SDLV132 - Taking into account, by substructuring, of a solid mass generalized in a modal computation of line of trees

Summarized:

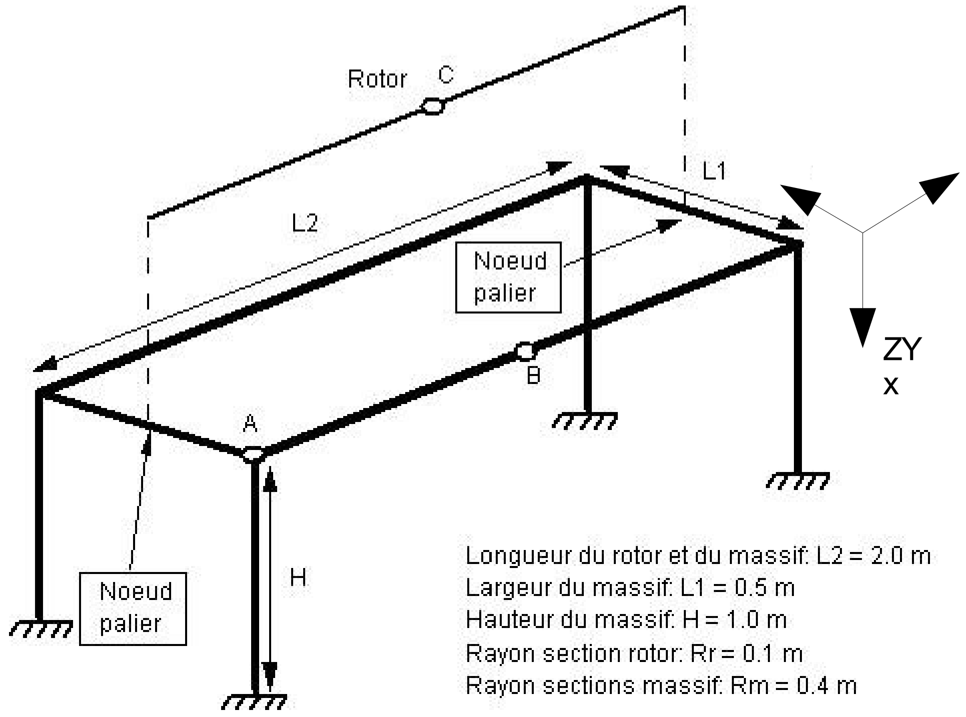
This test makes it possible to validate the taking into account, by substructuring, of a solid mass generalized for a computation of line of trees.

In this test, there is a model of rotor with constant circular section resting on a solid mass via bearings considered as infinitely rigid. This example is drawn from the handbook of qualification of CADYRO, software finite elements intended to model the dynamic behavior of rotors.

1 Problem of reference

1.1 Geometry

the structure is composed of a rotor of length L2 and circular section, two infinitely rigid bearings and a solid mass of circular beams sections.



Appears 1.1-a: Model rotor with 2 bearings and a solid mass

Coordinated of the nodes in the reference (X, Y, Z) :

Support: $A(0.0/-0.25/0.0)$
$B(0.0/-0.25/1.0)$
Rotor: $C(0.0/0.0/1.0)$

1.2 Properties of the material

the geometrical characteristics and material are listed in the following table.

Material	$E=210^{11} N/m^2$	$\rho=7800\,kg/m^3$	$\nu=0.0$
Length of the rotor		$L=2\,m$	
Radius of the rotor		$Rr=0.1\,m$	
Length of the solid mass		$L=2\,m$	
Width of the solid mass		$l=0.5\,m$	
Height of the solid mass		$H=1\,m$	
Radius of the beams of the solid mass		$Rm=0.1\,m$	

Table 1.2-1

two nodes bearings are located exactly in the middle of each with dimensions solid mass.

The coefficients of stiffness in translation of the bearings are: $Kzz=Kyy=1.0\mathrm{E}+12\ kg.s^{-2}$

$$Kzy=Kyz=0.0\ kg.s-2$$

$$Czz=Cyy=Czy=Cyz=0.0\ kg.s^{-1}$$

1.3 Boundary conditions

the bearings of the rotor rest on the solid mass via connections considered as infinitely rigid. The four feet of the solid mass are clamped. The rotor and the solid mass thus are coupled perfectly with the nodes bearings, according to the method of CRAIG-BAMPTON.

