

SDNV109 – Full voluminal cylinder 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 model with and without gyroscopic stiffness.

It is about a simple model of full, free-free cylinder in rotation around its axis. This example is drawn from the reference [1].

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

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1 Problem of reference

The objective of this case test is to validate gyroscopic modeling in 3D of a full cylinder (options MECA_GYRO and RIGI_ROTATION) in Code_Aster.

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

1.1 Geometry

One considers a cylinder full length $L=0,4\text{ m}$, and of ray $R=0,01\text{ m}$.

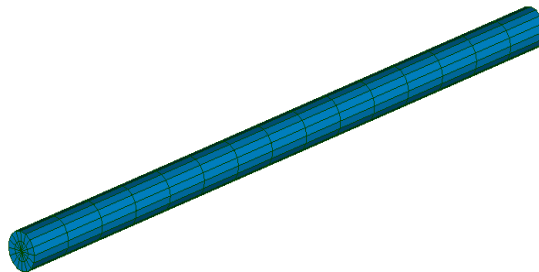


Image 1.1-1: Geometry of the full cylinder

1.2 Material properties

The cylinder has a density of $\rho=7800\text{ kg/m}^3$.

The Young modulus is $E=200.10^9\text{ N m}^{-2}$ and the Poisson's ratio is $\nu=0$.

1.3 Boundary conditions and loadings

One blocks the movements in X, Y and Z of the nodes mediums of the sections at the ends of the cylinder.

It is with the stop or in rotation at the following speeds: 10000,20000,40000,60000,80000 and 100000 tr/min.

2 Reference solution

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

1. ANSYS V14.

3 Modeling A

3.1 Characteristics of modeling

The rotor is modelled by linear voluminal elements (PENTA6 and HEXA8).

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 taking account or not effect of softening by the stiffness centrifuges (option RIGI_ROTA).

3.2 Characteristics of the grid

Many meshes HEXA8	240
Many meshes PENTA6	240

Table 3.2-1

3.3 Results: comparison enters calculations Code_Aster and ANSYS

The tables below give the digital values tested in this CAS-test. They is the Eigen frequencies of the full cylinder in free-free configuration with the stop and rotation.

Identification	Type of reference	Value of reference	Tolerance
Mode 1	\EXTERNAL'	364,48	1,00%
Mode 2	\EXTERNAL'	364,48	1,00%
Mode 3	\EXTERNAL'	1462,6	1,00%
Mode 4	\EXTERNAL'	1462,6	1,00%
Mode 5	\EXTERNAL'	3004,3	1,00%
Mode 6	\EXTERNAL'	3308,3	1,00%
Mode 7	\EXTERNAL'	3308,3	1,00%
Mode 8	\EXTERNAL'	4483,9	1,00%
Mode 9	\EXTERNAL'	5925,4	1,00%

Table 3.3-1: Summary of the results tested with the stop

Identification	Type of reference	Value of reference	Tolerance
Mode 1	\EXTERNAL'	234,26	1,00%
Mode 2	\EXTERNAL'	567,1	1,00%
Mode 3	\EXTERNAL'	1306,2	1,00%
Mode 4	\EXTERNAL'	1637,6	1,00%
Mode 5	\EXTERNAL'	3004,3	1,00%
Mode 6	\EXTERNAL'	3147,8	1,00%
Mode 7	\EXTERNAL'	3477	1,00%
Mode 8	\EXTERNAL'	4483,9	1,00%
Mode 9	\EXTERNAL'	5764,4	1,00%
Mode 10	\EXTERNAL'	6090,8	1,00%

Table 3.3-2: Summary of the results tested at the speed of 10000 tr/min without centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	\EXTERNAL'	198,01	1,00%
Mode 2	\EXTERNAL'	530,85	1,00%
Mode 3	\EXTERNAL'	1296,8	1,00%
Mode 4	\EXTERNAL'	1628,2	1,00%
Mode 5	\EXTERNAL'	3004,3	1,00%
Mode 6	\EXTERNAL'	3143,7	1,00%
Mode 7	\EXTERNAL'	3472,9	1,00%
Mode 8	\EXTERNAL'	4480,8	1,00%
Mode 9	\EXTERNAL'	5762,1	1,00%
Mode 10	\EXTERNAL'	6088,5	1,00%

