Macro-order CALC_TEST_GEOMECA

1 Goal

This macro-order makes it possible to simulate for a material point various ways of loading characteristic of tests géomechanics, and post-to treat the got results. The user provides as starter the behavior, the material, as of the parameter lists of loading which correspond to several occurrences of the same test. The tests available are the following:

- drained monotonous triaxial compression test
- monotonous triaxial compression test not drained
- drained cyclic shear test
- cyclic triaxial compression test not drained
- drained cyclic triaxial compression test alternate
- drained cyclic triaxial compression test nonalternate
- drained cyclic test oedometric
- test of isotropic compression cyclic drained

Product of the curves to the format xmgrace and/or the structures of data `table`.

Contents

2 Syntax

```
CALC_ESSAI_GEOMECA(

♦   MATER       = chechmate ,                                [to
subdue]
♦   BEHAVIOR= _F (see the document [U4.51.11]),
◊   CONVERGENCE = _F (
       /RESI_GLOB_RELA     =   1.E-6,                   [DEFECT]
       /|RESI_GLOB_MAXI    =   resmax,                  [R]
        | RESI_GLOB_RELA       =  resrel,                  [R]
        ITER_GLOB_MAXI     =   /10,                     [DEFECT]
                               /maglob,                 [I]
                    ),
```

triaxial Compression test monotonous drained (`TD`)

```
♦   |    ESSAI_TD = _F (

           ♦ PRES_CONF    = l_pconf,                    [l_R]
           ♦  EPSI_IMPOSE = l_epsimpo,                  [l_R]
           ◊  KZERO       =/1. ,                     [DEFECT]
                           / kzero,                     [R]
           ◊  NB_INST     =/100,                     [DEFECT]
                           / nbinst,                    [I]
           ◊  TABLE_RESU  = l_tabres,                   [l_CO]
           ◊  GRAPH   =/(‘P-Q’, ‘EPS_AXI-Q’,
                              ‘EPS_AXI-EPS_VOL’,
                                 ‘P-EPS_VOL’),          [DEFECT]
                           / l_typgraph,                [l_Kn]
           ◊  TABLE_REF   = l_tabref,                  [l_table]

                    ),
```

triaxial Compression test monotonous not drained (`TND`)

```
    |   ESSAI_TND = _F (

           ♦ PRES_CONF   = l_pconf,                     [l_R]
           ♦  EPSI_IMPOSE = l_epsimpo,                  [l_R]
           ◊  BIOT_COEF   =/1. ,                     [DEFECT]
                           / biot,                      [R]
           ◊  KZERO       =/1. ,                     [DEFECT]
                           / kzero,                     [R]
           ◊  NB_INST     =/100,                     [DEFECT]
                           / nbinst,                    [I]
           ◊  TABLE_RESU  = l_tabres,                   [l_CO]
           ◊  GRAPH   =/(‘P-Q’, ‘EPS_AXI-Q’,
                              ‘EPS_AXI-PRE_EAU’),       [DEFECT]
                           / l_typgraph,                [l_Kn]
           ◊  TABLE_REF   = l_tabref,                  [l_table]

                     ),
```

drained cyclic Test shear (`CISA_C`)

```
    |   ESSAI_ CISA_C = _F (

           ♦ PRES_CONF   = l_pconf,                     [l_R]
```

```
            ♦  GAMMA_IMPOSE = l_disimpo,                 [l_R]
            ♦  NB_CYCLE    = nbcyc,                      [I]
            ◊  GAMMA_ELAS   =/1.E-7 ,                  [DEFECT]
                             / diselas,                  [R]
            ◊  KZERO       =/1. ,                      [DEFECT]
                             / kzero,                    [R]
            ◊  NB_INST     =/25 ,                      [DEFECT]
                             / nbinst,                   [I]
            ◊  TABLE_RESU  = l_tabres,                   [l_CO]
            ◊  GRAPH    =/(' GAMMA- SIGXY ', 'GD',
                                'GAMMA-G', 'GAMMA-D'),    [DEFECT]
                           / l_typgraph,                 [l_Kn]
            ◊  TABLE_REF   = l_tabref,                   [l_table]

                     ),
```

triaxial Compression test cyclic not drained (TND_C)

```
    |   ESSAI_ TND_C = _F (

            ♦ PRES_CONF   = l_pconf,                     [l_R]
            ♦  SIGM _IMPOSE = l_ sig impo,               [l_R]
            ♦  NB_CYCLE    = nbcyc,                      [I]
            ♦  UN_SUR_K    = unsurk ,                    [R]
            ◊  RU_MAX      =/0.8,                      [DEFECT]
                             / Ru max,                   [R]
            ◊  KZERO       =/1. ,                      [DEFECT]
                             / kzero,                    [R]
            ◊  BIOT_COEF   =/1. ,                      [DEFECT]
                             / biot,                     [R]
            ◊  NB_INST     =/25 ,                      [DEFECT]
                             / nbinst,                   [I]
            ◊  TABLE_RESU  = l_tabres,                   [l_CO]
            ◊  GRAPH    =/('P-Q', 'SIG_AXI-PRE_EAU',
                                ' EPS _AXI-PRE_EAU',
                                ' EPS _AXI-Q', 'NCYCL-DSIGM'),   [DEFECT]
                             / l_typgraph,               [l_Kn]
            ◊  TABLE_REF   = l_tabref,                   [l_table]

                    ),
```

drained cyclic triaxial Compression test alternate (TD _A)

```
    |   ESSAI_ TD_A = _F (

            ♦ PRES_CONF    = l_pconf,                    [l_R]
            ♦  EPSI_IMPOSE = l_epsimpo,                  [l_R]
            ♦  NB_CYCLE    = nbcyc,                      [I]
            ◊  EPSI_ELAS   =/1.E-7 ,                   [DEFECT]
                             / epselas,                  [R]
            ◊  KZERO       =/1. ,                      [DEFECT]
                             / kzero,                    [R]
            ◊  NB_INST     =/25 ,                      [DEFECT]
                             / nbinst,                   [I]
            ◊  TABLE_RESU  = l_tabres,                   [l_CO]
            ◊  GRAPH    =/('P-Q', 'EPS_AXI-Q', 'EPS_VOL-Q',
                             'EPS_AXI-EPS_VOL', 'P-EPS_VOL',
                                'EPSI-E'),               [DEFECT]
```

```
                    / l_typgraph,                [l_Kn]
      ◊  TABLE_REF   = l_tabref,                 [l_table]

               ),
```

drained cyclic triaxial Compression test nonalternate (TD _NA)

```
  |   ESSAI_ TD_NA = _F (

      ♦ PRES_CONF    = l_pconf,                  [l_R]
      ♦  EPSI_IMPOSE = l_epsimpo,                [l_R]
      ♦  NB_CYCLE    = nbcyc,                    [I]
      ◊  EPSI_ELAS   =/1.E-7 ,                [DEFECT]
                      / epselas,                 [R]
      ◊  KZERO       =/1. ,                   [DEFECT]
                      / kzero,                   [R]
      ◊  NB_INST     =/25 ,                   [DEFECT]
                      / nbinst,                  [I]
      ◊  TABLE_RESU  = l_tabres,                 [l_CO]
      ◊  GRAPH   =/('P-Q', 'EPS_AXI-Q', 'EPS_VOL-Q',
                      'EPS_AXI-EPS_VOL', 'P-EPS_VOL',
                        'EPSI-E'),               [DEFECT]
                    / l_typgraph,                [l_Kn]
      ◊  TABLE_REF   = l_tabref,                 [l_table]

               ),
```

drained Test oedometric cyclic (OEDO _C)

```
  |   ESSAI_OEDO_C = _F (

      ♦ PRES_CONF   = l_pconf,                   [l_R]
      ♦ SIGM_IMPOSE = l_sigimpo,                 [l_R]
      ♦ SIGM_DECH   = l_sigdech,                 [l_R]
      ◊  KZERO       =/1. ,                   [DEFECT]
                      / kzero,                   [R]
      ◊  NB_INST     =/25,                    [DEFECT]
                      / nbinst,                  [I]
      ◊  TABLE_RESU  = l_tabres,                 [l_CO]
      ◊  GRAPH   =/('P-EPS_VOL',
                       'SIG_AXI-EPS_VOL'),       [DEFECT]
                    / l_typgraph,                [l_Kn]
      ◊  TABLE_REF   = l_tabref,                 [l_table]

             ),
```

cyclic isotropic Compression test drained (ISOT _C)

```
  |   ESSAI_ISOT_C = _F (

      ♦ PRES_CONF   = l_pconf,                   [l_R]
      ♦ SIGM_IMPOSE = l_sigimpo,                 [l_R]
      ♦ SIGM_DECH   = l_sigdech,                 [l_R]
      ◊  KZERO       =/1. ,                   [DEFECT]
                      / kzero,                   [R]
      ◊  NB_INST     =/25,                    [DEFECT]
                      / nbinst,                  [I]
      ◊  TABLE_RESU  = l_tabres,                 [l_CO]
```

```
        ◊   GRAPH    =/('P-EPS_VOL'),              [DEFECT]
                       / l_typgraph,                      [l_Kn]
        ◊   TABLE_REF    = l_tabref,                      [l_table]

            ),


◊    INFORMATION =/1 ,
    [DEFECT]
            / 2, );
```

3 Opérandes

3.1 Operand MATER

♦ MATER = chechmate, [to subdue]

This keyword makes it possible to inform the name of material defined by DEFI_MATERIAU [U4.43.01], where are provided the parameters necessary to the selected behavior.

3.2 Word-key BEHAVIOR

The syntax of this keyword is described in the document [U4.51.11].
In the framework of this macro-order, the use of the operand RELATION keyword BEHAVIOR is limited to the elastoplastic laws of ground following:

- 'MOHR_COULOMB'
- 'CAM_CLAY'
- 'CJS'
- 'DRUCK_PRAGER'
- 'DRUCK_PRAG_N_A'
- 'HUJEUX'

3.3 Keyword CONVERGENCE

◊ CONVERGENCE =_F ()

If none of the two operands following is present, then all occurs like if: RESI_GLOB_RELA = 1.E-6.

3.3.1 Operand RESI_GLOB_RELA/RESI_GLOB_MAXI

◊ |RESI_GLOB_RELA = resrel , [R]

The algorithm continues the total iterations as long as:

$$\max_{i=1,\ldots,nbddl} |F_i^n| > \text{resrel} \,.\, max|L|$$

where F^n is the residue of the iteration n and L the vector of the imposed loading and the reactions of supports (cf [R5.03.01] for more details).

When the loading and the reactions of support become worthless, i.e. when L is null (for example in the case of a total discharge), one tries to pass from the relative convergence criteria RESI_GLOB_RELA with the absolute convergence criteria RESI_GLOB_MAXI. This operation is transparent for the user (message of alarm emitted in the file .mess). When the vector L becomes again different from zero, one passes by again automatically with the relative convergence criteria RESI_GLOB_RELA.
However, this mechanism of swing cannot function with the first step of time. Indeed, to find a value of RESI_GLOB_MAXI reasonable in an automatic way (since the user did not inform it), one needs to have had at least a step converged on a mode RESI_GLOB_RELA . Consequently, if the loading is null as of the first moment, calculation stops. The user must already then check that the null loading is normal from the point of view of the modeling which it carries out, and if such is the case, to find another convergence criteria (RESI_GLOB_MAXI for example).

If this operand is absent, the test is carried out with the value by default, except if RESI_GLOB_MAXI is present.

◊ |RESI_GLOB_MAXI = resmax , [R]

The algorithm continues the total iterations as long as:

$$\max_{i=1,\ldots,nbddl} |F_i^n| > \text{resmax}$$

where F^n is the residue of the iteration n (Cf [R5.03.01] for more details). If this operand is absent, the test is not carried out.

If RESI_GLOB_RELA and RESI_GLOB_MAXI both are present, the two tests are carried out.

3.3.2 Operand ITER_GLOB_MAXI

```
◊   ITER_GLOB_MAXI =   /10                     [DEFECT]
                       /maglob
```

Maximum iteration count carried out to solve the total problem at every moment (10 by defaults).

3.4 Word key ESSAI_TD

This keyword factor (répétable) makes it possible to carry out a series of simulations of the same drained triaxial compression test for which one varies the parameters of loading (confining pressure and imposed axial deformation), post-to treat the got results and to write them in the form of graphs (with the format xmgrace) and/or of tables.

3.4.1 Operands PRES_CONF, EPSI_IMPOSE, NB_INST

```
♦   PRES_CONF   = l_pconf,        [l_R]
♦    EPSI_IMPOSE = l_epsimpo,     [l_R]
◊   NB_INST     =/100,        [DEFECT]
                 / nbinst,        [I]
```

The operand PRES_CONF allows to define the list of the confining pressures which will be maintained with course of each test. In the same way the operand EPSI_IMPOSE allows to define the list of the end values of the loading of compression (slope of imposed axial deformation).
For this test, one makes correspond to each confining pressure an end value for slope of axial deformation (see figure 3.4.1-a) : lists PRES_CONF and EPSI_IMPOSE must thus have even cardinal. This cardinal corresponds to the number of simulations which will be carried out under this keyword factor.
Constraints and deformations being counted negatively in compression, values indicated for PRES_CONF and EPSI_IMPOSE must be strictly negative.

