and if GROUP_NO_2 `is used`, one should give one group, the aforementioned containing one node.

Precaution for use:

The trace of the section of the beam on the shell part must correspond exactly to the edge meshes defined by `MAILLE_1` or `GROUP_MA_1` . This implies the identity of the centres of inertia, of surfaces of the sections shell and beam in opposite.

4.18.6 Operands of option "3D_TUYAU"

♦OPTION = "3D_TUYAU",

Cette option makes it possible to connect a massive part 3D with a part modelized with elements `PIPE`.

♦AXE_POUTRE =

Définit the axis of the pipe to be connected, whose end is only one node (`lno2` or `lgno2`).

♦CARA_ELEM = will cara

Idem [§4.19.4].

♦ / MAILLE_1 =
/GROUP_MA_1 =

These operands define the surface meshes of the massive part modelizing the trace of the section of the pipe on this massive part. This meshes must be affected by finite elements of sides of elements 3D before.

♦ / NOEUD_2 =
/GROUP_NO_2 =

These operands define the node of the pipe to be connected to the massive part.

Note:

A connection between a massive part 3D and a pipe part requires six linear relations for the degrees of freedom of beam, plus a relation on the mode of swelling, plus twelve relations corresponding to the transmission of the modes of Fourier two and three of ovalization of the pipe.

4.18.7 Operands of option "COQ_TUYAU"

♦ OPTION = "COQ_TUYAU"

Cette option makes it possible to connect a part with a grid in shell to a part with a grid with elements pipe.

♦AXE_POUTRE =

Permet to define the axis of the pipe to be connected, whose end is `lno2` or `lgno2` (only one node).

♦CARA_ELEM = will cara,

Concept created by command `AFFE_CARA_ELEM`, containing the geometrical characteristics of the shell.

♦ /MAILLE_1 =
/GROUP_MA_1 =

These operands define the edge meshes of the part with a grid in shells (the edge meshes are thus `SEG2` or `SEG3` following the selected modelization). This meshes must be affected by edge finite elements of shells before.

♦ /NOEUD_2 =

/GROUP_NO_2 =

These operands define the node of the pipe to be connected to the shell part. Thus if NOEUD_2 is used one should give one node, and if GROUP_NO_2 is used, one should give one group, the aforementioned containing one node.

Precaution for use:

The trace of the section of the pipe on the shell part must correspond exactly to the edge meshes defined by MAILLE_1 or GROUP_MA_1 . This implies the identity of the centres of inertia, of surfaces of the sections shell and pipe in opposite. Consequently connections of type "bypass" are impossible.

Note:

A connection between a shell part and a pipe part requires the same linear relations as option "COQ_POU" on the degrees of freedom of beam of the element pipe besides the relations on the degrees of freedom of ovalization, warping and swelling.

4.18.8 Operands of option "PLAQ_POUT_ORTH"

♦OPTION = "PLAQ_POUT_ORTH"

Cette option makes it possible to connect a part with a grid with elements TRI3 and QUA4 (modelizations DKT, DST and DKTG) with a part modelized by a beam element or discrete.

♦ / MAILLE_1=
/GROUP_MA_1 =

These operands define the meshes of the plate which modelize the trace of the section of the beam on this part. This meshes must be affected by finite elements of plate, modelizations DKT, DST and DKTG.

♦ /NOEUD_2 =
/GROUP_NO_2 =

These operands define the node to be connected to the plate. Thus if NOEUD_2 is used, one should give one node and if GROUP_NO_2 is used, one should give one group, the aforementioned containing one node. The node must carry the following degrees of freedom: DX, DY, DZ, DRX, DRY MARTINI, DRZ.

◊VERIF_EXCENT= / "NON",
/ "OUI", [DEFAUT]

the node of the beam must coincide, except for a tolerance, with the center of gravity of the meshes which modelize the trace of this beam on slab. In the event of noncompliance with this rule, 2 behaviors are possible:

- if VERIF_EXCENT = "OUI" , behavior by defect, an error message is emitted and the code stops in fatal error.
- if VERIF_EXCENT = "NON" , a message of information is emitted.

This operand makes it possible not to be obliged to position exactly the beams at the center of gravity of the trace of the section, which is not inevitably known at the time of the realization of the mesh. In the case, where this rule is not complied with, the user is informed of the distance between the node of the beam and this center of gravity either by a fatal error (VERIF_EXCENT = "OUI") or by the emission of a message of information (VERIF_EXCENT = "NON").

Note:

With an aim of simplifying the input of the data the following checks are not carried out:

- There is no checking which the axis of the beam is perpendicular to the plate.
- There is no checking between the computation of the mechanical characteristics (S, I,…) realized on the meshes of the trace of the section of beam and the mechanical characteristics assigned to the beam with aid `CARA_ELEM`.

To make these checks would be needed that the user gives besides the node of the beam, the name of the mesh affected by `the CARA_ELEM` which has as an end the node of connection. In the large majority of the cases this mesh is unknown of the user, it is the software of mesh which defines its name.

4.18.9 Operand **ANGL_MAX**

```
◊   ANGL_MAX =  /  1.  ,            [DEFAUT]
                /angl  ,            [R]
```

Angle (in degree) allowing to check if the meshes of the lists `lma1` or `lgma1` have norms forming an angle higher than `Eng` between them. If it is the case, there is emission of an alarm message. The programming is made in cases 3D: "`3D_TUYAU`", "`3D_POU`", "`PLAQ_POUT_ORTH`".

4.18.10 Operand **NUME_LAGR**

- If "`NORMAL`", the two Lagrange multipliers associated with the relation will be such as the first will be located before all the terms implied in the relation and the second after, in the assembled matrix.
- If "`APRES`", the two Lagrange multipliers associated with the relation will be located after all the terms implied in the relation, in the assembled matrix.
  This choice has the advantage of having an assembled matrix whose overall dimension is weaker but has the disadvantage to be able to reveal a singularity in the matrix.

4.19 Key word LIAISON_UNIF

4.19.1 Drank

This key word factor makes it possible to impose the same unknown value, for a degree of freedom given, on a set of nodes.

These nodes are defined by the mesh groups, the meshes, the nodes groups or the list of nodes to which they belong.

4.19.2 Syntax

- for AFFE_CHAR_MECA and AFFE_CHAR_MECA_F

```
LIAISON_UNIF =_F  (
                     ♦  /  MAILLE=lma              ,
[l_maille]
                        /GROUP_MA    =lgma  ,          [l_gr_maille]
                        /NOEUD       =lno      ,          [l_noeud]
                        /GROUP_NO    =lgno  ,          [l_gr_noeud]
                     ♦  D.O.F. =       |  "DX",
                                    |  "DY",
                                    |  "DZ",
                                    |  "DRX",
                                    |  "DRY",
                                    |  'DRZ',
                  )
```

4.19.3 Operand

```
♦  /  NET
   /GROUP_MA
   /NOEUD
   /GROUP_NO
```

These operands make it possible to define a list of n nodes N_i from which one eliminated the redundancies, (for MESH and GROUP_MA, it acts of connectivities of the meshes).

♦DDL

Cette operand makes it possible to define a list of degrees of freedom u_i with $i=1,r$ r texts taken among: "DX", "DY", "DZ", "DRX", "DRY", "DRZ"

Les $r\times(n-1)$ resulting kinematical conditions are:

$$u_i(N_1)=u_i(N_k)$$

for $k\in\{2,\dots,n\}$
$i\in\{1,\dots,r\}$

4.20 Word-key LIAISON_CHAMNO

4.20.1 Drank

Word-key factor usable to define a linear relation between all the degrees of freedom present in a concept CHAM_NO. This key word can be also used to impose on structure (or a part) a given work, for a loading computed as a preliminary with another AFFE_CHAR_MECA and leading to an assembled vector produces by ASSE_VECTEUR [U4.61.23].

4.20.2 Syntax (AFFE_CHAR_MECA only)

```
LIAISON_CHAMNO=_F (    ♦  CHAM_NO   =chamno          ,
[cham_no]
                       ♦  COEF_IMPO =    β ,            [R]
                       ◊NUMÉRIQUE_LAGR  = /  "NORMAL",        [DEFECT]
                                          /  "APRES",
                   )
```

4.20.3 Opérandes

CHAM_NO =

Nom of the cham_no which is used to define the linear relation. The degrees of freedom connected are all those present in the chamno. The coefficients to be applied to the degrees of freedom are the values of the chamno for these degrees of freedom.

Example:

Let us suppose that one has a bearing chamno on two nodes of name $N01$ and $N02$ respectively carrying degrees of freedom "DX", "DY" and "DZ" for the N01 node and "DX", "DY", "DZ", "DRX", "DRY" and "DRZ" for the node $N02$.

Also let us suppose that the chamno has the following values for these degrees of freedom:

```
2.    "DX'     N01
1.    "DY'     N01
3.    "DZ'     N01
1.    "DX'     N02
4.    "DY'     N02
2.    "DZ'     N02
3.    "DRX'    N02
5.    "DRY'    N02
2.    "DRZ'    N02
```

the linear relation that one will impose is:

```
  2.*DX (N01) +1.*DY (N01) +3.*DZ (N01)
+ 1.*DX (N02) +4.*DY (N02) +2.*DZ (N02)
+ 3.*DRX (N02) +5.*DRY (N02) +2.*DRZ (N02) = β
```

COEF_IMPO =

It is the value of the real coefficient β to the second member of the linear relation.

NUME_LAGR =

- if "NORMAL", the two Lagrange multipliers associated with the relation will be such as the first will be located before all the terms implied in the relation and the second after, in the assembled matrix,
- if "APRES", the two Lagrange multipliers associated with the relation will be located after all the terms implied in the relation, in the assembled matrix.

This choice has the advantage of having an assembled matrix whose overall dimension is weaker but has the disadvantage to be able to reveal a singularity in the matrix.

4.21 Mot-clé LIAISON_RBE3

4.21.1 Drank

Word-key factor usable to define linear relations of type RBE3 between the degrees of freedom of a master node and slave nodes. They are relations making it possible to specify the value of certain degrees of freedom of a master node as being the weighted average of certain displacements and certain rotations of slave nodes.
The produced linear relations are such as the forces seen by the master node are distributed to the slave nodes proportionally at their distance to the center of gravity of the slave nodes. The possible additional weightings provided by the user can be taken into account. For more precise details, one will be able to refer to Doc. of reference [R3.03.08].

