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## Operator DYNA\_TRAN\_MODAL

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### 1 Drank

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Compute the response transient dynamics of a system deadened or not in generalized coordinates. The computation is carried out by modal superposition or substructuring.

NON-null initial conditions can be introduced making it possible amongst other things to use the results of a former computation.

The loading is given in the form of a linear combination of generalized vectors and functions of time describing the temporal evolution of these vectors.

Six explicit integration methods: "EULER", "DEVOGE", "ADAPT\_ORDRE1" and "ADAPT\_ORDRE2" (integration methods with time step adaptive of order 1 or ordre2), "RUNGE\_KUTTA\_32" and "RUNGE\_KUTTA\_54" (integration methods with time step adaptive of the family of Runge-Kutta with orders 54 and 32 respectively), an integral method "ITMI" and an implicit integration method: "NEWMARK" are available. The explicit algorithms and "ITMI" support computation with taking into account of non- linearities located with the nodes of the shocks type and friction. Methods "EULER", "ADAPT\_ORDRE1" and "ADAPT\_ORDRE2" support the taking into account of non- linearities of type fluid blade and standard antiseismic device. Methods "RUNGE\_KUTTA\_32", and "RUNGE\_KUTTA\_54" support the taking into account of non- linearities located with the nodes of the shocks type and friction as well as non-linearities of type antiseismic device.

To be able to calculate the response of a revolving machine on nonlinear bearings, a coupler with code EDYOS was developed and requires the joint use of the key word factors COUPLAGE\_EDYOS and PALIER\_EDYOS.

The data structure `result` contains for various times of computation, the results generalized and the calculated shock forces.

The conversion of the results generalized in physical space is possible by operators `REST_GENE_PHYS` [U4.63.31] or for a component by `RECU_FONCTION` [U4.32.03].

Product a concept of the `tran_gene` type.

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## 2 Syntax

```

tranmo [tran_gene] = DYNA_TRAN_MODAL      (

  ◊reuse =tranmo ,

  ♦ MATR_MASS =ma , [matr_asse_gene_R]
  ♦ MATR_RIGI =ri , [matr_asse_gene_R]
  ♦ MATR_AMOR =am , [matr_asse_gene_R]
  ◊ AMOR_MODAL = _F (
    /AMOR_REDUIT =la , [l_R]
    /LIST_AMOR =l_amor , [listr8]
  ),

  ◊ SCHEMA_TEMPS =_F (
    ♦ SCHEMA = ( | "NEWMARK", [DEFAULT]
                 | "EULER",
                 | "DEVOGE",
                 | "ADAPT_ORDRE1",
                 | "ADAPT_ORDRE2",
                 | "RUNGE_KUTTA_54",
                 | "RUNGE_KUTTA_32",
                 | "ITMI",
                 ) ,

    # key Keys only associated with diagram "NEWMARK" :
    ◊ BETA =/0.25, [DEFAULT]
      /beta, [R]
    ◊ GAMMA =/0.5, [DEFAULT]
      /gamma, [R]

    # Key word only associated with diagrams "RUNGE_KUTTA_*":
    ◊ TOLERANCE =/1.E-3, [DEFAULT]
      /tol, [R]

    # key Keys only associated with diagram "ITMI" :
    ◊BASE_ELAS_FLUI= mix, [melasflu]
    ◊NUMÉRIQUE_VITE_FLUI= Nvitf, [I]
    ◊ETAT_STAT = "NON", [DEFAULT]
      /"OUI",
    ◊ PREC_DUREE=/1.E-2 , [DEFAULT]
      /prec, [R]
    ◊ CHOC_FLUI=/ "NON", [DEFAULT]
      /"OUI",
    ◊ NB_MODE=Nmode , [I]
    ◊ NB_MODE_FLUI=Nmodef , [I]
    ◊ TS_REG_ETAB=tsimu , [R]
  ),

  ♦ INCREMENT =_F ( ♦ /LIST_INST = litps, [listr8]
                    /PAS = dt, [R]
    ◊INST_INIT =ti , [R]
    ◊ /INST_FIN = tf, [R]
    /NUME_FIN = nufin, [I]

    ◊VERI_PAS = "OUI", [DEFAULT]
      /"NON",

    # Operands specific to an integration by time step adaptive of order 1 and 2
    ◊VITE_MIN = "NORM", [DEFAULT]
      /"MAXI",
    ◊COEF_MULT_PAS = 1.1 , [DEFAULT]

```

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

```

                                /cmp , [R]
    ◇COEF_DIVI_PAS = 1.33333334, [DEFAULT]
                                /cdp , [R]
    ◇PAS_LIMI_RELA =/1.E-6 , [DEFAULT]
                                /per , [R]
    ◇ NB_POIN_PERIODE =/50 , [DEFAULT]
                                /N , [I]
    ◇NMAX_ITER_PAS = 16, [DEFAULT]
                                / N, [I]
# Operands specific to an integration by time step adaptive (order 1 and 2) like Runge-Kutta
    ◇PAS_MAXI =dtmax , [R]
    ◇PAS_MINI =dtmin , [R] ),
    ◇ ETAT_INIT = _F ( ◆ / RESULTAT =res, [tran_gene]
    .. If RESULTAT
        ◇ /INST_INIT =to , [R]
        /NUME_ORDR =no , [I]
        ◇ / CRITERE = ' RELATIF', [DEFAULT]
        ◇ accuracy = /1.E-06, [DEFAULT]
        /prec, [R]
        / CRITERE = "ABSOLU",
        ◆ accuracy = prec, [R]

        / | DEPL =do ,
[vect_asse_gene]
        | QUICKLY =vo ,
[vect_asse_gene]
    ),
    ◇ EXCIT =_F ( ◇ VECT_ASSE_GENE =v ,
[vect_asse_gene]
        ◇NUMÉRIQUE_ORDRE =nmordr , [I]
        ◇/FONC_MULT =f, [function]
        / COEF_MULT =a, [R]
        /◇ACCE =ac , [function]
        ◇VITE =vi , [function]
        ◇DEPL =dp , [function]
# Operands and key keys specific to the seismic analysis
        ◇MULT_APPUI = "NON", [ DEFAULT]
        / "OUI",
        ◇DIRECTION = (dx, Dy, dz, drx, dry, drz), [l_R]
        ◇ / NOEUD =lno , [l_noeud]
        / GROUP_NO =lgrno ,
[l_groupe_no]
        ◆◆ CORR_STAT = ' OUI'
        ◆ D_FONC_DT =dfdt , [function]
        ◆ D_FONC_DT2 =dfdt2 , [function]
    ),
    ◇ /MODE_STAT = psi, [mode_meca]
    /MODE_CORR = modcor, [mult_elas, modē_meca]
    ◇ EXCIT_RESU=
    _F ( ◆RESULTAT=resuforc ,
[vect_asse_gene]
        ◇/COEF_MULT=ai , [R]
        /COEF_MULT_C =aci , [C]
    ),
# End of the operands and key keys specific to the seismic analysis

```

```

◇CHOC = _F (
  ◇INTITULE =int , [l_Kn]

  /◇/NOEUD_1 =no1 , [node]
    /GROUP_NO_1 =grnol , [group_no]
  ◇/NOEUD_2 =no2 , [node]
    /GROUP_NO_2 =grno2 , [group_no]
  /◇/MAILLE =ma , [mesh]
    /GROUP_MA =grma , [group_ma]

  ◇OBSTACLE =obs , [obstacle]
  ◇ NORM OBST =nor , [listr8]
  ◇ORIG_OBST =ori , [listr8]
  ◇JEU = 1. , [DEFAULT]
    /clearance, [R]

  ◇ ANGL_VRIL =gamma , [R]

  ◇ DIST_1 = dist1, [R]
  ◇ DIST_2 = dist2, [R]

  ◇SOUS_STRUC_1 =ss1 , [K8]
  ◇SOUS_STRUC_2 =ss2 , [K8]
  ◇ coordinate = "GLOBAL",
[DEFAULT] /nom_sst, [K8]

  ◇ RIGI_NOR =kn , [R]
  ◇ AMOR_NOR = 0. , [DEFAULT]
    /Cn, [R]
  ◇RIGI_TAN = 0. , [DEFAULT]
    /kt, [R]
  ◇AMOR_TAN = ct, [R]
  ◇ FRÖTTEMENT =
    /"NON" [DEFAULT]
    /"COULOMB"
      ◆ COULOMB = driven [R]
    /"COULOMB_STAT_DYNA"
      ◆ COULOMB_STAT = driven [R]
      ◆ COULOMB_DYNA = mud [R]

# Operands specific to the taking into account of a transient velocity
for the rotors (variable rotational speed)
  ◇VITESSE_VARIABLE = "NON", [DEFAULT]
    /"OUI",
  # if VITESSE_VARIABLE=' OUI':
    ◆VITE_ROTA =vrota , [function]
    ◆ MATR_GYRO =gyro , [matr_asse_gene_R]
    ◇ ACCE_ROTA =arota , [function]
    ◇ MATR_RIGY =gyro , [matr_asse_gene_R]
  # if VITESSE_VARIABLE=' NON':
    ◆VITE_ROTA = 0.0, [DEFAULT]
    /vrota, [R]

# Keyword specific to the taking into account of a crack in a rotor
  ◇ROTOR_FISS=_F (
    /◇/NOEUD_G =nog , [node]
      /GROUP_NO_G =grnog , [group_no]
    ◇/NOEUD_D =nod , [node]
      /GROUP_NO_D =grnod , [group_no]
    ◆ ANGL_INIT =0.0 , [DEFAULT]
    ◇ ANGL_ROTA =0.0 , [function]
    ◆K_PHI =kphi [function]
    ◆ _DK_DPFI =dkdphi [function]
  )

```

# Operands and key keys specific to the taking into account of a fluid blade

```

◇ LAME_FLUIDE = "NON", [DEFAULT]
                /"OUI",
# if LAME_FLUIDE=' OUI':
◇ ALPHA = 0., [DEFAULT]
                /alpha, [R]
◇ BETA = 0., [DEFAULT]
                /beta, [R]
◇ CHI = 0., [DEFAULT]
                /chi, [R]
◇ DELTA = 0., [DEFAULT]
                /delta, [R]
    
```