The operand NB_INST allows to define temporal discretization of the loading (see figure 3.4.1-a) , with a value by default of 100 pas de loading during the slope.

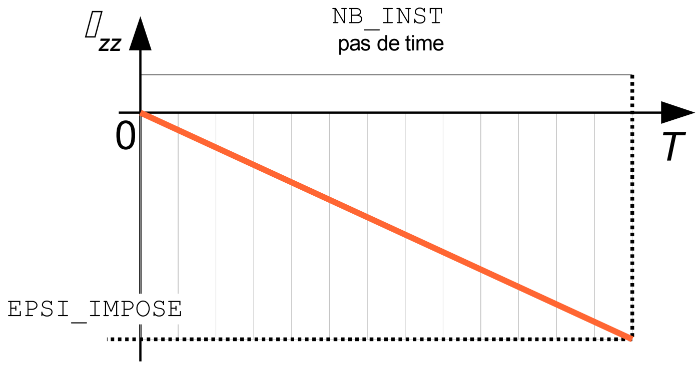

Figure 3.4.1-a: discretization and pace of the loading for the keywords `ESSAI_TD` and `ESSAI_TND`

3.4.2 Operand KZERO

```
◊    KZERO        =/1. ,                      [DEFECT]
                   / kzero,                       [R]
```

Valor of the coefficient of the grounds at rest, allows to define an anisotropic state of containment: $\sigma_{xx}=\sigma_{yy}=K_0\sigma_{zz}=K_0\,\mathrm{PRES\_CONF}$

Note: When the value of KZERO is well informed different from 1, the real confining pressure of the test is not more PRES_CONF , it becomes:

$$P_c=\frac{(1+2.K_0)\,\mathrm{PRES\_CONF}}{3}$$

3.4.3 Operand TABLE_RESU

```
◊    TABLE_RESU = l_tabres ,          [l_CO ]
```

This operand optional makes it possible to give the list of the names of the concepts produced by the macro-order which will be then of type [table] . Each produced table contains the gross profits and post-treaties of a simulation of test: the list TABLE_RESU must thus have even cardinal that the lists PRES_CONF and EPSI_IMPOSE .
The title of each produced table is supplemented by the macro-order, it understands:

- the name of the keyword factor (here ESSAI_TD) and its number of occurrence (this one being répétable)
- the couple of values (PRES_CONF, EPSI_IMPOSE) characterizing it loading of the test

Example:

```
TABRES1 =CO ('TRES1')
TABRES2 =CO ('TRES2')
TABRES3 =CO ('TRES3')

CALC _ ESSAI_GEOMECA (
   …
   ESSAI_TD = _F ( PRES_CONF   = (- 1.0E4, - 1.5E4, - 2.0E4) ,
                   EPSI_IMPOSE = (- 1.0E-2, - 1.0E-2, - 1.0E-2) ,
                   TABLE_RESU  = ( TABRES1, TABRES2, TABRES3 ), ),
   …
                    );
```

TABRES1 , TABRES 2 , and TABRES 3 are successively filled according to the order of the lists PRES_CONF and EPSI_IMPOSE , the table below specifies test results contained in each table.

EPSI_IMPOSE → / PRES_CONF ↓	-1.0E-2	-1.0E-2	-1.0E-2
-1.0E4	TABRES1		
-1.5E4		TABRES2	
-2. 0 E4			TABRES3

3.4.4 Operand **GRAPH**

```
◊   GRAPH =/('P-Q', 'EPS_AXI-Q', 'EPS_AXI-EPS_VOL',
                'P-EPS_VOL'),                          [DEFECT]
          / l_typgraph,                                [l_Kn]
```

This operand makes it possible to specify the types of the graphs produced by the macro-order. These graphs recapitulate the results of the simulations carried out under the keyword current factor. The value by default is the list of all the types of graphs available for the keyword factor, but it is possible to exclude some from them by informing a list containing only the types desired among those which appear in the list of values by default. Graphs available for the test TD are:

- 'P-Q ': diverter of constraints: $q=|\sigma_{zz}-\sigma_{xx}|$ according to the average pressure: $p=1/3(\sigma_{xx}+\sigma_{yy}+\sigma_{zz})$.
- 'EPS_AXI-Q': D eviator of constraints according to the axial deformation.
- 'EPS_AXI-EPS_VOL': D voluminal eformation: $\epsilon_v=\epsilon_{xx}+\epsilon_{yy}+\epsilon_{zz}$, function of the axial deformation.
- 'P-EPS_VOL': D voluminal eformation ϵ_v according to the average pressure p .

The files containing these graphs are written with the format xmgrace in the same repertoire specified by the user (standard repe as a result in astk), and are named in the following way:

' *name of the keyword factor* ' _ ' *number of occurrence* ' _ ' *type of graph* ' .dat

For example:

```
ESSAI_TD = ( _F ( … GRAPH = ( ' P-Q ',' EPS_AXI-Q ' ),… ),
             _F ( … GRAPH = ( ' P-Q ' ),             … ),),
```

product following files:

```
Essai_TD_1_P-Q.dat,  Essai_TD_1_EPS_AXI-Q.dat  , Essai_TD_2_P-Q.dat …
```

3.4.5 Operand **TABLE_REF**

```
◊  TABLE_REF = l_tabreF,             [l_table]
```

This operand makes it possible to inform curves of reference (for example, experimental) tabulées and stored in the form of tables, in order to superimpose them on the curves resulting from the simulations carried out under the keyword current

factor. These curves of reference are then included in the files produced by the keyword `GRAPH` .
Each table contained in the list `TABLE_REF` must be created as a preliminary using the operator `CREA_TABLE` [U4.33.02], and formatted in the following way:

```
tabref = CREA_TABLE (
   LISTE= (_F (PARA=' TYPE'    , LISTE_K= [typgraph,]),
          _F (PARA=' LEGENDE', LISTE_K= [malegend,]),
          _F (PARA=' ABSCISSE', LISTE_R=l_absc),
          _F (PARA=' ORDONNEE', LISTE_R=l_ordo),),);
```

with:

- `typgraph` a character string whose value belongs obligatorily to the list of values by default of the keyword `GRAPH`. This value makes it possible to identify the type of graph (and thus the file) to which the curve of reference must be added.
- `malegend` a character string which contains the legend associated with the curve with reference
- `l_absc` and `l_ordo` are lists python of real respectively containing the X-coordinates and the ordinates of the points of the curve of reference. These lists must thus have even cardinal

3.5 Word key ESSAI_TND

This keyword factor (répétable) makes it possible to carry out a series of simulations of the same triaxial compression test not drained (total saturation is supposed) for which one varies the parameters of loading (confining pressure and imposed axial deformation), post-to treat the got results and to write them in the form of graphs (with the format xmgrace) and/or of tables.

3.5.1 Operands PRES_CONF, EPSI_IMPOSE, NB_INST

```
♦   PRES_CONF   = l_pconf,        [l_R]
♦   EPSI_IMPOSE = l_epsimpo,      [l_R]
◊    NB_INST     =/100,        [DEFECT]
                  / nbinst,       [I]
```

These operands have the same meaning as for the keyword factor `ESSAI_TD` (§ 3.4.1).

3.5.2 Operand BIOT_COEF

```
◊   BIOT_COEF =/1.                  [DEFECT]
             / biot            [R]
```

Value of the coefficient of Biot.

3.5.3 Operand KZERO

```
◊    KZERO       =/1. ,                       [DEFECT]
                   / kzero,                      [R]
```

Value of the coefficient of the grounds at rest, makes it possible to define an anisotropic state of containment: $\sigma_{xx}=\sigma_{yy}=K_0\sigma_{zz}=K_0\,\mathrm{PRES\_CONF}$

Note: When the value of KZERO is well informed different from 1, the real confining pressure of the test is not more PRES_CONF , it becomes:

$$P_c = \frac{(1+2.K_0)\,\text{PRES\_CONF}}{3}$$

3.5.4 Operand **TABLE_RESU**

```
◊   TABLE_RESU = l_tabres ,            [l_CO]
```

This operand has the same meaning as for the keyword factor ESSAI_TD (§ 3.4.3).

3.5.5 Operand **GRAPH**

```
◊    GRAPH =/('P-Q', 'EPS_AXI-Q', 'EPS_AXI-PRE_EAU'), [DEFECT]
                 / l_typgraph,
   [l_Kn]
```

This operand has the same meaning as for the keyword factor ESSAI_TD (§ 3.4.4), only the list of the values by default. Graphs available for this test (TND) are the following:

- 'P-Q' : D eviator of constraints $q = |\sigma_{zz} - \sigma_{xx}|$ according to the average pressure.
- 'EPS_AXI-Q' : D eviator according to the axial deformation.
- 'EPS_AXI-PRE_EAU' : pressure of water (pore water pressure) according to the axial deformation.

3.5.6 Operand **TABLE_REF**

```
◊   TABLE_REF = l_tabreF,            [l_table]
```

This operand has the same meaning as for the keyword factor ESSAI_TD (§ 3.4.5).

3.6 Word key **ESSAI_CISA_C**

This keyword factor (répétable) makes it possible to carry out a series of simulations of the same drained cyclic shear test for which one varies the parameters of loading (confining pressure, amplitude of shearing strain and many cycles), post-to treat the got results and to write them in the form of graphs (with the format xmgrace) and/or of tables.

3.6.1 Operands **PRES_CONF, EPSI_IMPOSE, NB_CYCLE, NB_INST**

```
♦   PRES_CONF    = l_pconf,           [l_R]
♦   GAMMA_IMPOSE = l_disimpo,         [l_R]
♦    NB_CYCLE    = nbcyc,             [I]
◊    NB_INST     =/25,             [DEFECT]
                   / nbinst,          [I]
```

These operands make it possible to define the loading of each simulation to be carried out under the keyword factor running, like its discretization. Their significance is summarized with the figure 3.6.1-a and below detailed:

- PRES_CONF allows to define the list of the confining pressures (strictly negative) which will be kept during each test.
- GAMMA_IMPOSE allows to define the list of the amplitudes (strictly positive) of shearing strain $\gamma = 2\,\varepsilon_{xy}$ imposed cyclic loading.

- NB_CYCLE corresponds to the number of cycles, fixed for all simulations.
- NB_INST allows to define the temporal discretization of the loading, and corresponds to the number of steps of loading per quarter of cycle

For each confining pressure PRES_CONF, as many simulations are carried out as there are elements in the list GAMMA_IMPOSE. Contrary to the tests TD and TND (see respectively §3.4 and §3.5), these lists are not in bijection and there is on the whole $card(\mathrm{PRES\_CONF}).card(\mathrm{GAMMA\_IMPOSE})$ simulations carried out.

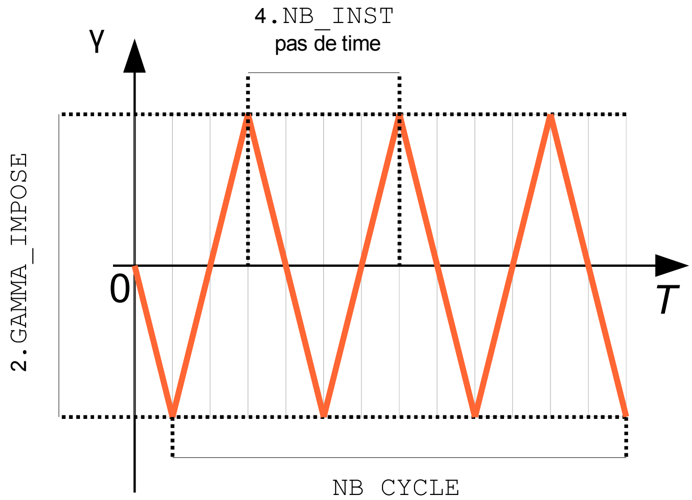

Figure 3.6.1-a: discretization and pace of the loading for the keyword ESSAI_CISA_C, for 3 cycles

3.6.2 Operand GAMMA_ELAS

```
◊    GAMMA_ELAS    =/1.E-7,          [DEFECT]
                   / diselas,           [R]
```

For each confining pressure, the modulus of maximum secant rigidity (i.e. healthy material) are given by simulating a slope of imposed shearing strain (in terms of distortion) whose end value is GAMMA_ELAS. This value must be such as material remains in its field of elasticity (linear or not, according to the relation of behavior used). GAMMA_ELAS is worth 1.E-7 by default, and any value indicated by the user must be lower to him. If the well informed value does not make it possible to remain in the field of elasticity, the code stops in fatal error.

3.6.3 Operand KZERO

```
◊    KZERO         =/1. ,                        [DEFECT]
                     / kzero,                        [R]
```

Value of the coefficient of the grounds at rest, makes it possible to define an anisotropic state of containment: $\sigma_{xx}=\sigma_{yy}=K_0\sigma_{zz}=K_0\,\mathrm{PRES\_CONF}$

Note: When the value of KZERO is well informed different from 1, the real confining pressure of the test is not more PRES_CONF , it becomes:

$$P_c=\frac{(1+2.K_0)\,\mathrm{PRES\_CONF}}{3}$$

3.6.4 Operand TABLE_RESU

◊ `TABLE_RESU = l_tabres ,` `[l_CO]`

This operand optional makes it possible to give the list of the names of the concepts produced by the macro-order which will be then of type `[table]` . The size of this list must check:

$$card(\mathrm{TABLE\_RESU}) = card(\mathrm{PRES\_CONF}) + 1$$

Indeed, each produced table gathers the gross profits of all the simulations carried out for the same confining pressure (PRES_CONF), in which each simulation corresponds to a package of contiguous columns whose titles all are indexed by the same entirety (index of the value considered in the list GAMMA_IMPOSE). An additional table recapitulating the postprocessings carried out at the conclusion of all simulations is also produced. This table contains for each confining pressure (PRES_CONF) values of the modulus of standardized secant rigidity G/G_{max} and of the rate of depreciation D in with respect to the amplitudes of the imposed distortion (GAMMA_IMPOSE). This table corresponds in the name of concept given in last position in the list TABLE_RESU . Extracts of these tables are presented in the example below.

