SSNL133 – Elastic postbuckling of a structure in L

Summarized:

An L-shaped structure made up of two slender beams of mean rectangular section is embedded with one of its ends and is subjected to a force at its other end. One seeks the behavior postbuckling associated with the positive values with the force. The field of the test is:

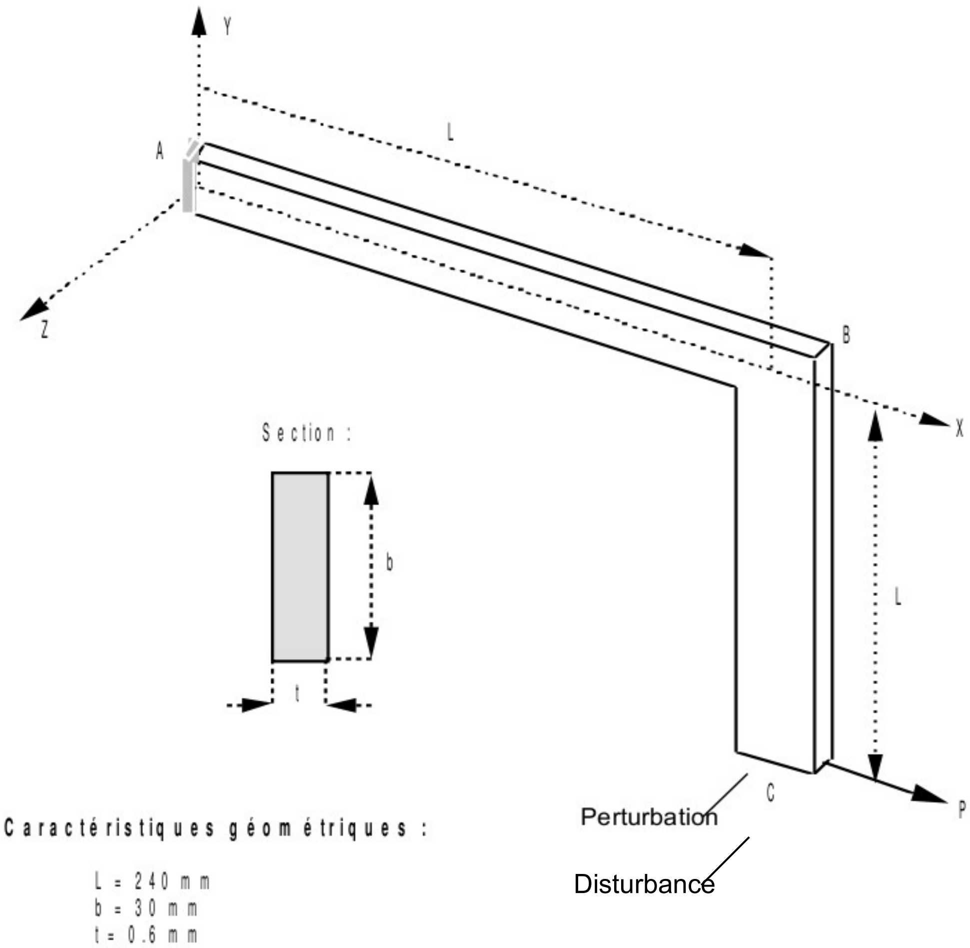
- nonlinear elastic mechanics (large displacements, large rotations),
- buckling of beams (instability),
- The modelization is relative to POU_D_TGM, POU_D_T_GD, POU_D_TG, POU_D_T and POU_D_E.

It makes it possible to test the kinematics in large displacements and large rotations activated via key word GROT_GDEP.

Note: one will be able to refer to the case test SSLL105 for a determination of the critical loads of buckling for this structure.

1 Problem of reference

1.1 Geometry



1.2 Material properties

$E=71240\,MPa$
$\nu=0.3$

1.3 Boundary conditions and loadings

Boundary condition: fixed support in A
Loading in C according to pseudo-TEMPS $t\in[0;5]$:

$F_x=1.0\times t[N]$
$F_z=0.001\times t[N]$ (disturbance to initiate the behavior postbuckling of the blade)

2 Reference solution

2.1 Méthode de calcul used for the reference solution

One takes as reference solution, the response postbuckling obtained with modelization `POU_D_T_GD` (modelization A), which will provide values of NON-regression.

2.2 Results of reference

Tests of NON-regression on some points of curved force-displacement representative of the behavior of the structure (Applied force at the point C according to the displacement of the following C point X and Z).

2.3 Uncertainty on the Different

solution modelization Aster.

2.4 Bibliographical references

[1] G. DEVESA: Processing of large displacements in the element of angle with 7 d.o.f. established in *the Code_Aster* validation by a case classical test (HM - 77/94/079).

