Definition of a stress field and of a field of internal variables initial

Summary:

It is explained how to manufacture two of the fields constituting the initial state of a non-linear calculation (STAT_NON_LINE) : the stress field and the field of internal variables.

- the components of the stress field have an “analytical” form (for example: state of a ground subjected to the “weight of the grounds”),
- the components of the field of internal variables are constant the nonworthless ones.

In both cases, the solution consists in connecting a certain number of orders CREA_CHAMP.

For the stress field, the difficulty consists in evaluating the “analytical formulas” (OPERATION=' EVAL').
For the field of internal variables, the difficulty comes owing to the fact that size associated with the internal variables (VARI_R) has a number a priori unspecified of components : ‘V1’, ‘V2’,…

The suggested solutions are put in work in the test ZZZZ130A.

1 Definition of the analytical stress field

It is supposed that the model contains finite elements of continuous medium (`MODELISATION=' 3D'`). It is wanted that in each point of Gauss, the components of the constraints have the following expressions:

```
SIZZ = RHO*G*Z
SIXX = SIYY = KP*SIZZ
```

where:
`RHO` : density
`G` : acceleration of gravity
`Z` : 3rd coordinate of space
`KP` : coefficient of "pushed" of the grounds

The suggested solution consists with:

1) to define three functions "formulas" corresponding to `SIXX`, `SIYY` and `SIZZ`,
2) to constitute a field whose components are the preceding functions,
3) to evaluate the formulas of the field by providing him the field of geometry necessary to their evaluation.

1.1 Stage 1: to define the formulas

```
RHO=1000.
G=10.
KP=3.

SIZZ = FORMULA (REEL= """ (REAL: Z) = RHO*G*Z   """)
SIXX = FORMULA (REEL= """ (REAL: Z) = KP*SIZZ (Z)   """)
SIYY = FORMULA (REEL= """ (REAL: Z) = KP*SIZZ (Z)   """)
```

1.2 Stage 2: to create the field of formulas SIG1

```
SIG1=CRÉA_CHAMP (OPERATION=' AFFE', TYPE_CHAM=' ELGA_NEUT_F',
                 MODELE=MO,  PROL_ZERO=' OUI',
      AFFE=_F (ALL = 'YES', NOM_CMP = ('X1', 'X2', 'X3',),
                              VALE_F  = (SIXX, SIYY, SIZZ,)))
```

Remarks

- *the field `SIG1` that one creates is one `cham_elem` at the points of Gauss (`ELGA`),*
- *the only fields being able to have components of the type "functions" are the fields of the size `NEUT_F` . It will thus have to be remembered that the component `'X1'` of `SIG1` is actually `'SIXX'` , etc…,*
- *the keyword `PROL_ZERO=' OUI'` is obligatory because for all the types of element, them `cham_elem_NEUT_R` currently 6 components have: `'X1'` , `'X2'` ,…, `'X6'` . It is thus necessary to agree "to prolong" by zero the field out of the 3 nonaffected components. The prolongation by "zero" for a field whose components are texts (names of the functions) consists in assigning the chain" "to each component absent from the field. Attention thus, it does not act of a worthless function. One can note it while using `INFO=2` to print the field `SIG1` .*

1.3 Stage 3: to evaluate the formulas of the field SIG1

The field SIG1 is a field known at the points of Gauss of the elements of the model. In each point, one will want to evaluate the functions SIXX, SIYY and SIZZ. For that, it is necessary to have the values of all the variables appearing in the functions (here Z). These variables must be known on the same points as the field of functions. It is thus necessary to have a field containing the geometry of the points of Gauss (cham_elem_GEOM_R / ELGA).

This field of geometry of the points of Gauss (CHXG) is obtained starting from the grid (MY) by the 2 following orders:

```
CHXN=CRÉA_CHAMP (OPERATION=' EXTR', TYPE_CHAM=' NOEU_GEOM_R',
      NOM_CHAM=' GEOMETRIE', MAILLAGE=MA)

CHXG=CRÉA_CHAMP (OPERATION=' DISC', TYPE_CHAM=' ELGA_GEOM_R',
      MODELE=MO,   CHAM_GD=CHXN
```

The first order extracts the field from geometry (with the nodes) of the grid. The second transforms the field of geometry to the nodes into a field of geometry at the points of Gauss by using the functions of form of the finite elements of the model.