Example:

```
TABRES1=CO ('TRES1')
TABRES2 =CO ('TRES2')
FRETTED =CO ('T FRETTED ')


CALC_ESSAI_GEOMECA (
    …
    ESSAI_CISA_C = _F ( PRES_CONF    = (- 1.0E5, - 2.05E5,),
                        GAMMA_IMPOSE  =  (1.0E-5,  5.0E-5,  1.0E-4,
1.0E-3) ,
                       NB_CYCLE     = 3,
                       TABLE_RESU   = ( TABRES1, TABRES2, FRETTED ),
),
    …
                    );
```

The table below specifies for this example the results of simulations contained in the tables TABRES1 and TABRES2 , as well as the order in which these tables are filled out.

GAMMA_IMPOSE / PRES_ CONF	1.0E-5	5.0E-5	1.0E-4	1.0E-3
-1.0E5	TABRES1	TABRES1	TABRES1	TABRES1
-2.05E5	TABRES2	TABRES2	TABRES2	TABRES2

An extract of the table below is presented TABRES1 containing the gross profits of the simulations carried out for the first value of PRES_CONF (TABRES2 being built same manner, for the second value of PRES_CONF).

```
#
#----------------------------------------------------------------------------
#
#Resultats rough: ESSAI_CISA_C number 1/PRES_CONF = -1.000000E+05
#
 GAMMA_IMPOSE_1 INST_1       GAMMA_1      SIG_XY_1     GAMMA_IMPOSE_2 INST_2       GAMMA_2      SIG_XY_2     …
   1.00000E-05  0.00000E+00  0.00000E+00  0.00000E+00   5.00000E-05  0.00000E+00  0.00000E+00  0.00000E+00…
  -             4.00000E-01 -4.00000E-07 -3.79317E+01   -            4.00000E-01 -2.00000E-06 -1.89658E+02…
  -             8.00000E-01 -8.00000E-07 -7.58633E+01   -            8.00000E-01 -4.00000E-06 -3.79317E+02…
```

```
 -          1.20000E+00 -1.20000E-06 -1.13795E+02   -          1.20000E+00 -6.00000E-06 -5.50536E+02…
 -          1.60000E+00 -1.60000E-06 -1.51727E+02   -          1.60000E+00 -8.00000E-06 -7.19697E+02…
 -          2.00000E+00 -2.00000E-06 -1.89658E+02   -          2.00000E+00 -1.00000E-05 -8.88778E+02…
 -          2.40000E+00 -2.40000E-06 -2.27590E+02   -          2.40000E+00 -1.20000E-05 -1.05778E+03…
 -          2.80000E+00 -2.80000E-06 -2.65522E+02   -          2.80000E+00 -1.40000E-05 -1.22670E+03…
 -          3.20000E+00 -3.20000E-06 -3.03453E+02   -          3.20000E+00 -1.60000E-05 -1.39554E+03…
 -          3.60000E+00 -3.60000E-06 -3.41385E+02   -          3.60000E+00 -1.80000E-05 -1.56429E+03…
 -          4.00000E+00 -4.00000E-06 -3.79317E+02   -          4.00000E+00 -2.00000E-05 -1.73297E+03…
 -          4.40000E+00 -4.40000E-06 -4.15150E+02   -          4.40000E+00 -2.20000E-05 -1.90156E+03…
 -          4.80000E+00 -4.80000E-06 -4.49001E+02   -          4.80000E+00 -2.40000E-05 -2.07007E+03…
 -          5.20000E+00 -5.20000E-06 -4.82849E+02   -          5.20000E+00 -2.60000E-05 -2.23850E+03…
 -          5.60000E+00 -5.60000E-06 -5.16693E+02   -          5.60000E+00 -2.80000E-05 -2.40684E+03…
 -          6.00000E+00 -6.00000E-06 -5.50535E+02   -          6.00000E+00 -3.00000E-05 -2.57510E+03…
 -          6.40000E+00 -6.40000E-06 -5.84374E+02   -          6.40000E+00 -3.20000E-05 -2.74327E+03…
 -          6.80000E+00 -6.80000E-06 -6.18209E+02   -          6.80000E+00 -3.40000E-05 -2.91136E+03…
 -          7.20000E+00 -7.20000E-06 -6.52041E+02   -          7.20000E+00 -3.60000E-05 -3.07937E+03…
 -          7.60000E+00 -7.60000E-06 -6.85870E+02   -          7.60000E+00 -3.80000E-05 -3.24729E+03…
 -          8.00000E+00 -8.00000E-06 -7.19695E+02   -          8.00000E+00 -4.00000E-05 -3.41511E+03…
 -          8.40000E+00 -8.40000E-06 -7.53517E+02   -          8.40000E+00 -4.20000E-05 -3.58284E+03…
 -          8.80000E+00 -8.80000E-06 -7.87336E+02   -          8.80000E+00 -4.40000E-05 -3.75049E+03…
 -          9.20000E+00 -9.20000E-06 -8.21152E+02   -          9.20000E+00 -4.60000E-05 -3.91805E+03…
 -          9.60000E+00 -9.60000E-06 -8.54965E+02   -          9.60000E+00 -4.80000E-05 -4.08436E+03…
 -          1.00000E+01 -1.00000E-05 -8.88774E+02   -          1.00000E+01 -5.00000E-05 -4.24698E+03…
 -          1.04000E+01 -9.60000E-06 -8.50842E+02   -          1.04000E+01 -4.80000E-05 -4.05732E+03…
 -          1.08000E+01 -9.20000E-06 -8.12911E+02   -          1.08000E+01 -4.60000E-05 -3.86767E+03…
 -          1.12000E+01 -8.80000E-06 -7.74979E+02   -          1.12000E+01 -4.40000E-05 -3.67801E+03…
 -          1.16000E+01 -8.40000E-06 -7.37047E+02   -          1.16000E+01 -4.20000E-05 -3.48835E+03…
 -          1.20000E+01 -8.00000E-06 -6.99116E+02   -          1.20000E+01 -4.00000E-05 -3.31514E+03…
 -          1.24000E+01 -7.60000E-06 -6.61184E+02   -          1.24000E+01 -3.80000E-05 -3.14591E+03…
 -          1.28000E+01 -7.20000E-06 -6.23252E+02   -          1.28000E+01 -3.60000E-05 -2.97673E+03…
 -          1.32000E+01 -6.80000E-06 -5.85321E+02   -          1.32000E+01 -3.40000E-05 -2.80759E+03…
 -          1.36000E+01 -6.40000E-06 -5.47389E+02   -          1.36000E+01 -3.20000E-05 -2.63849E+03…
 -          1.40000E+01 -6.00000E-06 -5.09458E+02   -          1.40000E+01 -3.00000E-05 -2.46942E+03…
 -          1.44000E+01 -5.60000E-06 -4.71526E+02   -          1.44000E+01 -2.80000E-05 -2.30040E+03…
 -          1.48000E+01 -5.20000E-06 -4.33594E+02   -          1.48000E+01 -2.60000E-05 -2.13142E+03…
 -          1.52000E+01 -4.80000E-06 -3.95663E+02   -          1.52000E+01 -2.40000E-05 -1.96247E+03…
 -          1.56000E+01 -4.40000E-06 -3.57731E+02   -          1.56000E+01 -2.20000E-05 -1.79357E+03…
 -          1.60000E+01 -4.00000E-06 -3.19799E+02   -          1.60000E+01 -2.00000E-05 -1.62471E+03…
 -          1.64000E+01 -3.60000E-06 -2.81868E+02   -          1.64000E+01 -1.80000E-05 -1.45589E+03…
 -          1.68000E+01 -3.20000E-06 -2.43936E+02   -          1.68000E+01 -1.60000E-05 -1.28711E+03…
 -          1.72000E+01 -2.80000E-06 -2.06004E+02   -          1.72000E+01 -1.40000E-05 -1.11836E+03…
 -          1.76000E+01 -2.40000E-06 -1.68073E+02   -          1.76000E+01 -1.20000E-05 -9.49666E+02…
 -          1.80000E+01 -2.00000E-06 -1.30141E+02   -          1.80000E+01 -1.00000E-05 -7.81009E+02…
 -          1.84000E+01 -1.60000E-06 -9.23287E+01   -          1.84000E+01 -8.00000E-06 -6.12391E+02…
 …       …          …          …          …          …          …          …
```

Ci below, one also presents the contents of the additional table TABBILA , recapitulating postprocessings (G/G_{max} and D) realized at the conclusion of all simulations. Each package of contiguous columns whose titles are indexed by even whole (index of the value considered in the list PRES_CONF) corresponds to the postprocessings carried out for the same confining pressure.

```
#
#------------------------------------------------------------------------------
#
#Resultats total: ESSAI_CISA_C number 1
#
PRES_CONF_1  GAMMA_IMPOSE_1 G_SUR_GMAX_1 DAMPING_1    PRES_CONF_2  GAMMA_IMPOSE_2 G_SUR_GMAX_2 DAMPING_2
-1.00000E+05    1.00000E-05  9.37244E-01  1.79484E-02 -2.00000E+05    1.00000E-05  9.65623E-01  1.30248E-02
-               5.00000E-05  8.95847E-01  7.93301E-03 -               5.00000E-05  9.26152E-01  6.34512E-03
-               1.00000E-04  7.91534E-01  5.24988E-02 -               1.00000E-04  8.82990E-01  2.26809E-02
-               1.00000E-03  2.81687E-01  2.16980E-01 -               1.00000E-03  3.69590E-01  1.89750E-01
```

3.6.5 Operand GRAPH

◊ GRAPH =/('GAMMA-SIGXY', 'GAMMA-G', 'GAMMA-D' , 'GD'), [DEFECT]
/ l_typgraph, [l_Kn]

This operand has the same meaning as for the keyword factor ESSAI_TD (§ 3.4.4), only the list of the values by default (and thus of the types of graph available) differs. The graphs available for the cyclic drained shear test are:

– 'GAMMA-SIGXY': Contrainte of shearing according to the distortion.
– 'GAMMA-G': modulus of standardized secant rigidity, according to the distortion applied $\gamma=2\varepsilon_{xy}$.
– 'GAMMA-D': rate of depreciation according to the distortion applied.
– 'GD' : cyclic damping according to the standardized secant module.

3.6.6 Operand TABLE_REF

```
◊   TABLE_REF = l_tabreF,             [l_table]
```

This operand has the same meaning as for the keyword factor ESSAI_TD (§3.4.5).

3.7 Word key ESSAI_TND_C

This keyword factor (répétable) makes it possible to carry out a series of simulations of the same triaxial compression test not drained (total saturation is supposed) cyclic for which one varies the parameters of loading (confining pressure, amplitude of imposed axial effective constraint, and many cycles), post-to treat the got results and to write them in the form of graphs (with the format xmgrace) and/or of tables.

3.7.1 Operands PRES_CONF, SIGM_IMPOSE, NB_CYCLE, NB_INST

```
♦   PRES_CONF   = l_pconf,            [l_R]
♦   SIGM_IMPOSE = l_sigimpo,          [l_R]
♦    NB_CYCLE    = nbcyc,             [I]
◊    NB_INST     =/25,             [DEFECT]
                  / nbinst,           [I]
```

These operands make it possible to define the loading of each simulation to be carried out under the keyword factor running, like its discretization. Their significance is summarized with the figure 3.7.1-a and below detailed:

- PRES_CONF allows to define the list of the confining pressures (strictly negative) which will be kept during each test.
- SIGM_IMPOSE allows to define the list of the amplitudes (strictly positive) of axial effective constraint of the cyclic loading imposed (with PRES_CONF the average constraint).
- NB_CYCLE corresponds to the number of cycles, fixed for all simulations.
- NB_INST allows to define the temporal discretization of the loading, and corresponds to the number of steps of loading per quarter of cycle

For each confining pressure PRES_CONF, as many simulations are carried out as there are elements in the list SIGM_IMPOSE. Contrary to the tests TD and TND (see respectively §3.4 and §3.5), these lists are not in bijection and there is on the whole $card(\text{PRES\_CONF}).card(\text{SIGM\_IMPOSE})$ simulations carried out.

