SSLL105 - Elastic buckling of a structure in L

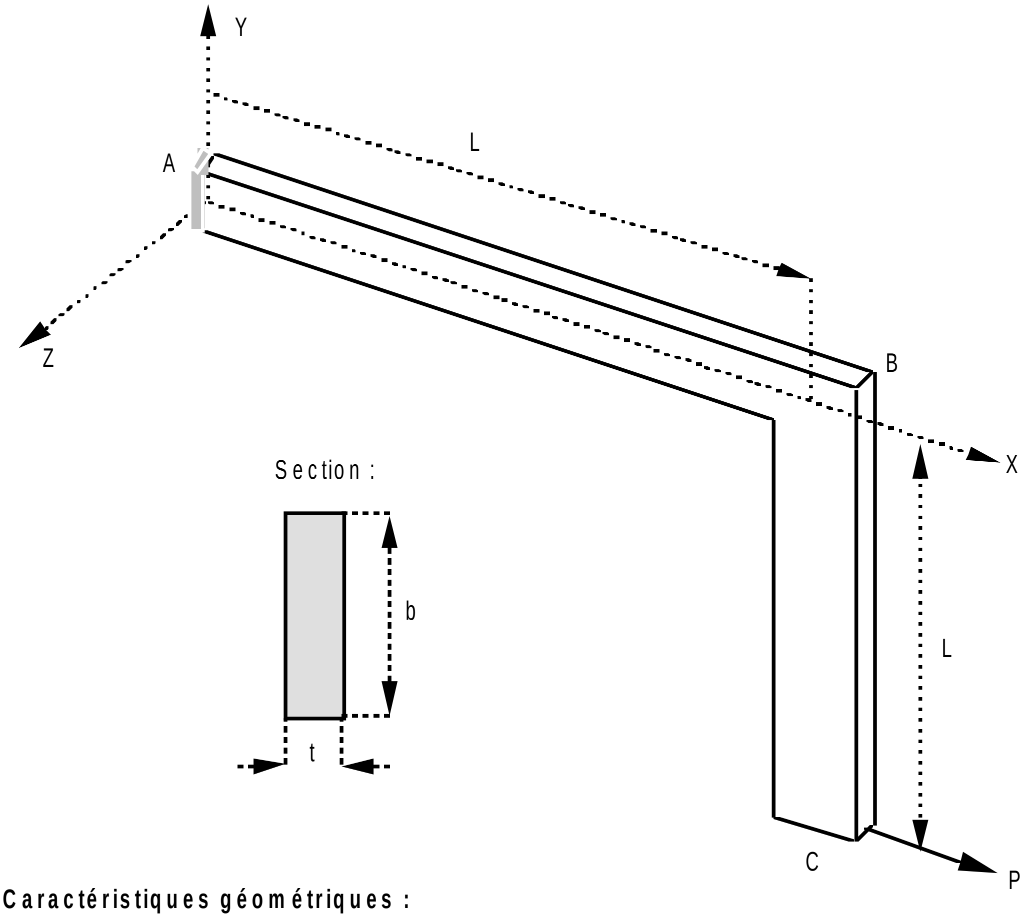
Summarized:

A structure in form of L made up of two slender beams of mean rectangular section is subjected to a force at an end, and is embedded at the other end. One seeks the critical loads of elastic buckling associated with the positive and negative values of the force. The field of the test is:

- linear elastic mechanics,
- buckling of beams,
- the first 3 modelizations are relative to (POU_D_E, POU_D_T, POU_D_TG).
- 4th (POU_D_E) and the 5th (POU_D_TGM) modelizations test the criterion of buckling in the nonlinear operator of static.

1 Problem of reference

1.1 Geometry



Caractéristiques géométriques :

L = 240 mm
b = 30 mm
t = 0.6 mm

1.2 Material properties

Modulus Young: $E=71240\,MPa$
Poisson's ratio: $\nu=0.3$

1.3 Boundary conditions and loadings

- Boundary conditions: fixed support in A
- Loading: $F=P_x$
  - case 1: $P_x=-1\,N$
  - case 2: $P_x=+1\,N$

2 Reference solution

2.1 Method of calculating used for the Average reference solution

enters the results got with various codes (8 results in [bib1]).

2.2 Results of reference

Values of the critical load for the two loading cases.

2.3 Uncertainty on the solution

the maximum variation compared to the average of results used is of 2%. This value is thus associated with uncertainty relating to the value of reference.

2.4 Bibliographical references

1 G. DEVESA: Processing of large displacements in the element of angle to 7 degrees of freedom established in *Code_Aster,* validation by a case classical test (HM - 77/94/079).

3 Modelization A

3.1 Characteristic of the modelization

20 elements POU_D_E

3.2 Characteristics of the mesh

Many nodes: 21
Number of meshes and types: 20 SEG2

3.3 Quantities tested and results

Loading case	Reference	Tolerance (%)
1	1.088	0.19
2	– 0.680	0.19

4 Modelization B

4.1 Characteristic of the modelization

20 elements POU_D_T

4.2 Characteristics of the mesh

Many nodes: 21
Number of meshes and types: 20 SEG2

4.3 Quantities tested and results

Loading case	Reference	Tolerance (%)
1	1.088	0.19
2	– 0.680	0.19

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

5.3 Quantities tested and results

Loading case	Reference	Tolerance (%)
1	1.088	0.35
2	– 0.680	1.2

Note:

The results of this modelization differ slightly from the others and are identical to those obtained by the Aster computation of the reference [bib1].

6 Modelization D

6.1 Characteristic of the modelization

20 elements POU_D_E

6.2 Characteristics of the mesh

Many nodes: 21
Number of meshes and types: 20 SEG2

6.3 Quantities tested and results

Loading case	Reference	Tolerance (%)
1	1.088	0.12
2	– 0.680	0.025

One test also the management of the event "INSTABILITY" of DEFI_LIST_INST. More exactly this event occurs because the coefficient of critical load crosses the value -1 and that must thus start the associated action, always definite under DEFI_LIST_INST.

As one wants to continue computation in spite of this detected instability, one specifies:
ACTION = "CONTINUE".

7 Modelization E

7.1 Characteristic of the modelization

20 elements POU_D_TGM

7.2 Characteristics of the mesh

Many nodes: 21
Number of meshes and types: 20 SEG2

7.3 Characteristics of the mesh of the cross-sectional area (fibers)

Many fibers: 100
Number of meshes and types: 100 QUA4

7.4 Quantities tested and results

Loading case	Reference	Tolerance (%)
1	1.088	0.184
2	0.680	1.471

Note:

The results of this modelization differ slightly from the others probably because of warping.

8 Summary of the results

the results of the 5 modelizations are very close to the reference solution which is an average of results of 8 codes. One notes a small effect due to warping since the results of the modelizations C and E (POU_D_TG/POU_D_TGM) are slightly different from the others, while remaining to less 2% of the reference.

Although the two last modelizations (D and E) implement the nonlinear criterion of buckling of CRIT_STAB in the nonlinear operator of static, they do not use the same approach.

In the modelization D, it is the criterion of Eulerian which is used because one is in small displacements (DEFORMATION=' PETIT') and the tangent matrix contains only the material stiffness matrix.

In the modelization E, one placed oneself in large displacements (DEFORMATION=' REAC_GEOM', although that is not necessary to deal with this problem), the tangent matrix understands at the same time the stiffness material and geometrical, which makes it possible to illustrate the nonlinear criterion generalized in which one tests the singularity of the tangent matrix. One thus does not predict any more the critical load but it is detected (by observing the change of sign of the smallest eigenvalue of the tangent matrix, cf R7.05.01).