[2] H. Shakourzadeh. Modelization of the three-dimensional structure-beams with thin-walleds and simulation of the geometrical and elastoplastic nonlinear behavior. Doctorate, University of Compiegne, Compiegne (1994).

3 Modelization A

3.1 Characteristic of the modelization

20 elements `POU_D_T_GD`

3.2 Characteristics of the mesh

Many nodes: 21
Number of meshes and types: 20 `SEG2` (10 in each branch)

3.3 Quantities tested and results

For this modelization, the tests are of NON-regression. The values seem references in all the other modelizations.

3.3.1 Graphic results of the modelization A

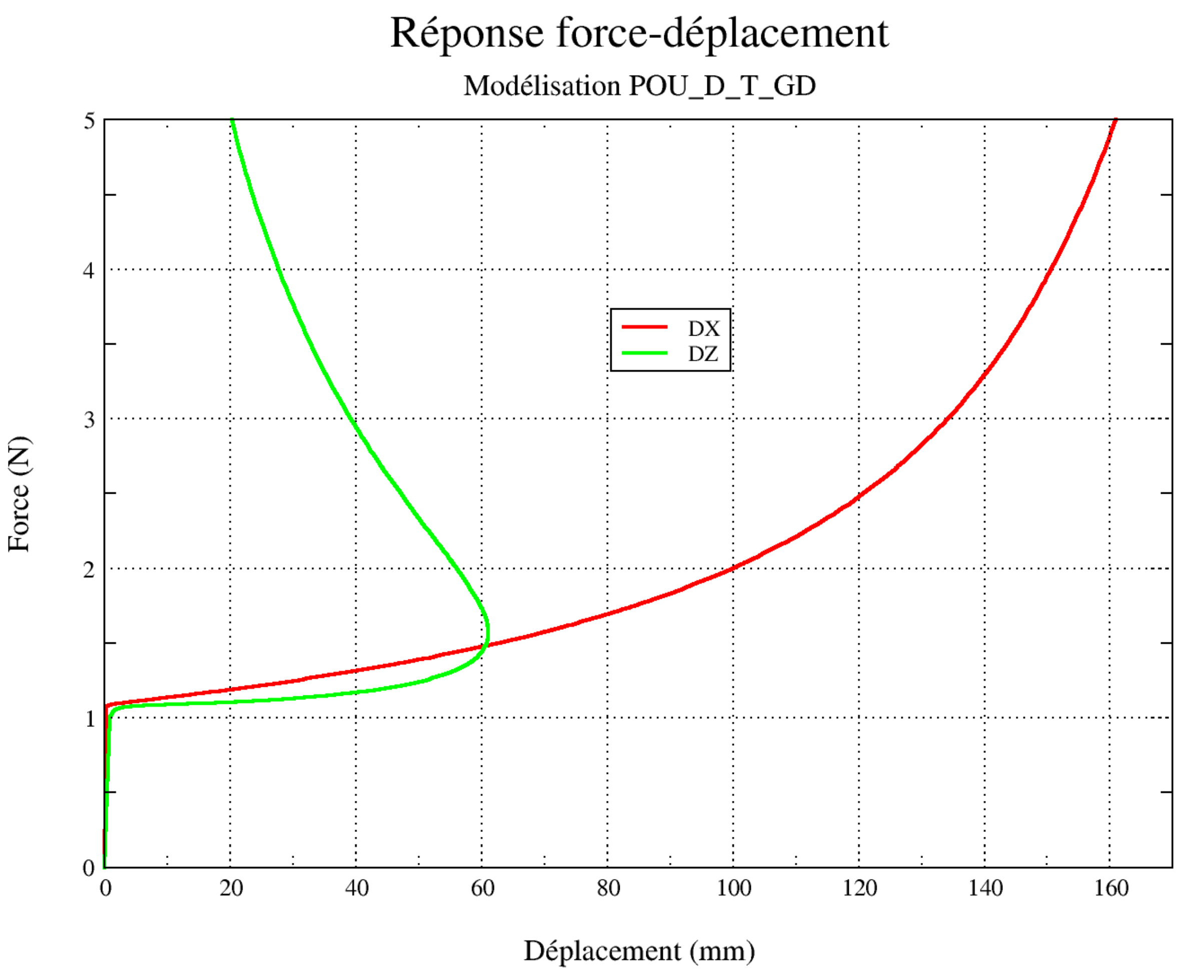


Figure 3.3.1-a : Response Force-displacement, modelization POU_D_T_GD.

The values being used as reference for the all other modelizations are those of table 3.3.1-a. The tolerances are adapted so that the test passes on the various platforms.

