Operator \texttt{PRE\_SEISME\_NONL}

1 \hspace{1cm} \textbf{Goal}

The purpose of this operator is to simplify the implementation of the method Laplace-Time by allowing the realization of non-linear calculations with impedances produced by MISS3D.

The use of the method Laplace-Time (\textit{cf.} [U2.06.05]) requires several operations:

1) the calculation of a base of modes of interface necessary for the projection of the impedances obtained with the operator \texttt{CALC\_MISS} (\textit{cf.} [U7.03.12]);

2) the creation of a new model which assembles these matrices of impedance, that it is within the framework of a resolution in physical base or with techniques of dynamic reduction (\textit{cf.} [U2.07.04]);

3) possibly the transition statics-dynamics when a state of prestressed must be taken into account at the beginning of transitory calculation.

According to the arguments as starter, this order allows the realization of the operations mentioned previously, i.e., it makes it possible to produce the concepts necessary to call on the macro-order \texttt{CALC\_MISS} [U7.03.12] or to exploit of them the results of type calculation of impedance.
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2 Syntax

PRE_SEISME_NONL (  
  ♦ RESULT = _F (  
    ♦ / RESULT = CO ('resu'), [evol_noli]  
    ♦ / MODEL = CO ('Mo'), [model]  
    ♦ / GRID = CO ('e-mail'), [grid]  
    ♦ / CHAM_MATER = CO ('chmat'), [cham_mater]  
    ♦ / CARA_ELEM = CO ('carac'), [cara_elem]  
    # PRE_CALC_MIS is obligatory for creation  
    # of the concepts of the type bases modal or macronutrient  
    ♦ / BASE_MODELE = CO ('bamo'), [mode_meca]  
    ♦ / MACR_ELEM_DYNA = CO ('mael'), [macr_elem_dyna]  
    # POST_CALC_MIS is obligatory for creation  
    # of a load with option 'LAPL_TEMPS'  
    ♦ / LOAD = _F (  
      ♦ / NAME = CO ('l_char'), [l_char_meca]  
      ♦ / OPTION = / 'COND_LIM', [DEFECT]  
      ♦ / 'LAPL_TEMPS', [TXM]  
      ),  
    ),  
  ♦ / PRE_CALC_MIS = _F (  
    ♦ / CALC_MISS_OPTION = / 'ISS', [TXM]  
    ♦ / 'ISFS', [TXM]  
    ♦ / NMAX_MODE_ISS = nbiss, [I]  
    # IF CALC_MISS_OPTION == 'ISFS'  
    ♦ / NMAX_MODE_IFS = nbifs, [I]  
    ♦ / GROUP_MA_INTERF = grma_int, [grma]  
    ♦ / GROUP_NO_CENT = grno_cent, [grno]  
    ♦ / REDUC_DYNA_ISS = / 'NOT', [DEFECT]  
    ♦ / 'YES', [TXM]  
    ♦ / REDUC_DYNA_IFS = / 'NOT', [DEFECT]  
    ♦ / 'YES', [TXM]  
  ),  
  ♦ / POST_CALC_MIS = _F (  
    ♦ / MACR_ELEM_DYNA = mael, [macr_elem_dyna]  
    ♦ / GROUP_MA_INTERF = grma_int, [grma]  
    ♦ / GROUP_NO_CENT = grno_cent, [grno]  
    ♦ / UNITE_RESU_RIGI = uresrig, [I]  
    ♦ / UNITE_RESU_AMOR = uresamo, [I]  
    ♦ / UNITE_RESU_MAS = uresmas, [I]  
  ),  
  ♦ / STAT_DYNA = _F (  
    ♦ / RESULTAT = resu, [evol_noli]  
    ♦ / EXCIT = _F (  
      ♦ / LOAD = tank, [char_meca]  
      ♦ / [char_cine_meca]  
      ♦ / FONC_MULT = fonct, /[fonction_sdaster]  
      ♦ / [nappe_sdaster]  
      ♦ / [formula]  
      ♦ / TYPE_CHARGE = / 'FIXE_CSTE', [DEFECT]  
      ♦ / 'FIXE_PILO', [TXM]  
      ♦ / 'SUIV', [TXM]  
      ♦ / 'DIDI', [TXM]  
  )