4.21.2 Syntax (AFFE_CHAR_MECA only)

```
LIAISON_RBE3=_F ( ♦  / GROUP_NO_MAIT=gno,            [gr_noeud]
                     / NOEUD_MAIT=no,               [node]
                  ♦ DDL_MAIT=ddl_mait,              [l_Kn]
                  ♦  / GROUP_NO_ESCL=lgno,          [l_gr_noeud]
                     / NOEUD_ESCL=lno ,             [l_noeud]
                  ♦ DDL_ESCL= d. o. f.,
[l_Kn]
                  ◊ COEF_ESCL=formule βi ,              [l_R]
                  ◊ NUME_LAGR= /  "NORMAL",         [DEFECT]
                               /  "APRES",
                )
```

4.21.3 Operands

♦ / GROUP_NO_MAIT=gno,
/ NOEUD_MAIT=no,
Identification of the master node of the linear relation.

♦ DDL_MAIT=ddl_mait,
Identification of the degrees of freedom of the master node implied in the linear relation. One expects a list including at more the 6 entries among "DX", "DY", "DZ", "DRX", "DRY", "DRZ".

♦ / GROUP_NO_ESCL=lgno,
/ NOEUD_ESCL=lno,
Identification of the slave nodes of the linear relation.

♦ DDL_ESCL= d. o. f.,
Identification of the degrees of freedom of the slave nodes implied in the linear relation. The list must have a length equal to the number of slave nodes Chaque term of the list must be a combination of inputs "DX", "DY", "DZ", "DRX", "DRY", "DRZ", separated by a dash " -".

◊ COEF_ESCL=formule β_i ,
Liste of weight coefficients of the terms of the linear relation for each slave node. The list must:

- either to have the same length which the number of slave nodes
- or be length 1, in which case this coefficient is used for all the slave nodes

◊ NUME_LAGR =

- if "NORMAL", the two Lagrange multipliers associated with the relation will be such as the first will be located before all the terms implied in the relation and the second after, in the assembled matrix.
- if "APRES", the two Lagrange multipliers associated with the relation will be located after all the terms implied in the relation, in the assembled matrix.

Example

If one wants to create a relation of the type RBE3 between:

- degrees of freedom "DX", "DY", "DZ", "DRX" of master node "NO1" ;

and:

- degrees of freedom "DX", "DY", "DZ" of slave node "NO2" with the weight coefficient 0.1 ;
- degrees of freedom "DX", "DY", "DZ", "DRX" of slave node "NO3" with the weight coefficient 0.2 ;
- degrees of freedom "DX" , "DY" , "DZ" , "DRX" of slave node "NO4" with the weight coefficient 0.3 ;

one must write the command:

```
LIAISON_RBE3=_F (  GROUP_NO_MAIT='NO1",
                   DDL_ MAIT= ("DX", "DY", "DZ", "DRX"),
                   GROUP_NO_ESCL= ("NO2", "NO3", "NO4"),
                   DDL_ESCL= ("DX-DY-DZ", "DX-DY-DZ-DRX",
                             "DX-DY-DZ-DRX"),
                   COEF_ESCL= (0.1, 0.2,0.3),
                 )
```

4.22 Word-key CHAMNO_IMPO

4.22.1 Drank

It acts by way of a light adaptation of key word LIAISON_CHAMNO of operator AFFE_CHAR_MECA. The aforementioned makes it possible to apply like coefficients of linear relation the contents of a cham_no .
In the case of key word CHAMNO_IMPO, one takes the contents of a cham_no like second member of the linear relation. It is thus strictly equivalent to a manual procedure where one recovers the values of the cham_no to the hand then one imposes them via DDL_IMPO.

4.22.2 Syntax (AFFE_CHAR_MECA only)

```
    CHAMNO_IMPO=_F  (  ♦  CHAM_NO   =chamno         ,
[cham_no_sdaster]
                       ♦  COEF_MULT =     β  ,          [R]
                       ◊ NUME_LAGR =  /  "NORMAL",      [DEFECT]
                                      /  "APRES",)
```

4.22.3 Opérandes

CHAM_NO =

Nom of the cham_no which is used to define the specified values.

COEF_MULT =

multiplying Coefficient of the cham_no.

NUME_LAGR =

- if "NORMAL", the two Lagrange multipliers associated with the relation will be such as the first will be located before all the terms implied in the relation and the second after, in the assembled matrix,
- if "APRES", the two Lagrange multipliers associated with the relation will be located after all the terms implied in the relation, in the assembled matrix.

This choice has the advantage of having an assembled matrix whose overall dimension is weaker but has the disadvantage to be able to reveal a singularity in the matrix.

4.23 Key word LIAISON_INTERF

4.23.1 Drank

Word-key factor répétable and usable with a model containing at the same time static finite elements and macro-elements condensing certain subdomains. It makes it possible to define linear relations between the physical degrees of freedom of the application interfaces of the part of model in finite elements and the generalized coordinates of modes of reduced representation of the motions of application interface contained in certain macro-elements of static condensation.

4.23.2 Syntax (AFFE_CHAR_MECA only)

```
        LIAISON_INTERF=_F (    ♦MACR_ELEM_DYNA  =macrel  ,
[macr_elem_dyna]
                              ◊TYPE_LIAISON   = /  "RIGID",          [DEFECT]
                                                /  "SOUPLE",)
```

4.23.3 Opérandes

MACR_ELEM_DYNA =

Nom of the macr_elem_dyna which is used to define the linear relations between the physical degrees of freedom of the interface between the field non-condensed modelized in finite elements and a field condensed by the macro-element and the components of the node compared to generalized coordinates of modes of motions of interface. That is necessary only when the modes of motions of application interface are a reduced base of all the constrained modes corresponding each one to a mode of displacement for each physical degree of freedom of the application interface. One thus generates relations of the type LIAISON_DDL whose coefficients are calculated in a transparent way for the user between the nodes of the dynamic interface of the macro-element and those associated with the base of reduction which was used to constitute the macro-element.

TYPE_LIAISON =

- so "RIGID", one writes the relation between the physical degrees of freedom of the interface U_Σ and the components of the node compared to generalized coordinates q of modes of motions of interface Φ in the shape of simple product: $U_\Sigma = \Phi_q$. This choice makes it possible to have a connection more rigid than by taking into account all the constrained modes corresponding each one to a mode of displacement for each physical degree of freedom of the application interface.
- if "SOUPLE", one writes the relation between the physical degrees of freedom of the interface U_Σ and the components of the node compared to generalized coordinates q of modes of motions of interface Φ in the shape of double product: $\Phi^T U_\Sigma = \Phi^T \Phi q$. This choice makes it possible to have a connection more flexible than by taking into account all the constrained modes corresponding each one to a mode of displacement for each physical degree of freedom of the application interface.

4.24 Key word VECT_ASSE

4.24.1 Drank

Word-key making it possible to assign a second member in the form of a CHAM_NO in commands STAT_NON_LINE and DYNA_NON_LINE. This CHAM_NO is transmitted to these commands via the name of the loading.

4.24.2 Syntax

```
VECT_ASSE =chamno                  [cham_no_DEPL_R]
```

4.24.3 Opérande VECT_ASSE

chamno is the name of the CHAM_NO which will serve as second member in commands STAT_NON_LINE or DYNA_NON_LINE.

The mode of use can see itself in the following way:

```
tank = AFFE_CHAR_MECA    (
          MODELE=modele       ,
          VECT_ASSE=chamno    ,
                       );
resu = STAT_NON_LINE    (
          MODELE=modele       ,
          EXCIT=_F          (LOAD = tank),
          …            ) ;
```

4.25 Mot-clé FORCE_SOL

4.25.1 Drank

Word-key making it possible to take into account the internal force of a field of ground by using the temporal evolutions of the contributions in rigidity, mass and damping of the impedance of ground. The impedance of ground extracted at initial time makes it possible to constitute by MACR_ELEM_DYNA a macro-element representing the behavior of the field of ground which one adds to the structure model. The dynamic application interface of the macro-element is described either by a super-mesh of the model containing at the same time structure and this macro-element, or by a nodes group if the physical application interface coincides with the modal dynamic application interface.
One can also take into account, if it exists, the temporal evolution of the seismic forces, assigned to this same dynamic application interface in the form of logical unit.
This kind of load is taken into account in command DYNA_NON_LINE.

4.25.2 Syntax (AFFE_CHAR_MECA only)

```
FORCE_SOL=_F (   ♦ |  UNITE_RESU_RIGI =UNIRESRI  ,          [I]
                   |  UNITE _RESU_AMOR =UNIRESAM ,          [I]
                   |  UNITE_RESU_MASS =UNIRESMA  ,          [I]
                 ◊  UNITE_RESU_FORC =UNIRESFO ,             [I]
                 ♦ /   SUPER_MAILLE =sup_ma   ,       [super_maille]
                   /  GROUP_NO_INTERF =gnintf,        [group_no]
              )
```

4.25.3 Opérandes UNITE_RESU_RIGI/UNITE_RESU_AMOR/UNITE_RESU_MASS

Ces operands make it possible to introduce the temporal evolutions of the contributions in rigidity, mass and damping of the impedance of ground in the form of logical units. It is necessary at least that one of these operands is present.

4.25.4 Operands UNITE_RESU_FORC

Cet operand makes it possible to introduce, if it exists and in the form of logical unit, the temporal evolution of the seismic forces, assigned to the dynamic interface of the macro-element representing the behavior of the field of ground which one adds to the structure model.

4.25.5 Operands SUPER_MAILLE/GROUP_NO_INTERF

Ces operands make it possible to describe the dynamic interface of the macro-element representing the behavior of the field of ground which one adds to the model of structure either by a super-mesh of the model containing at the same time structure and this macro-element by key word SUPER_MAILLE, or by a nodes group by key word GROUP_NO_INTERF if the physical interface coincides with the modal dynamic interface.

4.25.6 Example of use

an example of use is provided in the case test MISS03B [V1.10.122].

4.26 Key word FORCE_FACE

4.26.1 Drank

Word-key factor usable to apply **surface forces** to **a face** (of voluminal element) defined by one or more meshes or of the mesh groups of type **triangle** or **quadrangle**.