Force (N)	DX (mm)	DZ (mm)	Tolerance/ DX	Tolerance/ DZ
1.0	1.9557493475982E-01	8.1849504440533E-01	1.0E-06	1.0E-06
1.2	2.2003159601578E+01	4.5085834614729E+01	2.0E-05	1.5E-05
1.4	5.1370721240215E+01	5.9127605459760E+01	4.0E-06	6.5E-06
1.6	7.2307885049332E+01	6.1008538728158E+01	6.5E-06	1.5E-05
2.0	9.9971229134146E+01	5.5985405418044E+01	2.5E-06	1.5E-05
3.0	1.3415730437940E+02	3.9186532467172E+01	1.0E-06	1.0E-05
4.0	1.5070726872507E+02	2.7659987903886E+01	4.0E-06	1.0E-05
5.0	1.6092765462757E+02	2.0199252710901E+01	1.0E-06	1.0E-05

Table3.3.1-a

3.4 Remarks

the strategy adopted to obtain the response in force-displacement of structure is to control in force.
It is in addition necessary to use the automatic subdivision of the time step. Indeed, element `POU_D_T_GD` does not converge uniformly in residue and it is thus difficult to conclude a computation its with a uniform time division unless taking the very small ones time step what is sub-optimal.

4 Modelization B

4.1 Characteristic of the modelization

20 elements POU_D_TGM

4.2 Characteristics of the mesh

Many nodes: 21
Number of meshes and types: 20 SEG2 (10 in each branch)

4.3 Characteristic of the mesh of the cross-sectional area

Many fibers: 100 (10 in each side)
Number of meshes and types: 100 QUAD4

4.4 Quantities tested and Values

4.4.1 results tested

the values tested result from table 3.3.1-a.

Force (N)	DX (mm)	DZ (mm)	Tolerance/ DX	Tolerance/ DZ
1.0	1.9557493475982E-01	8.1849504440533E-01	2.0E-02	7.0E-02
1.2	2.2003159601578E+01	4.5085834614729E+01	6.0E-02	1.0E-02
1.4	5.1370721240215E+01	5.9127605459760E+01	2.2E-02	1.5E-02
1.6	7.2307885049332E+01	6.1008538728158E+01	2.0E-02	2.0E-02
2.0	9.9971229134146E+01	5.5985405418044E+01	1.0E-02	2.2E-02
3.0	1.3415730437940E+02	3.9186532467172E+01	1.0E-02	2.0E-02
4.0	1.5070726872507E+02	2.7659987903886E+01	1.0E-02	1.0e-02
5.0	1.6092765462757E+02	2.0199252710901E+01	1.0E-02	0.5E-02

One uses a technique of length of arc to obtain the response of structure, times of computation cannot thus be directly imposed. However one endeavours to choose the values of the state of control closest to times of reference.