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BEHAVIOR = _F (see the document [U4.51.11]),
♦ CONVERGENCE = _F (see the document [U4.51.03]),
♦ BASE_MODALE = bamo,
♦ UNITE_IMPE_TEMPS = _F {
   ♦ UNITE_RESU_RIGI = uresrig,
   ♦ UNITE_RESU_AMOR = uresamo,
   ♦ UNITE_RESU_MASS = uresmas,
},
♦ UNITE_IMPE_FREQ = uimpfr,
♦ FORCE_SOL = fsol,
♦ COEF_AMOR = / 0.0, [DEFECT]
   / coefamo, [R]
♦ NB_INST = / 100.0 [DEFECT]
   / nbinst, [R]
),

# the declaration of the keyword following must be coherent
# with the keyword informed in RESULT
♦ AFFE_MODELE = _F ( to see the document [U4.41.01] ),
♦ AFFE_MATERIAL = _F (see the document [U4.43.03] ),
♦ AFFE_CARA_ELEM = _F (see the document [U4.42.01] ),
♦ AFFE_CHAR_MECA = _F (see the document [U4.44.01] ),
♦ INFORMATION = / 1,
[DEFECT]
   / 2, [I]
3 Operands

3.1 Operand RESULT

\[ \text{RESULT} = _F ( \] \\
\[ \quad / \text{RESULT} = \text{CO (‘resu’), } \] [evol_noli]

Allows PRE_SEISME_NONL to produce the concepts at exit of the macro-order.
The keyword RESULT is to be used only with STAT_DYNA.

3.1.1 Operand MODEL/GRID/CHAM_MATER/CARA_ELEM

\[ / \text{MODEL} = \text{CO (‘Mo’), } \] [model]
\[ / \text{GRID} = \text{CO (‘e-mail’), } \] [grid]
\[ / \text{CHAM_MATER} = \text{CO (‘chmat’), } \] [cham_mater]
\[ / \text{CARA_ELEM} = \text{CO (‘carac’), } \] [cara_elem]

Allows PRE_SEISME_NONL to produce the concepts at exit of the macro-order.
The declaration of these concepts must be coherent with the data sunken in the operands
AFFE_MODELE (cf. §3.5), AFFE_MATERIAU (cf. §3.6), AFFE_CARAELEM (cf. §3.7) and
AFFE_CHAR_MECA (cf. §3.8) defined inside this macro-order.

These keywords make it possible to inform the name of the concepts which the user wishes to create:
- the name of the model (Mo) whose elements are the object of mechanical calculation,
- the name of the grid (e-mail) possibly containing new nodes and meshes,
- the name of the material field (chmat) affected on the grid e-mail,
- the name of the characteristics (carac) elements of hull, beam, pipe, bars, cable, and
discrete elements affected on the model Mo.

In case of a dynamic reduction (cf. [U2.07.04] and [U4.44.01]), these concepts created will contain the
additional elements necessary to later calculations.

3.1.2 Operand BASE_MODELE/MACR_ELEM_DYNA

\[ / \text{BASE_MODELE} = \text{CO (‘bamo’), } \] [mode_meca]
\[ / \text{MACR_ELEM_DYNA} = \text{CO (‘mael’), } \] [macr_elem_dyna]

These keywords cannot be used without informing the keyword factor PRE_CALC_MISS (cf. §3.2).
Indeed, they make it possible to inform the following concepts at exit:
- the name of the modal base (bamo) containing the modes of interface used as projection of
the impedances of ground bases,
- the name of the macronutrient (mael) who points on bamo and which can be directly used in
CALC_MISS (cf. [U7.03.12]).

3.1.3 Operand LOAD

\[ \text{LOAD} = _F ( \] \\
\[ \quad / \text{NAME} = \text{CO (‘l_char’), } \] [l_char_meca]
\[ \quad / \text{OPTION} = / \text{‘COND_LIM’, } \] [DEFECT]
\[ \quad / \text{‘LAPL_TEMPS’, } \] [TXM]

This keyword makes it possible to create a load related to the boundary conditions (OPTION =
‘COND_LIM’), obligatory when one seeks to make dynamic reduction, or with the method Laplace-
3.2 **Operand PRE_CALC_MISS**

```plaintext
◊ / PRE_CALC_MISS = _F (  
  ♦ CALC_MISS_OPTION = / 'ISS', [TXM]  
     / 'ISFS', [TXM]  
  ♦ NMAX_MODE_ISS = nbiss, [I]  
  # If CALC_MISS_OPTION == 'ISFS'  
     ♦ NMAX_MODEIFS = nbifs, [I]  
     ♦ GROUP_MA_INTERF = grma_int, [grma]  
     ♦ GROUP_NO_CENT = grno_cent, [grno]  
     ♦ REDUC_DYNA_ISS = / 'NOT', [DEFECT]  
       / 'YES', [TXM]  
     ♦ REDUC_DYNA_IFS = / 'NOT', [DEFECT]  
       / 'YES', [TXM]  
),
```

3.2.1 **Operand REDUC_DYNA_ISS/REDUC_DYNA_IFS**

These operands indicate the manner of representing the kinematics of the interfaces of ISS or YEWS by means of a base of static modes (REDUC_DYNA_* = 'NOT') or of the dynamic modes (REDUC_DYNA_* = 'YES').

