Operator CALCULATION

1 Goal

To calculate the internal constraints and variables for the integration of a non-linear law of behavior.

To calculate the elementary vectors vect_elem internal and nodal forces and elementary matrices matr_elem of a tangent matrix.

Calculate the elementary vectors vect_elem forces corresponding to the variables of order.

Product a structure of data of the type table_container.

2 Syntax

```
table_container        = CALCULATION
    (  ♦ MODEL         = Mo,                                  [model]
       ♦ CHAM_MATER    = chmat,                               [cham_mater]
       ◊ CARA_ELEM     = carac,                               [cara_elem]
       ♦ OPTION        =  /'BEHAVIOR'                      [DEFECT]
                          /'MATR_TANG_ELEM'
                          /'FORC_INTE_ELEM'
                          /'FORC_NODA_ELEM'
                          /'FORC_VARC_ELEM_M'
                          /'FORC_VARC_ELEM_P'
       ◊ EXCIT         = _F (
                ♦ LOAD  = chi,                              [char_meca]
                ◊ FONC_MULT =fi,
    [function/formula]
             ),
       ♦ BEHAVIOR   =_F (see the document [U4.51.11]),
       ◊ DEPL          = depl,                                [cham_no]
       ◊ INCR_DEPL     = incdepl,                             [cham_no]
       ◊ SIGM          = sigm,                                [cham_elem]
       ◊ VARI          = vari,                                [cham_elem]
       ◊ TABLE         = table,                            [table_container]
       ◊ MODE_FOURIER   = nh,                                 [I]
       ♦ INCREMENT  = _F (
                ♦ LIST_INST = litps,                        [listr8]
                ♦ NUME_ORDRE =nuini,                        [I]
             ),
       ◊ INFORMATION    =  /1,                                    [DEFECT]
                        /2,
    )
```

3 Operands

3.1 Operand MODEL

♦ MODEL = Mo

Name of the concept defining the model whose elements are the object of calculation.

3.2 Operand CHAM_MATER

♦ CHAM_MATER = chmat

Name of the concept defining the affected material field on the model Mo.

3.3 Operand CARA_ELEM

◊ CARA_ELEM = carac

Name of the concept defining the characteristics of the elements of beam, hulls, etc…

3.4 Keyword EXCIT

◊ EXCIT

This keyword factor makes it possible to describe with each occurrence a load (requests and boundary conditions), and possibly a multiplying coefficient and/or a kind of load.
This keyword is useful to produce the matrix of the dualized limiting conditions of Dirichlet which will be integrated in matr_elem product by the calculation of the tangent matrix.

3.4.1 Operands LOAD

♦ LOAD: CH $_I$

CH$_I$ is the mechanical loading (possibly comprising the evolution of a field of temperature) specified with i ème occurrence of EXCIT.

3.4.2 Operand FONC_MULT

◊ FONC_MULT: F $_I$

F_I is the multiplying function of the time of the loading specified with I^{ème} occurrence of EXCIT.
The loading and boundary conditions for n occurrences of the keyword factor EXCIT are:

$$ch = \sum_{i=1}^{n} f_i . ch_i$$

For the conditions of Dirichlet, of course, only the specified value is multiplied by F_I.
By default: F_I=1.

3.5 Operand OPTION

♦ OPTION = /'BEHAVIOR' [defect]
/'MATR_TANG_ELEM'
/'FORC_INTE_ELEM'
/'FORC_NODA_ELEM'
/'FORC_VARC_ELEM_M'
/'FORC_VARC_ELEM_P'

Allows to specify what one calculates:

- 'BEHAVIOR' integrate the law of behavior and thus produces three objects: cham_elem constraints, cham_elem internal variables and one cham_elem comprising the code return of the law of behavior;
- 'MATR_TANG_ELEM' calculate the coherent tangent matrix (option FULL_MECA) and thus produces four objects: one cham_elem constraints, one cham_elem internal variables, one cham_elem comprising the code return of the law of behavior and one matr_elem tangent elementary matrices;
- 'FORC_INTE_ELEM' calculate the vector of the internal forces after integration of the law of behavior (RAPH_MECA in the language Aster) and thus produces four objects: one cham_elem constraints, one cham_elem internal variables, one cham_elem comprising the code return of the law of behavior and one vect_elem elementary vectors of the internal forces;
- 'FORC_NODA_ELEM' calculate the vector of the nodal forces starting from the constraints at the points of Gauss and produces one vect_elem elementary vectors of the nodal forces.
- 'FORC_VARC_ELEM_M' calculate the vector of the forces corresponding to the variables of orders at previous time (given by LIST_INST). See the related paragraph in the theoretical documentation of STAT_NON_LINE [R5.03.01].
- 'FORC_VARC_ELEM_P' calculate the vector of the forces corresponding to the variables of orders at time running (given by LIST_INST). See the related paragraph in the theoretical documentation of STAT_NON_LINE [R5.03.01].

