SDLL124 - Pin addition to in rotation with 3 discs subjected to the gyroscopy

Summary:

This test makes it possible to validate the calculation of the modes in rotation of a system of rotating shafts with order CALC_MODE_ROTATION .

In this test, it is about a simple model of rotor with 3 discs, supported by hydrodynamic bearings. This example is drawn from the reference [bib1].

The results of reference result from a calculation with ROTORINSA, [bib2], software finite elements intended to envisage the dynamic behavior of rotors in inflection.

A good agreement is observed between the results of Code_Aster and the reference solution.

1 Problem of reference

1.1 Geometry

A simple model of rotor supported by 2 stages (respectively first and last node of the rotor), is composed of 3 discs, the section of the tree is of $0.05\,m$ of ray. It measures $1.3\,m$ (cf appears below). The rotor is in rotation according to axis Z.

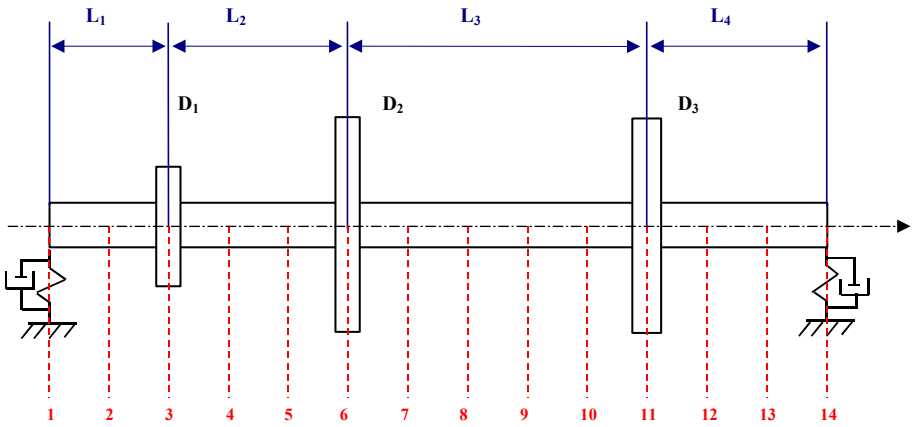

Figure 1.1-a- has: Model of rotor with 3 discs resulting from [bib1]

The respective lengths are:
$L_1=0.2\,m \quad L_2=0.3\,m \quad L_3=0.5\,m \quad L_4=0.3\,m$

1.2 Properties of material

The characteristics of material of the tree and the discs are:

- Young modulus $E=2.10^{11}$
- Density $\rho=7800\,kg/m^3$
- Poisson's ratio $\nu=0.3$

The characteristics of the discs are:

Disc	D_1	D_2	D_3
Thickness (m)	0.05	0.05	0.06
Interior ray (m)	0.05	0.05	0.05
External ray (m)	0.12	0.20	0.20

The characteristics of the stages are:

$K_{xx}=7.10^7\,N/m$	$K_y=5.10^7\,N/m$	$K_{yx}=K_{xy}=0$
$C_{xx}=7.10^2\,Ns/m$	$C_{yy}=5.10^2\,Ns/m$	$C_{yx}=C_{xy}=0$

1.3 Boundary conditions

To block the movements of type rigid body in the direction z, the degree of freedom is blocked DZ with the node of the first stage (first node of the tree).

2 Reference solution

2.1 Method of calculating

The results of reference are given by ROTORINSA, code with the finite elements intended to envisage the dynamic behavior of rotors in inflection. The following parameters were used for the results of reference:

- Calculation relates to a number of modes in rotation $NVES=8+4$, in ROTORINSA.
- The beach number of revolutions is defined of 0 with $30000\,tr/mn$ with a step $10000\,tr/mn$.

2.2 Sizes and results of reference

The Results of ROTORINSA give the frequencies of the modes in inflection.

The calculation of the modes in rotation is carried out with Code_Aster by using same modeling as ROTORINSA. The results of Code_Aster give at the same time the frequencies of the modes of inflection, torsion and traction/compression. The number of calculated modes is 20.

2.3 Bibliographical references

1 MR. LALANNE, G. FERRARIS, " Rotordynamics Prediction in Engineering ", Second Edition, Wiley, 2001.

2 ROTORINSA, software finite elements intended to envisage the dynamic behavior of rotors in inflection, LaMCoS UMR5259, INSA-Lyon.

3 Modeling A

3.1 Characteristics of the grid

The rotor is with a grid in 13 finite elements of tree of the type POU_D_T and of the same length and comprises 4 discrete elements of type DIS_TR for the modeling of the discs and stages. It is the same model with the finite elements which was selected for calculations by ROTORINSA.