According to the name of the operator called, the values are provided directly (AFFE_CHAR_MECA) or via a concept function (AFFE_CHAR_MECA_F).

4.26.2 Syntax

- for AFFE_CHAR_MECA

```
FORCE_FACE=_F  ( ♦  |  MAILLE=lma              ,       [l_maille]
                    |     GROUP_MA=lgma,          [l_gr_maille]
                 ♦  |  FX=fx                ,       [R]
                    |  FY=fy                ,       [R]
                    |  FZ=fz                ,       [R]
               )
```

- for AFFE_CHAR_MECA_F

```
FORCE_FACE=_F  ( ♦  |  MAILLE=lma              ,       [l_maille]
                    |     GROUP_MA=lgma,          [l_gr_maille]
                 ♦  |  FX=fxf               ,       [function]
                    |  FY=fyf               ,       [function]
                    |  FZ=fzf               ,       [function]
               )
```

4.26.3 Opérandes

fx, fy, fz fxf, fyf, fzf	values of the components in reference GLOBAL of the surface forces applied to the face.

4.26.4 Modelizations and meshes

This loading applies to the types of meshes and the following modelizations:

Net	Modélisation
TRIA3, TRIA6, QUAD4, QUAD8, QUAD9, QUAD8, TRIA6	3D, 3D SI, 3D_INCO 3D_HHMD, 3D_HMD, 3D_THHD, 3D_THHMD, 3D_THMD

Remarque:

- The rule of remanence (see U1.03.00) applies between the various quantities which one can affect: FX, FY,... .

4.27 Key word FORCE_ARETE

4.27.1 Drank

Word-key factor usable to apply linear **forces**, with **an edge** of voluminal **element** or shell. This edge is defined by one or more meshes or of the mesh groups of type **segment**.

According to the name of the operator called, the values are provided directly (AFFE_CHAR_MECA) or via a concept function (AFFE_CHAR_MECA_F).

4.27.2 Syntax

- for AFFE_CHAR_MECA

```
FORCE_ARETE =_F   ( ♦ |  MAILLE=lma              ,
[l_maille]
                      |    GROUP_MA=lgma,           [l_gr_maille]
                    ♦ |  FX=fx                ,        [R]
                      |  FY=fy                ,        [R]
                      |  FZ=fz                ,        [R]
                      |  MX=mx                ,        [R]
                      |  MY=my                ,        [R]
                      |  MZ=mz                ,        [R]
                  )
```

- for AFFE_CHAR_MECA_F

```
FORCE_ARETE =_F      ( ♦ |  MAILLE=lma              ,
[l_maille]
                         |    GROUP_MA=lgma,           [l_gr_maille]
                       ♦ |  FX=fxf               ,        [function]
                         |  FY=fyf               ,        [function]
                         |  FZ=fzf               ,        [function]
                         |  MX=mxf               ,        [function]
                         |  MY=myf               ,        [function]
                         |  MZ=mzf               ,        [function]
                     )
```

4.27.3 Opérandes

fx, fy, fz, MX, my, mz   values of the components in reference GLOBAL
fxf, fyf, fzf, mxf, myf, mzf : of the linear forces applied to the edge.

4.27.4 Modelizations and meshes

This loading applies to the types of meshes and the following modelizations:

Net	Modélisation
SEG2	DKT, DST, Q4G
SEG2, SEG3	3D, 3D SI, 3D_INCO
	COQUE_3D

4.28 Word-key FORCE_CONTOUR

4.28.1 Drank

Word-key factor usable to apply linear **forces**, at the edge of **a field** (2D, AXIS or AXIS_FOURIER) defined by one or more meshes or of the mesh groups.

According to the name of the operator called, the values are provided directly (AFFE_CHAR_MECA) or via a concept function (AFFE_CHAR_MECA_F).

4.28.2 Syntax

- for AFFE_CHAR_MECA

```
FORCE_CONTOUR=_F  ( ◊  | NET   =lma        ,          [l_maille]
                       | GROUP_MA=lgma    ,          [l_gr_maille]
                    ♦  | FX=fx               ,          [R]
                       | FY=fy               ,          [R]
                       | FZ=fz               ,          [R]
                       | MX=mx               ,          [R]
                       | MY=my               ,          [R]
                       | MZ=mz               ,          [R]
                  )
```

- for AFFE_CHAR_MECA_F

```
FORCE_CONTOUR=_F  ( ◊  | NET   =lma        ,          [l_maille]
                       | GROUP_MA=lgma    ,          [l_gr_maille]
                    ♦  | FX=fxf              ,          [function]
                       | FY=fyf              ,          [function]
                       | FZ=fzf              ,          [function]
                       | MX=mxf              ,          [function]
                       | MY=myf              ,          [function]
                       | MZ=mzf              ,          [function]
                  )
```

4.28.3 Opérandes

fx, fy, fz, MX, my, mz fxf, fyf, fzf, mxf, myf, mzf	values of the components in reference GLOBAL of the linear forces applied to contour.

4.28.4 Modelizations and meshes

This loading applies to the types of meshes and the following modelizations:

Net	Component	Modélisation
SEG2, SEG3	C_PLAN D_PLAN AXIS	Fx, Fy Fx, Fy Fx, Fy
SEG2, SEG3	AXIS_FOURIER	Fx (R), Fy (Z), Fz (θ)

Remarque:

Out of plane, the forces are with being provided per unit of length of the mesh, into axisymmetric, the forces required are brought back to a sector of 1 radian (divide the real loading by 2π *).*

4.29 Key word FORCE_INTERNE

4.29.1 Drank

Word-key factor usable to apply **volume forces** (2D or 3D), with **a field** defined by one or more meshes or of the mesh groups of the voluminal **type**.

According to the name of the operator called, the values are provided directly (AFFE_CHAR_MECA) or via a concept function (AFFE_CHAR_MECA_F).

4.29.2 Syntax

- for AFFE_CHAR_MECA

```
FORCE_INTERNE=_F  ( ♦  /  TOUT      =    'OUI”,
                       /  |  NET    =lma       ,          [l_maille]
                          |  GROUP_MA =lgma    ,        [l_gr_maille]
                    ♦  |  FX=fx                ,                 [R]
                       |  FY=fy                ,                 [R]
                       |  FZ=fz                ,                 [R]
                  )
```

- for AFFE_CHAR_MECA_F

```
FORCE_INTERNE=_F  ( ♦  /  TOUT      =    'OUI”,
                       /  |  NET    =lma       ,          [l_maille]
                          |  GROUP_MA =lgma    ,
[l_gr_maille]
                    ♦  |  FX=fxf               ,
[function]
                       |  FY=fyf               ,
[function]
                       |  FZ=fzf               ,
[function]
                  )
```

4.29.3 Opérandes

fx, fy, fz, fxf, fyf, fzf :	values of the components in reference GLOBAL of the volume forces applied to the field.

4.29.4 Modelizations and meshes

This loading applies to the types of meshes and the following modelizations:

Net	Modélisation
HEXA8, HEXA20, HEXA27 PENTA6, PENTA15 TETRA4, TETRA10 PYRAM5, PYRAM13	3D, 3D SI, 3D_INCO 3D_HHMD, 3D_HMD, 3D_THHD, 3D_THHMD, 3D_THMD, 3D_THHM, 3D_THM, 3D HM, 3D_THH, 3D_HHM
TRIA3, TRIA6, QUAD4, QUAD8, QUAD9	C_PLAN D_PLAN AXIS AXIS_FOURIER AXIS_SI AXIS_INCO AXIS_THHM, AXIS_HM, AXIS_THH, AXIS_HHM, AXIS_THM D_PLAN_THHM, D_PLAN_HM, D_PLAN_THH, D_PLAN_HHM, D_PLAN_THM

Remarques:

- *In 2D (resp 3D), the forces are with being provided per unit of area (resp volume), into axisymmetric, the forces required are brought back to a sector of 1 radian (divide the real loading by 2π).*
- The rule of remanence (see U1.03.00) applies between the various quantities which one can affect: `FX`, `FY`,… .

4.30 Key word PRES_REP

4.30.1 Drank

Word-key factor usable to apply **a pressure** to a field of continuum **2D or 3D** and/or **shears** with a field of continuum **2D**.

According to the name of the operator called, the values are provided directly (AFFE_CHAR_MECA) or via a concept function (AFFE_CHAR_MECA_F).

4.30.2 Syntax

- for AFFE_CHAR_MECA

```
|   PRES_REP=_F    ( ♦  /  TOUT      =    'OUI”,
                        /  |   NET    =lma         ,       [l_maille]
                           |   GROUP_MA =lgma      ,       [l_gr_maille]
                           |   FISSURE    =fiss ,          [fiss_xfem]
                     ♦  |  PRES      =P       ,            [R]
                        |  CISA_2D   =T       ,            [R]
                   )
```

- for AFFE_CHAR_MECA_F

```
|   PRES_REP=_F    ( ♦  /  TOUT      =    'OUI”,
                        /  |   NET    =lma         ,       [l_maille]
                           |   GROUP_MA =lgma      ,       [l_gr_maille]
                           |   FISSURE    =fiss ,          [fiss_xfem]
                     ♦  |  PRES      =Pf      ,            [function]
                        |  CISA_2D   =Tf      ,            [function]
                   )
```

4.30.3 Opérandes

| PRES = P (PF)

Valeur of imposed pressure

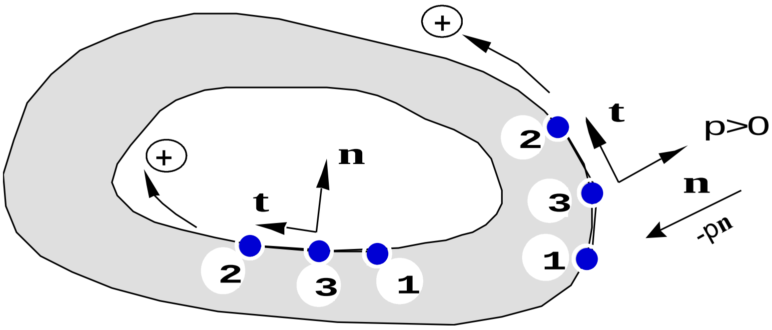
P (or PF) is positive according to the contrary meaning of the norm to the element: that is to say σ the tensor of the stresses, the imposed loading is: $\sigma_{ij} n_i n_j = -p n_i n_j$.

| CISA_2D = T (Tf)

Valeur of the shears imposed

T (or Tf) is positive according to the tangent with the element.