3.2.2 **Operand NMAX_MODE_ISS/NMAX_MODE_IFS**

These operands make it possible to inform the number of modes to in the case of calculate a calculation of ISS or ISFS. If REDUC_DYNA_* = 'YES', the value of the keyword NMAX_MODE_* corresponding must be a multiple of 6.

3.2.3 **Operand GROUP_MA_INTERF**

This keyword, which is obligatory, makes it possible to inform the group of meshes corresponding to the dynamic interface to consider (together interface of ISFS or that of ISS or that of YEWS) for the calculation of the modes of interface.

3.2.4 **Operand GROUP_NO_CENT**

This keyword indicates the group of nodes defined in the center of an interface making it possible to consider a rigid behavior of this interface. If this keyword is indicated a condition of the type LIAISON_SOLIDE (cf. [U4.42.01]) must, a priori, being seized by means of the operand AFFE_CHAR_MECA (cf. §3.8).

3.2.5 **Operand CALC_MISS_OPTION**

This keyword indicates if calculation to be realized is of type 'ISS' or of type 'ISFS'. The well informed value must thus be coherent with the other operands of PRE_CALC_MISS but also of the macro-order CALC_MISS (cf. [U7.03.12]).

3.3 **Operand POST_CALC_MISS**

```plaintext
◊ / POST_CALC_MISS = _F (  
  ♦ MACR_ELEM_DYNA = mael, [macr_elem_dyna]  
  ♦ GROUP_MA_INTERF = grma_int, [grma]  
  ♦ GROUP_NO_CENT = grno_cent, [grno]  
  ♦ UNITE_RESU_RIGI = uresrig, [I]  
  ♦ UNITE_RESU_AMOR = uresamo, [I]  
  ♦ UNITE_RESU_MAS = uresmas, [I]  
),
```

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3.3.1 **Operand MACR_ELEM_DYNA**
This keyword expects as starter a concept of the type `macr_elem_dyna` who primarily corresponds to the impedance (frequent or temporal) to assemble with the digital model and who is obtained before with, for example, the sequence of the order `LIRE_IMPE_MISS` (cf. [U7.02.32]) and `MACR_ELEM_DYNA` (cf. [U4.65.01]).

3.3.2 **Operand GROUP_MA_INTERF**
This keyword same as that is used in § 3.2.3.

3.3.3 **Operand GROUP_NO_CENT**
This operand same as that is used in § 3.2.4. It is particularly important when a calculation with `STAT_DYNA` (cf. §3.4) must be carried out thereafter.

3.3.4 **Operand UNITE_RESU_RIGI/UNITE_RESU_AMOR/UNITE_RESU_MASS**
Numbers of logical unit of the files containing of the temporal impedances of ground (or its decomposition in terms of inertia, damping and rigidity) for the method Laplace-Time.
Operands `UNITE_RESU_RIGI`, `UNITE_RESU_AMOR`, `UNITE_RESU_MASS`, being of a use specific to the method Laplace-Time, are mandatory at the time a concept charges with type `LAPL_TEMPS` (cf. §3.1.3) is asked at exit of this macro-order.

3.4 **Operand STAT_DYNA**

```plaintext
◊ / STAT_DYNA = _F (
  ♦ RESULTAT = resu, [evol_noli]
  ♦ EXCIT = _F {
    ♦ LOAD = tank, / [char_meca]
    ♦ FONC_MULT = fonct, / [fonction_sdaster]
  },
  ♦ TYPE_CHARGE =/‘FIXE_CSTE’, [DEFECT]
    / ‘FIXE_PILO’, [TXM]
    / ‘SUIV’, [TXM]
    / ‘DIDI’, [TXM]
  ),
  ♦ BEHAVIOR = _F (see the document [U4.51.11]),
  ♦ CONVERGENCE = _F (see the document [U4.51.03]),
  ♦ BASE_MODALE = bamo, [mode_meca]
  ♦ UNITE_IMPE_TEMPS = _F {
    ♦ UNITE_RESU_RIGI = uresrig, [I]
    ♦ UNITE_RESU_AMOR = uresamo, [I]
    ♦ UNITE_RESU_MASS = uresmas, [I]
  },
  ♦ UNITE_IMPE_FREQ = uimpfr, [I]
  ♦ FORCE_SOL = fsol, [char_meca]
  ♦ COEF_AMOR = / 0.0, [DEFECT]
    / coefamo, [R]
  ♦ NB_INST = / 100.0, [DEFECT]
    / nbinst, [R]
),
```

