SHLL102 – Harmonic response of a beam with 3 discs, subjected to the gyroscopic effect.

Abstract:

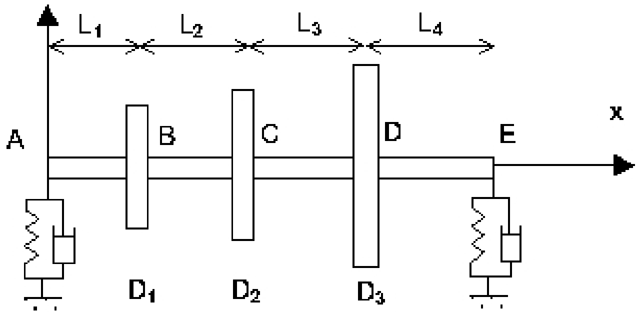
This problem consists in validating the effect of the gyroscopic matrix on a beam supported on each one of its ends, on linear bearings, a harmonic computation with a loading of the standard unbalance. The beam is full, of circular section and comprises three discs.

For this case test, the loading of the standard unbalance is installed on disc 2. The comparison relates to the value of the peaks of resonance of displacements of disc 2.

This problem thus makes it possible to test the effect of the gyroscopic matrix which was developed for a straight beam. The gyroscopic effect led to modify the resonance frequencies and the amplitudes displacements.

The got results are in concord with those given in reference. The references are based on the theory of the beams of Timoshenko.

1 Problem of reference



1.1 Geometry

Modelization:

	Mass (kg)	I_{xx} ($kg.m^2$)	$I_{yy}=I_{zz}$ ($kg.m^2$)
Disc D_1	14.580130	0.1232021	0.6463858
Disc D_2	45.945793	0.97634809	0.4977460
Disc D_3	55.134951	1.176177	0.6023493

Table 1.1-1 : Characteristics of the discs

Length of beam:

$L_1=AB=0.2\,m$
$L_2=BC=0.3\,m$
$L_3=CD=0.5\,m$
$L_4=DE=0.3\,m$

Circular section:

Diameter: $D=0.1\,m$

1.2 Elastic

$E=2.10^{11}\,Pa$
$\nu=0.3$
$\rho=7\,800\,kg/m^3$

1.3 material properties Boundary conditions and

loadings Bearings with viscous damping in A and in E

$K_{yy}=5.10^7\,N.m^{-1}$; $K_{zz}=7.10^7\,N.m^{-1}$; $K_{yz}=K_{zy}=0$
$C_{yy}=5.10^2\,N/(m.s^{-1})$; $C_{zz}=7.10^2\,N/(m.s^{-1})$; $C_{yz}=C_{zy}=0$

2 Reference solution

2.1 Method of calculating used for the reference solution

the reference solution is that presented in the work of Michel LALANNE and Guy FERRARIS.

The numerical résusltats were obtained by a code finite elements, in elements beam of the Timoshenko type. The modelization is realized with 14 nodes (13 elements beams).

2.2 Results of reference

With a loading of type unbalance, values of the 7 maximas of amplitude for the point C (disc 2), a rotational speed varying from 0 with $30000\,tr/min$.

2.3 Uncertainty on the solution

Lower than 1%.

2.4 Bibliographical references

1.Michel LALANNE and Guy FERRARIS, Rotordynamics, Prediction in Engineering, JOHN WILEY AND SOUNDS (1990).

3 Modelization A

3.1 Characteristic of the modelization

Modelization : 13 Elements équi-distribute Mesh: `beam` POU_D_T in x

3.2 the direction Characteristics of

the mesh Many nodes: 14
Number of meshes and types: 13 SEG2

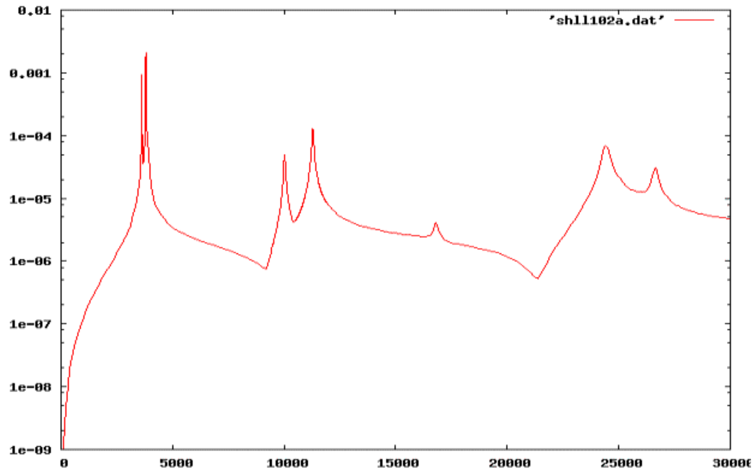
3.3 Loading

Unbalance of value $0.05 m.kg$, installed on the node C (disc 2).

4 Frequency

results in Hz	Eccentricity of reference (m)	Eccentricity Aster (m)	% Difference
60.34	9.38E-04	9.3763E-04	0.039
63.3	2.1E-03	2.0960E-03	0.190
166.97	4.99E-05	4.9921E-05	0.042
188.02	1.3E-04	1.3025E-04	0.195
279.78	4.21E-06	4.2042E-06	0.138
406.97	6.84E-05	6.8300E-05	0.146
443.52	3.11E-05	3.0666E-05	1.41

Table 4-1 : Eccentricities according to the frequencies



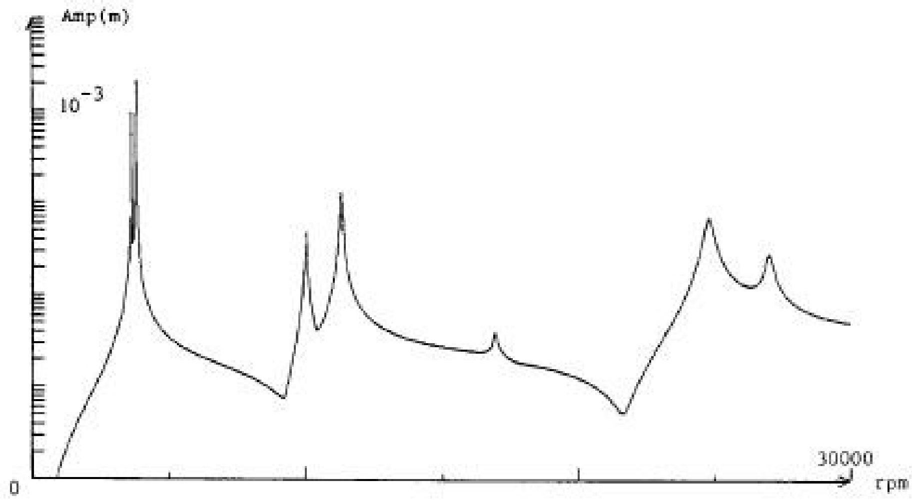


Figure 7 Mass unbalance response: $n = 8$

5 Summary of the results

It is noted that computations of *Code_Aster* reproduce those of the reference accurately. One notes a good establishment of the gyroscopic effect for the beam element, in the case of harmonic computation.