# End of the operands and key keys specific to the taking into account of a fluid blade

```

),
◇ PARA_LAME_FLUIDE = _F (
    ◇ NMAX_ITER =/20, [DEFAULT]
                /niter, [I]
    ◇ RESI_RELA =/1.E-3, [DEFAULT]
                /residu, [R]
    ◇ LAMBDA =/10, [DEFAULT]
                /lambda, [R]
),
◇ VERI_CHOC = _F (
    ◇ STOP_CRITERE = "OUI", [DEFAULT]
                / "NON",
    ◇ SEUIL =/0.5, [DEFAULT]
                /s, [R]
),
◇ ANTI_SISM = _F (
    ◆/NOEUD_1=no1, [node]
    /GROUP_NO_1 =grno1,
[group_no]
    ◆/NOEUD_2=no2, [node]
    /GROUP_NO_2 =grno2,
[group_no]
    ◇ RIGI_K1 = 0., [DEFAULT]
                /kN, [R]
    ◇ RIGI_K2 = 0., [DEFAULT]
                /kN, [R]
    ◇ SEUIL_FX = 0., [DEFAULT]
                /Py, [R]
    ◇ C = 0., [DEFAULT]
                /C, [R]
    ◇ PUIS_ALPHA = 0., [DEFAULT]
                /alpha, [R]
    ◇ DX_MAX = 1., [DEFAULT]
                /dx, [R]
),
◇ FLAMBAGE = _F (
    ◆/NOEUD_1=no1, [node]
    /GROUP_NO_1 =grno1,
[group_no]
    ◆/NOEUD_2=no2, [node]
    /GROUP_NO_2 =grno2,
[group_no]
    ◆OBSTACLE = obs, [obstacle]
    ◇ORIG_OBST = ori, [listr8]
    ◆ NORM_OBST = NOR, [listr8]
    ◇ANGL_VRIL = 0, [DEFAULT]
                /gamma, [R]
    
```

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```

◇JEU      = 1. , [DEFAULT]
           /jeu, [R]
◇DIST_1   = dist1, [R]
◇ DIST_2 = dist2, [R]
◇ coordinate = /"GLOBAL",
[DEFAULT]
           /nom_sst , [K8]
◇ RIGI_NOR = kN, [R]
◇ FNOR_CRIT = film, [R]
◇ FNOR_POST_FL = fseuil, [R]
◇ RIGI_NOR_POST_FL = k2, [R]
),

◇RELA_EFFO_DEPL =_F (
  ◆ NOEUD =noe , [node]
  ◇SOUS_STRUC =ss , [K8]
  ◇NOM_CMP =nomcmp , [K8]
  ◆RELATION =f , [function]
),

◇RELA_TRANSIS =_F (
  ◆ NOEUD =noe , [node]
  ◇SOUS_STRUC =ss , [K8]
  ◇NOM_CMP =nomcmp , [K8]
  ◆RELATION =f , [function]
),

◇RELA_EFFO_VITE =_F (
  ◆ NOEUD =noe , [node]
  ◇SOUS_STRUC =ss , [K8]
  ◇NOM_CMP=nomcmp , [K8]
  ◆RELATION =f , [function]
),

# key Keys factors only associated with the coupling with code EDYOS
◇COUPLAGE_EDYOS=_F (
  ◆ VITE_ROTA =vrota , [R]
  ◆PAS_TPS_EDYOS =dtedyos , [R]
),

◇PALIER_EDYOS=_F (
  ◆ /UNITE =uled , [I]
  /GROUP_NO =grnoed , [group_no]
  /NOEUD =noed , [node]
  ◇ TYPE_EDYOS = "PAPANL",
  / "PAFINL",
  / "PACONL",
  / "PAHYNL",
),

# End key keys factors associated only with the coupling with code EDYOS
◇ ARCHIVAGE =_F ( ◇ /LIST_INST = list [listr8]
                  /INST = in [R]
                  /PAS_ARCH = ipa [I]
                  ◇/ CRITERE = ' RELATIF', [DEFAULT]
                  ◇ accuracy = /1.E-06, [ DEFAULT]
                  /prec, [R]
                  / CRITERE = "ABSOLU",
                  ◆ accuracy = prec, [R]
                ),

◇ solver = _F (see [U4.50.01])