3.4.1 **Operand RESULT**
This operand expects as starter a concept of the type `evol_noli` corresponding to the result of a static calculation.
In particular, within the framework of the method Laplace-Time when one seeks to carry out a non-
linear seismic analysis with taking into account of the interaction ground-structure, the expected
concept corresponds to that produced by the operator STAT_NON_LINE \(\text{cf.} [U4.51.03]\).

3.4.2 **Operand EXCIT**

\text{Cf.} [U4.51.03].

In practice and in the framework of the method Laplace-Time, the keyword \textit{EXCIT} the whole waits of
loads used for the non-linear calculation whose result is seized in \textit{RESULT} (cf. §3.4.1).

3.4.3 **Operand BEHAVIOR/CONVERGENCE**

\text{Cf.} [U4.51.03]. Syntax is the same one as that of the keywords factor defined in the operator \textit{STAT_NON_LINE} and it
must be coherent with the result seized in \textit{RESULT} (cf. §3.4.1).

3.4.4 **Operand BASE_MODELE**

This keyword expects as starter the modal base being used to project the impedances of ground. This
base must be the same one as that used to project the impedances of ground indicated in
\textit{UNITE_IMPE_TEMPS} \(\text{cf.} \text{§3.4.5}\) and \textit{UNITE_IMPE_FREQ} \(\text{cf.} \text{§3.4.6}\) in the form of logical units.

3.4.5 **Operand UNITE_IMPE_TEMPS**

The three keywords of this operand have the same meaning as in § 3.3.4.

3.4.6 **Operand UNITE_IMPE_FREQ**

This keyword expects as starter the logical unit of the file containing the impedance of ground
calculated in the frequential field.

3.4.7 **Operand FORCE_SOL**

This keyword expects as starter a concept of load of the type ‘LAPL_TEMPS’ \(\text{cf.} \text{§3.1.3}\) such as
created as a preliminary by the use of the keyword \textit{POST_CALC_MISS} \(\text{cf.} \text{§3.3}\).

3.4.8 **Operand COEF_AMOR**

This keyword is a coefficient which makes it possible to control the value of viscous damping to add
on the level of the interface ground-structure in the shape of discrete elements of type \textit{DIS_TR}.
When \textit{COEF_AMOR} is worth 1.0, the value of damping which is assigned to the whole of the degrees of
freedom of each discrete element is of \(1.E16\ \text{N.s.m}^{-1}\).

3.4.9 **Operand NB_INST**

This keyword expects as starter the number of steps of time necessaries to stabilize the transition
statics-dynamics. The value by default is often sufficient.

3.5 **Operand AFFE_MODELE**

Allows to define the modelled physical phenomenon (mechanical, thermal, acoustic) and the type of
finite elements used. Syntax related to the keyword \textit{AFFE_MODELE} is the same one as that of the
operator bearing the same name \([U4.41.01]\). Only one occurrence of this keyword is authorized.

3.6 **Operand AFFE_MATERIAU**

Allows to assign materials to geometrical zones of a grid or a model. Syntax related to the keyword
\textit{AFFE_MATERIAU} is the same one as that of the operator bearing the same name \([U4.43.03]\). The only
difference relates to the operand \textit{MODEL} who is not obligatory when \textit{PRE_CALC_MISS} \(\text{cf.} \text{§3.2}\) is
present.
3.7 **Operand AFFE_CARA_ELEM**

Allows to assign to elements of structure of the geometrical and material characteristics. Syntax related to the keyword **AFFE_CARA_ELEM** is the same one as that of the operator bearing the same name [U4.42.01]. The only difference relates to the operand **MODEL** who is not obligatory when **PRE_CALC_MISS** (cf. §3.2) is present.

Only one occurrence of this keyword is authorized.

3.8 **Operand AFFE_CHAR_MECA**

Allows to affect loadings and boundary conditions on a mechanical model. Syntax related to the keyword **AFFE_CHAR_MECA** is the same one as that of the operator bearing the same name [U4.44.01]. The only difference relates to the operand **MODEL** who is not obligatory at the time only **PRE_CALC_MISS** (cf. §3.2) is present.

Only one occurrence of this keyword is authorized.

3.9 **Operand INFORMATION**

Allows to control the level of message of the macro-order.