One can then evaluate the functions thanks to the operator CREA_CHAMP / OPERATION=' EVAL' :

```
SIG2=CRÉA_CHAMP (OPERATION=' EVAL', TYPE_CHAM=' ELGA_NEUT_R',
      MODELE=MO, CHAM_F=SIG1,  CHAM_PARA= (CHXG,)   )
```

The field (SIG2) obtained by evaluation of a field of the size NEUT_F is a field of the size NEUT_R whose components have the same names as the components of NEUT_F : 'X1', 'X2',..., 'X6'.

Caution:

Components 'X4' , 'X5' , 'X6' (actually they are indefinite contain the largest possible reality), because they correspond to a non-existent function.

It still remains to change the size of the field SIG2 (NEUT_R - > SIEF_R) to finish the manufacturing of our analytical stress field:

```
SIGINI=CRÉA_CHAMP (OPERATION=' ASSE', TYPE_CHAM=' ELGA_SIEF_R',
      MODELE=MO,  PROL_ZERO=' OUI',
      ASSE=_F (ALL = 'YES',   CHAM_GD = SIG2,
            NOM_CMP = ('X1',  'X2',  'X3',),
            NOM_CMP_RESU = ('SIXX', 'SIYY', 'SIZZ',)))
```

Note:

- *only components 'X1' , 'X2' and 'X3' field SIG2 are recopied in this operation to give the components 'SIXX' , 'SIYY' , 'SIZZ' field SIGINI . This stress field must also contain the components related to shearings ('SIXY' , 'SIYZ' , 'SIXZ'). To obtain them (with a zero value), it is necessary to use the prolongation by zero (PROL_ZERO=' OUI'),*
- *handling made to obtain the worthless components of shearing, would have been simpler if there were explicitly affected on these 3 components a worthless function. One would not have had "to play" with the prolongations. But one would have profited from coincidence that the sizes SIEF_R and NEUT_R have all the two 6 components for cham_elem (ELGA) on the elements of the model.*

2 Definition of the field of internal variables not no one

2.1 Problem

One wants to create a field of initial internal variables for the order `STAT_NON_LINE`. This field should not be null everywhere. More precisely, one wants:

```
STAT_NON_LINE:
    COMPORTEMENT= (_F (GROUP_MA=' MASSIF', RELATION = 'CJS'),
                _F (GROUP_MA=' BETON', RELATION = 'ENDO_LOCAL'),),
```

for the relation of behavior `'CJS'` (16 internal variables), one wants to affect:

```
V1 = 1.0   and  V9 = 9.0
```

for the relation of behavior `'ENDO_LOCAL'` (2 internal variables), one wants to affect:

```
V2 = 2.0
```

2.2 1st method

The operator to be used is `CREA_CHAMP/OPERATION=' AFFE'`. It makes it possible to affect (by mesh or `GROUP_MA`) the values which one wishes. The difficulty comes owing to the fact that size associated with the internal variables (`VARI_R`) is different from the different one: one does not know a priori which are its components. Moreover the name of its components translates this ignorance: `'V1'`, `'V2'`,…
According to the behavior which the user will choose in `STAT_NON_LINE`, the number of internal variables changes. In our example, the behavior `'CJS'` require 16 variables whereas `'ENDO_LOCAL'` uses only 2 of them.

The operation of assignment is done in the following way:

```
VAIN1=CRÉA_CHAMP (OPERATION=' AFFE', TYPE_CHAM=' ELGA_VARI_R',
      MODELE=MO, PROL_ZERO=' OUI',
      AFFE= (
        _F (GROUP_MA= 'CONCRETE', NOM_CMP= 'V2', VALE = 2.),
        _F (GROUP_MA= 'MASSIVE',
             NOM_CMP= ('V1', 'V9', 'V16',),
             VALE =     (1. ,  9. ,   0. ,)),
   )
)
```

Important remarks:

- *The keyword `PROL_ZERO=' OUI'` allows to affect only the nonworthless components. But as the order is not aware amongst internal variables ranges by the meshs, it is based on the affected number highest.*
  In the example above, on the group ' `MASSIF'` , it is important to affect `'V16'` (here to 0.) so that the field has 16 components.
- *It is mportant for the non-linear calculation which will follow that the field of internal variables is coherent with the behaviors which one will choose. I*
  Here, it is necessary that the meshs of the group `'CONCRETE'` 2 internal variables (and only 2) and those of the group have `'MASSIVE'` in 16 have.

Caution:

If the model comprises other types of behavior (for which one does not wish to initialize the field with nonworthless values), it is also necessary to affect zero values explicitly to them. This disadvantage (to have to know ALL the behaviors used and their number of internal variables) can be raised below with the 2nd method (but it is more complicated).