4.4.2 Graphic results of the modelization B

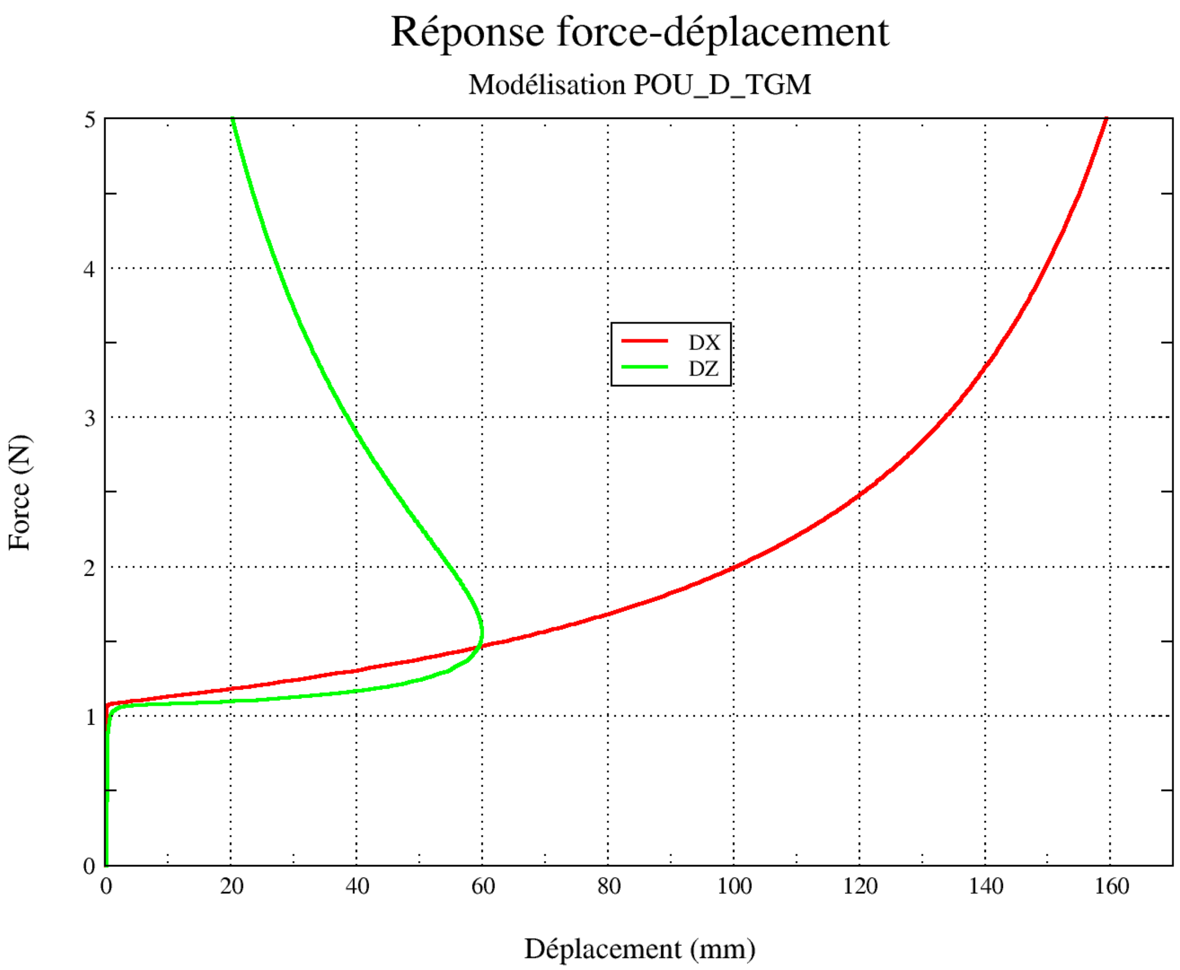


Figure 4.4.2-a.

4.4.3 Remarks

the relative variations with the results of the modelization A taken as reference are in the rather weak whole in spite of a variation of 7.0% in DZ at the time 1.0 and of 6.0% in DX time 1.2 . It is noticed that the differences decrease in the course of time and are finally weak at time 5.0 . Kinematics “GROT_GDEP” of element POU_D_TGM is thus very satisfactory.

5 Modelization C

5.1 Characteristic of the modelization

20 elements POU_D_TG

5.2 Characteristics of the mesh

Many nodes: 21
Number of meshes and types: 20 SEG2 (10 in each branch)

5.3 Characteristic of the mesh of the cross-sectional area

Many fibers: 100 (10 in each side)
Number of meshes and types: 100 QUAD4

5.4 Quantities tested and Values

5.4.1 results tested

the values tested are those of table 3.3.1-a.

Force (N)	DX (mm)	DZ (mm)	Tolerance/ DX	Tolerance/ DZ
1.0	1.9557493475982E-01	8.1849504440533E-01	6.0E-03	1.6E-03
1.2	2.2003159601578E+01	4.5085834614729E+01	2.5E-04	2.0E-02
1.4	5.1370721240215E+01	5.9127605459760E+01	1.7E-03	2.0E-02
1.6	7.2307885049332E+01	6.1008538728158E+01	2.0E-04	2.0E-02
2.0	9.9971229134146E+01	5.5985405418044E+01	4.0E-03	2.0E-02
3.0	1.3415730437940E+02	3.9186532467172E+01	1.0E-02	5.0E-03
4.0	1.5070726872507E+02	2.7659987903886E+01	1.5E-02	8.0E-03
5.0	1.6092765462757E+02	2.0199252710901E+01	1.5E-02	2.0E-02

One uses a technique of length of arc to obtain the response of structure, times of computation cannot thus be directly imposed. However one endeavours to choose the values of the state of control closest to times of reference.

