SDLL400 - Beam in vibration with center of excentré torsion

Summary:

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

It makes it possible to test the taking into account of an eccentricity of the center of torsion on the calculation of Eigen frequencies of a right beam (a modeling with elements POU_D_E, right beam of Euler).

1 Problem of reference

1.1 Geometry

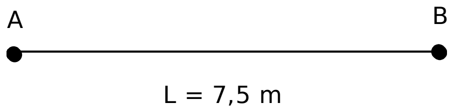

Figure 1.1-a

Right beam length $7,5m$.

Characteristics of the section:

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

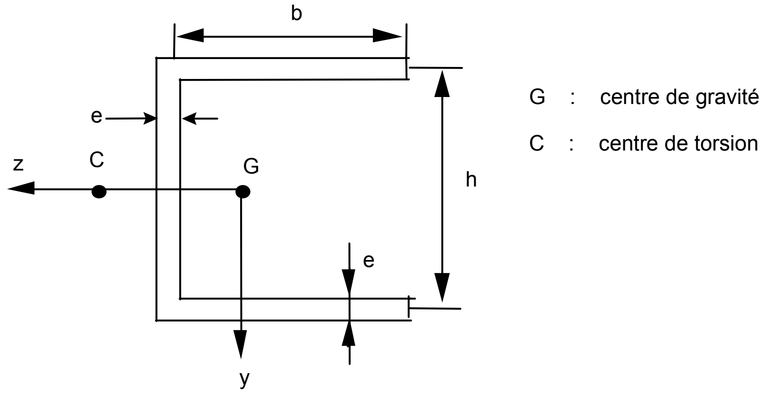

Figure 1.1-b : Section of the beam in U

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

One has by [bib1] the following data:

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

One calculates starting 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 materials

Young modulus: $E=2.07\,10^{11}\,Pa$
Poisson's ratio: $\nu=0,3$
Density: $\rho=7850\,kg/m^3$

1.3 Boundary conditions

Boundary condition:

Problem plan: DZ and DRY blocked.
Nodes A and B supported: DX and DY blocked

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

The degrees of freedom are always in G, and one takes account of the 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 Eigen frequencies solutions of the homogeneous problem without damping.

It is partially given in [bib1]. The method of resolution, of 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 modeling to one 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-A : 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 calculations: constants of torsion J_x and of shearing k_y are not provided in the article. They should have been recomputed starting from the geometry of the section.

2.2 Results of reference

Eigen frequencies 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
- Report n° 2314/A of the Institute Aerotechnics “Proposal and realization for new cases tests missing with the validation of the beams ASTER”

3 Modeling A

3.1 Characteristics of modeling

The model is composed of 15 elements right beam of Euler.

3.2 Characteristics of the grid

15 elements POU_D_E

3.3 Sizes tested and results

Mode	STONE results	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-A : Comparison ASTER/CAILLOU in POU_D_E with eccentricity

Mode	Reference results	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-B : Comparison ASTER/Référence [bib1] in POU_D_E with eccentricity

4 Summary of the results

The results are rather close to the reference solution (digital). (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 offsetting of the center of torsion in the matrices of mass and rigidity.