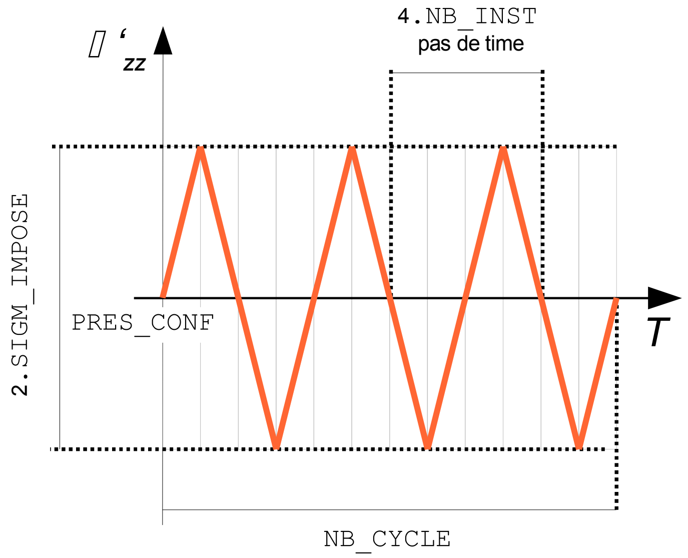

Figure 3.7.1-a: discretization and pace of the loading for the keyword ESSAI_TND_C, for 3 cycles

Note:

For loose sands, control in constraint of the test raises difficulties at the time of the crossing of the two lines of instability, represented blue on the Figure 3.7.1-c. Indeed, the imposition of an instruction of maximum constraint higher than the acceptable maximum constraint on the line of instability led either to a divergence, or with a solution distorts (brutal jump of visible constraint on the Figure 3.7.1-c). Indeed, the line of instability represents the place of all the maximum acceptable ones of constraints of a monotonous test TND for various values of initial consolidation (black curve).

The problem does not arise for a dense sand, because there are no maximum constraints in this case, as one can see it the black curve of the Figure 3.7.1-b.

For this test, there thus exists a procedure ***automatic*** *of management of the unstable situations. It consists in detecting instability and continuing the test in controlled deformation. The criteria of detection are the following:*

not convergence of calculation

$$\frac{\Delta Q}{\Delta P} < 0.25 \text{ and } \frac{\Delta \varepsilon_{zz}^{+}}{\Delta \varepsilon_{zz}^{-}} > 10$$

One continues on the remaining number of cycles per sequence of monotonous tests TND to controlled deformation, at a rate of two tests per cycle ($\pm\varepsilon_{max}$ to reach $\pm\sigma_{max}$). The instruction of maximum deformation ε_{max} imposed is of 4%, or 12% if the preceding instruction were insufficient. The list of moments for these tests TND spreads out from 0 to 100 seconds per 0.2 seconds temporal step (or 0.1 seconds if the instruction is $\varepsilon_{max}=12\%$).

The sequence of a test TND to deformation controlled with the other is carried out by a resumption of calculation as from the last moment when the instruction in constraint $\pm\sigma_{max}$ is reached.

On the Figure 3.7.1-d, one shows on an example of sand releases (CAS-test comp012c) the solution obtained with or without the procedure of management of instability.

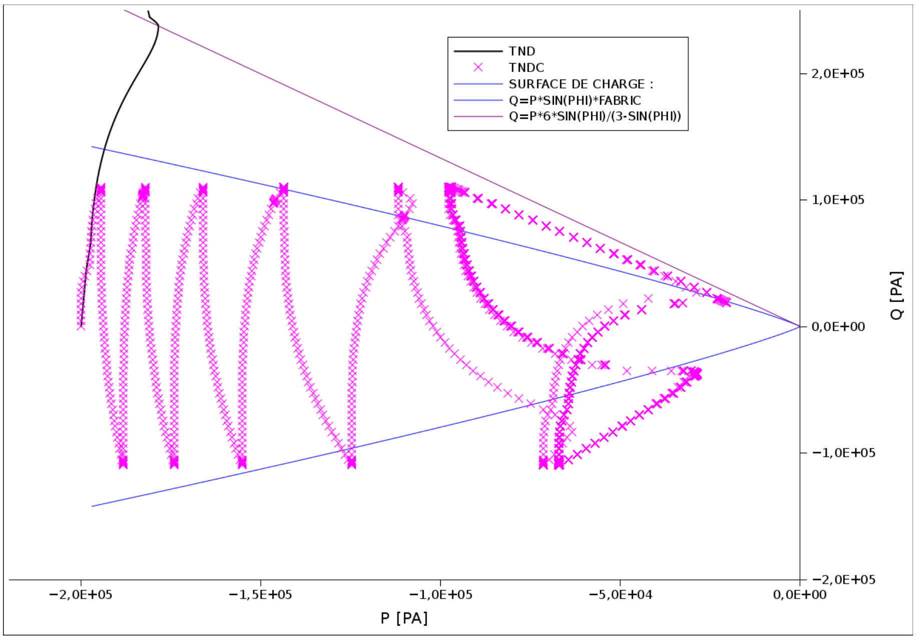

Figure 3.7.1-b: Result of tests TND (black) and TND_C (pink) for a dense sand. The state of rupture is represented by the line violet, and the lines of instability are blue.

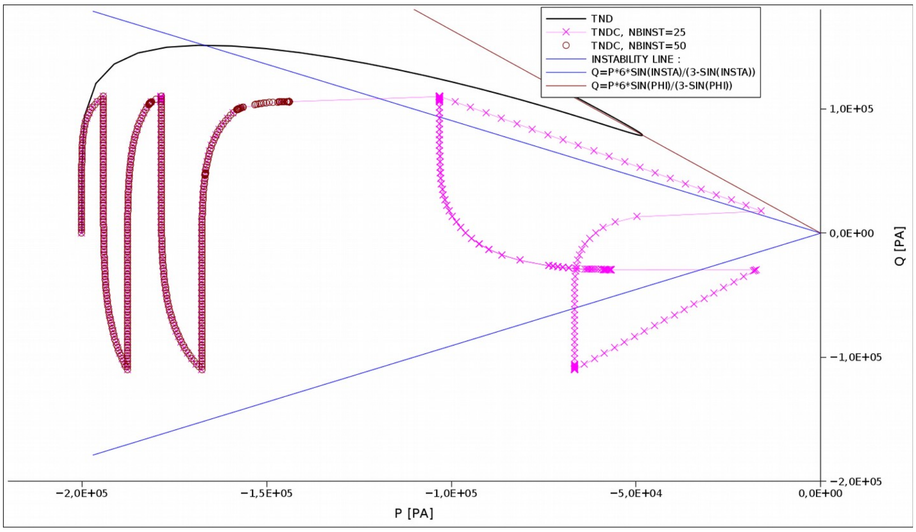

Figure 3.7.1-c: Result of tests TND (black) and TND_C (pink) for a loose sand. The state of rupture is represented by the line violet, and the lines of instability are blue.

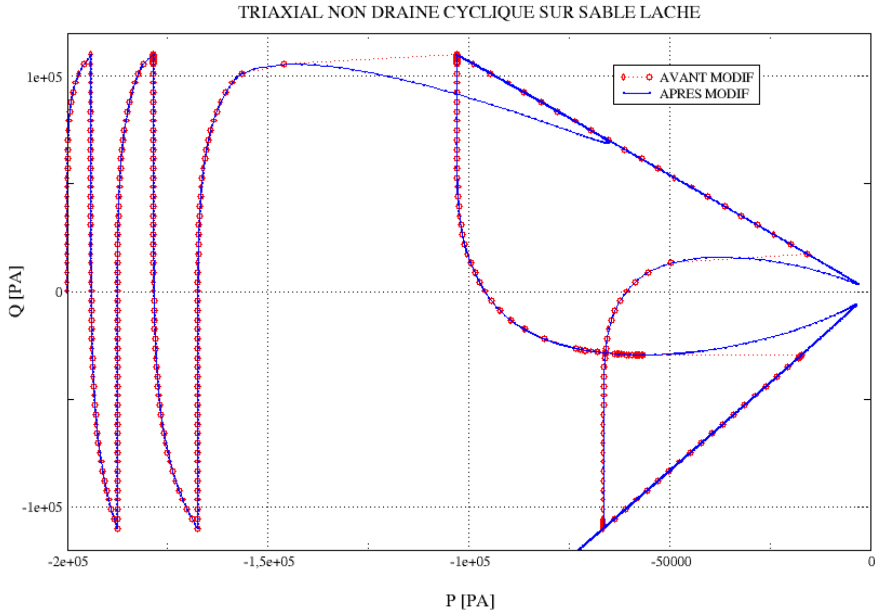

Figure 3.7.1-d: Result of a test TND_C for a sand releases with (blue) or without (red) the procedure of management of instability.

3.7.2 Operand RU_MAX

◊ RU_MAX =/0.8 [DEFECT]
/ rumax [R]

Maximum value of the criterion of liquefaction, to compare with: $r_u = \left| \frac{u}{P_0} \right|$

3.7.3 Operand BIOT_COEF

◊ BIOT_COEF =/1. [DEFECT]
/ biot [R]

Value of the coefficient of Biot.

3.7.4 Operand UN_SUR_K

♦ UN_SUR_K = unsurk [R]

Value of the reverse of the module of compressibility of water.

3.7.5 Operand KZERO

◊ KZERO =/1. , [DEFECT]
/ kzero, [R]

Value of the coefficient of the grounds at rest, makes it possible to define an anisotropic state of containment: $\sigma_{xx} = \sigma_{yy} = K_0 \sigma_{zz} = K_0 \mathrm{PRES\_CONF}$

Notice *:*

When the value of `KZERO` *is well informed different from 1, the real confining pressure of the test is not more* `PRES_CONF` *, it becomes:*

$$P_c=\frac{(1+2.\mathrm{K}_0)\,\mathrm{PRES\_CONF}}{3}$$

3.7.6 Operand TABLE_RESU

```
◊   TABLE_RESU = l_tabres ,        [l_CO]
```

This operand optional makes it possible to give the list of the names of the concepts produced by the macro-order which will be then of type `[table]` . The size of this list must check:

$$card(\mathrm{TABLE\_RESU})=card(\mathrm{PRES\_CONF})+1$$

Indeed, each produced table gathers the gross profits of all the simulations carried out for the same confining pressure (`PRES_CONF`), in which each simulation corresponds to a package of contiguous columns whose titles all are indexed by the same entirety (index of the value considered in the list `SIGM_IMPOSE`). An additional table recapitulating the postprocessings carried out at the conclusion of all simulations is also produced. This table contains for each confining pressure (`PRES_CONF`) the number of cycles to the end of which the criterion of liquefaction of the ground was reached, in with respect to the amplitudes of imposed effective constraint (`SIGM_IMPOSE`). The criterion of liquefaction is considered reached if $r_u \geq rumax$, with:

$$r_u=\left|\frac{u}{P_0}\right|$$

u indicating the pore water pressure and P_0 confining pressure. This table corresponds in the name of concept given in last position in the list `TABLE_RESU` . Extracts of these tables are presented in the example below.

Example:

```
TABRES1=CO ('TRES1')
TABRES2=CO ('TRES2')
TABRES3=CO ('TRES3')
TABBILA=CO ('TBILA')

CALC_ESSAI_GEOMECA (
   …
   ESSAI_TND_C = _F ( PRES_CONF   = (- 3.E4, - 3.25E4, - 3.5E4,),
                      SIGM_IMPOSE                                  =
(1.E4,1.1E4,1.2E4,1.3E4,1.6E4,),
                      NB_CYCLE    = 25,
                      UN_SUR_K    =  1.E-12,
                      TABLE_RESU   =  (TABRES1,  TABRES2,  TABRES3,
TABBILA), ),
   …
                    );
```

The table below specifies for this example the results of simulations contained in the tables `TABRES1`, `TABRES2` and `TABRES3`, as well as the order in which these tables are filled out.