For the definition of the norms and tangents, one will refer to the definitions given to [§4.1]. Example:



| FISSURE =fiss , [fiss_xfem]

the imposition of a pressure on the lips of a crack X-FEM is done by the specific key word FISSURES , since no group of mesh corresponds to the lips. One then informs the names of the cracks (coming from command DEFI_FISS_XFEM [U4.82.08]) about which one wishes to apply the pressure.

4.30.4 Modelizations and meshes

the loading of pressure applies to the types of meshes and the following modelizations:

Type of Mesh	Modelization
SEG2 SEG3	AXIS, D_PLAN, C_PLAN, AXIS_FOURIER D_PLAN_HHM, D_PLAN_HM, D_PLAN_THHM, D_PLAN_THM
SEG3	AXIS_HHM, AXIS_HM, AXIS_THHM, AXIS_THM
TRIA6 QUAD8	3D_HHM, 3D HM, 3D_THHM, 3D_THM
TRIA3, QUAD4 TRIA6, QUAD8, QUAD9	3D

the loading of shears applies to the meshes and the following modelizations:

Type of Mesh	Modelization
SEG2 SEG3	AXIS, D_PLAN, C_PLAN, AXIS_FOURIER

4.31 Word-key EFFE_FOND

Word-key factor usable to calculate the basic effect on a branch of pipework (modelization 3D exclusively) subjected to an internal pressure P.

4.31.1 Syntax

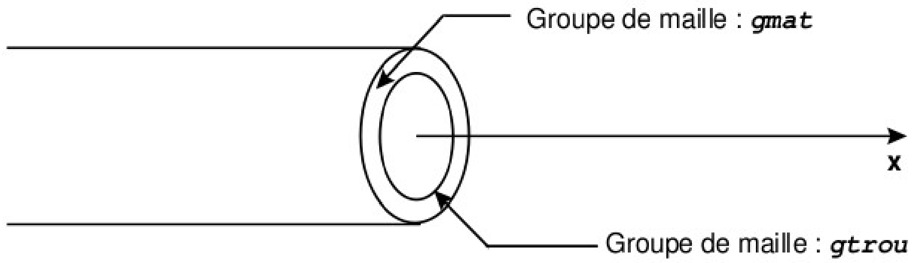
- for `AFFE_CHAR_MECA`

```
|   EFFE_FOND =_F  ( ♦  |   NET  =lma          ,          [l_maille]
                        |   GROUP_MA=lgma      ,          [l_gr_maille]
                     ♦GROUP_MA_INT=gtrou          ,
[l_gr_maille]
                     ♦PRES=p                   ,              [R]
                 )
```

- for `AFFE_CHAR_MECA_F`

```
|   EFFE_FOND =_F  ( ♦  |   NET  =lma          ,          [l_maille]
                        |   GROUP_MA=lgma      ,          [l_gr_maille]
                     ♦GROUP_MA_INT=gtrou          ,
[l_gr_maille]
                     ♦PRES=pf                  ,              [function]
                 )
```

4.31.2 Opérandes




```
♦   |        GROUP_MA=gmat,
    |   MAILLE=lma                 ,
```

Together of the surface meshes modelizing the material section of pipework (`gmat` on the figure) where the pressure will be applied.

```
♦GROUP_MA_INT=gtrou                ,
```

Together of the linear meshes (`SEG2` or `SEG3`) modelizing the contour of the hole (option on the figure).

The knowledge of this meshes is necessary because one needs compute the area of hole.

Indeed, the force resulting (or basic effect) due to stopping from hole at the end is worth:

$$F_b = \pi R_i^2 P \cdot x$$

This basic force or effect applies to the wall of the tube (`gmat`). The force divided agent is worth:

$$F_p = \frac{\pi R_i^2}{\pi \left(R_e^2 - R_i^i \right)} P \cdot x = P \frac{S_{trou}}{S_{mat}} \cdot x$$

```
♦PRES     :  p (or PF)
```

internal Pressure with the pipework. One applies in fact F_p to $gmat$ (with $p > 0$ following the contrary meaning of the norm to the element).

4.32 Mot-clé PRE_EPSI

4.32.1 Drank

Word-key factor usable to apply a predeformation ε_{pre}. It is a loading of strain average, overall uniform applied to an element 2D, 3D or of structure. The assignment can be done on one or more meshes, one or more mesh groups or on all the elements of the model.

The second computed elementary member will be $\int_{Ve} A\,\varepsilon_{pre}:\varepsilon(v^*)dV_e$ where A indicates the elasticity tensor (recovered in the field material for all the models for which are defined the elastic characteristics).

One should not confuse this predeformation with the initial strain ε_{ini} used into nonlinear, because this predeformation does not intervene directly in the statement of the constitutive law.

This predeformation is usable for example to solve the elementary problems determining the elastic correctors in the basic cell (2D, 3D), in periodic homogenisation. The moduli of homogenized elasticity are obtained by calculating by operator POST_ELEM [U4.81.22] key word ENER_POT the potential energy of elastic strain to the equilibrium starting from the correctors. But that can be useful for other applications.

4.32.2 Syntax

- for AFFE_CHAR_MECA

```
PRE_EPSI =_F  ( ♦  /  TOUT     =   'OUI”,
                   /  | NET    =lma       ,         [l_maille]
                      | GROUP_MA =lgma    ,         [l_gr_maille]

                ♦   | EPXX=epsxx          ,            [R]
                    | EPYY=epsyy          ,            [R]
                    | EPZZ=epszz          ,            [R]
                    | EPXY=epsxy          ,            [R]
                    | EPXZ=epsxz          ,            [R]
                    | EPYZ=epsyz          ,            [R]
                    | EPX=epsx            ,            [R]
                    | KY=ky               ,            [R]
                    | KZ=kz               ,            [R]
                    | EXX=exx                 ,            [R]
                    | EYY=eyy                 ,            [R]
                    | EXY=exy                 ,            [R]
                    | KXX=kxx                 ,            [R]
                    | KYY=kyy                 ,            [R]
                    | KXY=kxy                 ,            [R]
              )
```

- for AFFE_CHAR_MECA_F

```
PRE_EPSI =_F  ( ♦  /  TOUT     =   'OUI”,
                   /  | NET    =lma       ,         [l_maille]
                      | GROUP_MA =lgma    ,         [l_gr_maille]

                ♦  | EPXX=epsxxf          ,            [function]
                   | EPYY=epsyyf          ,            [function]
                   | EPZZ=epszzf          ,            [function]
                   | EPXY=epsxyf          ,            [function]
                   | EPXZ=epsxzf          ,            [function]
                   | EPYZ=epsyzf          ,            [function]
              )
```

4.32.3 Opérandes

| `EPXX = epsxxouepsxxf`
| `EPYY = epsyyouepsyyfcomposantes` of the tensor of the strains
| `EPZZ = epszzouepszzfinitiales` in reference `GLOBAL`
| `EPXY = epsxyouepsxyf`
| `EPXZ = epsxzouepsxzf` (in 3D only)
| `EPXZ = epsxz` or `epsxzf`

Remarques:

For the elements beams only: constant strain field generalized by element:

| `EPX = epsx :`

strain according to the axis of the beam

| `KY = ky :`

variation of curvature according to the local y *axis* $-\frac{d\,\theta_y}{dx}$

| `KZ = kz :`

variation of curvature according to the local z *axis* $\frac{d\,\theta_z}{dx}$

Pour curved beams, only `EPX` is taken into account currently. Emission of a fatal error message if the user provides `KY` or `KZ` .

For the elements shells only: constant strain field initial by element:

| `EXX, EYY, EXY :` strains of membrane
| `KXX, KYY, KXY :` variations of curvatures

4.32.4 Modelizations and meshes

This loading applies to the types of meshes and the following modelizations:

Type of Mesh	Modelization
TRIA3, TRIA6 QUAD4, QUAD8, QUAD9	C_PLAN, AXIS, D_PLAN
HEXA8, HEXA20, HEXA27 PENTA6, PENTA15 PYRAM5, PYRAM13 TETRA4, TETRA10	3D
SEG2	POU_D_E, POU_D_T, POU_D_TG, POU_C_T
TRIA3, QUAD4	DKT, DST, Q4G
HEXA20	3D SI
QUAD8	AXIS_SI, D_PLAN_SI

4.33 Word-key FORCE_POUTRE

4.33.1 Drank

Word-key factor usable to apply linear **forces**, to elements of type beam (POU_D_T_*, POU_D_E,…) defined on all the mesh or one or more meshes or of the mesh groups. The forces are definite component by component, either in reference GLOBAL, or in the local coordinate system of the element defined by operator AFFE_CARA_ELEM [U4.42.01].

According to the name of the operator called, the values are provided directly (AFFE_CHAR_MECA) or via a concept function (AFFE_CHAR_MECA_F).

4.33.2 Syntax

- for AFFE_CHAR_MECA

```
FORCE_POUTRE =_F  ( ♦  /  TOUT     =   'OUI',
                       /  |  NET    =lma        ,          [l_maille]
                          |  GROUP_MA =lgma      ,         [l_gr_maille]
                    ♦  /  |  FX=fx               ,          [R]
                          |  FY=fy               ,          [R]
                          |  FZ=fz               ,          [R]
                       /  |  N=n                 ,          [R]
                          |  VY=vy               ,          [R]
                          |  VZ=vz               ,          [R]
                    ◊TYPE_CHARGE=       /  “FORCE”,        [DEFECT]
                                        /  “VENT”,
                  )
```

- for AFFE_CHAR_MECA_F

```
FORCE_POUTRE =_F  ( ♦  /  TOUT     =   'OUI',
                       /  |  NET    =lma        ,          [l_maille]
                          |  GROUP_MA =lgma      ,         [l_gr_maille]
                    ♦  /  |  FX=fxf              ,         [function]
                          |  FY=fyf              ,         [function]
                          |  FZ=fzf              ,         [function]
                       /  |  N=nf                ,         [function]
                          |  VY=vyf              ,         [function]
                          |  VZ=vzf              ,         [function]
                    ◊TYPE_CHARGE=       /  “FORCE”,        [DEFECT]
                                        /  “VENT”,
                  )
```

4.33.3 Operands

```
♦  /  |  FX  :  Force according to X                [R] or [function]
      |  FY  :  Force according to Y                [R] or [function]
      |  FZ  :  Force according to Z                [R] or [function]
   /  |  N   :  Force of traction and compression   [R] or [function]
```

| `VY` : Transverse force following `Y` `[R]` or `[function]`

| `VZ` : Transverse force following `Z` `[R]` or `[function]`

Notons which one must remain homogeneous in each occurrence of the key word factor `FORCE_POUTRE` : either all the components are defined in reference `GLOBAL` or all the components are defined in the reference of definition of the beam.