Table 3.3-3: Summary of the results tested at the speed of 10000 tr/min with centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	'EXTERNAL'	160,75	1,00%
Mode 2	'EXTERNAL'	826,43	1,00%
Mode 3	'EXTERNAL'	1168,2	1,00%
Mode 4	'EXTERNAL'	1831,1	1,00%
Mode 5	'EXTERNAL'	2995,5	1,00%
Mode 6	'EXTERNAL'	3004,3	1,00%
Mode 7	'EXTERNAL'	3653,9	1,00%
Mode 8	'EXTERNAL'	4483,9	1,00%
Mode 9	'EXTERNAL'	5607,9	1,00%
Mode 10	'EXTERNAL'	6260,8	1,00%
Mode 11	'EXTERNAL'	9016,9	1,00%

Table 3.3-4: Summary of the results tested at the speed of 20000 tr/min without centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	'EXTERNAL'	31,41	4,00%
Mode 2	'EXTERNAL'	697,09	1,00%
Mode 3	'EXTERNAL'	1131	1,00%
Mode 4	'EXTERNAL'	1793,8	1,00%
Mode 5	'EXTERNAL'	2978,9	1,00%
Mode 6	'EXTERNAL'	3004,3	1,00%
Mode 7	'EXTERNAL'	3637,3	1,00%
Mode 8	'EXTERNAL'	4471,5	1,00%
Mode 9	'EXTERNAL'	5598,7	1,00%
Mode 10	'EXTERNAL'	6251,6	1,00%
Mode 11	'EXTERNAL'	9010,8	1,00%

Table 3.3-5: Summary of the results tested at the speed of 20000 tr/min with centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	'EXTERNAL'	93,25	1,00%
Mode 2	'EXTERNAL'	942,95	1,00%
Mode 3	'EXTERNAL'	1424,6	1,00%
Mode 4	'EXTERNAL'	2268,6	1,00%
Mode 5	'EXTERNAL'	2714,8	1,00%
Mode 6	'EXTERNAL'	3004,3	1,00%
Mode 7	'EXTERNAL'	4031,6	1,00%
Mode 8	'EXTERNAL'	4483,7	1,00%
Mode 9	'EXTERNAL'	5308,3	1,00%
Mode 10	'EXTERNAL'	6614,1	1,00%
Mode 11	'EXTERNAL'	8721,5	1,00%

Table 3.3-6: Summary of the results tested at the speed of 40000 tr/min without centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	\EXTERNAL'	302,1	1,00%
Mode 2	\EXTERNAL'	798,89	1,00%
Mode 3	\EXTERNAL'	1029,3	1,00%
Mode 4	\EXTERNAL'	2124,5	1,00%
Mode 5	\EXTERNAL'	2649,1	1,00%
Mode 6	\EXTERNAL'	3004,3	1,00%
Mode 7	\EXTERNAL'	3965,9	1,00%
Mode 8	\EXTERNAL'	4433,9	1,00%
Mode 9	\EXTERNAL'	5271,7	1,00%
Mode 10	\EXTERNAL'	6577,5	1,00%
Mode 11	\EXTERNAL'	8698,5	1,00%

Table 3.3-7: Summary of the results tested at the speed of 40000 tr/min with centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	\EXTERNAL'	64,44	1,00%
Mode 2	\EXTERNAL'	774,29	1,00%
Mode 3	\EXTERNAL'	2061,5	1,00%
Mode 4	\EXTERNAL'	2465	1,00%
Mode 5	\EXTERNAL'	2762,7	1,00%
Mode 6	\EXTERNAL'	3004,3	1,00%
Mode 7	\EXTERNAL'	4440,1	1,00%
Mode 8	\EXTERNAL'	4483,5	1,00%
Mode 9	\EXTERNAL'	5026,4	1,00%
Mode 10	\EXTERNAL'	6985	1,00%
Mode 11	\EXTERNAL'	8426	1,00%