◇INFO=/1 ,
[DEFAULT]

```

```
                /2 ,  
    ◇IMPRESSION =_F (   
        ◇/TOUT = "OUI", [DEFAULT]  
        /NIVEAU = | ' DEPL_LOC',  
                  | ' VITE_LOC',  
                  | ' FORC_LOC',  
                  | ' TAUX_CHOC',  
        ◇INST_INIT = Ti, [R]  
        ◇INST_FIN = tf, [R]  
        ),  
    ◇TITER=titer , [l_Kn]  
)
```

## 3 Operands

### 3.1 Matrixes generalized

In the case of a computation by modal recombination, the generalized matrixes must be established by the operator `PROJ_MATR_BASE` [U4.63.12] or by macro-command `PROJ_BASE` [U4.63.11], from same modal base.

In the case of a computation by dynamic substructuring, the generalized matrixes must be established by the operator `ASSE_MATR_GENE` [U4.65.04], from same generalized classification.

◆ `MATR_MASS` = `my`

Mass matrix of the generalized system.  
Concept of the `matr_asse_gene_R` type.

◆ `MATR_RIGI` = `laughed`

Stiffness matrix of the generalized system.  
Concept of the `matr_asse_gene_R` type.

◇ `MATR_AMOR` = `amndt`

Damping matrix of the generalized system.  
Concept of the `matr_asse_gene_R` type.  
This option is not available with method "DEVOGE".

### 3.2 Key word `AMOR_MODAL`

This key word makes it possible to take into account a damping equivalent to modal damping broken up on a basis of modes precalculated in the form of concept of the `mode_meca` type. This damping is taken overall into account in the dynamic balance equation like a correct force with the second member  $-C\dot{X}$ .

#### 3.2.1 Operands `AMOR_REDUIT` / `LIST_AMOR`

◇ / `AMOR_REDUIT` =  $L \eta$

Lists reduced dampings ( $\eta_1, \eta_2, \dots, \eta_n$  percentages of critical damping the) corresponding ones to each mode of the system in the form of list of realities.

This option is not available in dynamic substructuring because reduced dampings must be defined for each substructure separately (operator `MACR_ELEM_DYNA` [U4.65.01]).

#### Note:

*If the number of reduced dampings given is lower than the number of basic vectors used in modal base, depreciation of the additional vectors is taken equal to the last damping of the list.*

/ `LIST_AMOR` = `c_formuleformule`  $\eta$

Name of the concept of the `listr8` type containing the list of reduced dampings.

### 3.3 Diagrams of integration. Key word `SCHEMA_TEMP`

Under this key word one can inform a diagram of integration with, possibly, its parameters. The diagrams available are to be declared under operand `SCHEMA`.

#### 3.3.1 Operand `SCHEMA`

◇ `SCHEMA` =

Choice of the numerical method of resolution.

In the case of a classical computation by modal recombination, the user has six methods of the explicit type, an integral method and method of an implicit type.

In the case of a computation by dynamic substructuring [R4.06.04], the transitory method of calculating on modal base calculated by substructuring supports all the diagrams of integration evoked except the integral method. On the other hand, the transitory method of calculating on the "bases" of substructures supports only the diagram of Eulerian and the diagrams to time step adaptive.

### 3.3.1.1 SCHEMA = "NEWMARK" : implicit scheme

This diagram allows only the integration of linear problems. It is the diagram by default for the resolution. One can specify the parameters of integration  $\beta$  and  $\gamma$  :

◇ BETA = beta

Value of the parameter  $\beta$  for the method of NEWMARK. By default  $\beta=0.25$  .

◇ GAMMA = gamm

Value of the parameter  $\gamma$  for the method of NEWMARK. By default  $\gamma=0.5$  .

### 3.3.1.2 SCHEMA = "EULER" : explicit diagram of order 1

This diagram supports computation with taking into account of all localised non-linearities available.

### 3.3.1.3 SCHEMA = "DEVOGE" : explicit diagram of order 4

the diagram of DEVOGELAERE supports computation with taking into account of all localised non-linearities available.

### 3.3.1.4 SCHEMA = "ADAPT\_ORDRE2" : explicit diagram of order 2

This diagram (called "ADAPT" in the previous versions of the code) supports computation with taking into account of all localised non-linearities available. This method uses the diagram of the central differences, the algorithm of adaptation of time step leans on the computation of a "apparent frequency":

$$f_{APt} = \frac{1}{2\pi} \sqrt{\frac{\ddot{x}_t - \ddot{x}_{t-1}}{x_t - x_{t-1}}}$$

One time step specifies Ci after the operands specific to the integration method by adaptive. They are the operands following of the key word factor INCREMENT :

◇NB\_POIN\_PERIODE = N

Number of points per apparent period. It is this parameter which fixes the accuracy of computation. It must be at least equal to 20; its value by default (50) guarantees a satisfactory accuracy (about 1%) in most case.

◇VITE\_MIN =

Method of calculating the velocity of reference used to evaluate the apparent frequency.

When the denominator of the apparent frequency ( $x_n - x_{n-1}$ ) becomes weak, this one can become very high, which leads to an unjustified refinement of time step. To cure it, the algorithm uses the following criterion:

$$\frac{|x_n - x_{n-1}|}{\Delta t} \leq V_{min} \Rightarrow f_{APn} = \frac{1}{2\pi} \sqrt{\frac{\ddot{x}_n - \ddot{x}_{n-1}}{V_{min} \Delta t}}$$

$V_{min}$  can be calculated in two ways different according to the value from VITE\_MIN:

$$\text{"NORM"} = V_{min}(t_n) = \frac{\|V(t_n)\|}{100} \text{ for all the degrees of freedom.}$$

Can be used:

- if the system has several degrees of freedom,
- if the order of magnitude of displacement is not too different according to the degrees of freedom.

$$\text{"MAXI"} = V_{min}^i(t_n) = \frac{\text{Max}(|V^i(t_p)|)}{100} \text{ for the degree of freedom } i.$$

Can be used:

- if the system has a small number of degrees of freedom (from 1 to 3),
- for a system with several degrees of freedom, if the order of magnitude of displacement is very different according to the degrees of freedom (for example in the presence of degrees of freedom of Lagrange under - structuring),
- if the order of magnitude velocity does not vary too much in the course of time.

◇NMAX\_ITER\_PAS = N

maximum Number of reductions of time step per computation step. It is by default equal to 16, which limits the coefficient of reduction of the step to  $0,75^{16} = 10^{-2}$  by iteration (when time step is too high, one takes again computation with a weaker step:  $\Delta t_n' = 0,75 \Delta t_n$ ).

NMAX\_ITER\_PAS can be:

- increased to allow time step to fall in a more brutal way,
- decreased if time step seems excessively refined, for example in the presence of discontinuities (solid friction, discontinuous excitation,...).

If, at a given time, one reaches this maximum number of successive reductions of time step, then the code nevertheless will consider that the final step is correct and will pass to the following step. An alarm message is then transmitted, which announces a possible risk of loss of accuracy and which advises with the user to start again computation with parameters modified (while playing on PAS, NMAX\_ITER\_PAS and/or COEF\_DIVI\_PAS) to make it possible to cross the difficulty with time step the smaller.

◇COEF\_MULT\_PAS = cmp

Coefficient of increase in the step when the error is sufficiently weak:

$$\Delta t_n < \frac{0,75}{Nf_{APn}} \Rightarrow \Delta t_{n+1} = \text{cmp} \Delta t_n.$$

Its value by default (cmp=1.1) guarantees stability and accuracy, but it can in general be increased (with more until 1.3) to accelerate integration.

◇COEF\_DIVI\_PAS = cdp

Coefficient of refinement of time step ( $> 1$ ) when the error is higher than 1, that the nombre of iterations maximum (N\_MAX\_ITER\_PAS) is not reached and that the time step minimal one is not reached:

$$\Delta t_n < \frac{1}{Nf_{APn}}, N_{iter} < N_{iter\_max} \text{ and } \Delta t_n > plr \Delta t_{initial}$$
$$\Rightarrow \Delta t_n = \frac{\Delta t_n}{cdp}$$

the value by default is of 1.33333334 , that is to say a reduction of a factor 0.75 .

◇PAS\_LIMI\_RELA = plr

Coefficient applied to time step initial to define the limit of refinement and thus the time step minimal one:

The value by default is of 1.33333334 , that is to say a reduction of a factor 0.75 .

$$\Delta T_{min} = plr \Delta t_{initial}$$

### 3.3.1.5 SCHEMA = "RUNGE\_KUTTA\_54" : diagram clarifies with adaptive step.

This diagram is part of the family of the diagrams of integration of the Runge-Kutta type. In particular, it is the explicit diagram of integration of Dormand-Prince (54) [R5.06.04] with time step adaptive.

Diagram "RUNGE\_KUTTA\_54" supports the taking into account of all nonthe - linearities available in the operator except for non-linearities of fluid blade.

The computation the time step optimal one is done by control of the error between the approximations of order 5 and 4 of the prediction of the vector of state (concatenation of the displacement vectors and velocity).

This diagram leans on the condition of control of the following relative error:

$$err \leq 1$$

with

$$err = \frac{1}{n} \sum_i \sqrt{\left(\frac{y_{i1} - \hat{y}_{i1}}{sc_i}\right)^2} \text{ and } sc_i = tol \cdot MAX(|y_{i0}|, |y_{i1}|)$$

where

- $y_{i1}$  is the value of the prediction of order 5 of the component  $i$  of the vector of state  $y$
- $\hat{y}_{i1}$  is the value of the prediction of order 4 of the component  $i$  of the vector of state  $y$
- $n$  is the size of the vector of state  $y$
- $y_{i0}$  is the value of the component  $i$  of the vector of state  $y$  with the actual position

◇TOLERANCE = tol

Value of control of relative error given by the user intervening in the statement of  $sc_i$ . By default it is worth 1.E-3.

### 3.3.1.6 SCHEMA = "RUNGE\_KUTTA\_32" : diagram clarifies with adaptive step.

Like diagram "RUNGE\_KUTTA\_54", diagram "RUNGE\_KUTTA\_32" is part of the family of the diagrams of integration of the Runge-Kutta type. In this case, it is the explicit diagram of integration of Bogacki-Shampine (32) [R5.06.04] with time step adaptive.

