# SDNV110 – Voluminal rotor in rotation around its axis, taken into account of the gyroscopy

**Summary:**

This test makes it possible to validate the calculation of the modes in rotation of a voluminal rotor with and without gyroscopic stiffness.

It is about a model of rotor, supported by two stages and in rotation around its axis. This example is drawn from the references [1] and [2].

The results of calculations are compared with those obtained with ANSYS . The results coincide perfectly with the reference solution.

# Contents

# 1 Problem of reference

The objective of this case test is to validate gyroscopic modeling in 3D of a rotor (options `MECA_GYRO` and `RIGI_ROTA`) in Code_Aster.

One compares the results got by the modeling of Code_Aster with those obtained in ANSYS.

## 1.1 Geometry

One considers the rotor represented on the diagram below. It is about a tree length 0.3454 m and variable section, supported on two stages located respectively at the positions 0.1651 m (stage 1) and 0,287 m (stage 2). The rotor comprises a disc of ray interns 0.0203 m and of external ray 0.0495 m (thickness 0,028 m).

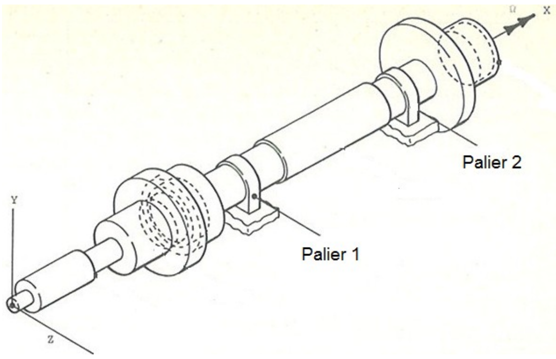


**Image 1.1-1: Geometry of the rotor**

## 1.2 Material properties

The cylinder has a density of $\rho=7\,800\,kg/m^3$ .
The Young modulus is $E=207.10^9\,N\,m^{-2}$ and the Poisson's ratio is $\nu=0{,}3$ .

## 1.3 Boundary conditions and loadings

The tree rests on two stages (Palier1 and Palier2) having the following characteristics in stiffness:

- Configuration a: Kxx = Kyy = 4.378x10 $^7$ N/m, Kxy = Kyx = 0
- Configuration b: Kxx = Kyy = 3.503x10 $^7$ N/m, Kxy = Kyx = -8,756 x10 $^6$

It is with the stop or in rotation at the speed of 100000 tr/min.

# 2 Reference solution

The reference solution is a calculation 3D carried out with ANSYS V14.

1. ANSYS V14.
2. H.D. Nelson and J.M. McVaugh, “The dynamics of Rotor-Bearing System using Finite Elements”, Newspaper of Engineering for industry, May 1976, pg: 593-600.

# 3 Modeling A

## 3.1 Characteristics of modeling

The rotor is modelled by quadratic voluminal elements (PENTA15 and HEXA20). It rests on two stages having the characteristics given by configuration A above.

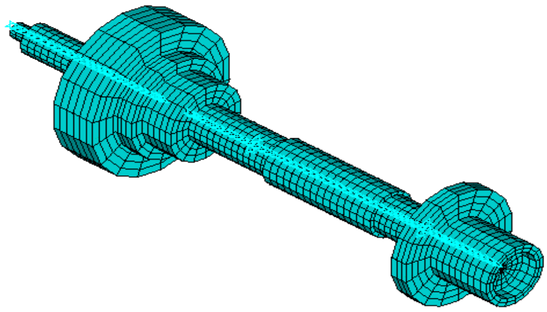

**Image 3.1-1: Grid of the rotor**

CALC_MODES calculate the modes suitable for stop (IE. without gyroscopic damping) and at several number of revolutions, IE. with gyroscopic damping (option MECA_GYRO), but by not taking account of the effect of softening by the stiffness (option centrifuges RIGI_ROTA).