5.4.2 Graphic results of the modelization C

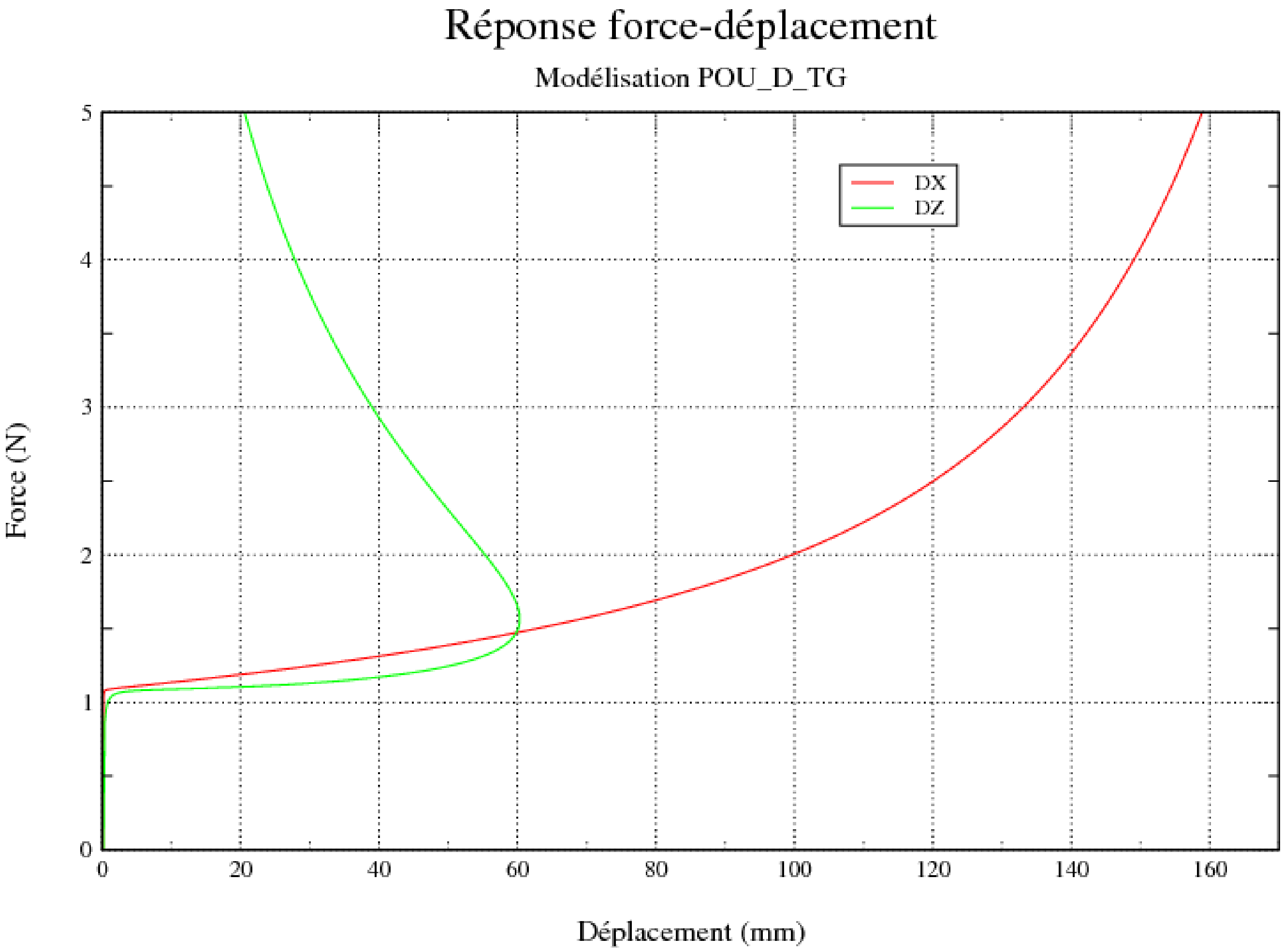


Figure 5.4.2-a`POU_D_TG`**.**

5.4.3 Remarks

the relative variations with the results of the modelization A taken as reference are weak. One does not notice contrary to modelization `POU_D_TGM` of reduction in the variation in the course of time. Kinematics "`GROT_GDEP`" of element `POU_D_TG` is very satisfactory.

6 Modelization D

6.1 Characteristic of the modelization

20 elements POU_D_T

6.2 Characteristics of the mesh

Many nodes: 21
Number of meshes and types: 20 SEG2 (10 in each branch)

6.3 Characteristic of the mesh of the cross-sectional area

Many fibers: 100 (10 in each side)
Number of meshes and types: 100 QUAD4

6.4 Quantities tested and Values

6.4.1 results tested

the values tested result from table 3.3.1-a.

Force (N)	DX (mm)	DZ (mm)	Tolerance/ DX	Tolerance/ DZ
1.0	1.9557493475982E-01	8.1849504440533E-01	1.0E-02	1.5E-02
1.2	2.2003159601578E+01	4.5085834614729E+01	3.0E-02	0.2E-02
1.4	5.1370721240215E+01	5.9127605459760E+01	2.0E-02	2.0E-02
1.6	7.2307885049332E+01	6.1008538728158E+01	2.0E-02	2.0E-02
2.0	9.9971229134146E+01	5.5985405418044E+01	0.5E-02	2.2E-02
3.0	1.3415730437940E+02	3.9186532467172E+01	0.5E-02	2.0E-02
4.0	1.5070726872507E+02	2.7659987903886E+01	1.0E-02	1.4E-02
5.0	1.6092765462757E+02	2.0199252710901E+01	1.0E-02	1.0E-02

One uses a technique of length of arc to obtain the response of structure, times of computation cannot thus be directly imposed. However one endeavours to choose the values of the state of control closest to times of reference.