Like the preceding diagram, it supports the taking into account of all non-linearities available in the operator except for non-linearities of fluid blade.

For this diagram, the computation of time step optimal is done by control of the error between the approximations of order 3 and 2 of the prediction of the vector of state. The computation the time step optimal one, as for him, is done in a way similar to the preceding diagram.

### 3.3.1.7 SCHEMA = "ADAPT\_ORDRE1" : explicit diagram of order 1

This diagram is an alternative of preceding diagram "ADAPT\_ORDRE2". It is in fact a version of the diagram of Eulerian with time step adaptive. Apart from this difference, this diagram is used same way as the adaptive diagram of order 2: the syntax of the key word is same and the continuation methods of time step too.

### 3.3.1.8 SCHEMA = "ITMI" : diagram integral for the computation of the response of mechanical systems very slightly deadened with couplings fluidelastic

This diagram of integration by integral method allows, for the systems slightly damped, to obtain an exact response by taking account of the variations of fluidelastic forces obtained in the presence of shocks.

One describes Ci below the keywords specific to the computation of the response of linear mechanical systems very slightly deadened with couplings fluidelastic possibly associated with non-linearities located with the nodes of the shocks type and frictions.

◇BASE\_ELAS\_FLUI = mix

Modal base used for computation.

Concept of the melasflu type by the operator produces CALC\_FLUI\_STRU [U4.66.02] which contains all the modal bases calculated for different the definite rate of flow. This key word is compulsory for method "ITMI".

The computation transitory on modal base modified by the coupling fluidelastic is carried out in taking into account the values of added depreciation, which had with the flow of the fluid, which is present in the concept melasflu of entry . **Modal dampings, recovered fluidelastic base, replace those well informed under total key word AMOR\_REDUIT of operator DYNA\_TRAN\_MODAL .**

◇NUMÉRIQUE\_VITE\_FLUI = Nvitf

Rate of flow retained for computation (sequence number).

Allows to extract in the concept melasflu modal base corresponding to the rate of flow retained (cf [U4.66.02]). This key word is compulsory for method "ITMI".

◇ETAT\_STAT =

For the systems very slightly damped, this option makes it possible to avoid an expensive computation of the linear phase preceding the first shock. This phase, called thereafter "transitional stage" precedes the establishment by a mode made up of a succession of nonlinear phases of shocks and/or linear phases called of "flight" according to the forcing functions of the mechanical system applied. The time of transient corresponds to a displacement equal to the clearance of a thrust. It can be relatively important (50 to 100 seconds).

ETAT\_STAT = "YES" : the transition into only one of computation of the transitional stage allows time step.

The transition of the transitional stage is carried out by supposing the mechanical system in "flight". The time necessary on the way of the transient is estimated by the algorithm according to the mechanical characteristics of the system in "" vol' ". This estimate is based on a criterion where parameter PREC\_DUREE periods D" excitations due to the turbulent forces intervene and the.

#### Note:

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

If one asks for a simulation with computation in time step of the transitional stage, it will be necessary to take care to introduce a period of sufficiently long excitation. This period must correspond to the period necessary on the way of the transient increased by the period of simulation in established mode wished. This total period of simulation will be indicated via two operands `INST_INIT` and `INST_FIN` under the key word factor `INCREMENT`.

`ETAT_STAT = "NON"` : Simulation does not distinguish the transitory state from the established mode.

◇ `PREC_DUREE = prec`

Makes it possible to define the accuracy chosen to determine the period of the transitional stage according to the formula:

$$T_{tr} = \frac{-\ln(\text{prec})}{2\xi_0\omega_0} \text{ where } \xi_0 \text{ and } \omega_0 \text{ the reduced damping and the pulsation of each mode}$$

considered indicate respectively. The value by default of this parameter is 1%.

◇ `CHOC_FLUI =`

Determines the processing carried out by the algorithm during the shock phases with respect to the fluidelastic forces.

By default, the variation of the fluidelastic forces in shock phase related to the modification of the stiffness and the damping of the mechanical system (impact on the thrust) is not taken into account.

◇ `NB_MODE = Nmode`

Number of modes of the base modal retained for dynamic computation.

The preserved modes correspond to increasing frequencies (first modes). If `NB_MODE` is not specified, one takes all the modes of the modal base of the concept of the `melasflu` type.

◇ `NB_MODE_FLUI = Nmodef`

Number of modes of the base modal disturbed by the fluidelastic phenomena of coupling in shock phase (lower than the number of modes retained for dynamic computation).

The preserved modes correspond to `Nmodef` first increasing frequencies (first modes). If `NB_MODE_FLUI` is not specified, one takes the number of modes retained for dynamic computation.

◇ `TS_REG_ETAB = tsimu`

Lasted of desired simulation.

In the case of a simulation without preliminary computation and in time step of the transitional stage (`ETAT_STAT = "NON"`), this period corresponds to the period of simulation whatever the state of the system between times of beginning and end of simulation. Consequently one will have to make sure that:

$$TS\_REG\_ETAB \leq INST\_FIN - INST\_INIT$$

By default, one will have `TS_REG_ETAB = INST_FIN - INST_INIT`

In the case of a simulation with computation of the transitional stage (`ETAT_STAT = "YES"`), this period corresponds to the period of really desired simulation when the shock phase is established from the numerical point of view. Consequently one will have to make sure that:

$$TS\_REG\_ETAB \leq INST\_FIN - INST\_INIT - \text{"time considered transitory"}$$

If this last condition is not observed, the user is informed with accuracy of the minimum time of excitation necessary for its computation `INST_FIN - INST_INIT`.

By default, one a: `TS REG ETAB = INST FIN - INST INIT - "time considered transitory"`

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

**Note:**

*This diagram of integration is not usable in pursuit and does not allow computation by under - dynamic structuring.*

*The presence of key word `CHOC` is imperative even for simulations of phases without shocks known as "phases of flight".*

*The taking into account of non-linearities of type fluid blade was not introduced to date into the diagram of integration.*

## 3.4 Key word INCREMENT

### 3.4.1 Operands `LIST_INST` / `NOT/VERI_PAS/PAS_MINI/PAS_MAXI`

◆ `/LIST_INST = l_temp`

Concept lists realities of the `listr8` type.

List realities defining times  $t_i$  of computation of the solution

- Diagrams "RUNGE\_KUTTA\_54" and "RUNGE\_KUTTA32":  
For the diagrams of the Runge-Kutta type, key word `LIST_INST` is not taken into account.

`/PAS = dt`

- Schémas "EULER", "DEVOGE", "NEWMARK":  
Time step transient computation.

- Diagrams "ADAPT\_ORDRE1" and "ADAPT\_ORDRE2":  
Indicate the time step initial one used by the algorithm.  
This parameter must be sufficiently weak:

- to allow the computation of the static phases (which always uses the time step maximum one),
- to start the algorithm correctly.

It must however be sufficiently high not to penalize the group of computation.

- Diagram "ITMI":

Indicate time step retained for the first computation step (after possible transition of the transient). Thereafter, the algorithm automatically manages the computation step according to the stiffness of structure and the zones of transition flight/shock.

- Diagrams "RUNGE\_KUTTA\_54" and "RUNGE\_KUTTA32":

Indicate the time step initial one proposed by the user. If the error of prediction between the control statements checks  $err \leq 1$ , then it is the first computation step. If not, the algorithm automatically chooses the time step necessary one in order to check this condition. Thereafter, the choice of time step in the algorithms of Runge-Kutta is managed automatically.

◇ `VERI_PAS = reference mark`

Checking of time step of computation compared to time step limits given according to the highest frequency of the modes of modal base considered or the bases of under - structures.

# Operands specific to an integration by time step adaptive with diagrams "ADAPT\_ORDRE1", "ADAPT\_ORDRE2" like "RUNGE\_KUTTA\_54" and "RUNGE\_KUTTA\_32".

◇ `PAS_MAXI = dtmax`

maximum Value of time step. If the conditions of increase in time step are met, time step flow will be able to then increase up to this limiting value.

If the user does not give a value to this optional parameter, diagrams "ADAPT\_ORDRE1", "ADAPT\_ORDRE2" will consider a value noted  $dt_s$  from the cut-off frequency of the base (possibly corrected by the stiffness of shocks). On the other hand, the diagrams of Runge-Kutta will not have any limitation superior in terms of time step.

To find the operation of the previous versions of the code, it is enough to force:  
 $dt_{max} = dt$ , therefore the same value with the parameter NOT as with PAS\_MAXI.

If the user gives a value higher than  $dt_s$ , an alarm will be emitted attentive of a risk of loss of accuracy.

◇ PAS\_MINI = dtmin

minimal Value of time step. If the conditions of reduction in time step are met, time step flow will be able to then decrease up to this limiting value.

If the user does not give a value to this optional parameter, then the code will calculate the time step minimal one from PAS\_LIMI\_RELA.

To find the operation of the former versions of the code, it is thus enough not to define PAS\_MINI.