2 Reference solution

2.1 Method of calculating

the infinitely rigid bearings and the absence of rotation of the shaft make it possible to carry out a direct computation with *Code_Aster* of the first eigen modes of the structure solid mass-bearing-rotor which will be used as reference to computation substructure in *Code_Aster*.
The validation of the taking into account, by substructuring, of a solid mass generalized in a computation of lines of trees in *Code_Aster* will consist in comparing the eigenfrequencies obtained by a direct computation and a computation substructure (substructuring of the Craig-Bampton type).
One will also endeavor to validate each one of the substructures rotor-bearings and solid mass separately.

In addition to the comparison between total computation and computation substructure in *Code_Aster*, one validates also the results compared to those of CADYRO [1].

2.2 Quantities and results of reference

the results of *Code_Aster* give at the same time the frequencies of the modal modes and the deformed. Only the frequencies are actually tested.

2.3 References

[1] CADYRO, software finite elements intended to envisage the dynamic behavior of rotors in bending file of validation – note HP-61/94/049/B.

3 Modelization A

3.1 Characteristic of the modelization

3.2 Characteristics of the mesh

the rotor is with a grid in 40 finite elements of shaft of the type POU_D_T regularly distributed and comprises 2 discrete elements of the type DIS_TR for the modelization of the bearings.

Many nodes: 41
Number and type of elements: 40SEG2
2POI1

3.3 Quantities tested and results

the criteria of tolerance into relative are of 1% on the results of the type “SOURCE_EXTERNE” and of 5th-3% on the results of the type “NON_REGRESSION”.
The values of the first 6 eigenfrequencies of the rotor are the following ones.

N° Fréq	**Rotor ASTERCalcul**	**CADYRO**
	F (Hz)	F (Hz)
11.00 860E +021 .0090 E+02 21.00 860E +021 .0090 E+02 33.92 529E +023 .9305 E+02 43.92 529E +023 .9305 E+02 58.50 239E +028 .5242 E+02 68.50 239E +028 .5242 E+02		

Table 3.3-1 : Eigenfrequencies of the rotor

the values of the first 10 eigenfrequencies of the solid mass are the following ones.

N° Fréq	Rotor ASTERCalcul	CADYRO
	F (Hz)	F (Hz)
12.19 224E +022 .2104 5E+0 222.5 6714 E+02 2.591 47E+ 0233. 4496 5E+0 23.47 706E +024 4.176 55E+ 024.2 0215 E+02 54.88 441E +024 .9229 1E+0 265.1 7576 E+02 5.217 67E+ 0276. 1909 2E+0 26.24 727E +028 6.414 66E+ 026.4 5547 E+02 97.32 139E +027 .3637 5E+0 2107. 7629 7E+0 27.78 041E +02		
8		
9		
10		

Table 3.3-2 : Eigenfrequencies of the solid mass

the values of the first 7 frequencies to the stop, for the two methods of calculating (direct and substructure), are presented in the table below.

N° Freq	Rotor ASTER computation directCalcul	ASTER computation under-structuréCalcul	CADYRO
	F (Hz)	F (Hz)	F (Hz)
11.00675E+021.00675E+021.00717E+0221.00827E+021.00827E+021.00866E+0232.19250E+022.19933E+022.21064E+0242.56711E+022.56822E+022.59143E+0253.40422E+023.48884E+023.42981E+0263.91994E+023.92003E+023.92524E+0273.96857E+023.98334E+023.97556E+02			

Table 3.3-3 : Eigenfrequencies obtained by computations direct and substructure

4 Modelization B

4.1 Characteristic of the modelization

Identical to the modelization A, but use of operators CREA_ELEM_SSD and ASSE_ELEM_SSD. The computation modal of the direct model (not substructure) was not taken again.

4.2 Quantities tested and results

the values of the first 7 frequencies to the stop are presented in the table below.

N° Fréq	Aster computation computation under-structuréCalcul	CADYRO
	F (Hz)	F (Hz)
11.00712E+021.00717E+0221.00861E+021.00866E+0232.21761E+022.21064E+0242.59264E+022.59143E+0253.51439E+023.42981E+0263.92474E+023.92524E+0273.99088E+023.97556E+02		

Table 4.2-1 : Eigenfrequencies obtained by dynamic substructuring

5 Summary of the results

This benchmark makes it possible to numerically validate the taking into account of a solid mass generalized of line of trees by a computation substructure. The got results are in concord with the values of reference, resulting from the handbook of qualification of the code of lines of trees CADYRO.