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

Summary:

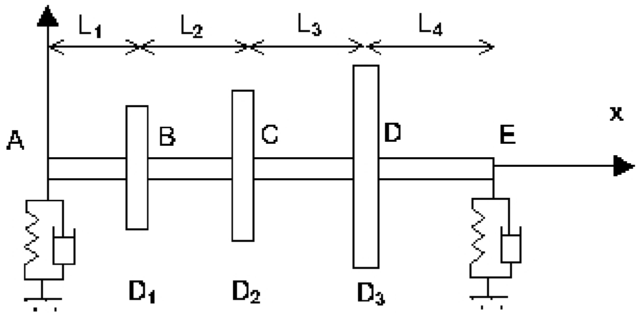
This problem consists in validating the effect of the gyroscopic matrix on a beam supported on each one of its ends, on linear supports, a harmonic calculation with a loading of the standard unbalance. The beam is full, of circular section and comprises three discs.

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 right beam. The gyroscopic effect led to modify the frequencies of resonance 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

Modeling:

	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	1.1716177	0.6023493

Table 1.1-1 : Characteristics of the discs

Length of the 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 Material properties

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

1.3 Boundary conditions and loadings

Elastic supports 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 digital résusltats were obtained by a code finite elements, in elements beam of the Timoshenko type. Modeling is carried out 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), for a number of revolutions 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 Modeling A

3.1 Characteristics of modeling

Modeling : 13 Elements équi-distribute beam POU_D_T in the direction x

3.2 Characteristics of the grid

Grid: Many nodes: 14
Many meshs and types: 13 SEG2

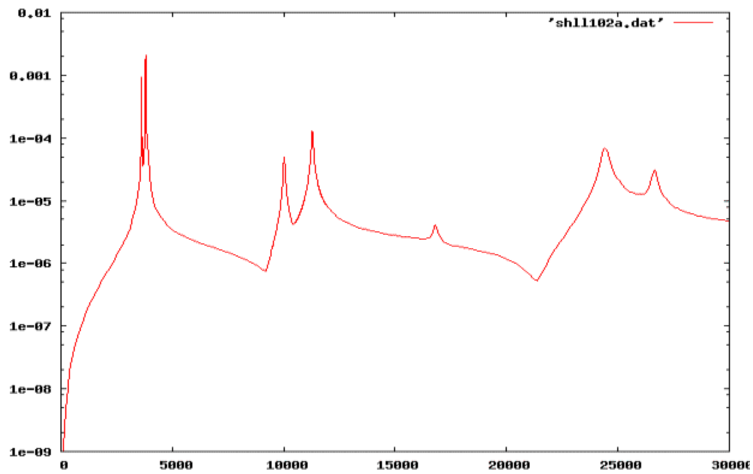
3.3 Loading

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

4 Results

Frequency 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



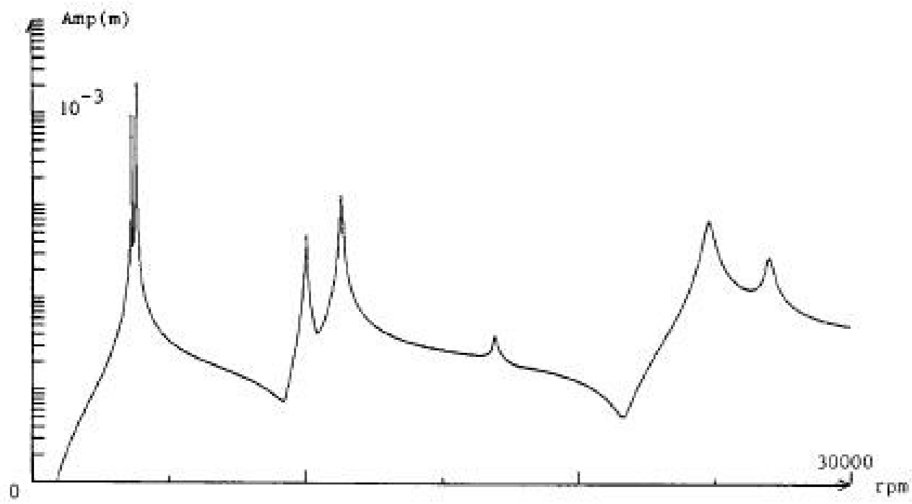


Figure 7 Mass unbalance response: $n = 8$

5 Summary of the results

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