## 3.4.2 Operands INST\_INIT/INST\_FIN/NUME\_FIN

◇ INST\_INIT = to

- Méthodes "EULER", "DEVOGE", "NEWMARK", "ADAPT\_ORDRE1" and "ADAPT\_ORDRE2" :

Time of beginning of transient computation. In the event of recovery, key word ETAT\_INIT is used : under this key word, initial time is recovered with operand INST\_INIT or taken equal to the last time of filed preceding computation. Operand INST\_INIT must thus be only used if there is no resumption of a preceding computation.

- Diagram "ITMI" :

Indicate the time of beginning of simulation. When computation in time step of the transitional stage is required, simulation begins with INST\_INIT + "computing time from the transient"

◇/ INST\_FIN = tf

Instant from end from simulation.

/NUME\_FIN = tf

Numéro of the time of end of computation in LIST\_INST

## 3.5 Key word ETAT\_INIT

Key word factor which allows a poursuite of a transient computation, while taking as initial state:

- that is to say result resulting from a computation by modal synthesis preceding EXCIT (RESULTAT);
- maybe displacements and velocities expressed in the form of generalized assembled vectors EXCIT (DEPL and QUICKLY)

### Note:

- This functionality is not available for a computation by transitory substructuring without double projection nor for method ITMI.
- During a poursuite, the state of dependancy or shock is not saved.

- Displacements and velocities generalized must be established by the operator `PROJ_VECT_BASE [U4.63.13]` from the modal base used for the generalized stiffness matrixes or by the operator `RECU_GENE [U4.71.03]` applied to a preceding computation.

### 3.5.1 Operands RESU/DEPL/QUICKLY

◇/RESULTAT = tran

Concept of the `tran_gene` type resulting from a preceding computation with `DYNA_TRAN_MODAL`.

/I DEPL = C

Concept of the `vect_asse_gene` type, generalized displacements initial.

IVITE = v0

Concept of the `vect_asse_gene` type, initial generalized velocities.

### 3.5.2 Operands INST\_INIT/NUME\_ORDR

◇/ INST\_INIT = to

previous Time of computation to extract and take as initial state in the case of a recovery. In the absence of this operand, moment of recovery is taken equal to the last moment of filed preceding computation.

/NUME\_ORDRE = nuord

Indicates the number of archivage of preceding computation to extract and take as initial state in the case of a recovery.

### 3.5.3 Operand CRITERE

◇CRITERE

Indicates with which accuracy the search of time must be done:

"RELATIF" : interval of search [(1-PREC) .instant, (1+prec) .instant]

"ABSOLU" : interval of search [time-PREC, instant+prec]

the criterion is "RELATIF" by default.

### 3.5.4 Operand accuracy

◇PRECISION =/1.E-06 [DEFAULT]  
/prec [R8]

Indicates with which accuracy the search of time must be done.

## 3.6 Description of the loading under separate variables: key word EXCIT

◇EXCIT

Key word defining the loading. This key word must be repeated as many times as there are vectors generalized loading  $f_i$ . The total loading is the sum of these vectors loading. This key word makes it possible to define the loading under has the shape of generalized vectors multiplied by multiplying functions.

### 3.6.1 Operands VECT\_ASSE\_GENE/NUME\_ORDRE

the loading is taken into account in the form of vector project on modal base `EXCIT=_F (VECT_ASSE_GENE)` or in the form of modal component `EXCIT =_F (NUME_MODE)` or both at the same time.

~ VECT\_ASSE\_GENE = v

generalized Vector allowing to describe the spatial distribution of the loading.

Concept of the vect\_asse\_gene type.

The generalized vectors must be established by the operator PROJ\_VECT\_BASE [U4.63.13] from the modal base used for the generalized matrixes. In the case of a computation by dynamic substructuring, the generalized vectors must be established by the operator ASSE\_VECT\_GENE [U4.65.05] from the generalized classification used for the generalized matrixes.

/NUME\_ORDRE = nmordr

Sequence number of the mode of excitation of the structure (Attention! One should not confuse the sequence number of the mode – given by modal computation in the order where they have calculated – and the number of the mode, entitled in Code\_Aster NUME\_MODE).

### 3.6.2 Operand FONC\_MULT/COEF\_MULT

◆/FONC\_MULT = F

Function of time (function) allowing to describe the temporal evolution of the vector loading.

/COEF\_MULT = has

multiplying Coefficient of the generalized vector (constant actual value compared to time).

## 3.7 Key word EXCIT\_RESU

Key word allowing to define a loading in the form of a generalized temporal evolution, without separation of variables (the most general case). This temporal evolution can be calculated from the operator PROJ\_BASE, option RESU\_GENE, which carries out the projection of result a transient dynamics (dyna\_trans).

### 3.7.1 Key word RESULTAT

◆/RESULTAT = resu\_gene

Data format resu\_gene defining the generalized loading.

### 3.7.2 Operand COEF\_MULT

◇/COEF\_MULT = F

multiplying Coefficient, is worth 1.0 by default.

## 3.8 Typical case of the seismic analysis

### 3.8.1 Taken into account of the modes neglected by static correction: key keys CORR\_STAT, MODE\_CORR and D\_FONC\_\*

During the seismic analysis of an excited mono structure, it is possible to take into account, a posteriori, the static effect of the neglected modes. In this case, during the return on physical base, calculated relative displacements (respectively velocities and relative accelerations) are corrected by a pseudo-mode.

One will find the details of this kind of correction in [R4.05.01].

Inside the key word factor EXCIT, CORR\_STAT=' OUI ' allows the taking into account of the modes neglected by static correction, it is then compulsory to inform key keys MODE\_CORR, D\_FONC\_DT and D\_FONC\_DT2.

◇ MODE\_CORR = modcor

Concept of the `mult_elas` type produces by macro-command `MACRO_ELAS_MULT` [U4.51.02] or `mode_meca` which corresponds to the linear static response of structure with a unit loading of type forces imposed (constant acceleration) in the direction of the seisme considered. It is noted that there is as much loading case than of direction of seisme.

◇ `EXCIT = _F (CORR_STAT)`

If `MODE_CORR` is present, `CORR_STAT=' OUI '` allows to take into account the contribution of the modal correction a posteriori for each occurrence of key word `EXCIT`.

◇ `EXCIT = _F ( D_FONC_DT and D_FONC_DT2 )`

`D_FONC_DT` and `D_FONC_DT2` are respectively the derivatives first and second derivative of the time of the defined accelerogram, in each seismic direction considered, by operand `FONC_MULT`. They balance the contribution of the modal correction a posteriori for each occurrence of key word `EXCIT` in order to respectively obtain the corrections velocity and acceleration on physical base.

#### Note:

- The taking into account of static correction excludes that from the multi-bearings.
- The concept `mult_elas` must lean on coherent numbers of the equations (even profile and even option of renumbering) with that of the system solved in operator `DYNA_TRAN_MODAL`.
- To  $i$  the  $i$ ème occurrence of key word `EXCIT` corresponds  $i$  the  $i$ ème elastic solution of `MODCOR`.
- So that static correction is actually taken into account during the return towards the physical coordinates in operator `REST_GENE_PHYS` or `RECU_FONCTION` `CORR_STAT=' OUI '` should be specified.

### 3.8.2 Taking into account of the multi-bearings: key keys `MODE_STAT`, `MULTI_APPUI` and `ACCE`, `QUICKLY`, `DEPL`

In the case of a multimedia structure, in order to restore the quantities calculated in the absolute coordinate system or to take into account nonlocated linearities, it is necessary taking into account to calculate the response generalized in the component of training. For more details, one will refer to the reference [R4.05.01].

Key keys `MODE_STAT`, `MULTI_APPUI`, `ACCE`, `QUICKLY`, `DEPL`, `DIRECTION` and `NOEUD` or `GROUP_NO`) specific to the taking into account of the multimedia character must be simultaneously present.

A `cham_no` resulting from the projection of a `CALC_CHAR_SEISME` represents the vector of excitation on the bearing. It should not be forgotten, even if information can appear redundant with the data of the bearing and the direction of seisme.

◇ `MODE_STAT = psi`

Concept of the `mode_meca` type by the command produces `MODE_STATIQUE` [U4.52.14] which corresponds to (3 or 6) the `nb_supports` static modes (where `nb_supports` is the number of supports which undergo a different acceleration).

◇ `EXCIT = _F (MULTI_APPUI)`

If one calculates the seismic response of a multimedia structure, `MULTI_APPUI = "YES"`, one compared to each time, the vector of absolute displacements of each point of shock considered, in order to determine if there is shock and to calculate the corresponding shock forces. If not, `MULTI_APPUI = "NON"`, one compared to each time, the vector of relative displacements of each node likely to shock.

◇ `EXCIT = _F ( /◇ACCE =ac ,  
◇VITE =vi ,  
◇DEPL =dp )`

Names of the functions acceleration (ACCE), velocity (QUICKLY) and displacement (DEPL) imposed during computation of the seismic multimedia structure response.

**Note:**

*If the structure is mono-excited, the accelerogram is defined by key word FONC\_MULT .*

◇EXCIT = \_F (DIRECTION = (dx, Dy, dz, drx, dry, drz))

Component of the vector giving the direction of the seisme in the total reference.

◇ EXCIT = \_F ( / NOEUD =lno  
/ GROUP\_NO =lgrno )

Lists names of nodes (or nodes group) corresponding to the bearings concerned where the seisme is imposed.

◇EXCIT = \_F (VECT\_ASSE\_GENE = v)

Vector project of the seismic excitation (resulting from CALC\_CHAR\_SEISME [U4.63.01])

## 3.9 Taken into account of a transient rotational speed

### 3.9.1 Precise Operand

VITESSE\_VARIABLE if the rotational speed of the rotor is variable according to time (VITESSE\_VARIABLE = "OUI" for the transients velocity) or constant (VITESSE\_VARIABLE = "NON").

### 3.9.2 Operands VITE\_ROTA, MATR\_GYRO, ACCE\_ROTA and MATR\_RIGY

These operands are the parameters defining the transient rotational speed.