◊`TYPE_CHARGE=` `'VENT'`

If p is the pressure exerted by the wind on a normal flat surface with its direction,

$\boldsymbol{\nu}=(\nu_x, \nu_y, \nu_z)$ the unit vector having the direction and the meaning velocity of the wind,

$\varnothing$ the diameter of the cable on which is exerted the wind,

then:

`FX` = $p\,\varnothing\,\nu_x$
`FY` = $p\,\varnothing\,\nu_y$
`FZ` = $p\,\varnothing\,\nu_z$

`TYPE_CHARGE=` `'FORCE'` `[DEFAUT]`

Cas of an unspecified linear force.

4.33.4 Modelizations and meshes

This loading applies to the types of meshes and the following modelizations:

Net	**Modélisation**
`SEG2`	`POU_D_T, POU_C_T, POU_D_E POU_D_TGM`

This loading is not currently available for modelization `POU_D_TG`.

Note: the rule of remanence (see U1.03.00) applies between the various quantities which one can affect: `FX`, `FY`,… .

4.34 Key word DDL_POUTRE

4.34.1 Drank

Word-key factor usable to lock D.O.F. in a local coordinate system of a beam.
The local coordinate system of a beam is defined:

- by the axis X determined by the mesh to which the node belongs. The mesh is directed towards the specified node. To avoid the indetermination, it is necessary that the node to which the condition relates belongs to only one SEG. In the case or it belongs to several meshes, the user defines the mesh giving the local directional sense.
- by VECT_Y : a vector whose projection on the orthogonal level with the axis X defines the axis Y. The axis Z is given using X and Y
- by ANGL_VRIL : angle of gimlet, given in degrees, makes it possible to direct a local coordinate system around the axis X.

4.34.2 Syntax

- for AFFE_CHAR_MECA

```
DDL_POUTRE =_F    ( ♦  |  NODE     =lno     ,          [l_noeud]
                       |  GROUP_NO =lgno    ,          [l_gr_noeud]
                    ♦  |  DX  =UX              ,          [R]
                       |  DY  =UY              ,          [R]
                       |  DZ  =UZ              ,          [R]
                       |  DRX =         θx  ,          [R]
                       |  DRY =         θy  ,          [R]
                       |  DRZ =         θz  ,          [R]
# definition of the local coordinate system
                    ◊  |  NET    =lma     ,          [l_maille]
                       |  GROUP_MA =lgma   ,          [l_gr_maille]
                    ♦  /  ANGL_VRIL =  G,              [R]
                       /VECT_Y    =     (V1, V2, V3)  [l_R]
                  )
```

4.34.3 Opérandes

DX = ux DY = uy DZ = uz	Valeur of the component of displacement in **translation** imposed on the specified nodes
DRX = θ_x DRY = θ_y DRZ = θ_z	Valeur of the component of displacement in **rotation** imposed on the specified nodes

ANGL_VRIL = G

angle of gimlet, given in degrees, makes it possible to direct a local coordinate system around the axis X.

VECT_Y = (V1, V2, V3)

vector whose projection on the orthogonal level with the axis X defines the axis Y.
The axis Z is given using X and Y

4.34.4 Modelizations and meshes

This loading applies to the types of meshes and the following modelizations:

Net	Modélisation

SEG2	POU_D_T, POU_C_T, POU_D_TG, POU_D_E, POU_D_TGM

4.35 Word-key FORCE_TUYAU

4.35.1 Drank

Word-key factor usable to apply a pressure to elements pipe, defined by one or more meshes or of the mesh groups.

4.35.2 Syntax

- AFFE_CHAR_MECA :

```
    |  FORCE_TUYAU=_F ( ♦  /  TOUT     =   'OUI',
                           /  |  NET   =lma      ,          [l_maille]
                              |  GROUP_MA =lgma  ,
[l_gr_maille]
                        ♦PRES=p              ,                 [R]
                    )
```

- AFFE_CHAR_MECA_F :

```
    |  FORCE_TUYAU=_F ( ♦  /  TOUT     =   'OUI',
                           /  |  NET   =lma      ,          [l_maille]
                              |  GROUP_MA =lgma  ,
[l_gr_maille]
                        ♦PRES=pf             ,
[function]
                    )
```

4.35.3 Opérande

PRES =p (PF),

Valeur of the imposed pressure (real or function).
p is positive when the pressure is intern with the pipework.

4.35.4 Modelizations and meshes

This loading applies to the types of meshes and the following modelizations:

Net	Modélisation
SEG3, SEG4	"TUYAU_3M"
SEG3	"TUYAU_6M"

4.36 Word-key FORCE_COQUE

4.36.1 Drank

Word-key factor usable to apply surface forces, to elements of type shell (DKT, DST, Q4G,…) defined on all the mesh or one or more meshes or of the mesh groups.

According to the name of the operator called, the values are provided directly (AFFE_CHAR_MECA) or via a concept function (AFFE_CHAR_MECA_F).

4.36.2 Syntax

- for AFFE_CHAR_MECA

```
FORCE_COQUE =_F   ( ♦  /  TOUT     =   'OUI',
                       /  |  NET    =lma        ,          [l_maille]
                          |  GROUP_MA =lgma   ,
[l_gr_maille]
                    ♦  /  |  FX=fx              ,             [R]
                          |  FY=fy              ,             [R]
                          |  FZ=fz              ,             [R]
                          |  MX=mx              ,             [R]
                          |  MY=my              ,             [R]
                          |  MZ=mz              ,             [R]
                        ◊ PLAN=     /  "MOY",
                                    /  "INF",
                                    /  "SUP",
                                    /  "MAIL",             [DEFECT]
                       /PRES     =p     ,                  [R]
                        /  |  F1=f1             ,             [R]
                           |  F2=f2             ,             [R]
                           |  F3=f3             ,             [R]
                           |  MF1=mf1               ,            [R]
                           |  MF2=mf2               ,            [R]
                  )
```

- for AFFE_CHAR_MECA_F

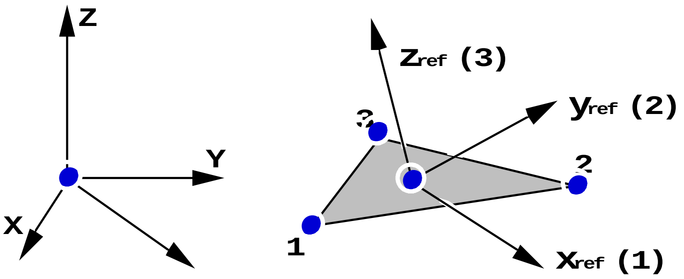
```
FORCE_COQUE =_F   ( ♦  /  TOUT     =   'OUI',
                       /  |  NET    =lma        ,          [l_maille]
                          |  GROUP_MA =lgma   ,
[l_gr_maille]
                    ♦  /  |  FX=fxf             ,
[function]
                          |  FY=fyf             ,
[function]
                          |  FZ=fzf             ,
[function]
                          |  MX=mxf             ,
[function]
                          |  MY=myf             ,
[function]
                          |  MZ=mzf             ,
[function]
                       ◊PLAN=       /  "MOY",
                                    /  "INF",
                                    /  "SUP",
                                    /  "MAIL",             [DEFECT]
                       /PRES     =pf       ,               [function]
                       /  |  F1=f1f            ,
[function]
```

```
                                              |   F2=f2f          ,
      [function]
                                              |   F3=f3f          ,
      [function]
                                              |   MF1=mf1f        ,
      [function]
                                              |   MF2=mf2f        ,
      [function]
                                    )
```

4.36.3 Opérandes

Les operands of FORCE_COQUE can be defined:

- in reference GLOBAL of axes X, Y and Z,
- in a reference of reference defined on each mesh or groups of mesh (reference defined on the variety); this reference is built around the norm with the shell element (z_{ref}) and of a direction fixes (x_{ref}) (for the group of mesh) defined by key word ANGL_REP at the same time as the thickness of the shell (see key word factor SHELL operator AFFE_CARA_ELEM [U4.42.01]).



ANGL_REP: (45. 0.)

♦ / |	FX	:	Force according to X	[R] or [function]
|	FY	:	Force according to Y	[R] or [function]
|	FZ	:	Force according to Z	[R] or [function]
|	MX	:	Moment of axis X	[R] or [function]
|	MY	:	Moment of axis Y	[R] or [function]
|	MZ	:	Moment of axis Z	[R] or [function]
/PRES		:	Normal pressure with shell	[R] or [function]
/ |	F1	:	Force of membrane according to x_{ref}	[R] or [function]
|	F2	:	Force of membrane according to y_{ref}	[R] or [function]
|	F3	:	Following normal force z_{ref}	[R] or [function]
|	MF1	:	Bending moment of axis X	[R] or [function]
|	MF2	:	Bending moment of axis Y	[R] or [function]

Notons which one must remain homogeneous in each occurrence of the key word factor FORCE_COQUE: either very out of component of force in reference GLOBAL or very out of component of force in the reference of definition of the shell.

The pressure applied is positive according to the contrary meaning of the norm to the element (defined by the first 3 nodes of each mesh (cf [§4.25.3])).

```
◊PLAN   =   /  "MOY",
            /  "INF",
            /  "SUP",
            /  "MAIL",          [DEFAUT]
```

Permet to define a load vector force on the average, lower, higher level or of the mesh.

