SDLL400 - Beam in vibration with Summarized excentré

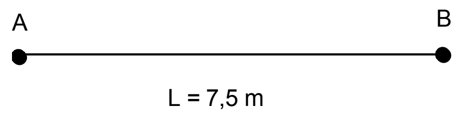
center of torsion:

This test is resulting from the validation independent of version 4 of beam models.

It makes it possible to test the taking into account of an eccentricity of the center of torsion on the computation of eigenfrequencies of a straight beam (a modelization with elements `POU_D_E`, straight beam of Eulerian).

1 Problem of reference

1.1 Geometry

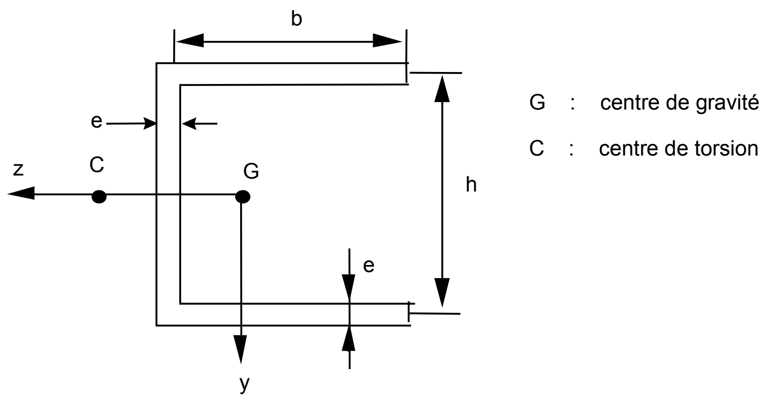


Appears 1.1-a

Straight beam length $7,5\,m$.

Characteristics of the section:

It is the beam in U presented [Figure 1.1-b].



Appear 1.1-b : Section of the beam in U

$$h=200\,mm$$
$$b=273\,mm$$
$$e=8,2\,mm$$

One has by [bib1] the following data:

$$I_y=I_z=5,022\,10^{-5}\,m^4$$
$$ZGC=221,5\,mm$$

One calculates from the geometry of the section:

$$S=6,117\,10^{-3}\,m^2$$
$$J_x=1,28\,10^{-7}\,m^4$$

1.2 Properties of the materials

Modulus Young: $E=2.07\,10^{11}\,Pa$

Poisson's ratio: $\nu=0,3$

Density: $\rho=7850\,kg/m^3$

1.3 Boundary conditions

Boundary condition:

Plane problem: DZ and DRY blocked.
Nodes A and B supported: DX and DY blocked

the taking into account of eccentricity is done using operand LIAISON_DDL of the command AFFE_CHAR_MECA.

The degrees of freedom are always in G, and one takes account of eccentricity by: $DY(G)=DY(C)+GC\wedge\Theta_x$

2 Reference solutions

2.1 Method of calculating used for the reference solutions

They is the eigenfrequencies solutions of the homogeneous problem without damping.

It is partially given in [bib1]. The method of resolution, finite elements type, relates to a model POU_D_TG. However, a series of results is provided if the effects of the torsion of warping are neglected, which brings back the modelization to a POU_D_T.

N° mode	1	2	3	4	5
Frequency (Hz)	3,797	7,788	11,74	15,68	19,62

Table 2.1-AA : Results of reference according to [bib1]

One can grant a certain confidence to these results published in a newspaper at reading committee. However uncertainties exist if one wants to reproduce these computations: the constants of torsion J_x and shears k_y are not provided in the article. They should have been recomputed from the geometry of the section.

2.2 Results of reference

Eigenfrequencies of the beam without damping

2.3 Uncertainty on the solution

Comparison between codes (STONE [bib2] and ASTER), and analytical solution.

2.4 Bibliographical references

• WU J.S. & CHEN K.Z. : Dynamic Analysis of has Chanel beam had to has moving load. J. of Sound and Vibration, vol. 188, n° 3, pp 337-345, 1995.
• Code STONE version 4 of October 30th, 1996, IAT
• Ratio n° 2314/A of the Institute Aerotechnics “Proposal and realization of new cases tests missing with the validation of beams ASTER”

3 Modelization A

3.1 Characteristic of the modelization

The model is composed of 15 elements straight beam of Eulerian.

3.2 Characteristics of the mesh

15 elements POU_D_E

3.3 Quantities tested and results

Mode	Results STONE	Results *Aster*	Variation (%)
1	3,79432	3.7966	0.063
2	7,43340	7.4513	0.242
3	11,4450	11.5108	0.575
4	15,3439	15.5027	1.036
5	19,4766	19.8060	1.692

Table 4.1-AA : Comparison ASTER/CAILLOU in POU_D_E with eccentricity

Mode	Results Reference	Results *Aster*	Variation (%)
1	3.79700	3.7966	– 0.008
2	7.78800	7.4513	– 4.322
3	11.7400	11.5108	– 1.952
4	15.6800	15.5027	– 1.130
5	19.6200	19.8060	0.948

Table 4.1-BB : Comparison ASTER/Référence [bib1] in POU_D_E with eccentricity

4 Summary of the results

the results are rather close to the reference solution (numerical). (variation $<5\%$), for which certain data missed and thus had to be estimated. They correspond on the other hand very well to the results of the code STONE of the IAT (given identical to those of *Code_Aster*).

This makes it possible to validate the taking into account of the eccentring of the center of torsion in the mass matrixes and stiffness.