If VITESSE\_VARIABLE = "OUI", then should be informed the following parameters:

- ◆ VITE\_ROTA =fonction giving the model angular velocity imposed on the rotor
- ◆ MATR\_GYRO gyroscopic =matrice of damping
- ◇ ACCE\_ROTA =fonction giving the model of acceleration imposed on the rotor
- ◇ MATR\_RIGY gyroscopic =matrice of stiffness

**Note:**

*If ACCE\_ROTA is not provided, she is neglected (IE. no numerical derivative from VITE\_ROTA).*

If VITESSE\_VARIABLE = "NON", it is necessary to inform the value constant rotational speed.

- ◆ VITE\_ROTA =vit ess of rotation of the shaft [by default 0.0]

## 3.10 Taken into account of nonlocalised linearities of standard shock, friction, fissured rotor and fluid blade

### 3.10.1 Not localised linearities of standard shock and friction: key word CHOC

◇CHOC

This key word factor is used for the study of the structure response (generally slender) whose displacements are limited in one (or several) (S) - not specified a priori by the user by the

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presence of an obstacle (the various types of obstacles available are described in the documentation [U4.44.21] of operator `DEFI_OBSTACLE`), of another antagonistic structure or an effect of fluid blade.

### 3.10.1.1 Operand `INTITULE`

◇ `INTITULE` = int

Entitled (eight characters to the maximum) allowing to name non-linearity. If nothing is specified by the user, the heading is the name of the `NOEUD_1`.

### 3.10.1.2 Operands `NOEUD_1/NOEUD_2/GROUP_NO_1/GROUP_NO_2. /GROUP_MA`

◆ `NOEUD_1` or `GROUP_NO_1`

Node or name of the group of node of the structure to which the condition of non-linearity relates. In the case of a nonlinear computation by dynamic substructuring, one substructure indicates under this key word the node of shock pertaining to the first (the different ones under - structures do not belong to the same mesh).

◇ `NOEUD_2` or `GROUP_NO_2`

Node or name of the group of node of the second structure to which the condition of non-linearity relates. This operand is specific with the definition of a contact between two mobile structures.

In the case of a nonlinear computation per dynamic substructuring, one the indicated node specifies the node of shock coinciding with in `NOEUD_1` (or `GROUP_NO_1`), but pertaining to the second substructure.

#### Note:

*| It is checked that the nodes groups contain well one and only one node.*

◆ `GROUP_MA` or `MESH`

One can also enter the nodes of shocks in opposite in the form of meshes `SEG2` drawn the mesh. Thus one preserves the same way of describing the shocks as for `DYNA_NON_LINE` with the discrete elements of shock (`DIS_CHOC`). One can enter a list of `MESH` or `GROUP_MA`.

### 3.10.1.3 Operand `OBSTACLE`

◆ `OBSTACLE` = obs

Name of the concept of type `obstacle` defining the geometry of an indeformable obstacle or the form wraps clearance between two antagonistic structures. It is produced by the operator `DEFI_OBSTACLE` [U4.44.21].

### 3.10.1.4 Operand `NORM_OBST`

◆ `NORM_OBST` = NOR

List of 3 realities defining the norm in the plane of cut of the obstacle, i.e. the vector  $X_{loc}$ . One advises that  $X_{loc}$  is the direction of neutral fiber or a generator of studied structure.

### 3.10.1.5 Operand `ORIG_OBST`

◇ `ORIG_OBST` = ori

List of 3 realities defining the position of the origin of the obstacle in the total reference (compulsory key word in the case of shocks between a mobile structure and a fixed wall). In the case of shocks between two mobile structures, the code considers by default that the origin is located in the middle of the two nodes of shock `NOEUD_1` (or node of the `GROUP_NO_1`) and `NOEUD_2` (or node of the `GROUP_NO_2`).

### 3.10.1.6 Operand `JEU`

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

◇JEU = clearance

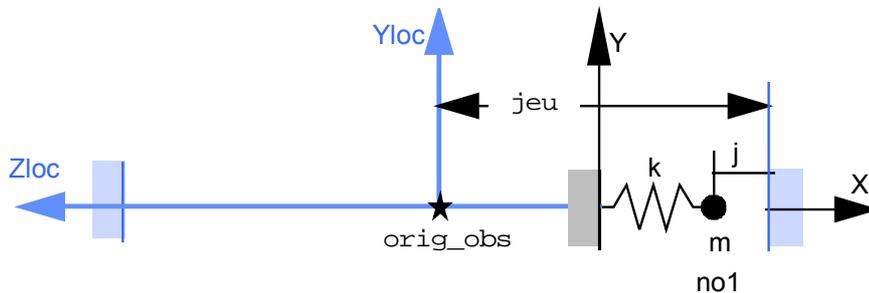
In the case of a shock between a mobile structure and an indeformable obstacle, operand JEU represents:

- the half-distance inter-planes for obstacles of the type PLAN\_Y and PLAN\_Z
- the radius of the circular obstacle for an obstacle of the type RINGS

This key word is unutilised in the case of obstacles discretized by segments of the DISCRETE type.

**Note:**

*The obstacle of the type PLAN\_Y or PLAN\_Z comprises in fact two plane obstacles. Thus if the user wishes to model the shock on a single level, not to be constrained by the rebound of structure studied on the symmetric level, one advises with the user to very push back it far (cf [3.6.1.6 Figure - has]), J represents real clearance between studied structure and the obstacle .*



**Appears 3.6.1.6 - has: Spring-mass system impacting a fixed wall**

**Note :**

*Key word JEU is not used in the case of shock between mobile structures.*

The various cases of clearances are represented in the documentation of DEFI\_OBSTACLE [U4.44.21].

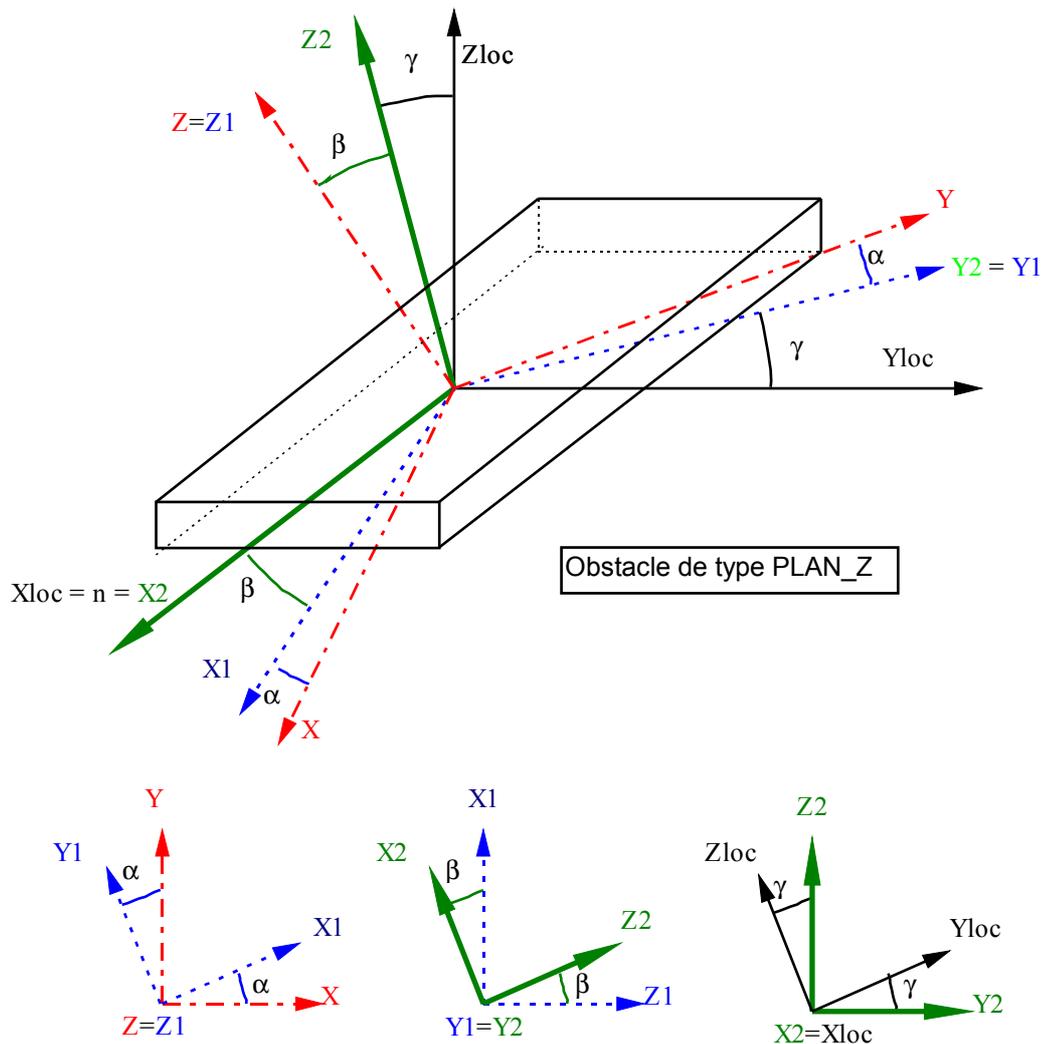
### 3.10.1.7 Operand ANGL\_VRIL

◇ ANGL\_VRIL = gamma

$\gamma$ , angle in degrees defining the angular position of the local coordinate system of the obstacle in its plane.

By convention, the norm  $n$  with the plane of cut of the obstacle, NORM\_OBST defines the axis  $X_{loc}$  of the local coordinate system. One passes from the total reference  $X, Y, Z$  to the reference of the plane of the obstacle  $n, y_2, z_2$  by a product of two rotations of angles  $\alpha$  around  $Z$  then  $\beta$  around transformed  $y_1, Y$ .

The position of the obstacle in this plane is obtained by a rotation of angle  $\beta$  around the normal direction  $X_{loc}$  (cf [3.6.1.7 Figure - has]).



**Appear 3.6.1.7 - has: Rotations allowing to pass from the total reference to the local coordinate system of the obstacle.**

The angles  $\alpha$  and  $\beta$  are automatically given from the normal to the obstacle  $n$ . The local coordinate system  $X_{loc}, Y_{loc}, Z_{loc}$  results then from the reference  $n, y_2, z_2$  by rotation of an angle of gimlet ANGL\_VRIL around  $n$ .

**Note:**

- If the user does not specify anything, the angle of gimlet is calculated by the code in the case of shocks between mobile structures with obstacles of the type BI\_PLAN.
- With regard to the other types of obstacles, the value by default of gamma is zero.

**3.10.1.8 Operands DIST\_1/DIST\_2**

◇DIST\_1 = dist1

Distance characteristic of matter surrounding NOEUD\_1: no1 (or GROUP\_NO\_1).  
 Operand specific to the contact between two mobile structures.

◇DIST\_2 = dist2

Distance characteristic of matter surrounding NOEUD\_2: no2 (or GROUP\_NO\_2).  
 Operand specific to the contact between two mobile structures.

**Note:**

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

- $DIST_1$  and  $DIST_2$  are defined within the meaning of the outgoing norms of two solids as screw - with-screw ( $DIST_1$  and  $DIST_2$  are positive because they represent the thickness of studied structures).
- Because of the computation of the normal distance from shock, the sum of  $DIST_1$  and  $DIST_2$  must be sufficiently large compared to the supposed amplitude of the relative displacement of the nodes of shocks (cf [R5.06.03]).

### 3.10.1.9 Operands SOUS\_STRUC\_1/SOUS\_STRUC\_2

◇SOUS\_STRUC\_1 = ss1

Name of the substructure which contains the node of shock informing key word NOEUD\_1 (or GROUP\_NO\_1).

◇SOUS\_STRUC\_2 =ss2

Name of the substructure which contains the node of shock informing key word NOEUD\_2 (or GROUP\_NO\_2).

### 3.10.1.10Operand LOCATES

◇REPERE = reference mark

Specifies the reference in which the position of the obstacle is defined.

/ "GLOBAL"

the absolute position of the obstacle is defined independently of rotations and translations to which the various substructures are subjected.

/nom\_sst

Name of one substructure.

The position and the norm of the obstacle are given in the reference used of the substructure to define the coordinates of the nodes nom\_sst, the position and the norm finales of the obstacle being result of rotation and the translation to which is subjected under - structure.

### 3.10.1.11Operand RIGI\_NOR

◆RIGI\_NOR = kN

Value of the normal stiffness of shock (unit  $N/m$  in USI).

### 3.10.1.12Operand AMOR\_NOR

◇ AMOR\_NOR = Cn

Value of the normal damping of shock (unit  $N m/s$  in USI).

### 3.10.1.13Operand RIGI\_TAN

◆RIGI\_TAN = kt

Valeur of the tangencial stiffness of shock (unit  $N/m$  in USI).

### 3.10.1.14Operand AMOR\_TAN

◇AMOR\_TAN = ct

Valeur of the tangencial damping of shock (unit  $N m/s$  in USI).

#### Note:

If a stiffness  $k_t$  is specified and that key word AMOR\_TAN is absent, the code calculates a damping optimized in order to minimize the residual oscillations in dependancy according to the formula:

$$c_i = 2\sqrt{(k_i + k_t)m_i} - 2\xi_i\sqrt{k_i m_i}$$

where  $i$  am the index of the dominating mode in the response of structure.

### 3.10.1.15 Operand FROTTEMENT

◇FROTTEMENT =/"NON"

the condition of contact is without friction.

/"COULOMB"

◆ COULOMB = driven

Value of the coefficient of kinetic friction (without dimension).

/"COULOMB\_STAT\_DYNA"

◆ COULOMB\_STAT = driven

Value of the adhesion coefficient (without dimension).

◆ COULOMB\_DYNA = mud

Value of the coefficient of friction (without dimension).

### 3.10.2 Not localised linearities of fissured rotor: ROTOR\_FISS

the operands following are specific with transient computation with localised non-linearity of standard "rotor fissured" for computations of line of trees modelled in 1D (beam). The crack is considered completely included in a section of the rotor. It is delimited by two nodes distinct but confused coordinates, one connected to the left part of line of trees, the other with the right part. They respectively represent the left lip and the right lip of crack.

The behavior of crack is given by a model of crack stiffness and its derivative. This model is in addition given by computations 3D into quasi-static. It does not depend on the geometry of the rotor but only of and the coefficient fissure shape of dimension.