6.4.2 Graphic results of the modelization D

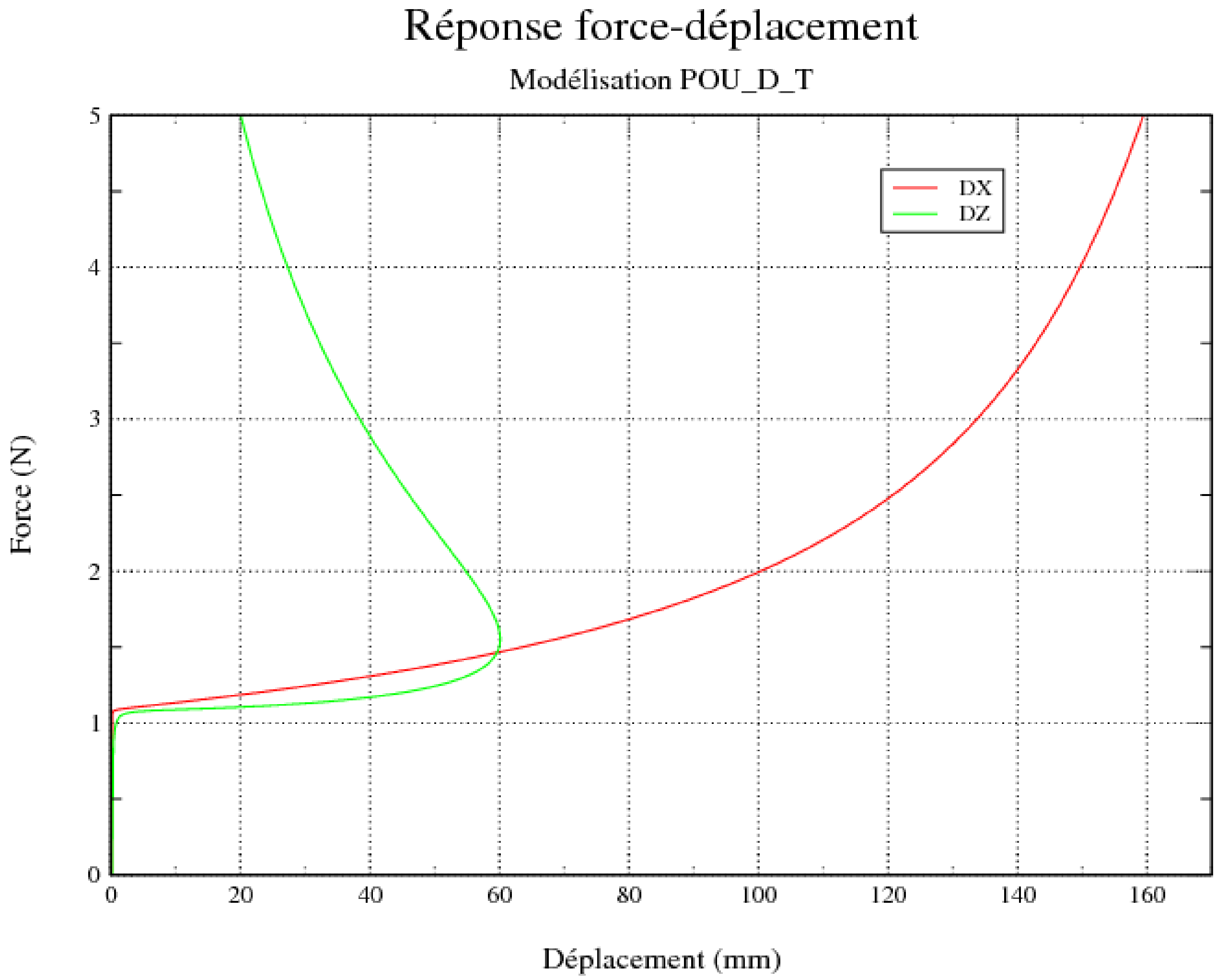


Figure : Response Force-displacement, modelization .

6.4.3 Remarks

the relative variations with the results of the modelization A taken as reference are weak. One does not notice contrary to modelization `POU_D_TGM` of reduction in the variation in the course of time. Kinematics "`GROT_GDEP`" of element `POU_D_T` is thus very satisfactory.

7 Modelization E

7.1 Characteristic of the modelization

20 elements POU_D_E

7.2 Characteristics of the mesh

Many nodes: 21
Number of meshes and types: 20 SEG2 (10 in each branch)

7.3 Characteristic of the mesh of the cross-sectional area

Many fibers: 100 (10 in each side)
Number of meshes and types: 100 QUAD4

7.4 Quantities tested and Values

7.4.1 results tested

the values tested result from table 3.3.1-a.