2.3 2nd method

This method (more complicated) makes it possible to affect explicitly only the meshs which have nonworthless components.

The problem is to obtain a field containing a good amount of internal variables for each mesh according to the behavior which will be affected for him in STAT_NON_LINE. To solve this problem, one will carry out a fictitious non-linear calculation (with the real behaviors). The field of internal variables product will be then a “model” good of field.

One will thus make:

1) fictitious non-linear calculation => UBID
2) extraction of the field of internal variables (VBID) result UBID
3) assignment of the nonworthless values in the field VAIN2
4) zero setting of VBID + overload of the values of VAIN2 to produce the result VAIN22

2.3.1 Fictitious non-linear calculation

```
BETON=DEFI_MATERIAU (ELAS=_F (E = 20000. , NAKED = 0.),
               ECRO_LINE=_F (  SY = 6. , D_SIGM_EPSI = -10000.)  )

 MASSIF=DEFI_MATERIAU (    ELAS=_F (  E = 35.E3, NAKED = 0.15),
     CJS=_F (  BETA_CJS = -0.55, GAMMA_CJS = 0.82, PA = -100.0,
                RM = 0,289, N_CJS = 0.6, KP = 25.5E3, RC = 0,265, A_CJS =
0.25,))

CHMAT=AFFE_MATERIAU (  MAILLAGE=MA, AFFE= (
       _F (GROUP_MA = ‘MASSIVE’, MATER = MASSIVE),
       _F (GROUP_MA = ‘CONCRETE’, MATER = CONCRETE),))

TEMPS1=DEFI_LISTE_REEL (  VALE= (0. , 1.) )
CHAR_U1=AFFE_CHAR_MECA (MODELE=MO,
         DDL_IMPO=_F (NODE = (‘N1’, ‘N2’, ‘N3’,), DX=0., DY=0., DZ=0.) )

UBID=STAT_NON_LINE (MODELE=MO, CHAM_MATER=CHMAT,
       EXCIT= _F (LOAD = CHAR_U1,),
       COMPORTEMENT= (_F (GROUP_MA=' MASSIF', RELATION = ‘CJS’),
                     _F (GROUP_MA=' BETON', RELATION = ‘ENDO_LOCAL’),),
       NEWTON=_F (  MATRIX = ‘ELASTIC’),
       CONVERGENCE=_F (STOP = ‘NOT’,  # to continue without convergence
                ITER_GLOB_MAXI = 1, ITER_INTE_MAXI = 1),
      INCREMENT=_F (LIST_INST = TEMPS1),
              )
```

2.3.2 Recovery of the field of internal variables “model”

```
VABID=CRÉA_CHAMP (OPERATION=' EXTR', TYPE_CHAM=' ELGA_VARI_R', INFO=1,
      NOM_CHAM=' VARI_ELGA', RESULTAT=UBID, NUME_ORDRE=1,)
```

Note:

VABID is not null.

2.3.3 Assignment of the nonworthless values in one map of NEUT_R

```
VAIN2=CRÉA_CHAMP (OPERATION=' AFFE', TYPE_CHAM=' CART_NEUT_R', MODELE=MO,
     AFFE= (
           _F (GROUP_MA= 'CONCRETE', NOM_CMP= ('X2',), VALE = (2. ,)),
             _F  (GROUP_MA=  'MASSIVE',  NOM_CMP=  ('X1',  'X9',),  VALE  =  (1.  ,
9. ,)),
          )
     )
```

2.3.4 Zero setting of the field of internal variables “model” and overloads nonworthless values

```
VAIN22=CRÉA_CHAMP (OPERATION=' ASSE', TYPE_CHAM=' ELGA_VARI_R', MODELE=MO,
      # put at zero:
      ASSE= (_F (TOUT= = 'YES', CHAM_GD = VABID, CUMUL=' OUI', COEF_R=0.),
      # overloads nonworthless values:
                 _F  (GROUP_MA=  'CONCRETE',  CHAM_GD  =  VAIN2,  CUMUL='  OUI',
COEF_R=1.,
               NOM_CMP= ('X2',), NOM_CMP_RESU= ('V2',),),
                  _F  (GROUP_MA=  'MASSIVE',  CHAM_GD  =  VAIN2,  CUMUL='  OUI',
COEF_R=1.,
               NOM_CMP= ('X1', 'X3'), NOM_CMP_RESU= ('V1', 'V9',),),
           )
      )
```

Notice;

For the zero setting and overloads it nonworthless values, one uses the keywords CUMUL=' OUI' and COEF_R=0 .