SIGM_IMPOSE ▯ PRES_CONF ‾	1.E4	1.1E4	1.2E4	1.3E4	1.6E4
-3.E4	TABRES1	TABRES1	TABRES1	TABRES1	TABRES1
-3.25E4	TABRES2	TABRES2	TABRES2	TABRES2	TABRES2
-3.5E4	TABRES3	TABRES3	TABRES3	TABRES3	TABRES3

An extract of the table below is presented `TABRES2` containing the gross profits of the simulations carried out for the second value of `PRES_CONF`.

```
#
#------------------------------------------------------------------------------
#
#Resultats rough: ESSAI_TND_C number 1/PRES_CONF = -3.250000E+04
#
 SIGM_IMPOSE_1 INST_1       EPS_AXI_1    EPS_LAT_1     … PRE_EAU_1    SIGM_IMPOSE_2 INST_2       …
   1.00000E+04  0.00000E+00  0.00000E+00  0.00000E+00  … -0.00000E+00   1.10000E+04  0.00000E+00  …
  -             4.00000E-01  2.37788E-06 -1.18887E-06  … -1.33316E+02  -             4.00000E-01  …
  -             8.00000E-01  5.27009E-06 -2.63491E-06  … -2.66632E+02  -             8.00000E-01  …
  -             1.20000E+00  8.17434E-06 -4.08697E-06  … -3.99948E+02  -             1.20000E+00  …
  -             1.60000E+00  1.10910E-05 -5.54522E-06  … -5.33263E+02  -             1.60000E+00  …
  -             2.00000E+00  1.40203E-05 -7.00984E-06  … -6.66579E+02  -             2.00000E+00  …
  -             2.40000E+00  1.69628E-05 -8.48101E-06  … -7.99895E+02  -             2.40000E+00  …
  -             2.80000E+00  1.99187E-05 -9.95886E-06  … -9.33211E+02  -             2.80000E+00  …
  -             3.20000E+00  2.30002E-05 -1.14996E-05  … -1.06631E+03  -             3.20000E+00  …
  -             3.60000E+00  2.65689E-05 -1.32839E-05  … -1.19796E+03  -             3.60000E+00  …
  -             4.00000E+00  3.06705E-05 -1.53346E-05  … -1.32706E+03  -             4.00000E+00  …
  -             4.40000E+00  3.53282E-05 -1.76634E-05  … -1.45247E+03  -             4.40000E+00  …
  -             4.80000E+00  4.05684E-05 -2.02834E-05  … -1.57305E+03  -             4.80000E+00  …
  -             5.20000E+00  4.64193E-05 -2.32088E-05  … -1.68756E+03  -             5.20000E+00  …
  -             5.60000E+00  5.29170E-05 -2.64576E-05  … -1.79469E+03  -             5.60000E+00  …
  -             6.00000E+00  6.01011E-05 -3.00496E-05  … -1.89303E+03  -             6.00000E+00  …
  -             6.40000E+00  6.80160E-05 -3.40070E-05  … -1.98113E+03  -             6.40000E+00  …
  -             6.80000E+00  7.67173E-05 -3.83576E-05  … -2.05731E+03  -             6.80000E+00  …
  -             7.20000E+00  8.62682E-05 -4.31330E-05  … -2.11975E+03  -             7.20000E+00  …
  -             7.60000E+00  9.67455E-05 -4.83717E-05  … -2.16636E+03  -             7.60000E+00  …
  -             8.00000E+00  1.08244E-04 -5.41211E-05  … -2.19469E+03  -             8.00000E+00  …
  -             8.40000E+00  1.20878E-04 -6.04380E-05  … -2.20193E+03  -             8.40000E+00  …
  -             8.80000E+00  1.34791E-04 -6.73947E-05  … -2.18477E+03  -             8.80000E+00  …
  -             9.20000E+00  1.50170E-04 -7.50842E-05  … -2.13899E+03  -             9.20000E+00  …
  -             9.60000E+00  1.67253E-04 -8.36253E-05  … -2.05939E+03  -             9.60000E+00  …
  -             1.00000E+01  1.86360E-04 -9.31790E-05  … -1.93918E+03  -             1.00000E+01  …
  -             1.04000E+01  1.84117E-04 -9.20575E-05  … -1.80586E+03  -             1.04000E+01  …
  -             1.08000E+01  1.81336E-04 -9.06674E-05  … -1.67255E+03  -             1.08000E+01  …
  -             1.12000E+01  1.78318E-04 -8.91580E-05  … -1.53923E+03  -             1.12000E+01  …
  -             1.16000E+01  1.75296E-04 -8.76474E-05  … -1.40592E+03  -             1.16000E+01  …
  -             1.20000E+01  1.72272E-04 -8.61353E-05  … -1.27260E+03  -             1.20000E+01  …
  -             1.24000E+01  1.69244E-04 -8.46217E-05  … -1.13928E+03  -             1.24000E+01  …
  -             1.28000E+01  1.66214E-04 -8.31066E-05  … -1.00597E+03  -             1.28000E+01  …
  -             1.32000E+01  1.63181E-04 -8.15900E-05  … -8.72652E+02  -             1.32000E+01  …
  -             1.36000E+01  1.60145E-04 -8.00719E-05  … -7.39335E+02  -             1.36000E+01  …
  -             1.40000E+01  1.57105E-04 -7.85523E-05  … -6.06019E+02  -             1.40000E+01  …
  -             1.44000E+01  1.54063E-04 -7.70311E-05  … -4.72703E+02  -             1.44000E+01  …
  -             1.48000E+01  1.51017E-04 -7.55085E-05  … -3.39387E+02  -             1.48000E+01  …
  -             1.52000E+01  1.47969E-04 -7.39842E-05  … -2.06071E+02  -             1.52000E+01  …
  -             1.56000E+01  1.44857E-04 -7.24283E-05  … -7.26273E+01  -             1.56000E+01  …
  …          …          …          …           …              …          …
```

Ci below, one also presents the contents of the additional table `TABBILA`, recapitulating the postprocessings (many cycles to liquefaction) carried out at the conclusion of all simulations. Each package of contiguous columns whose titles are indexed by the same entirety (index of the value considered in the list `PRES_CONF`) corresponds to the postprocessings carried out for the same confining pressure.

```
#
#------------------------------------------------------------------------------
#
#Resultats total: ESSAI_TND_C number 1
#
  PRES_CONF_1   NCYCL_1         SIGM_IMPOSE_1  PRES_CONF_2   NCYCL_2         SIGM_IMPOSE_2  PRES_CONF_3   NCYCL_3
SIGM_IMPOSE_3
 -3.00000E+04   1.10000E+01    1.00000E+04  -3.25000E+04   1.50000E+01    1.00000E+04  -3.50000E+04   2.10000E+01
1.00000E+04
 -              7.00000E+00   1.10000E+04  -              1.10000E+01   1.10000E+04  -              1.50000E+01
1.10000E+04
 -              6.00000E+00   1.20000E+04  -              8.00000E+00   1.20000E+04  -              1.10000E+01
1.20000E+04
```

```
 -            4.00000E+00   1.30000E+04 -            6.00000E+00   1.30000E+04 -            8.00000E+00
1.30000E+04
 -            3.00000E+00   1.60000E+04 -            3.00000E+00   1.60000E+04 -            4.00000E+00
1.60000E+04
#
```

3.7.7 Operand GRAPH

```
◊   GRAPH =/('P-Q', 'SIG_AXI-PRE_EAU', EPS_AXI-PRE_EAU',
              'EPS_AXI-Q', 'NCYCL-DSIGM'),        [DEFECT]
             / l_typgraph,                         [l_Kn]
```

This operand has the same meaning as for the keyword factor ESSAI_TD (§ 3.4.4), only the list of the values by default differs, them graphs available are:

– 'P-Q' : diverter of constraints $q=\sigma_{zz}-\sigma_{xx}$ according to the average pressure $p=1/3(\sigma_{xx}+\sigma_{yy}+\sigma_{zz})$.
– 'SIG_AXI-PRE_EAU':pore water pressure u according to axial stress.
– 'EPS_AXI-PRE_EAU: pore water pressure according to the axial deformation.
– 'EPS_AXI-Q': diverter q according to the axial deformation.
– 'NCYCL-DSIGM': L forced imposed and the number of cycle for which the criterion of liquefaction is reached.

3.7.8 Operand TABLE_REF

```
◊  TABLE_REF = l_tabreF,             [l_table]
```

This operand has the same meaning as for the keyword factor ESSAI_TD (§3.4.5).

3.8 Word key ESSAI_TD_A

This keyword factor (répétable) makes it possible to carry out a series of simulations of the same cyclic drained triaxial compression test alternate for which one varies the parameters of loading (confining pressure, imposed axial deformation, and many cycles), post-to treat the got results and to write them in the form of graphs (with the format xmgrace) and/or of tables.

3.8.1 Operands PRES_CONF, EPSI_IMPOSE, NB_CYCLE, NB_INST

```
♦  PRES_CONF   = l_pconf,           [l_R]
♦  EPSI_IMPOSE = l_epsimpo,         [l_R]
♦   NB_CYCLE    = nbcyc,            [I]
◊   NB_INST     =/25,             [DEFECT]
                 / nbinst,          [I]
```

These operands make it possible to define the loading of each simulation to be carried out under the keyword factor running, like its discretization. Their significance is summarized with the figure 3.8.1-a and below detailed:

- PRES_CONF allows to define the list of the confining pressures (strictly negative) which will be kept during each test.
- EPSI_IMPOSE allows to define the list of the amplitudes (strictly positive) of axial deformation of the imposed cyclic loading.
- NB_CYCLE corresponds to the number of cycles, fixed for all simulations.
- NB_INST allows to define the temporal discretization of the loading, and corresponds to the number of steps of loading per quarter of cycle

For each confining pressure PRES_CONF, as many simulations are carried out as there are elements in the list EPSI_IMPOSE. Contrary to the tests TD and TND (see respectively §3.4 and §3.5), these lists are not in bijection and there is on the whole $card(\mathrm{PRES\_CONF}).card(\mathrm{EPSI\_IMPOSE})$ simulations carried out.

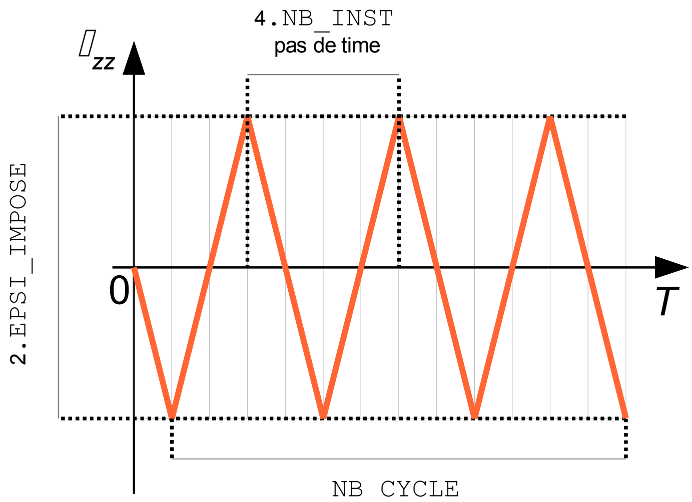

Figure 3.8.1-a: discretization and pace of the loading for the keyword ESSAI_TD_A, for 3 cycles

3.8.2 Operand EPSI_ELAS

◊ EPSI_ELAS =/1.E-7, [DEFECT]
/ epselas, [R]

For each confining pressure, the cyclic modulus Young are equivalent maximum (i.e. of healthy material) is given by simulating a cycle of alternate loading controlled in axial deformation imposed up to the value EPSI_ELAS. This value must be such as material remains in its field of elasticity (linear or not, according to the relation of behavior used). EPSI_ELAS is worth 1.E-7 by default, and any value indicated by the user must be lower to him. If the well informed value does not make it possible to remain in the field of elasticity, the code stops in fatal error.

3.8.3 Operand KZERO

◊ KZERO =/1. , [DEFECT]
/ kzero, [R]

Value of the coefficient of the grounds at rest, makes it possible to define an anisotropic state of containment: $\sigma_{xx}=\sigma_{yy}=K_0\sigma_{zz}=K_0\,\mathrm{PRES\_CONF}$

Note: When the value of KZERO is well informed different from 1, the real confining pressure of the test is not more PRES_CONF , it becomes:

$$P_c=\frac{(1+2.\mathrm{K}_0)\,\mathrm{PRES\_CONF}}{3}$$

3.8.4 Operand TABLE_RESU

◊ TABLE_RESU = l_tabres , [l_CO]

This operand optional makes it possible to give the list of the names of the concepts produced by the macro-order which will be then of type [table] . The size of this list must check:

$$card(\text{TABLE\_RESU}) = card(\text{PRES\_CONF}) + 1$$

Indeed, each produced table gathers the gross profits of all the simulations carried out for the same confining pressure (PRES_CONF), in which each simulation corresponds to a package of contiguous columns whose titles all are indexed by the same entirety (index of the value considered in the list EPSI_IMPOSE). An additional table recapitulating the postprocessings carried out at the conclusion of all simulations is also produced. This table contains for each confining pressure (PRES_CONF) values of the Young modulus cyclic standardized equivalent E/E_{max} for the last simulated cycle, in with respect to the imposed amplitudes of deformation (EPSI_IMPOSE). E and E_{max} are calculated in the following way:

$$E = \left|\frac{\Delta q}{\Delta \epsilon_a}\right|$$

with: $\Delta q = q_{max} - q_{min}$ and $\Delta \epsilon_a = \epsilon_{a,max} - \epsilon_{a,min}$

This table corresponds in the name of concept given in last position in the list TABLE_RESU . Extracts of these tables are presented in the example below.

Example:

```
TABRES1=CO ('TRES1')
TABRES2=CO ('TRES2')
TABBILA=CO ('TBILA')

CALC_ESSAI_GEOMECA (
   …
   ESSAI_TD_A = _F ( PRES_CONF   = (- 3.E4, - 5.E4),
   EPSI_IMPOSE = (1.E-4,5.E-4,1.E-3,2.E-3,5.E-3),
   NB_CYCLE    = 3,
   TABLE_RESU  = (TABRES1, TABRES2, TABBILA), ),
   …
                  );
```

The table below specifies for this example the results of simulations contained in the tables TABRES1, TABRES2, as well as the order in which these tables are filled out.

