PYNL02 - STAT_NON_LINE in splitted commands for a Summarized elastoplastic

computation:

The purpose of this document is validating the methodology of resolution of a nonlinear problem (here a problem of elastoplasticity) in splitted commands, without using command STAT_NON_LINE .

1 Problem of reference

1.1 Geometry

One considers a unit cube.

1.2 Properties of the material

One considers a material with a constitutive law of Von Mises with mixed hardening (VMIS_ECMI_TRAC).
The elastic properties are the following ones:
•Young modulus: $E=221300\,MPa$
•Poisson's ratio: $\nu=0,3$
The constant of Prager is worth: $C=2200\,MPa$.
Curve of tension considered is given on Figure 1.2-1 .

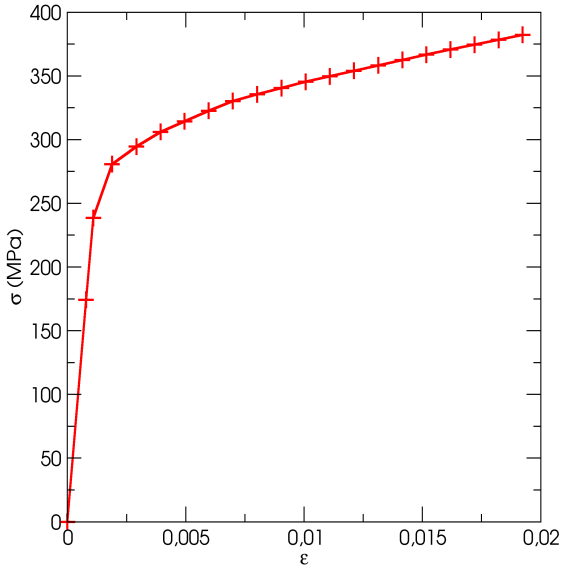

Figure 1.2-1 : Curve of tension

1.3 Boundary conditions and loadings

the lower face (in the plane $z=0$) is clamped.
The upper face (in the plane $z=1$) is subjected to a vertical displacement $dz=10^{-2}[\ m\ ]$.

2 Reference solution

the reference solution is obtained by a numerical resolution of the problem using command STAT_NON_LINE. The stress field and the field of local variables are thus obtained.
The increment of load is discretized in 2 times between 0 and 1.
An elastic prediction is carried out, and one reactualizes the tangent matrix with each iteration and each increment.

The table of convergence is represented below:

```
 INSTANT DE CALCUL :  5.000000000E-01

 ------------------------------------------------------------------------
 |   ITERATIONS   |     RESIDU     |     RESIDU     |     OPTION     |
 |     NEWTON     |     RELATIF    |     ABSOLU     |   ASSEMBLAGE   |
 |                | RESI_GLOB_RELA | RESI_GLOB_MAXI |                |
 ------------------------------------------------------------------------
 |     0        X | 3.98344E-01  X | 1.21090E+02    |ELASTIQUE       |
 |     1        X | 7.07348E-04  X | 9.25744E-02    |TANGENTE        |
 |     2          | 8.74324E-10    | 1.14308E-07    |TANGENTE        |
 ------------------------------------------------------------------------

 INSTANT DE CALCUL :  1.000000000E+00

 ------------------------------------------------------------------------
 |   ITERATIONS   |     RESIDU     |     RESIDU     |     OPTION     |
 |     NEWTON     |     RELATIF    |     ABSOLU     |   ASSEMBLAGE   |
 |                | RESI_GLOB_RELA | RESI_GLOB_MAXI |                |
 ------------------------------------------------------------------------
 |     0        X | 3.84934E-01  X | 1.67339E+02    |ELASTIQUE       |
 |     1        X | 5.82064E-04  X | 1.29881E-01    |TANGENTE        |
 |     2          | 6.38364E-10    | 1.42368E-07    |TANGENTE        |
 ------------------------------------------------------------------------
```

Figure 2-1 : Table of convergence of reference

3 Modelization A

3.1 Characteristic of the modelization

In this modelization, one replaces command STAT_NON_LINE by splitted commands. The boundary conditions are applied by dualisation (Lagranges)

3.2 Characteristic of the mesh

The mesh is composed of only one mesh HEXA8.

3.3 Quantities tested and results

One tests the difference between the stress field (respectively of local variables) calculated by STAT_NON_LINE and by the command CALCUL, with convergence at the last time.

Identification	Reference	% difference
$min(\Delta\sigma)$	0	0
$max(\Delta\sigma)$	0	0
$min(\Delta vi)$	0	0
$max(\Delta vi)$	0	0

table in convergence is also identical to that of reference:

```
instant  0.5
IterNewton | Resi_Glob_rela   | Resi_Glob_Maxi   | Convergence
     0     |   3.983444e-01   |   1.210901e+02   |    0
     1     |   7.073482e-04   |   9.257440e-02   |    0
     2     |   8.743236e-10   |   1.143078e-07   |    1

instant  1.0
IterNewton | Resi_Glob_rela   | Resi_Glob_Maxi   | Convergence
     0     |   3.849340e-01   |   1.673393e+02   |    0
     1     |   5.820635e-04   |   1.298814e-01   |    0
     2     |   6.383644e-10   |   1.423681e-07   |    1
```

Figure 3.3-1: Table of convergence obtained via the command CALCUL

4 Summary of the results

This test made it possible to validate the methodology of resolution of a nonlinear problem (here a problem of elastoplasticity) in splitted commands, without using command STAT_NON_LINE.
In this test, the range of methodology is restricted:
- no the external forces (loading imposed via of Lagranges)
- not of loading of temperature (command variables)
- not of control,
- not linear search,
- not contact,
- the NUME_DDL does not change during time step (in particular, the nodes whose displacement is imposed do not vary).