3.6 Keyword INCREMENT

♦ INCREMENT

Defines the time intervals taken in the incremental method.

The moments thus defined have physical direction only for relations of behavior where time intervenes explicitly (viscoelastic or viscoplastic for example). In the other cases, they allow only indicer the increments of load and to parameterize the evolution of a possible field of temperature.

3.6.1 Operand LIST_INST

♦ LIST_INST = litps

The moments of calculation are those defined in the concept litps by the operator DEFI_LIST_REEL [U4.34.01].

3.6.2 Operands NUME_ORDRE

♦ NUME_ORDRE = digital

Allows to define the sequence number (and thus the moment) for which will be calculated the sizes in **table_container.**

3.7 Keyword TABLE

♦ TABLE

Allows to introduce one table_container not-vacuum to supplement (with the adequate sequence number) with the new concepts calculated in the operand CALCULATION.
If the table contains already fields for the sequence number claimed by the keyword INCREMENT/NUMÉRIQUE_ORDRE , these chamsp is crushed and an alarm is emitted to warn the user.

3.8 Keyword DEPL/INC_DEPL/SIGM/VARI

```
◊  DEPL        =  depl,        [cham_no],
◊  INCR_DEPL   =  incdepl,     [cham_no],
◊  SIGM        =  sigm,        [cham_elem],
◊  VARI        =  vari,        [cham_elem],
```

Allows to introduce inlet limits to calculate the various fields by the order CALCULATION :
- DEPL give a field of displacement;

- INCR_DEPL is the increment of the field of displacement since the beginning of the step of time;
- SIGM give a stress field;
- VARI give a field of internal variables.

Note:

It is necessary to take care to be coherent between the behavior requested by BEHAVIOR and field of the internal variables cuts it.
*The field of the constraints being used to calculate the option FORC_NODA_ELEM is not the same one according to calculations requested. Indeed, if one integrates the law of behavior (options BEHAVIOR, MATR_TANG_ELEM, FORC_INTE_ELEM), then the stress field taken in the calculation of the option FORC_NODA_ELEM will be that calculated **afterwards** the integration of the behavior. In this case, SIGM is the tensor of the constraints **initial** and will not be that employed in the calculation of FORC_NODA_ELEM. On the other hand, if only the option FORC_NODA_ELEM is asked, then one will use the field of the constraints directly given by SIGM.*

3.9 Operand MODE_FOURIER

◊ MODE_FOURIER = nh

Positive or null entirety indicating the harmonic of FOURIER on whom one calculates the elementary vector for an axisymmetric model 2D.

3.10 Operand INFORMATION

◊ INFORMATION =inf

Allows to carry out in the file message various intermediate impressions.

4 Use of CALCULATION and of table_container

CALCULATION only a table_container produces in which is stored for each sequence number one or more fields (forced, internal variables, elementary vectors of the internal forces, elementary matrices of the tangent matrix).

To extract these fields, it is advisable to use the order EXTR_TABLE. For example, if one wants the field of the constraints resulting from the order CALCULATION, one will make:

```
CONT=CALCUL (OPTION= ('BEHAVIOR', 'FORC_INTE_ELEM', 'MATR_TANG_ELEM'),
             MODELE=MO,
             CHAM_MATER=CHMAT,
             INCREMENT=_F (LIST_INST=LISTE,
                           NUME_ORDRE=1),
             EXCIT=_F (CHARGE=CHARGE),
             DEPL=U,
             INCR_DEPL=DU,
             SIGM=SIGP,
             VARI=VARIP,
             COMPORTEMENT=_F (RELATION=' VMIS_ISOT_LINE',),
             INFO=2,);

SIGM=EXTR_TABLE (TYPE_RESU=' CHAM_GD_SDASTER',
                 TABLE=CONT,
                 NOM_PARA=' NOM_SD',
                 FILTRE=_F (NOM_PARA=' NOM_OBJET',
                            VALE_K=' SIEF_ELGA'),)
```

To calculate the second member of the external forces or other quantities (like the matrices masses), one can use the orders CALC_VECT_ELEM or CALC_MATR_ELEM.

matr_elem or them vect_elem can be assembled via the orders ASSE_VECTEUR and ASSE_MATRICE.

It should be noted that them MATR_ELEM of rigidity produced by CALCULATION contain also the contribution resulting from the dualisation of the limiting conditions of Dirichlet (EXCIT).

An example of use of CALCULATION is available in the CAS-test pynl01a.