EPSI_IMPOSE / PRES_CONF	1.E-4	5.E-4	1.E-3	2.E-3	5.E-3
-3.E4	TABRES1	TABRES1	TABRES1	TABRES1	TABRES1
-5.E4	TABRES2	TABRES2	TABRES2	TABRES2	TABRES2

An extract of the table below is presented TABRES2 containing the gross profits of the simulations carried out for the second value of PRES_CONF.

```
#
#---------------------------------------------------------------------------
#
#Resultats rough: ESSAI_TD_A number 1/PRES_CONF = -5.000000E+04
#
EPSI_IMPOSE_1 INST_1       EPS_AXI_1    EPS_LAT_1     …  EPSI_IMPOSE_2 INST_2      …
  1.00000E-04  0.00000E+00  0.00000E+00  0.00000E+00  …  5.00000E-04  0.00000E+00  …
```

```
-           4.00000E-01 -4.00000E-06 -1.97971E-06  …  -           4.00000E-01…
-           8.00000E-01 -8.00000E-06 -3.80754E-06  …  -           8.00000E-01…
-           1.20000E+00 -1.20000E-05 -5.47994E-06  …  -           1.20000E+00…
-           1.60000E+00 -1.60000E-05 -7.15274E-06  …  -           1.60000E+00…
-           2.00000E+00 -2.00000E-05 -8.82571E-06  …  -           2.00000E+00…
-           2.40000E+00 -2.40000E-05 -1.04989E-05  …  -           2.40000E+00…
-           2.80000E+00 -2.80000E-05 -1.21721E-05  …  -           2.80000E+00…
-           3.20000E+00 -3.20000E-05 -1.38456E-05  …  -           3.20000E+00…
-           3.60000E+00 -3.60000E-05 -1.55192E-05  …  -           3.60000E+00…
-           4.00000E+00 -4.00000E-05 -1.71930E-05  …  -           4.00000E+00…
-           4.40000E+00 -4.40000E-05 -1.88669E-05  …  -           4.40000E+00…
-           4.80000E+00 -4.80000E-05 -2.05409E-05  …  -           4.80000E+00…
-           5.20000E+00 -5.20000E-05 -2.22151E-05  …  -           5.20000E+00…
-           5.60000E+00 -5.60000E-05 -2.38895E-05  …  -           5.60000E+00…
-           6.00000E+00 -6.00000E-05 -2.55640E-05  …  -           6.00000E+00…
-           6.40000E+00 -6.40000E-05 -2.72385E-05  …  -           6.40000E+00…
-           6.80000E+00 -6.80000E-05 -2.88926E-05  …  -           6.80000E+00…
-           7.20000E+00 -7.20000E-05 -3.04742E-05  …  -           7.20000E+00…
-           7.60000E+00 -7.60000E-05 -3.19868E-05  …  -           7.60000E+00…
-           8.00000E+00 -8.00000E-05 -3.34349E-05  …  -           8.00000E+00…
-           8.40000E+00 -8.40000E-05 -3.48219E-05  …  -           8.40000E+00…
-           8.80000E+00 -8.80000E-05 -3.61512E-05  …  -           8.80000E+00…
-           9.20000E+00 -9.20000E-05 -3.74257E-05  …  -           9.20000E+00…
-           9.60000E+00 -9.60000E-05 -3.86481E-05  …  -           9.60000E+00…
-           1.00000E+01 -1.00000E-04 -3.98209E-05  …  -           1.00000E+01…
-           1.04000E+01 -9.60000E-05 -4.10210E-05  …  -           1.04000E+01…
-           1.08000E+01 -9.20000E-05 -4.23186E-05  …  -           1.08000E+01…
-           1.12000E+01 -8.80000E-05 -4.36541E-05  …  -           1.12000E+01…
-           1.16000E+01 -8.40000E-05 -4.49913E-05  …  -           1.16000E+01…
-           1.20000E+01 -8.00000E-05 -4.63303E-05  …  -           1.20000E+01…
-           1.24000E+01 -7.60000E-05 -4.76712E-05  …  -           1.24000E+01…
-           1.28000E+01 -7.20000E-05 -4.90139E-05  …  -           1.28000E+01…
-           1.32000E+01 -6.80000E-05 -5.03585E-05  …  -           1.32000E+01…
-           1.36000E+01 -6.40000E-05 -5.17050E-05  …      -           1.36000E+01…
-           1.40000E+01 -6.00000E-05 -5.30534E-05  …  -           1.40000E+01…
-           1.44000E+01 -5.60000E-05 -5.44039E-05  …  -           1.44000E+01…
-           1.48000E+01 -5.20000E-05 -5.54605E-05  …  -           1.48000E+01…
-           1.52000E+01 -4.80000E-05 -5.38679E-05  …  -           1.52000E+01…
-           1.56000E+01 -4.40000E-05 -5.22783E-05  …  -           1.56000E+01…
-           1.60000E+01 -4.00000E-05 -5.06917E-05  …  -           1.60000E+01…
-           1.64000E+01 -3.60000E-05 -4.91081E-05  …  -           1.64000E+01…
-           1.68000E+01 -3.20000E-05 -4.75276E-05  …  -           1.68000E+01…
-           1.72000E+01 -2.80000E-05 -4.59671E-05  …  -           1.72000E+01…
-           1.76000E+01 -2.40000E-05 -4.44567E-05  …  -           1.76000E+01…
-           1.80000E+01 -2.00000E-05 -4.29952E-05  …  -           1.80000E+01…
 …          …           …           …           …   …           …     …
```

Ci below, one also presents the contents of the additional table `TABBILA` , recapitulating postprocessings (E/E_{max}) realized at the conclusion of all simulations. Each package of contiguous columns whose titles are indexed by the same entirety (index of the value considered in the list `PRES_CONF`) corresponds to the postprocessings carried out for the same confining pressure.

```
#
#-----------------------------------------------------------------------------
#
#Resultats total: ESSAI_TD_A number 1
#
PRES_CONF_1  EPSI_IMPOSE_1 E_SUR_EMAX_1 PRES_CONF_2  EPSI_IMPOSE_2 E_SUR_EMAX_2
-3.00000E+04   1.00000E-04  4.08330E-01 -5.00000E+04   1.00000E-04  4.30922E-01
-              5.00000E-04  1.72000E-01 -              5.00000E-04  2.05213E-01
-              1.00000E-03  1.13241E-01 -              1.00000E-03  1.38724E-01
-              2.00000E-03  7.38666E-02 -              2.00000E-03  9.14469E-02
-              5.00000E-03  4.33285E-02 -              5.00000E-03  5.32730E-02
```

3.8.5 Operand GRAPH

```
◊    GRAPH    =/('P-Q', 'EPS_AXI-Q', 'EPS_VOL-Q',
                 'EPS_AXI-EPS_VOL', 'P-EPS_VOL',
                              'EPSI-E'),          [DEFECT]
                 / l_typgraph,                       [l_Kn]
```

This operand has the same meaning as for the keyword factor `ESSAI_TD` (§ 3.4.4), only the list of the values by default differs, the graphs available for this test are:

- `'P-Q'`: Deviator of constraints q according to the average pressure.
- `'EPS_AXI-Q'`: diverter q according to the axial deformation.

– `'EPS_VOL-Q'`: diverter q according to the voluminal deformation ϵ_v .
– `'EPS_AXI-EPS_VOL'`: voluminal deformation according to the axial deformation.
– `'P-EPS_VOL'`: voluminal deformation according to the average pressure.
– `'EPSI-E'`: Evolution of the Young modulus according to the double amplitude: $2.\mathrm{EPSI\_IMPOSE}$.

3.8.6 Operand TABLE_REF

```
◊   TABLE_REF = l_tabreF,              [l_table]
```

This operand has the same meaning as for the keyword factor ESSAI_TD (§ 3.4.5).

3.9 Word key ESSAI_TD_NA

This keyword factor (répétable) makes it possible to carry out a series of simulations of the same cyclic drained triaxial compression test nonalternate for which one varies the parameters of loading (confining pressure, imposed axial deformation, and many cycles), post-to treat the got results and to write them in the form of graphs (with the format xmgrace) and/or of tables.

3.9.1 Operands PRES_CONF, EPSI_IMPOSE, NB_CYCLE, NB_INST

```
♦   PRES_CONF   = l_pconf,            [l_R]
♦   EPSI_IMPOSE = l_epsimpo,          [l_R]
♦    NB_CYCLE    = nbcyc,             [I]
◊    NB_INST     =/25,             [DEFECT]
                  / nbinst,           [I]
```

These operands make it possible to define the loading of each simulation to be carried out under the keyword factor running, like its discretization. Their significance is summarized with the figure 3.9.1-a and below detailed:

- `PRES_CONF` allows to define the list of the confining pressures (strictly negative) which will be kept during each test.
- `EPSI_IMPOSE` allows to define the list of the amplitudes (strictly negative) of axial deformation of the imposed cyclic loading.
- `NB_CYCLE` corresponds to the number of cycles, fixed for all simulations.
- `NB_INST` allows to define the temporal discretization of the loading, and corresponds to the number of steps of loading per quarter of cycle

For each confining pressure `PRES_CONF`, as many simulations are carried out as there are elements in the list `EPSI_IMPOSE`. Contrary to the tests TD and TND (see respectively §3.4 and §3.5), these lists are not in bijection and there is on the whole $card(\mathrm{PRES\_CONF}).card(\mathrm{EPSI\_IMPOSE})$ simulations carried out.

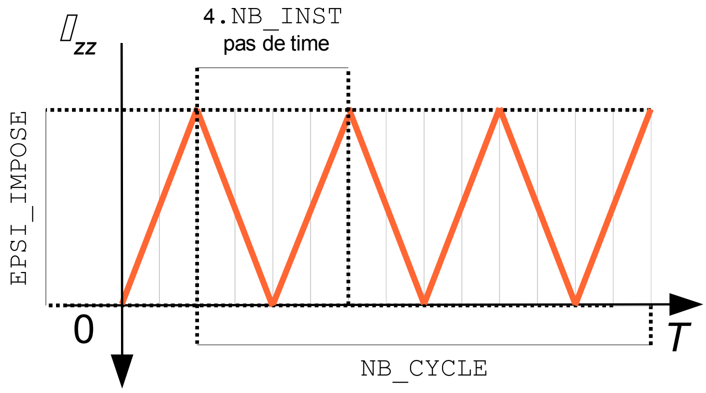

Figure 3.9.1-a: discretization and pace of the loading for the keyword `ESSAI_TD_NA`, for 3 cycles

3.9.2 Operand `EPSI_ELAS`

```
◊    EPSI_ELAS    =/1.E-7,          [DEFECT]
                   / epselas,       [R]
```

For each confining pressure, the cyclic modulus Young are equivalent maximum (i.e. of healthy material) is given by simulating a cycle of nonalternate loading controlled in axial deformation imposed up to the value `EPSI_ELAS`. This value must be such as material remains in its field of elasticity (linear or not, according to the relation of behavior used). `EPSI_ELAS` is worth `1.E-7` by default, and any value indicated by the user must be lower to him. If the well informed value does not make it possible to remain in the field of elasticity, the code stops in fatal error.

3.9.3 Operand `KZERO`

```
◊    KZERO        =/1. ,                      [DEFECT]
                    / kzero,                     [R]
```

Value of the coefficient of the grounds at rest, makes it possible to define an anisotropic state of containment: $\sigma_{xx}=\sigma_{yy}=K_0\sigma_{zz}=K_0\,\mathrm{PRES\_CONF}$

Note: When the value of `KZERO` is well informed different from 1, the real confining pressure of the test is not more `PRES_CONF` , it becomes:

$$P_c=\frac{(1+2.K_0)\,\mathrm{PRES\_CONF}}{3}$$

3.9.4 Operand `TABLE_RESU`

```
◊   TABLE_RESU = l_tabres ,         [l_CO]
```

This operand optional makes it possible to give the list of the names of the concepts produced by the macro-order which will be then of type `[table]` . The size of this list must check:

$$card(\mathrm{TABLE\_RESU})=card(\mathrm{PRES\_CONF})+1$$

Indeed, each produced table gathers the gross profits of all the simulations carried out for the same confining pressure (`PRES_CONF`), in which each simulation corresponds to a package of contiguous columns whose titles all are indexed by the same entirety (index of the value considered in the list `EPSI_IMPOSE`). An additional table recapitulating the postprocessings carried out at the conclusion of all simulations is also produced. This table contains for each confining pressure (`PRES_CONF`) This table contains for each confining pressure (`PRES_CONF`) values of the Young modulus cyclic standardized equivalent E/E_{max} for the last simulated cycle, in with respect to the imposed amplitudes of deformation (`EPSI_IMPOSE`). E and E_{max} are calculated in the following way:

$$E=\left|\frac{\Delta q}{\Delta \epsilon_a}\right|$$

with: $\Delta q=q_{max}-q_{min}$ and $\Delta \epsilon_a=\epsilon_{a,max}-\epsilon_{a,min}$
This table corresponds in the name of concept given in last position in the list `TABLE_RESU` . Extracts of these tables are presented in the example below.

Example:

```
TABRES1=CO ('TRES1')
TABRES2=CO ('TRES2')
TABBILA=CO ('TBILA')

CALC_ESSAI_GEOMECA (
   …
   ESSAI_TD_CA = _F ( PRES_CONF   = (- 3.E4, - 5.E4),
   EPSI_IMPOSE = (- 1.E-4, - 5.E-4, - 1.E-3, - 2.E-3, - 5.E-3),
   NB_CYCLE    = 3,
   TABLE_RESU  = (TABRES1, TABRES2, TABBILA), ),
   …
                  );
```

The table below specifies for this example the results of simulations contained in the tables `TABRES1` and `TABRES2` , as well as the order in which these tables are filled out.