If d the eccentring and h the thickness of the shell are noted,

$(F2X, F2Y, F2Z, M2X, M2Y, M2Z)$ the torsor of the forces on the level defined by the user (excentré i.e)
$(F1X, F1Y, F1Z, M1X, M1Y, M1Z)$ the torsor of the forces in the plane of the mesh

Les formulas of transition are the following ones:

- if the plane of computation is the plane of the mesh:

$$F2 = F1$$
$$M2 = M1$$

- if the plane of computation is the excentré average layer:

$$F2 = F1$$
$$M2X = M1X - dx\, F1Y$$
$$M2Y = M1Y + dx\, F1X$$

- if the plane of computation is the excentré higher layer:

$$F2 = F1$$
$$M2X = M1X - d + \frac{h}{2}.F1Y$$
$$M2Y = M1Y + d + \frac{h}{2}.F1X$$

- if the plane of computation is the excentré lower layer:

$$F2 = F1$$
$$M2X = M1X - d - \frac{h}{2}.F1Y$$
$$M2Y = M1Y + d - \frac{h}{2}.F1X$$

/ `"MOY'` one applies the load vector force to the excentré average layer
/ `"INF'` one applies the load vector force to the lower skin
/ `"SUP'` one applies the load vector force to the higher skin
/ `"MAIL'` one applies the load vector force to the level of the plane of the
Modélisations

4.36.4 mesh and meshes

This loading applies to the types of meshes and the following modelizations:

Net	Modélisation
`TRIA3 QUAD4`	`DKT, DST`
`QUAD4`	`Q4G`
`TRIA7 QUAD9`	`COQUE_3D`

Note:
- *This loading is available only on one three-dimensional mesh (defined by `COOR_3D`).*
- The rule of remanence (see U1.03.00) applies between the various quantities which one can affect: `FX`, `FY`,... .

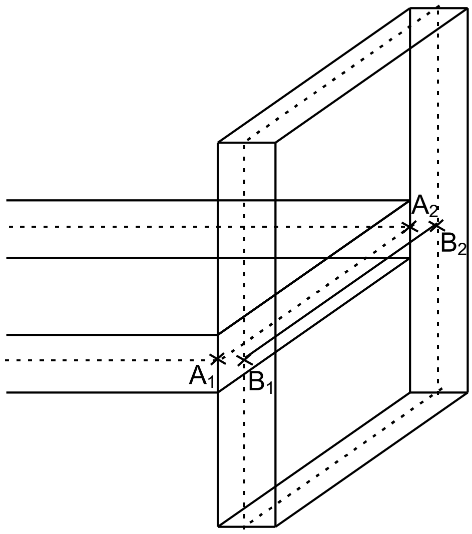
4.37 Key word LIAISON_COQUE

4.37.1 Drank

Word-key factor making it possible to represent the connection between shells by means of linear relations. The conventional approach admits that two planes with a grid in shells are cut according to a line which belongs to the mesh of structure.

That has the disadvantage of twice counting the volume which is the intersection of the two shells.

The idea is thus to stop the mesh of a shell perpendicular to a shell given to the level of the higher or lower skin of the latter.



One represented in features full volume with the shells and in dotted lines the average planes of these shells (which result from the mesh).

The horizontal shell stops in $A_1 A_2$ and the projection of $A_1 A_2$ on the average level of the vertical shell is $B_1 B_2$ (that one represented in full features).

The link between the 2 shells is made by connections of solid body between the nodes in with respect to the segments $A_1 A_2$ and $B_1 B_2$.

For example for the nodes A_1 and B_1 , one will write the formula (valid in small rotations):

$$U(B_1)=U(A_1)+\Omega(A_1)\wedge A_1 B_1$$

and equality of rotations:

$$\Omega(B_1)=\Omega(A_1)$$

4.37.2 Syntax

- for `AFFE_CHAR_MECA` and `AFFE_CHAR_MECA_F`

```
LIAISON_COQUE = _F
    (  ♦  |  GROUP_MA_1=l_gma1         ,
[l_gr_maille]
          |  MAILLE_1=l_ma1            ,          [l_maille]
          |  GROUP_NO_1=l_gno1         ,          [l_gr_noeud]
          |  NOEUD_1=l_no1         ,          [l_noeud]

       ♦  |  GROUP_MA_2=l_gma2         ,
[l_gr_maille]
          |  MAILLE_2=l_ma2            ,          [l_maille]
          |  GROUP_NO_2=l_gno2         ,          [l_gr_noeud]
          |  NOEUD_2=l_no2         ,          [l_noeud]

       ◊NUMÉRIQUE_LAGR=          /  "NORMAL",          [DEFECT]
```

```
                                          /   "APRES",
                   )
```

4.37.3 Operands

| GROUP_MA_1
| MAILLE_1
| GROUP_NO_1
| NOEUD_1

À l' aide de key words GROUP_MA_1, MAILLE_1, GROUP_NO_1 and NOEUD_1, one draws up the first list of nodes (nonredundant) representing the trace of the shell perpendicular to the current shell.

On our example, they would be the nodes of the segment $B_1 B_2$ or the segment $A_1 A_2$.

| GROUP_MA_2
| MAILLE_2
| GROUP_NO_2
| NOEUD_2

À l' aide de key words GROUP_MA_2, MAILLE_2, GROUP_NO_2 and NOEUD_2, one draws up the second list of nodes (nonredundant) pertaining to the perpendicular shell and in the nodes of the first list. Opposite is adjusted by the program according to the criterion of smaller distance.

On our example if the first list is drawn up by the nodes of $A_1 A_2$, the second list is drawn up by the nodes of $B_1 B_2$.

◊NUMÉRIQUE_LAGR= / "NORMAL", [DEFECT]
/ "DEFAUT",

Voir key word LIAISON_SOLIDE [§4.19].

Important remarks:

1) *After the key words GROUP_MA _ , MESH _ , GROUP_NO _ and NODE _ , a node can appear several times, it is the program which is given the responsability to eliminate the useless occurrences and thus to obtain a nonredundant list of nodes.*
2) *After the elimination of the pointless occurrences of the nodes in the two lists of nodes, these two lists must be imperatively equal length.*
3) *The meshes given after key words GROUP_MA_1 , GROUP_MA_2 , MAILLE_1 and MAILLE_2 are of the edge meshes of the type SEG2 or SEG3 of the shell elements and for which one does not have inevitably affected a mechanical modelization.*

4.38 Key word RELA_CINE_BP

4.38.1 Drank

Ce type de loading can be defined for a mechanical system including a structure concrete and its cables of prestressing. The initial profiles of tension in the cables, as well as the coefficients of the kinematic relations between the degrees of freedom of the nodes of the cables and the degrees of freedom of the nodes of the structure concrete are beforehand given by operator DEFI_CABLE_BP [U4.42.04]. The concepts cabl_precont produced by this operator bring all the necessary information to the definition of the loading.

The multiple occurrences are authorized for the key word factor RELA_CINE_BP, in order to make it possible in the same call to operator AFFE_CHAR_MECA to define the contributions of each group of cables having been the subject of distinct calls to operator DEFI_CABLE_BP [U4.42.04]. With each group of cables considered, defined by a concept cabl_precont, an occurrence with the key word factor RELA_CINE_BP is associated.

The loading thus defined is used then for compute the state of equilibrium of the group structure concrete / cables of prestressing. However, the taking into account of this kind of loading is not effective in all the operators of resolution. The loading of the type RELA_CINE_BP is recognized for time only by operator STAT_NON_LINE [U4.51.03], option COMP_INCR exclusively.

4.38.2 Syntax (AFFE_CHAR_MECA only)

```
RELA_CINE_BP=_F          (
                ♦CABLE_BP=cabl_pr            ,              [cabl_precont]
                ◊SIGM_BPEL=           /  "OUI",
                                    /  "NON",             [DEFAUT]
                ◊RELA_CINE=           /  "OUI",              [DEFECT]
                                    /  "NON",
                ◊DIST_MIN=dmin            ,                  [R]
                  )
```

4.38.3 Opérandes

♦CABLE_BP=cabl_pr

Concept of the cabl_precont type produces by operator DEFI_CABLE_BP [U4.42.04]. This concept brings on the one hand the card of the initial stresses in the elements of the cables of the same group, and on the other hand the lists of the kinematic relations between the degrees of freedom of the nodes of these cables and the degrees of freedom of the nodes of the structure concrete.

```
◊SIGM_BPEL=           /  "OUI",
                    /  "NON",             [DEFAUT]
```

Indicateur of type text by which one specifies the taking into account of the initial stresses in the cables; the default value is "NON".
In case "NON", only the liaisonnement kinematical one is taken into account. It is useful if STAT_NON_LINE are connected whereas one has cables of prestressing. For the first STAT_NON_LINE it is necessary to have put "OUI", so that one sets up the tension in the cables. On the other hand, for the following STAT_NON_LINE, one should regard as loading only kinematical connections and thus define the loading with SIGM_BPEL = "NON", if not the tension is counted twice.
Since the restitution the macro one to put in tension the cables, the user should not need any more to make a AFFE_CHAR_MECA with SIGM_BPEL = "OUI", that should thus avoid the risks of error.

```
◊RELA_CINE=           /  "OUI",              [DEFECT]
                    /  "NON",
```

Indicateur of type text by which one specifies the taking into account of the kinematic relations between the degrees of freedom of the nodes of the cables and the degrees of freedom of the nodes of the structure concrete; default value "OUI".

◊DIST_MIN=dmin , [R] (see LIAISON_SOLIDE 4.18)

4.39 Word-key FORCE_ELEC

4.39.1 Drank

Word-key factor usable to apply the force of LAPLACE acting on a main conductor, due to the presence of a secondary conductor right (not being based on part of Aster *mesh*) compared to this main conductor.

In fact, the loading defined by FORCE_ELEC has a modulus which must be multiplied by the temporal function of intensity specified by operator DEFI_FONC_ELEC [U4.MK.10] to really represent the force of LAPLACE.

The main conductor lean on whole or part of the Aster *mesh* made up of linear elements in space and defined in this operator by one or more meshes, of the mesh groups or the totality of the mesh.

Note:

When the secondary conductor is not rectilinear key word INTE_ELEC [§4.40] will be used.