```

◇ROTOR_FISS=_F (
  /◆/NOEUD_G=lèvre left of the crack
    /GROUP_NO_G =groupe of node naming the left lip of right
  crack ◆/NOEUD _D=lèvre of the crack
    /GROUP_NO_D =groupe of node naming the left lip of the crack
  ◆ANGL_INIT=angle initial of the crack tip compared to its definition in the
  crack constitutive law [by default 0.0]
  ◆ ANGL_ROTA =fonction giving the imposed model of angular position of the
  crack tip compared to its definition in the crack constitutive law (transients velocity)
  ◆K_PHI =loi of behavior in stiffness of the crack
  ◆ DK_DPHI =dérivée of the constitutive law in stiffness
)
    
```

#### Directional sense of the axis of the rotor:

To respect the trigonometrical meaning of rotation, it is important to direct the rotor well: the axis of the rotor is automatically directed by crack, while going from left edge towards the edge right of crack.

### 3.10.3 Not localised linearities of standard fluid blade

the following key words and the operands relate to transient computation with nonlocalised linearities of standard fluid blade. This non-linearity is not available for the diagrams of integration of the Runge-Kutta type.

#### 3.10.3.1 Key word PARA\_LAMA\_FLUI

In this case, the system project takes the shape:

$$\Phi^t . M . \Phi . \ddot{\eta}_t + \Phi^t . C . \Phi . \dot{\eta}_t + \Phi^t . K . \Phi . \eta_t = \Phi^t . F_e(t) + \Phi^t . F_{fluide}(\Phi . \eta_t, \Phi . \dot{\eta}_t, \Phi . \ddot{\eta}_t)$$

$\ddot{\eta}_t$  is thus not given explicitly according to  $\eta_t, \dot{\eta}_t$ . To obtain generalized accelerations, one uses the algorithm of point fixes according to:

$\eta_t^0 = \eta_{t-1}^0$ ,  $\eta_t, \dot{\eta}_t$  are given. One repeats until convergence:

$$\ddot{\eta}_t^{i+1} = \left[ \Phi^t \cdot (\mathbf{M} + \lambda \cdot \mathbf{M}_a) \cdot \Phi \right]^{-1} \cdot \left( \Phi^t \cdot \mathbf{F}_{fluid} + \lambda \cdot \Phi^t \cdot \mathbf{M}_a \cdot \Phi \cdot \ddot{\eta}_t^i + \Phi^t \cdot \mathbf{F}_e - \Phi^t \cdot \mathbf{C} \cdot \Phi \cdot \dot{\eta}_t^i - \Phi^t \cdot \mathbf{K} \cdot \Phi \cdot \eta_t^i \right)$$

where  $M_a$  represent the diagonal contribution of the added mass matrix resulting from the fluid e: blade,

$\lambda$  is a parameter (higher than 1) used to guarantee the character contracting of the iterations of fixed point. By default  $\lambda = 10$ .

The convergence is tested by  $\|\ddot{\eta}_t^{i+1} - \ddot{\eta}_t^i\| < \varepsilon \cdot \|\ddot{\eta}_t^i\|$  where  $\varepsilon$  is the relative residue.

The operands according to are under this key word:

Maximum  $\diamond$ NMAX\_ITER =

niter Number of iterations of the algorithm. By default, niter = 20.

$\diamond$ RESI\_RELA = residue

relative Residue, noted  $\varepsilon$  above. By default,  $\varepsilon = 10^{-3}$

$\diamond$ LAMBDA = average

Parameter of convergence, noted  $\lambda$  above. By default  $\lambda = 10$ .

### 3.10.3.2 Operands LAME\_FLUIDE/ALPHA/BETA/CHI/DELTA of the key word factor CHOC

$\diamond$ LAME\_FLUIDE = reference mark

Specifies if the interaction between the node and the obstacle or the two nodes takes place in the presence of a fluid blade. By default, connection is supposed of standard dry contact.

The reaction force of the fluid blade [R5.06.05] takes the following general shape:

$$F_{fluid} = \alpha \cdot \left( \frac{\ddot{x}}{x+h} \right) + \beta \cdot \left( \frac{\dot{x}}{x+h} \right)^2 + \chi \cdot \frac{\dot{x}}{(x+h)^3} + \delta \cdot \frac{\dot{x} \cdot |\dot{x}|}{(x+h)^2}$$

where  $h$  is the thickness of the fluid blade at rest.

$\diamond$ ALPHA, BETA, CHI, DELTA

Parameters of the force of fluid blade.

## 3.11 Key word VERI\_CHOC

Key word which makes it possible to evaluate a posteriori, the aptitude of modal base to represent the impacts correctly.

If VERI\_CHOC is present, one calculates in each node of shock and for each mode, the rate of

reconstitution of the static solution:  $t_s = K_{statique} \sum_{i=1}^n \frac{(\Phi_i^T \cdot F_{impo})^2}{k_i}$  and, for information, the rate of

reconstitution of the shears:  $t_N = \sum_{i=1}^n \frac{\Phi_i^T \cdot F_{impo}}{k_i} \cdot (\Phi_i^T \cdot F_{impo} \cdot K \cdot \Phi_i)$ . One calculates then the values

cumulated on all the modes which constitute modal base used.

It is checked that the ratio of the flexibility neglected (static flexibility minus reconstituted static flexibility) on the flexibility of shock remains lower than the value given by operand SEUIL (SEUIL is worth 0.5 by default) if not:

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

- if STOP\_CRITERE = "YES" one stops the execution of the program (it is the case by default);
- if STOP\_CRITERE = "NON" one continues the execution of the program with emission of an alarm.

**Note:**

- This functionality is available only for obstacles of the plane *type* or *bi\_plan*.
- If the rate of reconstitution of the static solution is lower than the value of the threshold, one advises with the user to supplement modal base by the local modes at the points of shock which have an important local flexibility.
- The formula is not applicable in the event of static modes (noninvertible stiffness matrix). The computation continues then without checking of the criteria of shock and the user is informed by it.

### 3.12 Key word ANTI\_SISM

key word ANTI\_SISM is incompatible with a computation by dynamic substructuring. It makes it possible to calculate the nonlinear force which exists if an antiseismic device is placed between the two antagonistic nodes whose names are specified by the key keys (NOEUD\_1 or GROUP\_NO\_1 and NOEUD\_2 or GROUP\_NO\_2):

$$F_D = K_2 x + \frac{(K_1 - K_2)x}{\sqrt{1 + \left(K_1 \frac{x}{P_y}\right)^2}} + C \operatorname{sign}(\dot{x}) \left| \dot{x} \frac{x}{x_{max}} \right|^\alpha$$

◇RIGI\_K1 , RIGI\_K2, SEUIL\_FX, C, PUIS\_ALPHA and DX\_MAX

Parameters of the force due to the presence of an antiseismic device.

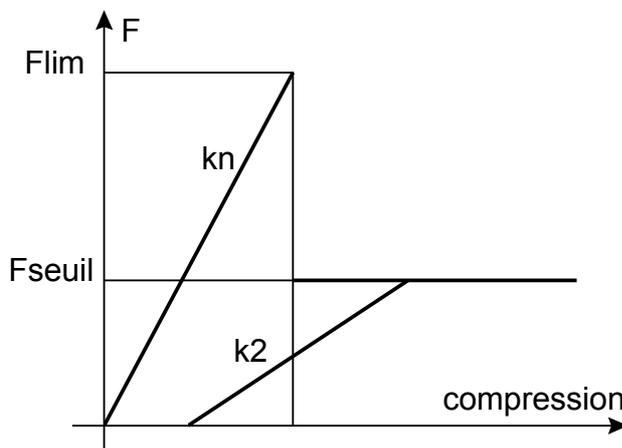
By way of an example, the values of the parameters for an antiseismic device of BULGE type are:

$$K1 = 6.E+06 \text{ N/m} \quad K2 = 0.53 E+06 \text{ N/m} \quad Py = 1200. \quad C = 0.07 E+05 \text{ Nm/s},$$

$$alpha = 0.2 \text{ and } x_{max} = 0.03 \text{ m (if the problem is posed in USI).}$$

### 3.13 Key word FLAMBAGE

This key word is used for the detection of possible buckling and the evaluating of the residual strain of an element during a shock between two mobile structures or a mobile structure and a fixed wall. The reaction force during a shock with taking into account of buckling can be summarized by the following diagram:



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It is considered that there is buckling if the reaction force  $F$  reached the value limits  $F_{lim}$  definite by the user. The normal stiffness of shock after buckling  $k2$  is then different from the stiffness before buckling  $kn$ .

Only the operands specific to key word `FLAMBAGE` are detailed. The other key keys make it possible to define the places of shock and are identical to the operands of key word `CHOC`.

◇FNOR\_CRIT = film

Normal force limits which involves the buckling of structure.

◇ limiting FNOR\_POST\_FL =

fseuil Normal force after buckling which causes a residual strain of structure.

◇ RIGI\_NOR\_POST\_FL = k2

Valeur of the normal stiffness after buckling.

**Note:**

*The computation of shock with buckling the taking into account of the fluid blade and the damping of shock does not allow.*

## 3.14 Key word `RELA_EFFO_DEPL`

◇RELA\_EFFO\_DEPL

Key word factor allowing to define a relation force-displacement or moment - rotation on a degree of freedom given in the shape of a nonlinear curve.

### 3.14.1 Operand `NOEUD`

◆NOEUD = No

Name of the node of the structure to which the relation relates.

### 3.14.2 Operand `SOUS_STRUC`

◇SOUS\_STRUC = ss

Nom of the substructure containing the node informing the operand `NOEUD`.

### 3.14.3 Operand `NOM_CMP`

◇NOM\_CMP = nomcmp

Name of the component of the node of the structure to which the relation relates.

### 3.14.4 Operand `RELATION`

◆RELATION = F

Name of the nonlinear function.

The nonlinear relation is defined from the linear limit of behavior.

**Note:**

*Contrary to key word `RELA_TRANSIS`, it does not exist of linear limit, the function defined under the key word `RELATION` is thus defined on  $]-\infty, \infty[$*

the balance equation, for modelled structure, subjected to a horizontal acceleration of soil  $a_x$  in the direction  $x$ , and having terms of correction coming from non-linearities is written:

$$M \ddot{x} + C \dot{x} + K x = -M a_x + F_c$$

where  $F_c$  is the corrective force due to nonthe linearity of the soil. It can be, for example, defined by the following relation (cf case test SDND103):

$$F_c(x) = f \frac{(x_{seuil})}{x_{seuil}} - f(x) \quad \text{with, if } x > x_{seuil} \quad f(x) = k_0 \left( 1 - \frac{|x|}{x_0} \right).$$

In example Ci above, one thus imposes, under the operand RELATION the function:

$$F_c(x) = \frac{k_0}{x_0} x [|x| - x_{seuil}].$$

## 3.15 Key word RELA\_TRANSIS

◇RELA\_TRANSIS

This key word factor was introduced in order to ensure a compatibility with the preceding versions. It corresponds in fact to key word RELA\_EFFO\_DEPL of version 4. It thus allows, just like current key word RELA\_EFFO\_DEPL to impose a relation force-displacement on a degree of freedom of a node given in the form of a nonlinear function. The nonlinear relation being defined from the linear limit of behavior.

The operands NOEUD, SOUS\_STRUC, NOM\_CMP and RELATION have the same meaning for key keys RELA\_EFFO\_DEPL, RELA\_TRANSIS and RELA\_EFFO\_VITE. They are thus not detailed in this paragraph.

## 3.16 Key word RELA\_EFFO\_VITE

◇RELA\_EFFO\_VITE

Key word factor allowing to define a relation force-velocity on a degree of freedom of a node given in the form of a nonlinear function.

The operands NOEUD, SOUS\_STRUC, NOM\_CMP and RELATION have the same meaning for key keys RELA\_EFFO\_DEPL, RELA\_TRANSIS and RELA\_EFFO\_VITE. They are thus not detailed in this paragraph.

## 3.17 Key word COUPLAGE\_EDYOS

◇COUPLAGE\_EDYOS

compulsory Key word factor during coupling with code EDYOS to compute: the response of revolving machines on nonlinear bearings. The factor key word PALIER\_EDYOS must then also be indicated (cf the following paragraph).

### 3.17.1 Operand VITE\_ROTA

◆VITE\_ROTA = vrot

Definition the rotational speed of the rotor out of turns per minute.

### 3.17.2 Operand PAS\_TPS\_EDYOS

◆PAS\_TPS\_EDYOS = dtedyos

Time step initial for code EDYOS.

## 3.18 Key word PALIER\_EDYOS

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

## ◇PALIER\_EDYOS

Second compulsory key word factor during coupling with code EDYOS. It makes it possible to define the position and the type of the nonlinear bearings whose responses will be calculated by EDYOS.

The data to be specified, for each nonlinear bearing, are:

- position of the bearing (either by the name of the node of the mesh, or by the name of the group containing this node alone),
- type of selected bearing (thus corresponding to a particular model EDYOS).

These data can be entered according to two operating processes.

That is to say all the data are in an external textual file, of which the logical unit will be specified by the key word UNITE.

Either one directly returns the data in the command file, via GROUP\_NO or NOEUD and TYPE\_EDYOS.

### 3.18.1 Operand UNITE

◇/UNITE = uled

Definition of the logical unit of the external textual file which contains the definition of the positions and the types of all the nonlinear bearings. Here an example of this file:

```
2
1 NOE0 PACONL
2 NOE10 PACONL
```

the first line indicates the nombre total of nonlinear bearings, here two.

Then, each line corresponds to a bearing, with three parameters: number (arbitrary) of bearing, position of the bearing (name of the node or the group of corresponding node) and models bearing EDYOS (here PACONL). For the second argument, the code will seek in all the nodes groups of the mesh, then if the name indicated is not found, the search continues in the names of nodes and in the event of failure, an error message is transmitted and precise that the name indicated by the user could not be found. The code stops then in fatal error.

### 3.18.2 Operand GROUP\_NO

◇/GROUP\_NO = grnoed

Group of node containing one node and which corresponds to the position of the nonlinear bearing considered.

### 3.18.3 Operand NOEUD

◇/NOEUD = noed

Name of the node which corresponds to the position of the nonlinear bearing considered. One classically advises to privilege the use of GROUP\_NO to NOEUD for reasons of more practical naming.

### 3.18.4 Operand TYPE\_EDYOS

◇/TYPE\_EDYOS = "PAPANL",  
/ "PAFINL",  
/ "PACONL",  
/ "PAHYNL",

Name of the model of bearing associated, according to the terminology of code EDYOS.

Only the following types of nonlinear bearings are authorized:

- PAPANL : pedestal bearings mobile,
- PAFINL : pedestal bearing fixed,
- PACONL : bearing with taking into account of possibilities of contact,
- PAHYNL : bearing hybrids (hydrodynamic/hydrostatic with pockets of rising).

## 3.19 Key word ARCHIVAGE

◇ ARCHIVAGE

Key word factor defining the archivage.

**Note:**

*For the diagrams of integration of the Runge-Kutta type, the archivage is done in a systematic way on all the urgent of computation. Thus, the values given in operands LIST\_ARCH, INST and PAS\_ARCH are not taken into account.*

### 3.19.1 Operand LIST\_ARCH/INST

◇ /LISTE\_INST = l\_arch

List of integers defining times of computation for which the solution must be filed in the result concept tran\_gene.

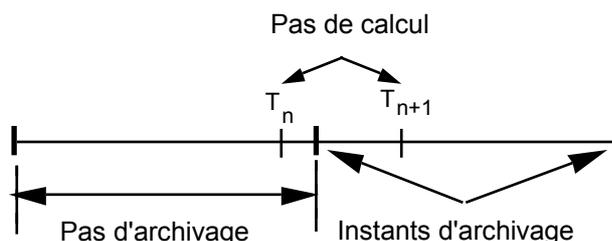
◇ /INST

Times of computation for which the solution must be filed in the result concept tran\_gene .

### 3.19.2 Operand PAS\_ARCH

◇ PAS\_ARCH = ipa

- Methods "EULER", "DEVOGE", "NEWMARK", "ITMI" :  
 Integer defining the periodicity of archivage of the solution of transient computation in the result concept tran\_gene.  
 If ipa = 5 one files all the 5 computation steps.  
 Whatever the option of archivage chosen, one files the last time step and all the associated fields to allow possible recovery.  
 By default one files all the computation steps.
- Methods "ADAPT\_ORDRE1" and "ADAPT\_ORDRE2" :  
 Integer which makes it possible to calculate the interval between two times of archivage in the result concept , equal to PAS\_ARCH\*PAS. With this convention, the step of archivage is always higher or equal to the maximum step used by computation.  
 With a variable step, times of archivage do not correspond exactly to computation steps. The algorithm thus files the quantities with the computation steps closest to the times of archivage indicated by the user (in  $T_n$  on this diagram):



### 3.19.3 Operand CRITERE

◇ CRITERE =

Indicates with which accuracy the search of time to be filed must be done:  
 "RELATIF" : interval of search [(1-prec) .instant, (1+prec) .instant]  
 "ABSOLU" : interval of search [time-prec, instant+prec]  
 the default value of the search criterion is "RELATIF".

### 3.19.4 Operand accuracy

◇ accuracy =/1.E-06 [DEFAULT]

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/prec [R]

Indicates with which accuracy the search of time to be filed must be done.

## 3.20 Operand INFO

◇INFO = imp

Whole allowing to specify the level of printing in the message file .

If INFO=1, one prints following information in the message file :

<I> <nom of the routine where information suivantes> is written  
If <I> <MDTR74>, one recalls that it is a transient computation on "classical" modal base,  
if not <I> <SSDT74> it is a transient computation on modal base by dynamic  
substructuring.

<----->  
Computation by modal superposition  
-----

! projection base is a >type of the base of projection<  
! Nb of equations is : Nb  
! the method used is : >nom of the integration method <  
! the base used is : >nom of modal base <  
! Nb of basic vectors is : nbb  
  
! the time step initial one is : value of time step initial  
! Nb of step of archive is : nba  
! the number of place (X) of shock is: nbchoc  
(beginning of information specific to the adaptive diagrams)  
! many points not period : NLP  
! coefficient of increase of time step : cmp  
! coefficient of division of time step : cdp  
! time step minimal : dtmini  
! time step maximum : dtmaxi  
! maximum number of reductions of the step : nbred  
! variable minimal velocity : >méthode of computation velocity of  
référence<

(fine of information specific to the adaptive diagrams)

! many computation steps are : nbc  
! Time step of computation is : value of time step of computation  
  
! the number of RELA\_EFFO\_DEPL is : nbrelaed  
(only if the number of relations is non-zero)  
! the number of RELA\_EFFO\_VITE is : nbrelaev  
(only if the number of relations is non-zero)  
-----

If INFO : 2, one prints, besides written information if INFO is worth 1, following information in the message file :

For each obstacle:

- The number and type of the obstacle;
- The name and the coordinated in the total reference of the node of shock (of the nodes of shock in the case of a shock between mobile structures);
- Directional sense, in the total reference, of the normal to the obstacle;
- The value of the angle of gimlet;
- The value of initial clearance;

And for each node of shock and each mode, the number of the mode, values of the local stiffness of shock and the rate of local compliance and the local flexibility.

One also prints at the end, for each node of shock:

RATE OF RESTIT COMPLIANCE: 9.9539E-01 is 99.53% of local flexibility;  
RATE OF RESTIT SHEARS: 1.8979E-02 is 1.89% of the shears.

One prints these quantity overall for all the modes and each mode.

One prints moreover:

- for each node of shock, local the flexibility ratios on flexibility of shock and static flexibility minus local flexibility on flexibility of shock,
- for each mode, its participation on the deformed shapes static in the nodes of shock. It is worth the ratio amongst conditioning of the matrix closed by the modal vector and the deformed static on the number of conditioning of the matrix of the static deformed shapes.

## 3.21 Operand PRINTING

◇IMPRESSION

Key word factor which makes it possible to print in the results file of the quantities, nonprintable by an operator of printing, such as local displacement, the local velocity, the forces of contact to the nodes of shock and the value cumulated on all the modes of the modal base of projection of the rate of reconstitution of the static solution.

### 3.21.1 Operands TOUT/NIVEAU

key word NIVEAU makes it possible to print one or more table (X) among "DEPL\_LOC", "VITE\_LOC", "FORC\_LOC" and "TAUX\_CHOC". With TOUT = "OUI" (default value), one prints the four tables.

### 3.21.2 Operands INST\_INIT/INST\_FIN

These two keys key make it possible to the user to filter the printings in each loop on time step.

## 3.22 Operand TITER

◇TITER = title

Titrate data structure result [U4.03.01].

# 4 Stage of execution

---

## 4.1 Checking on the matrixes

In the case of a computation by modal recombination, one checks that the generalized matrixes result quite from a projection on a common basis and with the same number of basic vectors. In the case of a computation by dynamic substructuring, one checks that the generalized matrixes result quite from the same generalized classification.

## 4.2 Checking and advice on the choice of time step for diagrams EULER, DEVOGE and NEWMARK :

One makes sure that the time step selected one checks the stability conditions of the numerical diagram (criterion of CFL):

- in the case of NEWMARK, stability is always assured but the going beyond the criterion can induce a lack of accuracy on result and is announced by a message; computation continues (with the risk to produce result not very precise or false).
- in the case of the diagrams of EULER and DEVOGE, if operand VERI\_PAS is worth "OUI" (default value), the execution is stopped, time step minimum is proposed. If operand VERI\_PAS is worth "NON" or if it is about an adaptive diagram, an alarm message is transmitted and computation continues (with the risk to produce result not very precise or false).

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

In a transient analysis without non-linearity, it should be taken care that time step is such as:

$$dt < 0,1 / f_n \text{ for NEWMARK and DEVOGE}$$
$$dt < 0,05 / f_n \text{ for EULER}$$

$f_n$  being the highest frequency of the modes of modal base considered.

**Note:**

*It is mentioned that with nonlocalised linearities the time step selected one must be sometimes much lower than this advised value .*

## 4.3 Stage of execution for methods "ADAPT\_ORDRE1" and "ADAPT\_ORDRE2" :

The execution is stopped when time step reached a minimal step equal to PAS X PAS\_LIMI\_REL.

**Note:**

*The diagram of the central differences does not restore in an exact way the own pulsations of a system, which leads to important miscalculations in the two following cases:*

- *Computation of one very a large number of periods of free oscillations;*
- *Computation of the oscillations of a system very slightly damped (  $\xi < 10^{-3}$  ) excited on a resonance frequency.*

*In these two cases, it is often necessary to increase parameter NB\_POIN\_PERIODE .*

*Methods "ADAPT\_ORDRE1" and "ADAPT\_ORDRE2" can be used in substructuring.*

*Time step can be recovered by the operator RECU\_FONCTION , with following syntax:*

```
not = RECU_FONCTION (  
    RESU_GENE = dynamoda  
    NOM_CHAM = "PTEM"  
    ... )
```

## 4.4 Stage of execution for method "ITMI"

the execution is stopped:

- when the period of excitation chosen by the user is incompatible with the desired time of simulation (mode established + simulation after obtaining the established mode). In this case, the user is informed with accuracy of the minimum time of excitation necessary for his computation,
- when the algorithm does not succeed in finding a solution converged at the time of the diagonalization of the stiffness matrix,
- when the phases of transition flight/shock cannot be given with a sufficient accuracy.