EPSI_IMPOSE / PRES_CONF	-1.E-4	-5.E-4	-1.E-3	-2.E-3	-5.E-3
-3.E4	TABRES1	TABRES1	TABRES1	TABRES1	TABRES1
-5.E4	TABRES2	TABRES2	TABRES2	TABRES2	TABRES2

An extract of the table below is presented `TABRES1` containing the gross profits of the simulations carried out for the first value of `PRES_CONF`.

```
#
#---------------------------------------------------------------------------
#
#Resultats rough: ESSAI_TD_NA number 1/PRES_CONF = -3.000000E+04
#
EPSI_IMPOSE_1 INST_1       EPS_AXI_1    …      Q_1         EPSI_IMPOSE_2 INST_2       EPS_AXI_2        …
 -1.00000E-04  0.00000E+00  0.00000E+00… 0.00000E+00  -5.00000E-04  0.00000E+00  0.00000E+00      …
 -             4.00000E-01 -2.00000E-06… -1.31868E+02  -             4.00000E-01 -1.00000E-05     …
 -             8.00000E-01 -4.00000E-06… -2.63773E+02  -             8.00000E-01 -2.00000E-05     …
 -             1.20000E+00 -6.00000E-06… -3.83349E+02  -             1.20000E+00 -3.00000E-05     …
 -             1.60000E+00 -8.00000E-06… -5.01328E+02  -             1.60000E+00 -4.00000E-05     …
 -             2.00000E+00 -1.00000E-05… -6.19314E+02  -             2.00000E+00 -5.00000E-05     …
 -             2.40000E+00 -1.20000E-05… -7.37316E+02  -             2.40000E+00 -6.00000E-05     …
 -             2.80000E+00 -1.40000E-05… -8.55333E+02  -             2.80000E+00 -7.00000E-05     …
 -             3.20000E+00 -1.60000E-05… -9.73365E+02  -             3.20000E+00 -8.00000E-05     …
 -             3.60000E+00 -1.80000E-05… -1.09142E+03  -             3.60000E+00 -9.00000E-05     …
 -             4.00000E+00 -2.00000E-05… -1.20948E+03  -             4.00000E+00 -1.00000E-04     …
```

```
 -          4.40000E+00 -2.20000E-05… -1.32756E+03  -          4.40000E+00 -1.10000E-04    …
 -          4.80000E+00 -2.40000E-05… -1.44566E+03  -          4.80000E+00 -1.20000E-04    …
 -          5.20000E+00 -2.60000E-05… -1.56377E+03  -          5.20000E+00 -1.30000E-04    …
 -          5.60000E+00 -2.80000E-05… -1.68190E+03  -          5.60000E+00 -1.40000E-04    …
 -          6.00000E+00 -3.00000E-05… -1.80004E+03  -          6.00000E+00 -1.50000E-04    …
 -          6.40000E+00 -3.20000E-05… -1.91819E+03  -          6.40000E+00 -1.60000E-04    …
 -          6.80000E+00 -3.40000E-05… -2.03636E+03  -          6.80000E+00 -1.70000E-04    …
 -          7.20000E+00 -3.60000E-05… -2.15454E+03  -          7.20000E+00 -1.80000E-04    …
 -          7.60000E+00 -3.80000E-05… -2.27274E+03  -          7.60000E+00 -1.90000E-04    …
 -          8.00000E+00 -4.00000E-05… -2.39096E+03  -          8.00000E+00 -2.00000E-04    …
 -          8.40000E+00 -4.20000E-05… -2.50919E+03  -          8.40000E+00 -2.10000E-04    …
 -          8.80000E+00 -4.40000E-05… -2.62744E+03  -          8.80000E+00 -2.20000E-04    …
 -          9.20000E+00 -4.60000E-05… -2.74570E+03  -          9.20000E+00 -2.30000E-04    …
 -          9.60000E+00 -4.80000E-05… -2.86398E+03  -          9.60000E+00 -2.40000E-04    …
 -          1.00000E+01 -5.00000E-05… -2.98068E+03  -          1.00000E+01 -2.50000E-04    …
 -          1.04000E+01 -5.20000E-05… -3.09519E+03  -          1.04000E+01 -2.60000E-04    …
 -          1.08000E+01 -5.40000E-05… -3.20767E+03  -          1.08000E+01 -2.70000E-04    …
 -          1.12000E+01 -5.60000E-05… -3.31820E+03  -          1.12000E+01 -2.80000E-04    …
 -          1.16000E+01 -5.80000E-05… -3.42689E+03  -          1.16000E+01 -2.90000E-04    …
 -          1.20000E+01 -6.00000E-05… -3.53382E+03  -          1.20000E+01 -3.00000E-04    …
 -          1.24000E+01 -6.20000E-05… -3.63908E+03  -          1.24000E+01 -3.10000E-04    …
 -          1.28000E+01 -6.40000E-05… -3.74272E+03  -          1.28000E+01 -3.20000E-04    …
 -          1.32000E+01 -6.60000E-05… -3.84486E+03  -          1.32000E+01 -3.30000E-04    …
 -          1.36000E+01 -6.80000E-05… -3.94553E+03  -          1.36000E+01 -3.40000E-04    …
 -          1.40000E+01 -7.00000E-05… -4.04480E+03  -          1.40000E+01 -3.50000E-04    …
 -          1.44000E+01 -7.20000E-05… -4.14272E+03  -          1.44000E+01 -3.60000E-04    …
 -          1.48000E+01 -7.40000E-05… -4.23935E+03  -          1.48000E+01 -3.70000E-04    …
 -          1.52000E+01 -7.60000E-05… -4.33473E+03  -          1.52000E+01 -3.80000E-04    …
 -          1.56000E+01 -7.80000E-05… -4.42892E+03  -          1.56000E+01 -3.90000E-04    …
 -          1.60000E+01 -8.00000E-05… -4.52195E+03  -          1.60000E+01 -4.00000E-04    …
 -          1.64000E+01 -8.20000E-05… -4.61387E+03  -          1.64000E+01 -4.10000E-04    …
 -          1.68000E+01 -8.40000E-05… -4.70471E+03  -          1.68000E+01 -4.20000E-04    …
 -          1.72000E+01 -8.60000E-05… -4.79452E+03  -          1.72000E+01 -4.30000E-04    …
 -          1.76000E+01 -8.80000E-05… -4.88332E+03  -          1.76000E+01 -4.40000E-04    …
 -          1.80000E+01 -9.00000E-05… -4.97116E+03  -          1.80000E+01 -4.50000E-04    …
 -          1.84000E+01 -9.20000E-05… -5.05805E+03  -          1.84000E+01 -4.60000E-04    …
  …        …        …        …        …          …        …                  …
```

Ci below, one also presents the contents of the additional table TABBILA , recapitulating postprocessings (E/E_{max}) realized at the conclusion of all simulations. Each package of contiguous columns whose titles are indexed by the same entirety (index of the value considered in the list PRES_CONF) corresponds to the postprocessings carried out for the same confining pressure.

```
#
#----------------------------------------------------------------------------
#
#Resultats total: ESSAI_TD_NA number 1
#
PRES_CONF_1  EPSI_IMPOSE_1 E_SUR_EMAX_1 PRES_CONF_2  EPSI_IMPOSE_2 E_SUR_EMAX_2
-3.00000E+04  -1.00000E-04  5.98636E-01 -5.00000E+04  -1.00000E-04  5.86002E-01
-             -5.00000E-04  2.82428E-01 -             -5.00000E-04  3.14085E-01
-             -1.00000E-03  2.02984E-01 -             -1.00000E-03  2.35722E-01
-             -2.00000E-03  1.42482E-01 -             -2.00000E-03  1.70079E-01
-             -5.00000E-03  8.65818E-02 -             -5.00000E-03  1.04653E-01
```

3.9.5 Operand GRAPH

```
◊   GRAPH   =/('P-Q', 'EPS_AXI-Q', 'EPS_VOL-Q',
                 'EPS_AXI-EPS_VOL', 'P-EPS_VOL',
                           'EPSI-E'),            [DEFECT]
                 / l_typgraph,                   [l_Kn]
```

This operand has the same meaning as for the keyword factor ESSAI_TD (§ 3.4.4), only the list of the values by default differs, the graphs available for this test are:

- 'P-Q': Deviator of constraints according to the average pressure.
- 'EPS_AXI-Q': diverter of constraints according to the axial déformaton.
- 'EPS_VOL-Q': diverter of constraints according to the voluminal deformation.
- 'EPS_AXI-EPS_VOL': voluminal deformation according to the axial deformation.
- 'P-EPS_VOL': voluminal deformation according to the pressure.
- 'EPSI-E': Evo lution of the Young modulus according to the imposed axial deformation: EPSI_IMPOSE .

Note: For this test, the graph '_EPSI_- E'_has as a X-coordinate $\varepsilon_{a,impose}$

3.9.6 Operand TABLE_REF

```
◊   TABLE_REF = l_tabreF,              [l_table]
```

This operand has the same meaning as for the keyword factor ESSAI_TD (§ 3.4.5).

3.10 Word key ESSAI_OEDO_C

This keyword factor (répétable) makes it possible to carry out a series of simulations of the same drained test oedometric cyclic for which one varies the parameters of loading (pressure of initial isotropic consolidation, amplitude of imposed axial effective constraint, and amplitude of axial effective constraint at the end of the discharge), post-to treat the got results and to write them in the form of graphs (with the format xmgrace) and/or of tables.

3.10.1 Operands PRES_CONF, SIGM_IMPOSE, NB_CYCLE, NB_INST

```
♦   PRES_CONF   = l_pconf,            [l_R]
♦   SIGM_IMPOSE = l_sigimpo,          [l_R]
♦   SIGM_DECH = l_sigdech,            [l_R]
◊    NB_INST     =/25,              [DEFECT]
                  / nbinst,           [I]
```

These operands make it possible to define the loading of each simulation to be carried out under the keyword factor running, like its discretization. Their significance is summarized with the figure 3.10.1-a and below detailed:

- PRES_CONF allows to define the list of the isotropic initial pressures of consolidation (strictly negative) describing the initial consolidation of the ground.
- SIGM_IMPOSE allows to define the list of the amplitudes (strictly negative) of axial effective constraint of the loading imposed.
- SIGM_DECH allows to define the list of the values (strictly negative) of the axial effective constraint at the end of the discharge, fixed for all the cycles of loading, with a pressure of initial consolidation given. Lists PRES_CONF and SIGM_DECH must have the same cardinal.
- NB_INST allows to define the temporal discretization of the loading, and corresponds to the number of steps of loading per half of cycle.

For each pressure of initial consolidation PRES_CONF, and each constraint of discharge SIGM_DECH, as many cycles are carried out as there are elements in the list SIGM_IMPOSE. Contrary to the tests TD and TND (see respectively §3.4 and §3.5), these lists are not in bijection and there is on the whole $card(\text{PRES\_CONF})$ simulations carried out, each simulation comprising $card(\text{SIGM\_IMPOSE})$ cycles.

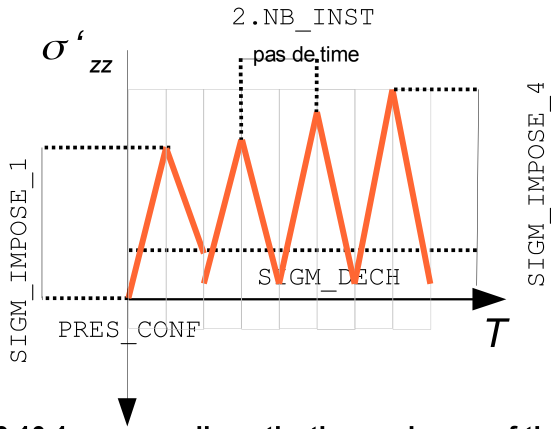

Figure 3.10.1-a : discretization and pace of the loading for the keyword `ESSAI_OEDO_C` , for 4 cycles

3.10.2 Operand `KZERO`

```
◊    KZERO        =/1. ,                          [DEFECT]
                    / kzero,                          [R]
```

Value of the coefficient of the grounds at rest, makes it possible to define an anisotropic state of containment: $\sigma_{xx}=\sigma_{yy}=K_0\sigma_{zz}=K_0\,\text{PRES\_CONF}$

3.10.3 Operand `TABLE_RESU`

```
◊   TABLE_RESU = l_tabres ,          [l_CO]
```

This operand optional makes it possible to give the list of the names of the concepts produced by the macro-order which will be then of type `[table]` . The size of this list must check:

$$card(\text{TABLE\_RESU})=card(\text{PRES\_CONF})$$

Indeed, each produced table gathers the gross profits of the simulation carried out for the same pressure of initial consolidation (`PRES_CONF`) and the same value of constraint at the end of the discharge (`SIGM_DECH`), each cycle of this simulation corresponds to a value (`SIGM_IMPOSE`).

```
TABRES1=CO ('TRES1')
TABRES2=CO ('TRES2')


CALC_ESSAI_GEOMECA (
    …
     ESSAI_OEDO_C = _F (PRES_CONF   = (- 1.E5, - 2.E5,),
                        SIGM_IMPOSE = (- 3.E5, - 4.E5, - 5.E5,),
                        SIGM_DECH   = (- 2.E5, - 3.E5,),
    …
                  );
```

The table below specifies for this example the results of simulations contained in the tables `TABRES1 and TABRES2`, as well as the order in which these tables are filled out.