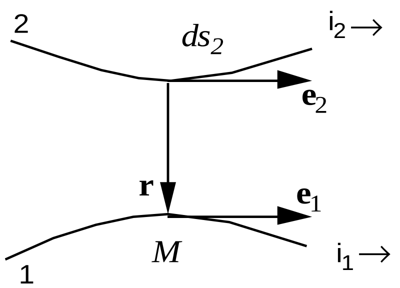
4.39.2 Syntax

```
FORCE_ELEC = _F
          (  ♦  /  TOUT      =    'OUI”,
                /  |  NET    =lma       ,              [l_maille]
                   |  GROUP_MA =lgma       ,
[l_gr_maille]
             ♦  /  |  FX = fx,                         [R]
                   |  FY = fy,                         [R]
                   |  FZ = fz,                         [R]
                /  ♦POSITION=          'PARA”,
                   ♦  /  TRANS=     (ux, uy, uz,),          [l_R]
                      /DIST      =d  ,                 [R]
                      /POINT2       =    (x2, y2, z2,),       [l_R]
                /  ♦POSITION=          'FINI”,
                   ♦POINT1=            (x1, y1, z1,),         [l_R]
                   ♦POINT2=            (x2, y2, z2,),         [l_R]
                /  ♦POSITION=          'INFI”
                   ♦POINT1=            (x1, y1, z1,),         [l_R]
                   ♦POINT2=            (x2, y2, z2,),         [l_R]
          )
```

4.39.3 Function of space

the function of space composing the linear density of force of LAPLACE exerted in a point M of conductor 1 (main conductor) by the elements of conductor 2 (secondary conductor) is:

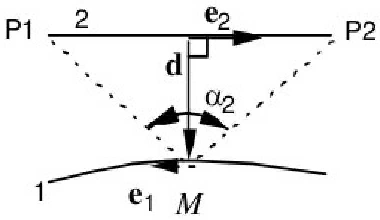
$$f(M)=\frac{e_1}{2}\wedge\int_2\frac{e_2\wedge r}{\|r\|^3}ds_2$$



avec $\|\mathbf{e}_1\|=\|\mathbf{e}_2\|=1$

In the case of a secondary right and finished conductor, this statement becomes:

$$\boldsymbol{f}(M)=\frac{\boldsymbol{e_1}}{2}\wedge\frac{\boldsymbol{n}}{d}\left(\sin\alpha_1-\sin\alpha_2\right)$$



with $\boldsymbol{n}=\frac{\boldsymbol{e_2}\wedge\boldsymbol{d}}{d}$ $d=\|\boldsymbol{d}\|$, $\|\boldsymbol{d}\|=1$

Dans the typical case of the secondary conductor infinite right, α_1 and α_2 tend towards $\frac{\pi}{2}$, one has then:

$$\boldsymbol{f}(M)=\boldsymbol{e_1}\wedge\frac{\boldsymbol{n}}{\boldsymbol{d}}$$

4.39.4 Operands

| FORCE_ELEC

Dans le cas où there are several secondary conductors infinite and parallel with the main conductor (key words COUR_PRIN and COUR_SECO in command DEFI_FONC_ELEC) one directly specifies the components of the direction of the force of LAPLACE which must be normalized to 1.

/ | FX = fx, fx2 + fy2 + fz2 = 1.
| FY = fy, (fx, fy, fz) colinéaire by the strength of LAPLACE
| FZ = fz,

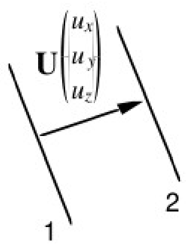
Sinon, the direction of the force of LAPLACE can be defined by the position of the secondary single conductor compared to the elements of the main conductor.

/ ♦POSITION

/ "PARA"

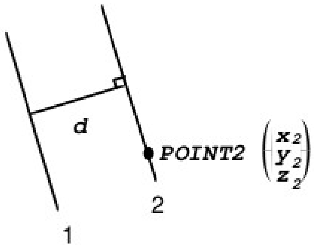
the secondary conductor is considered infinite and parallel with the main conductor. One can define his position in two manners:

/TRANS : (ux uy uz)



$\mathbf{U}\begin{pmatrix}u_x\\u_y\\u_z\end{pmatrix}$ the translation bringing of the main conductor 1 defines to the secondary conductor 2

/DIST = D,
/POINT2 = (x2, y2, z2),

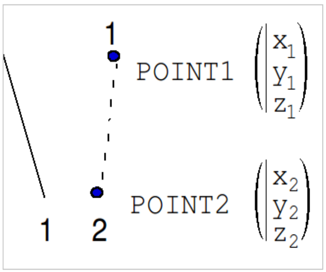


the secondary conductor 2 is defined by its distance in conductor 1 and one second point.

/ "FINI"

the secondary conductor is defined by two points corresponding at its ends POINT1 and POINT2.

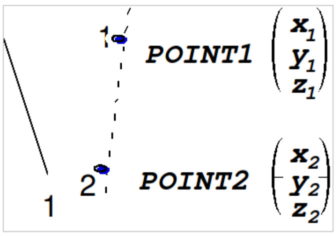
```
POINT1 = (x1, y1, z1),
POINT2 = (x2, y2, z2),
```



/ "INFI"

the secondary conductor is defined by two unspecified points POINT1 and POINT2.

```
POINT1 = (x1, y1, z1),
POINT2 = (x2, y2, z2),
```



Dans the two cases, it is preferable to choose POINT1 and POINT2 such as flow circulates of POINT1 with POINT2.

4.40 Key word INTE_ELEC

4.40.1 Drank

Word-key factor usable to apply the force of LAPLACE acting on a main conductor, due to the presence of a secondary conductor not necessarily right compared to this main conductor.

In fact, the loading defined by `INTE_ELEC` has a modulus which must be multiplied by the temporal function of intensity specified by operator `DEFI_FONC_ELEC` [U4.MK.10] to really represent the force of LAPLACE.

The main conductor lean on part of Aster *mesh* made up of linear elements in space and defined in this operator by one or more meshes, of the mesh groups or the totality of the mesh.

The secondary conductor is also based on part of Aster *mesh* made up of linear elements in the space and also specified in this operator by one or more meshes, of the mesh groups, or by a translation (or a symmetry planes) compared to the main conductor.

Note:

The difference of the use of key word `INTE_ELEC` compared to key word `FORCE_ELEC` lies in the fact that the geometry of the secondary conductor can not be rectilinear and lean on part of Aster mesh only one describes here.

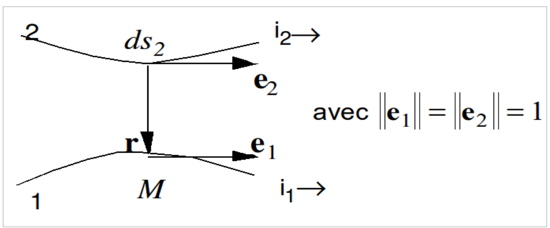
4.40.2 Syntax

```
    INTE_ELEC =_F  ( ♦  /  TOUT      =    'OUI',
                        /  |  NET    =lma        ,               [l_maille]
                           |  GROUP_MA =lgma    ,
[l_gr_maille]
                     ♦  /  |  MAILLE2    = lma  ,               [l_maille]
                           |  GROUP_MA2 = lgma ,
[l_gr_maille]
                        /TRANS  = (ux, uy, uz),                 [l_R]
                        /SYME    = (x0, y0, z0, ux, uy, uz),        [l_R]
                  )
```

4.40.3 Function of space

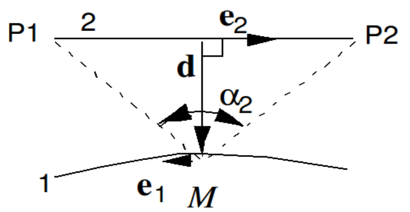
the function of space composing the linear density of forces of Laplace exerted in a point M of conductor 1 (main conductor) by the elements of conductor 2 (secondary conductor) can be expressed:

$$\boldsymbol{f}(M)=\frac{\boldsymbol{e}_1}{2}\wedge\int_2\frac{\boldsymbol{e}_2\wedge r}{\|r\|^3}ds_2$$



For each element I of the secondary conductor, one computes his contribution starting from the preceding statement and one adds:

$$\boldsymbol{f}(M)=\sum_i\frac{\boldsymbol{e}_1}{\mathbf{2}}\wedge\frac{\boldsymbol{n}}{d}\left(\sin\alpha_1-\sin\alpha_2\right)$$



with $\boldsymbol{n}=\frac{e_2\wedge \boldsymbol{d}}{d}$ $d=\|\boldsymbol{d}\|$, $\|\boldsymbol{n}\|=1$

4.40.4 TOUT `formulates` / `NET` / `GROUP_MA` / `MAILLE2` / `GROUP_MA2` / `TRANS` / `SYME`

`TOUT, MESH, GROUP_MA:`

The geometry of the main conductor defines where the loading is affected.

`MAILLE2, GROUP_MA2:`

The geometry of the secondary conductor defines.

`TRANS:`

A translation of the main conductor defines in the secondary conductor.

`SYME:`

A symmetry compared to a plane defines (given by a point $(x_0\, y_0 z_0)$ and the norm $(u_x u_y u_z)$ common to the main conductor and the secondary conductor).

4.41 Key word IMPE_FACE (“ ACOUSTIC” Phénomène)

4.41.1 But

the key word factor IMPE_FACE makes it possible to apply an acoustic impedance, with a face defined by one or more meshes or mesh groups of type triangle or quadrangle.
The values are directly given if the operator called is AFFE_CHAR_MECA ; if it is AFFE_CHAR_MECA_F, they come from a concept of type function.

4.41.2 Syntax

- for AFFE_CHAR_MECA

```
IMPE_FACE =_F      ( ♦  |   NET  =lma          ,        [l_maille]
                        |   GROUP_MA=lgma      ,        [l_gr_maille]
                     ♦IMPE   =Q           ,             [R]
                   )
```

- for AFFE_CHAR_MECA_F

```
IMPE_FACE =_F      ( ♦  |   NET  =lma          ,        [l_maille]
                        |   GROUP_MA=lgma      ,        [l_gr_maille]
                     ♦IMPE   =Qf               ,           [function]
                   )
```

4.41.3 Opérande IMPE_FACE

IMPE_FACE = Q (Qf)

acoustic Impédance applied to the face.