Force (N)	DX (mm)	DZ (mm)	Tolerance/ DX	Tolerance/ DZ
1.0	1.9557493475982E-01	8.1849504440533E-01	4.0E-03	1.2E-02
1.2	2.2003159601578E+01	4.5085834614729E+01	2.3E-02	1.0E-02
1.4	5.1370721240215E+01	5.9127605459760E+01	2.0E-02	1.5E-02
1.6	7.2307885049332E+01	6.1008538728158E+01	1.5E-02	1.5E-02
2.0	9.9971229134146E+01	5.5985405418044E+01	7.0E-03	2.0E-02
3.0	1.3415730437940E+02	3.9186532467172E+01	2.0E-03	1.7E-02
4.0	1.5070726872507E+02	2.7659987903886E+01	5.5E-03	1.0E-02
5.0	1.6092765462757E+02	2.0199252710901E+01	1.0E-02	1.0E-03

One uses a technique of length of arc to obtain the response of structure, times of computation cannot thus be directly imposed. However one endeavours to choose the values of the state of control closest to times of reference.

7.4.2 Graphic results of the modelization E

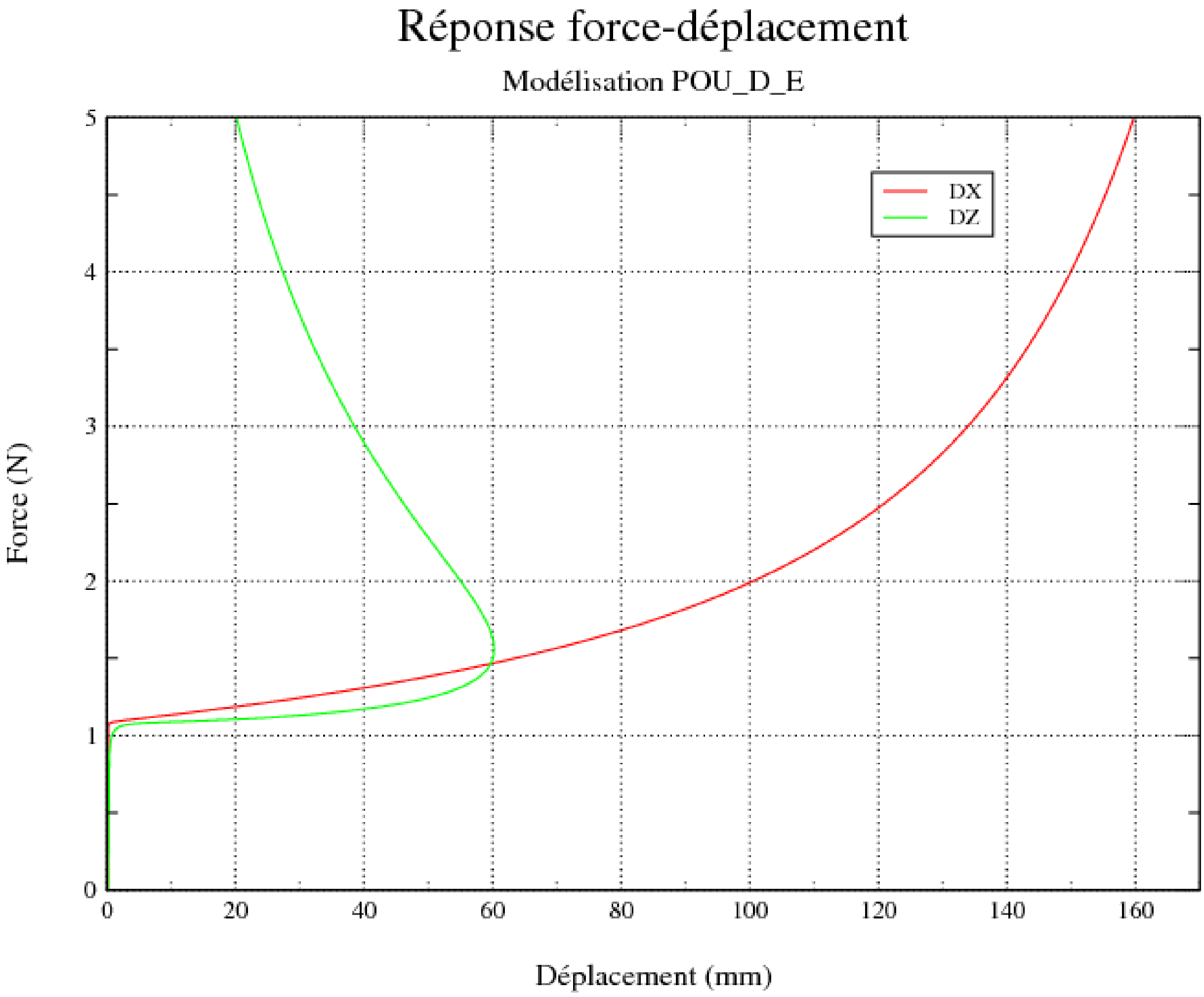
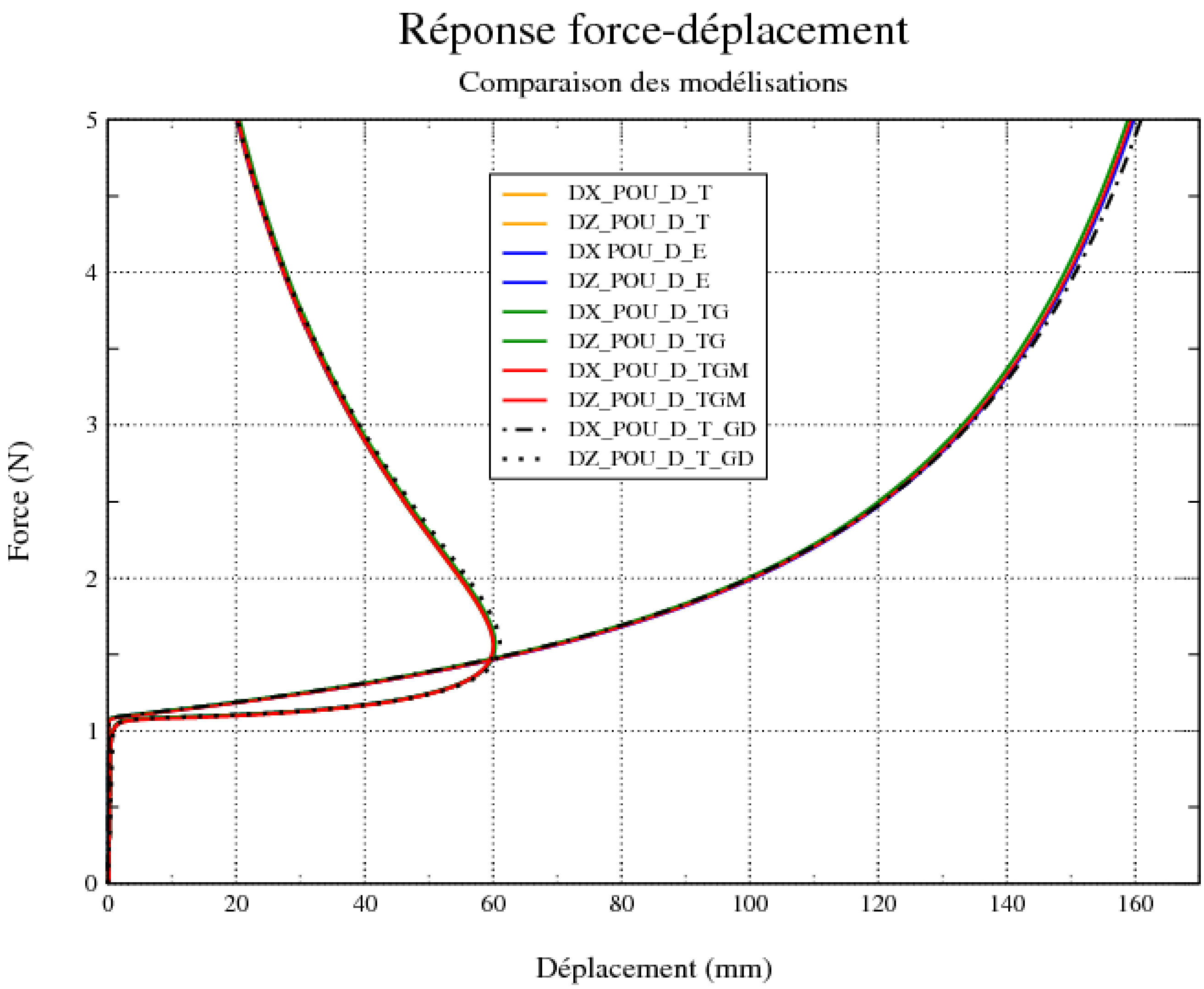


Figure POU_D_E.

7.4.3 Remarks

the relative variations with the results of the modelization A taken as reference are weak. One does not notice contrary to modelization POU_D_TGM of reduction in the variation in the course of time. Kinematics "GROT_GDEP" of element POU_D_E is thus very satisfactory.

8 Analyzes results



Appears 8-a : Response Force-displacement, comparison of the modelizations.

The figure8-a presents the curved force-displacement obtained with various modelizations.

One observes an excellent correlation of the results between the various modelizations.