<table>
<tr><th colspan="2">SIGM_IMPOSE</th><th rowspan="2">-3.E5</th><th rowspan="2">-4.E5</th><th rowspan="2">-5.E5</th></tr>
<tr><th>PRES_CONF</th><th>SIGM_DECH</th></tr>
<tr><td>-1.E5</td><td>-2.E5</td><td>TABRES1</td><td>TABRES1</td><td>TABRES1</td></tr>
<tr><td>-2.E5</td><td>-3.E5</td><td>TABRES2</td><td>TABRES2</td><td>TABRES2</td></tr>
</table>

An extract of the table below is presented `TABRES2` containing the gross profits of the simulations carried out for the second value of `PRES_CONF, and of SIGM_DECH`

```
#
#------------------------------------------------------------------------------
#
# ESSAI_OEDO_C number 1/PRES_CONF = -2.000000E+05/SIGM_DECH = -3.000000E+05
#
SIGM_IMPOSE_2 INST_2       EPS_VOL_2    P_2          SIG_AXI_2    SIG_LAT_2
-3.00000E+05  0.00000E+00  0.00000E+00 -2.00000E+05 -2.00000E+05 -2.00000E+05
-3.00000E+05  4.00000E-01 -7.39723E-05 -2.01077E+05 -2.12000E+05 -1.95616E+05
-3.00000E+05  8.00000E-01 -1.75678E-04 -2.02549E+05 -2.24000E+05 -1.91824E+05
-3.00000E+05  1.20000E+00 -3.18644E-04 -2.04590E+05 -2.36000E+05 -1.88885E+05
-3.00000E+05  1.60000E+00 -4.99908E-04 -2.07143E+05 -2.48000E+05 -1.86714E+05
-3.00000E+05  2.00000E+00 -7.15464E-04 -2.10149E+05 -2.60000E+05 -1.85224E+05
-3.00000E+05  2.40000E+00 -9.61164E-04 -2.13554E+05 -2.72000E+05 -1.84332E+05
-3.00000E+05  2.80000E+00 -1.23276E-03 -2.17306E+05 -2.84000E+05 -1.83959E+05
-3.00000E+05  3.20000E+00 -1.52656E-03 -2.21361E+05 -2.96000E+05 -1.84041E+05
-3.00000E+05  3.60000E+00 -1.83869E-03 -2.25674E+05 -3.08000E+05 -1.84511E+05
-3.00000E+05  4.00000E+00 -2.16608E-03 -2.30211E+05 -3.20000E+05 -1.85317E+05
 …            …            …            …            …             …
 …            …            …            …            …             …
 …            …            …            …            …             …
-3.00000E+05  2.00000E+01 -6.04300E-03 -2.76465E+05 -3.00000E+05 -2.64698E+05
-4.00000E+05  2.04000E+01 -6.11132E-03 -2.80404E+05 -3.16000E+05 -2.62606E+05
-4.00000E+05  2.08000E+01 -6.19529E-03 -2.81924E+05 -3.32000E+05 -2.56886E+05
-4.00000E+05  2.12000E+01 -6.28651E-03 -2.83575E+05 -3.48000E+05 -2.51363E+05
-4.00000E+05  2.16000E+01 -6.39457E-03 -2.85529E+05 -3.64000E+05 -2.46293E+05
-4.00000E+05  2.20000E+01 -6.51836E-03 -2.87762E+05 -3.80000E+05 -2.41643E+05
-4.00000E+05  2.24000E+01 -6.65666E-03 -2.90254E+05 -3.96000E+05 -2.37381E+05
-4.00000E+05  2.28000E+01 -6.80833E-03 -2.92984E+05 -4.12000E+05 -2.33476E+05
-4.00000E+05  2.32000E+01 -6.97209E-03 -2.95933E+05 -4.28000E+05 -2.29900E+05
 …            …            …            …            …             …
 …            …            …            …            …             …
 …            …            …            …            …             …
-4.00000E+05  3.96000E+01 -1.01176E-02 -3.27727E+05 -3.16000E+05 -3.33591E+05
-4.00000E+05  4.00000E+01 -9.76282E-03 -3.20137E+05 -3.00000E+05 -3.30206E+05
-5.00000E+05  4.04000E+01 -9.84598E-03 -3.24672E+05 -3.20000E+05 -3.27007E+05
-5.00000E+05  4.08000E+01 -9.94584E-03 -3.26579E+05 -3.40000E+05 -3.19868E+05
-5.00000E+05  4.12000E+01 -1.00631E-02 -3.28816E+05 -3.60000E+05 -3.13225E+05
-5.00000E+05  4.16000E+01 -1.02034E-02 -3.31485E+05 -3.80000E+05 -3.07228E+05
  …            …            …            …            …             …
```

3.10.4 Operand **GRAPH**

```
◊    GRAPH =/('P-EPS_VOL', 'SIG_AXI-EPS_VOL')   [DEFECT]
                          / l_typgraph,                      [l_Kn]
```

This operand has the same meaning as for the keyword factor `ESSAI_TD` (§ 3.4.4), only the list of the values by default differs, them graph available for this test are:

- `'P-EPS_VOL'` : voluminal deformation according to the average pressure.
- `'SIG_AXI-EPS_VOL'` : voluminal deformation according to axial stress.

3.10.5 Operand **TABLE_REF**

```
◊   TABLE_REF = l_tabreF,              [l_table]
```

This operand has the same meaning as for the keyword factor `ESSAI_TD` (§3.4.5).

3.11 Word key ESSAI_ISOT_C

This keyword factor (répétable) makes it possible to carry out a series of simulations of the same test of cyclic drained isotropic compression for which one varies the parameters of loading (pressure of initial isotropic consolidation, amplitude of effective constraint isotropic imposed, and isotropic amplitude of constraint of discharge), post-to treat the got results and to write them in the form of graphs (with the format xmgrace) and/or of tables.

3.11.1 Operands PRES_CONF, SIGM_IMPOSE, NB_CYCLE, NB_INST

```
♦   PRES_CONF    = l_pconf,            [l_R]
♦   SIGM_IMPOSE = l_sigimpo,           [l_R]
♦   SIGM_DECH = l_sigdech,             [l_R]
◊    NB_INST      =/25,              [DEFECT]
                   / nbinst,           [I]
```

These operands make it possible to define the loading of each simulation to be carried out under the keyword factor running, like its discretization. Their significance is summarized with the figure 3.9.1-a and below detailed:

- PRES_CONF allows to define the list of the isotropic initial pressures of consolidation (strictly negative) describing the initial consolidation of the ground.
- SIGM_IMPOSE allows to define the list of the amplitudes (strictly negative) of isotropic effective constraint imposed for each cycle.
- SIGM_DECH allows to define the list of the values (strictly negative) of the isotropic effective constraint at the end of the discharge, fixed for all the cycles of loading, with a pressure of initial consolidation given. Lists PRES_CONF and SIGM_DECH must have the same cardinal.
- NB_INST allows to define the temporal discretization of the loading, and corresponds to the number of steps of loading per half of cycle.

For each pressure of initial consolidation PRES_CONF, and each constraint of discharge SIGM_DECH, as many cycles are carried out as there are elements in the list SIGM_IMPOSE. Contrary to the tests TD and TND (see respectively §3.4 and §3.5), these lists are not in bijection and there is on the whole $card(\mathrm{PRES\_CONF})$ simulations carried out, each simulation comprising $card(\mathrm{SIGM\_IMPOSE})$ cycle.

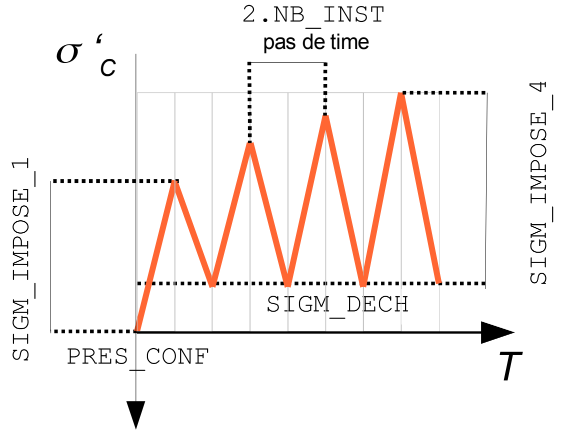

Figure 3.11.1-a: discretization and pace of the loading for the keyword ESSAI_ISOT_C, for 4 cycles

3.11.2 Operand KZERO

```
◊    KZERO        =/1. ,                       [DEFECT]
                    / kzero,                       [R]
```

Value of the coefficient of the grounds at rest, makes it possible to define an anisotropic state of containment: $\sigma_{xx}=\sigma_{yy}=K_0\sigma_{zz}=K_0\,\mathrm{PRES\_CONF}$

Note: When the value of KZERO is well informed different from 1, the real confining pressure of the test is not more PRES_CONF , it becomes:

$$P_c=\frac{(1+2.\mathrm{K}_0)\,\mathrm{PRES\_CONF}}{3}$$

The test becomes test of compression anistrope.

3.11.3 Operand TABLE_RESU

```
◊   TABLE_RESU = l_tabres ,        [l_CO]
```

This operand optional makes it possible to give the list of the names of the concepts produced by the macro-order which will be then of type [table] . The size of this list must check:

$$card(\mathrm{TABLE\_RESU})=card(\mathrm{PRES\_CONF})$$

Indeed, each produced table gathers the gross profits of the simulation carried out for the same pressure of initial consolidation (PRES_CONF) and the same value of constraint of discharge (SIGM_DECH), each cycle of this simulation corresponds to a value (SIGM_IMPOSE) .

```
TABRES1=CO ('TRES1')
TABRES2=CO ('TRES2')


CALC_ESSAI_GEOMECA (
   …
    ESSAI_ISOT_C = _F (PRES_CONF   = (- 1.E5, - 2.E5,),
                       SIGM_IMPOSE = (- 3.E5, - 4.E5, - 5.E5,),
                       SIGM_DECH   = (- 3.E5, - 4.E5,),

   …
                  );
```

The table below specifies for this example the results of simulations contained in the tables TABRES1 and TABRES2, as well as the order in which these tables are filled out.

SIGM_IMPOSE →		-3.E5	-4.E5	-5.E5
PRES_CONF ↓	SIGM_DECH ↓			
-1.E5	-3.E5	TABRES1	TABRES1	TABRES1
-2.E5	-4.E5	TABRES2	TABRES2	TABRES2

An extract of the table below is presented `TABRES2` containing the gross profits of the simulations carried out for the second value of `PRES_CONF` and of `SIGM_DECH`.

```
#
#-----------------------------------------------------------------------------
#
# ESSAI_ISOT_C number 1/PRES_CONF = -2.000000E+05/SIGM_DECH = -4.000000E+05
#
SIGM_IMPOSE_2 INST_2       EPS_VOL_2    P_2          Q_2
-3.00000E+05  0.00000E+00  0.00000E+00 -2.00000E+05  0.00000E+00
-3.00000E+05  4.00000E-01 -8.18931E-04 -2.12000E+05  5.82077E-11
-3.00000E+05  8.00000E-01 -1.62624E-03 -2.24000E+05  5.82077E-11
-3.00000E+05  1.20000E+00 -2.42215E-03 -2.36000E+05  1.16415E-10
-3.00000E+05  1.60000E+00 -3.20689E-03 -2.48000E+05  5.82077E-11
-3.00000E+05  2.00000E+00 -3.98066E-03 -2.60000E+05  2.91038E-11
-3.00000E+05  2.40000E+00 -4.74370E-03 -2.72000E+05  5.82077E-11
-3.00000E+05  2.80000E+00 -5.49620E-03 -2.84000E+05  1.16415E-10
-3.00000E+05  3.20000E+00 -6.23839E-03 -2.96000E+05  4.07454E-10
-3.00000E+05  3.60000E+00 -6.97045E-03 -3.08000E+05  5.82077E-11
-3.00000E+05  4.00000E+00 -7.69262E-03 -3.20000E+05  0.00000E+00
 …          …          …          …            …
 …          …          …          …            …
 …          …          …          …            …
-3.00000E+05  1.96000E+01 -1.32148E-02 -4.04000E+05  1.16415E-10
-3.00000E+05  2.00000E+01 -1.30199E-02 -4.00000E+05  5.82077E-11
-4.00000E+05  2.04000E+01 -1.36315E-02 -4.16000E+05  1.74623E-10
-4.00000E+05  2.08000E+01 -1.43845E-02 -4.32000E+05  2.32831E-10
-4.00000E+05  2.12000E+01 -1.51269E-02 -4.48000E+05  1.74623E-10
…          …          …          …            …
…          …          …          …            …
…          …          …          …            …
-4.00000E+05  4.00000E+01 -1.42415E-02 -4.00000E+05  5.82077E-11
-5.00000E+05  4.04000E+01 -1.50378E-02 -4.20000E+05  1.74623E-10
-5.00000E+05  4.08000E+01 -1.59739E-02 -4.40000E+05  5.82077E-11
-5.00000E+05  4.12000E+01 -1.68935E-02 -4.60000E+05  5.82077E-11
  …          …          …          …            …
```

3.11.4 Operand GRAPH

```
◊    GRAPH =/('P-EPS_VOL')              [DEFECT]
             / l_typgraph,                    [l_Kn]
```

This operand has the same meaning as for the keyword factor `ESSAI_TD` (§ 3.4.4), only the list of the values by default differs, the graph available for this test is:
- `'P-EPS_VOL'`: voluminal deformation according to the average pressure.

3.11.5 Operand TABLE_REF

```
◊   TABLE_REF = l_tabreF,              [l_table]
```

This operand has the same meaning as for the keyword factor `ESSAI_TD` (§3.4.5).