4.41.4 Modelizations and meshes

the loading applies to the types of meshes and the following modelizations:

Type of Mesh	Modelization
TRIA3, TRIA6 QUAD4, QUAD8, QUAD9	3D_FLUIDE

4.42 Word-key VITE_FACE (“ ACOUSTIC” Phénomène)

4.42.1 But

the key word factor VITE_FACE makes it possible to apply normal velocities, with a face defined by one or more meshes or mesh groups of type triangle or quadrangle.
The values are directly given if the operator called is AFFE_CHAR_MECA, if it is AFFE_CHAR_MECA_F, they come from a concept of type function.

4.42.2 Syntax

- for AFFE_CHAR_MECA

```
VITE_FACE =_F  ( ♦   |   NET   =lma        ,          [l_maille]
                     |   GROUP_MA=lgma     ,          [l_gr_maille]
                   ♦ VNOR =V               ,             [R]
               )
```

- for AFFE_CHAR_MECA_F

```
VITE_FACE =_F  ( ♦   |   NET   =lma        ,          [l_maille]
                     |   GROUP_MA=lgma     ,          [l_gr_maille]
                 ♦VNOR   =Vf               ,             [function]
               )
```

4.42.3 Opérande VNOR

VNOR = V (Vf)

normal Velocity applied to the face.

4.42.4 Modelizations and meshes

the loading applies to the types of meshes and the following modelizations:

Type of Mesh	Modelization
TRIA3, TRIA6 QUAD4, QUAD8, QUAD9	3D_FLUIDE

4.43 Word-key ONDE_PLANE

4.43.1 Drank

Word-key factor usable to impose a seismic loading by plane wave, corresponding to the loadings classically met during computations of interaction ground-structure by the integral equations (see [R4.05.01]).

4.43.2 Syntax (AFFE_CHAR_MECA_F only)

```
ONDE_PLANE=_F     (  ♦TYPE_ONDE=ty              ,               [txm]
                     ♦DIRECTION=            (kx, ky, kz),       [l_R]
                     ♦FONC_SIGNAL=f         ,               [function]
                     ◊  |      GROUP_MA=lgma,             [l_gr_maille]
                        |  MAILLE=lma           ,             [l_maille]
                  )
```

4.43.3 Opérandes

♦TYPE_ONDE=ty ,

Type of the wave:	"P"	wave of compression
	"SV"	waves of shears
	"SH"	waves of shears

♦DIRECTION= (kx, ky, kz),

Direction of the wave.

♦FONC_SIGNAL=v ,

Derived from the profile of the wave: $v(t)$ for $t \in [0,+\infty[$.

In harmonic, one plane wave elastic is characterized by its direction, its pulsation and its type (wave P for the compression waves, waves SV or SH for the waves of shears). Out of transient, the data of the pulsation, corresponding to one standing wave in time, must be overridden by the data of a profile of displacement which one will take into account the propagation in the course of time in the direction of the wave.

More precisely, one characterizes:

- one wave P by the function
- one wave S by the Avec $u(x,t)=f(k\cdot x-C_s t)\wedge k$

function:

- k , unit vector of direction
- f then represents the profile of the wave given according to the direction k .

Caution: it is the velocity $v(t)=\dot{u}(t)$ which the user gives in FONC_SIGNAL.

```
◊   |      GROUP_MA=l_gr_maille    ,
    |   MAILLE=l_maille         ,
```

Liste of the meshes of absorbing borders concerned with the introduction of the incident wave. If nothing is given, by defaults, in fact the meshes of modelization ABSO are concerned.

4.43.4 Modelizations and meshes

Type de Maille	Modelization
MECA_FACE_*	3D_ABSO
MEPLSE2, MEPLSE3	2D_ABSO

4.44 Word-key ONDE_FLUI (" ACOUSTIC" Phénomène)

4.44.1 But

the key word factor ONDE_FLUI makes it possible to apply an amplitude of pressure of sinusoidal incident wave arriving normally at a face defined by one or more meshes or mesh groups.

4.44.2 Syntax

- for AFFE_CHAR_MECA

```
ONDE_FLUI =_F  ( ♦  |   NET  =lma        ,          [l_maille]
                    |   GROUP_MA=lgma    ,          [l_gr_maille]
                 ♦PRES   =P          ,              [R]
             )
```

- for AFFE_CHAR_MECA_F

  developed Non.

4.44.3 Operand PRES

PRES = P,
Amplitude of pressure of sinusoidal incident wave arriving normally at the face.

4.44.4 Modelizations and meshes

the loading applies to the types of meshes and the following modelizations:

Type of Mesh	Modelization
TRIA3, TRIA6 QUAD4, QUAD8, QUAD9	3D_FLUIDE
SEG2, SEG3	2D_FLUIDE, AXIS_FLUIDE

4.45 Word-key `FLUX_THM_REP`

4.45.1 Drank

Word-key factor usable to apply to a field of continuum 2D or 3D defined by meshes or mesh groups a heat flux and/or a contribution of fluid mass (hydraulic flow).

4.45.2 Syntax

- for `AFFE_CHAR_MECA`

```
FLUX_THM_REP =_F  ( ♦  /   TOUT      =   'OUI',
                       /   |   MAILLE=lma                ,
[l_maille]
                           |      GROUP_MA=lgma ,
[l_gr_maille]
                    ♦  |   FLUN=phiT                 ,        [R]
                       |   FLUN_HYDR1=phie           ,        [R]
                       |   FLUN_HYDR2=phiv                    [R]
                  )
```

- for `AFFE_CHAR_MECA_F`

```
FLUX_THM_REP =_F  ( ♦  /   TOUT      =   'OUI',
                       /   |   MAILLE=lma                ,
[l_maille]
                           |      GROUP_MA=lgma ,
[l_gr_maille]
                    ♦  |   FLUN=phiTf                ,
[function]
                       |   FLUN_HYDR1=phief          ,        [function]
                       |   FLUN_HYDR2=phivf          ,        [function]
                  )
```

4.45.3 Opérandes

| `FLUN = phiT,`

Valeur of heat flux

$$\phi_T=\lambda_T\frac{\partial T}{\partial n}+h_m^e\phi^e+h_m^v\phi^v+h_m^a\phi^a$$

with: h_m^l : mass enthalpy of the liquid
h_m^v : mass enthalpy of the vapor
h_m^a : mass enthalpy of the air

ϕ^e and ϕ^v are below definite hydraulic flows

| `FLUN_HYDR1 = phie,`

Valeur of the hydraulic flow associated with the component water

| `FLUN_HYDR2 = phiv,`
Valeur of the hydraulic flow associated with the component air

$$\phi^e=\rho_e\left(\nabla P_e-\rho_e\boldsymbol{g}\right)\cdot\boldsymbol{n}$$
$$\phi^v=\rho_v\left(\nabla P_v-\rho_v\boldsymbol{g}\right)\cdot\boldsymbol{n}$$

with: ρ_e : density of the liquid
ρ_v : density of the vapor
P_e : pressure of liquid (`PRE1`)

P_v : steam pressure (PRE2)

4.45.4 Modelizations and meshes

Les normal flows apply to the types of meshes and the following modelizations:

Type of Mesh	Modelization
SEG2	D_PLAN_YYYY
SEG3	AXIS_YYYY, D_PLAN_YYYY
FACE8	3D_YYYY

with YYYY = THM or THH or THHM or HM or HHM.

4.46 Key word ARETE_IMPO

4.46.1 Drank

Word-key factor usable to impose, with all the nodes of a voluminal edge of the elements defined by a mesh or a mesh group, one or more values of displacement (or certain associated quantities).

4.46.2 Syntax

```
ARETE_IMPO=_F  ( ♦  /  MAILLE=lma                   ,          [l_maille]
                    /GROUP_MA       =lgma  ,          [l_gr_maille]
                 ◊SANS_MAILLE=lma1              ,         [l_maille]
                 ◊SANS_GROUP_MA=lgma1               ,         [l_gr_maille]
                 ◊SANS_NOEUD=lno1           ,         [l_noeud]
                      SANS_GROUP_NO=lgno1     ,          [l_gr_ node]
                 ♦  /  |  DX=ux        ,              [R]
                       |  DY=uy        ,              [R]
                       |  DZ=uz        ,              [R]
                       |  PRES=p       ,          [R]
                       |  PHI=phi          ,          [R]
                       |  TEMP=T       ,          [R]
                       |  PRE1=pr1         ,          [R]
                       |  PRE2=pr2         ,          [R]
                    /  |  DTAN=ut          ,          [R]      )
```

4.46.3 Opérandes

```
◊SANS_MAILLE=lma1            ,          [l_maille]
◊SANS_GROUP_MA=          lgma1,          [l_gr_maille]
◊SANS_NŒUD=lno1              ,          [l_noeud]
◊SANS_GROUP_NO=lgno1             ,          [l_gr_noeud]
```

Indique which one wants to omit the nodes of the lists lma1, lgma1, lno1, lgno1, of the list lma or lgma.

Example:
```
ARETE_IMPO = (  _F ( GROUP_NO =FBas, DX =0, DY =0, DZ =0),
                   _F (GROUP_MA =ALaterale, SANS_GROUP_NO = NBas, DTAN
      =10),)
```

the meaning of the 2nd occurrence of ARETE_IMPO is: "for all the nodes of the mesh group $Alateral$, $DTAN=10$ except for those of the nodes group $Nbas$ ". This makes it possible not to have redundant boundary conditions.

```
♦  /  |  DX  =
      |  DY  =
```

```
| DZ =
| PRES=
| PHI =
| TEMP=
| PRE1=
| PRE2=
```

Les components, imposed on all the nodes belonging to the specified meshes, are defined in **reference** GLOBAL of definition of the mesh.

The edges considered consist of SEG2 or SEG3.

Note:

Components PRES and PHI can intervene only on elements of modelizations "3D_FLUIDE" and "FLUI_STRU" , component PHI on elements of modelization "2D_FLUI_PESA", components TEMP , PRE1 , PRE2 on elements of modelizations THM .

```
/ | DTAN =
```

Les imposed components are defined according to the tangent with a mesh (**local coordinate system**).
DTAN : tangential component (see [U4.44.01 §4.1]).