Many nodes: 14
Number and type of elements: 13 SEG2
5 POI1

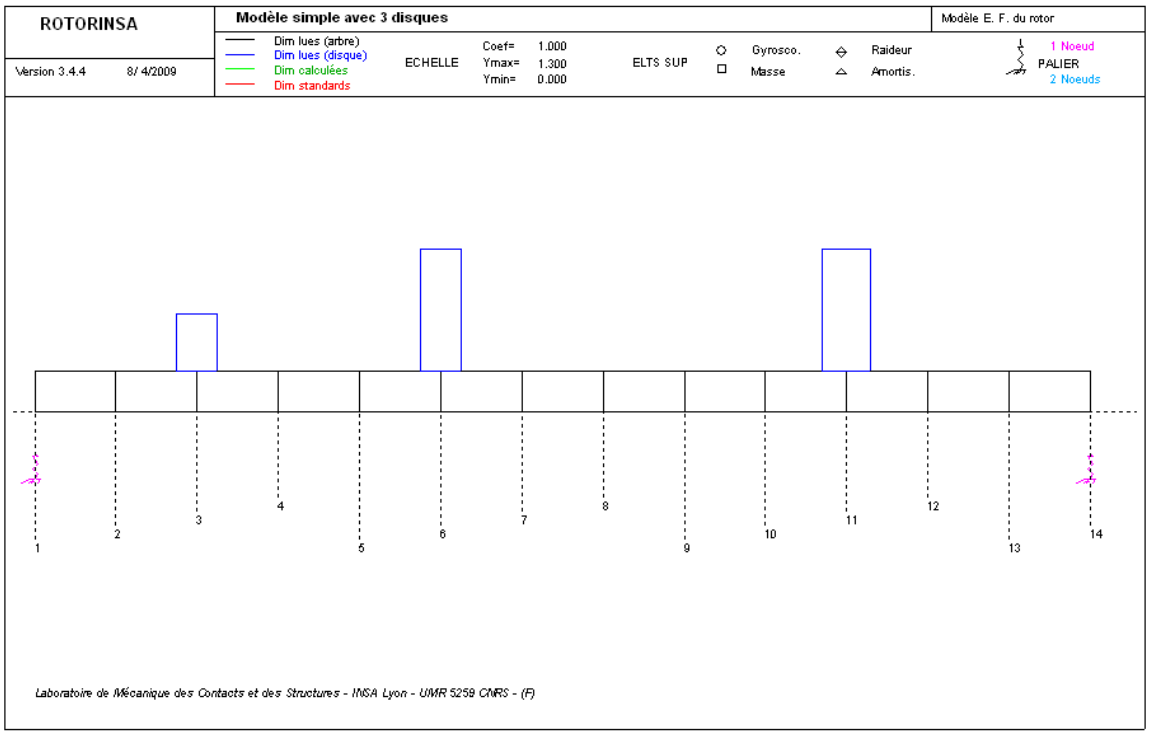

Figure 1-b: Characteristic of the model finite elements under ROTORINSA.

3.2 Sizes tested and results

3.2.1 Eigen frequencies according to the number of revolutions

Values of the first 8 frequencies of inflection for speeds $0\,tr/mn$ and $30000\,tr/mn$, for the two software, are presented in the table below.

N° Fréq in inflection	Number of revolutions (tr/mn)	ROTORINSA		Code_Aster	
		$F(Hz)$	Damping ratio	Tolerance of $F(Hz)$	Tolerance of damping reduced
1	0	6.06148E+01	5.03277E-04	1E-03	1.E-03
	30000	5.41119E+01	2.66235E-04	1.E-03	1.4E-03
2	0	6.30255E+01	3.98814E-04	1.E-03	1.E-03
	30000	6.81221E+01	6.52538E-04	1.E-03	6.E-03
3	0	1.69496E+02	3.12313E-03	1.E-03	2.E-03
	30000	1.54652E+02	3.04410E-03	3.E-03	17.E-03
4	0	1.85563E+02	2.85327E-03	1.E-03	2.E-03
	30000	1.96002E+02	2.76113E-03	2.E-03	20.E-03

Table 2-a: Eigen frequencies of standard inflection for Code_Aster and ROTORINSA

The frequencies obtained are in perfect adequacy with those of ROTORINSA.

In Code_Aster, one observes also frequencies and modes of torsion and modes of traction/compression. These modes are not calculated by ROTORINSA, because it models only the behavior in inflection. The values of these frequencies are tested in NON_REGRESSION.

4 Summary of the results

This CAS-test makes it possible to validate the functionality making it possible to use the nonsymmetrical discrete elements since one finds the same results by Code_Aster and ROTORINSA.