

PYNL02 - STAT_NON_LINE in orders burst for an elastoplastic calculation

Summary:

The purpose of this document is to validate the methodology of resolution of a non-linear problem (here a problem of elastoplasticity) in burst orders, without using the order `STAT_NON_LINE`.

1 Problem of reference

1.1 Geometry

A unit cube is considered.

1.2 Properties of material

One considers a material with a law of behavior of Von Mises with mixed work hardening (VMIS_ECMI_TRAC).

The elastic properties are the following ones:

- Young modulus: $E = 221\,300\text{ MPa}$
- Poisson's ratio: $\nu = 0,3$

The constant of Prager is worth: $C = 2200\text{ MPa}$.

The traction diagram considered is given on Figure 1.2-1.

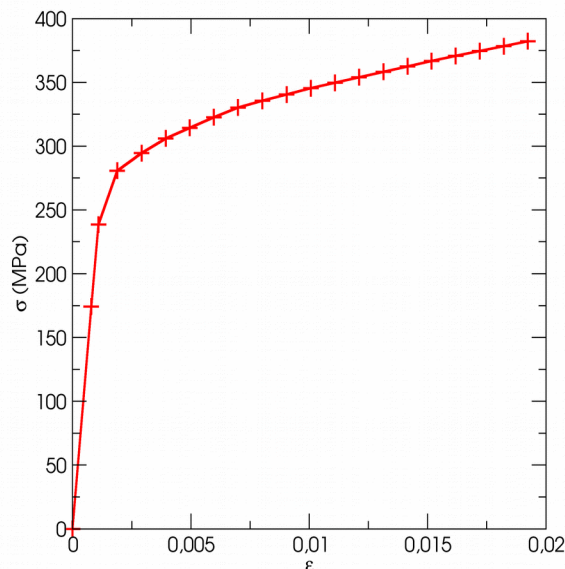


Figure 1.2-1 : Traction diagram

1.3 Boundary conditions and loadings

The lower face (in the plan $z=0$) is embedded.

The higher face (in the plan $z=1$) is subjected to a vertical displacement $dz = 10^{-2} [m]$.

2 Reference solution

The reference solution is obtained by a digital resolution of the problem using the order STAT_NON_LINE. One thus obtains the stress field and the field of internal variables.

The increment of load is discretized in 2 moments 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	

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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 Modeling A

3.1 Characteristics of modeling

In this modeling, the order is replaced `STAT_NON_LINE` by burst orders. The boundary conditions are applied by dualisation (Lagranges)

3.2 Characteristics of the grid

The grid is composed of only one nets `HEXA8`.

3.3 Sizes tested and results

One tests the difference between the stress field (respectively of internal variables) calculated by `STAT_NON_LINE` and by the order `CALCULATION`, with convergence at the last moment.

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

The table of 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 order `CALCULATION`

4 Summary of the results

This test made it possible to validate methodology of resolution of a non-linear problem (here a problem of elastoplasticity) in burst orders, without using the order STAT_NON_LINE.

In this test, the range of methodology is limited:

- pas de external forces (loading imposed via of Lagranges)
- pas de loading of temperature (variables of orders)
- pas de piloting,
- pas de searches linear,
- pas de contact,
- NUME_DDL do not change during step of time (in particular, the nodes whose displacement is imposed do not vary).