## 3.2 Characteristics of the grid

| | |
|---|---|
| Many meshs HEXA8 | 4230 |
| Many meshs PENTA6 | 1386 |
| Many meshs DIS_T | 2 |

**Table 3.2-1**

## 3.3 Results: comparison enters calculations Code_Aster and ANSYS

For information, one gives below the results of the revolving machine to the stop.

| Identification | Type of reference | Value of reference | Tolerance |
|---|---|---|---|
| Mode 1 | 'EXTERNAL' | 416,38 | 4,00% |
| Mode 2 | 'EXTERNAL' | 416,38 | 4,00% |
| Mode 3 | 'EXTERNAL' | 772,65 | 1,00% |
| Mode 4 | 'EXTERNAL' | 772,65 | 1,00% |
| Mode 5 | 'EXTERNAL' | 1344,3 | 1,00% |
| Mode 6 | 'EXTERNAL' | 1344,3 | 1,00% |

**Table 3.3-1: Summary of the results to the stop**

The tables below give the digital values tested in this CAS-test. They is the Eigen frequencies with 100000 tr/min of the rotor pressed on its two stages.

| Identification | Type of reference | Value of reference | Tolerance |
|---|---|---|---|
| Mode 1 | 'EXTERNAL' | 52,23 | 7,50% |
| Mode 2 | 'EXTERNAL' | 175,51 | 1,00% |
| Mode 3 | 'EXTERNAL' | 496,09 | 2,00% |
| Mode 4 | 'EXTERNAL' | 1032,4 | 1,00% |
| Mode 5 | 'EXTERNAL' | 1824,8 | 6,50% |
| Mode 6 | 'EXTERNAL' | 2438,5 | 3,00% |

**Table 3.3-2: Summary of the results tested at the speed of 100000 tr/min**

# 4 Modeling B

## 4.1 Characteristics of modeling

The rotor is modelled by quadratic voluminal elements (PENTA15 and HEXA20). It rests on two stages having the characteristics given by the configuration B above.

CALC_MODES calculate the modes suitable for stop (IE. without gyroscopic damping) and at several number of revolutions, IE. with gyroscopic damping (option MECA_GYRO), but by not taking account of the effect of softening by the stiffness (option centrifuges RIGI_ROTA).

## 4.2 Characteristics of the grid

| | |
|---|---|
| Many meshs HEXA8 | 4230 |
| Many meshs PENTA6 | 1386 |
| Many meshs DIS_T | 2 |

**Table 4.2-1**

## 4.3 Results: comparison enters calculations Code_Aster and ANSYS

For information, one gives below the results of the revolving machine to the stop.

| Identification | Type of reference | Value of reference | Tolerance |
|---|---|---|---|
| Mode 1 | 'SOURCE_EXTERNE' | 360,23 | 3,00% |
| Mode 2 | 'SOURCE_EXTERNE' | 416,4 | 4,00% |
| Mode 3 | 'SOURCE_EXTERNE' | 653,07 | 1,00% |
| Mode 4 | 'SOURCE_EXTERNE' | 772,68 | 1,00% |
| Mode 5 | 'SOURCE_EXTERNE' | 1191,5 | 2,00% |
| Mode 6 | 'SOURCE_EXTERNE' | 1344,4 | 1,00% |

**Table 4.3-1: Summary of the results tested with the stop**

The tables below give the digital values tested in this CAS-test. They is the Eigen frequencies with 100000 tr/min of the rotor pressed on its two stages.

| Identification | Type of reference | Value of reference | Tolerance |
|---|---|---|---|
| Mode 1 | 'SOURCE_EXTERNE' | 45,36 | 6,50% |
| Mode 2 | 'SOURCE_EXTERNE' | 148,76 | 1,00% |
| Mode 3 | 'SOURCE_EXTERNE' | 446,59 | 2,00% |
| Mode 4 | 'SOURCE_EXTERNE' | 1018,9 | 1,00% |
| Mode 5 | 'SOURCE_EXTERNE' | 1824,8 | 6,50% |
| Mode 6 | 'SOURCE_EXTERNE' | 2394 | 1,00% |

**Table 4.3-2: Summary of the results tested at the speed of 100000 tr/min**

For information, the results are also compared with those given by a modeling 1D of the Beam type of Timoshenko.

| Identification | Type of reference | Value of reference | Tolerance |
|---|---|---|---|
| Mode 1 | 'AUTRE_ASTER' | 45,36 | 6,50% |
| Mode 2 | 'AUTRE_ASTER' | 148,76 | 1,00% |
| Mode 3 | 'AUTRE_ASTER' | 446,59 | 2,00% |
| Mode 4 | 'AUTRE_ASTER' | 1018,9 | 1,00% |
| Mode 5 | 'AUTRE_ASTER' | 1824,8 | 6,50% |
| Mode 6 | 'AUTRE_ASTER' | 2394 | 1,00% |

**Table 4.3-3: Summary of the results tested at the speed of 100000 tr/min**

# 5 Summary of the results

The cas-test implements the rotation of a tree pressed on two stages around its axis. Modeling 3D of the gyroscopy programmed in Code_Aster compared to the results got with the model are equivalent 3D is thus validated in ANSYS.