Table 3.3-8: Summary of the results tested at the speed of 60000 tr/min without centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	\EXTERNAL'	466,39	2,00%
Mode 2	\EXTERNAL'	636,08	1,00%
Mode 3	\EXTERNAL'	1361	1,00%
Mode 4	\EXTERNAL'	2318,9	1,00%
Mode 5	\EXTERNAL'	2454,8	1,00%
Mode 6	\EXTERNAL'	3004,3	1,00%
Mode 7	\EXTERNAL'	4294	1,00%
Mode 8	\EXTERNAL'	4370,6	1,00%
Mode 9	\EXTERNAL'	4944,3	1,00%
Mode 10	\EXTERNAL'	6902,9	1,00%
Mode 11	\EXTERNAL'	8374,2	1,00%

Table 3.3-9: Summary of the results tested at the speed of 60000 tr/min with centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	'EXTERNAL'	48,99	1,00%
Mode 2	'EXTERNAL'	648,31	1,00%
Mode 3	'EXTERNAL'	2244	1,00%
Mode 4	'EXTERNAL'	2711,7	1,00%
Mode 5	'EXTERNAL'	3004,3	1,00%
Mode 6	'EXTERNAL'	3299,5	1,00%
Mode 7	'EXTERNAL'	4483,2	1,00%
Mode 8	'EXTERNAL'	4761,8	1,00%
Mode 9	'EXTERNAL'	4877,5	1,00%
Mode 10	'EXTERNAL'	7373,2	1,00%
Mode 11	'EXTERNAL'	8141,4	1,00%

Table 3.3-10: Summary of the results tested at the speed of 80000 tr/min without centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	'EXTERNAL'	133,46	1,00%
Mode 2	'EXTERNAL'	970,51	1,00%
Mode 3	'EXTERNAL'	1692,2	1,00%
Mode 4	'EXTERNAL'	1988,3	1,00%
Mode 5	'EXTERNAL'	2784,7	1,00%
Mode 6	'EXTERNAL'	3004,3	1,00%
Mode 7	'EXTERNAL'	4280,4	1,00%
Mode 8	'EXTERNAL'	4616,6	1,00%
Mode 9	'EXTERNAL'	4621,8	1,00%
Mode 10	'EXTERNAL'	7228	1,00%
Mode 11	'EXTERNAL'	8049,5	1,00%

Table 3.3-11: Summary of the results tested at the speed of 80000 tr/min with centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	'EXTERNAL'	39,45	1,00%
Mode 2	'EXTERNAL'	553,15	1,00%
Mode 3	'EXTERNAL'	2049,2	1,00%
Mode 4	'EXTERNAL'	3004,3	1,00%
Mode 5	'EXTERNAL'	3367,8	1,00%
Mode 6	'EXTERNAL'	3867,2	1,00%
Mode 7	'EXTERNAL'	4482,9	1,00%
Mode 8	'EXTERNAL'	4513,8	1,00%
Mode 9	'EXTERNAL'	5341,1	1,00%
Mode 10	'EXTERNAL'	7778,1	1,00%
Mode 11	'EXTERNAL'	7867,7	1,00%

Table 3.3-12: Summary of the results tested at the speed of 100000 tr/min without centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	`EXTERNAL`	199,92	3,00%
Mode 2	`EXTERNAL`	1305,4	1,00%
Mode 3	`EXTERNAL`	1666,3	1,00%
Mode 4	`EXTERNAL`	2023	1,00%
Mode 5	`EXTERNAL`	3004,3	1,00%
Mode 6	`EXTERNAL`	3114,1	1,00%
Mode 7	`EXTERNAL`	4161,7	1,00%
Mode 8	`EXTERNAL`	4288,4	1,00%
Mode 9	`EXTERNAL`	4949,1	1,00%
Mode 10	`EXTERNAL`	7552,7	1,00%
Mode 11	`EXTERNAL`	7724,5	1,00%

Table 3.3-13: Summary of the results tested at the speed of 100000 tr/min with centrifugal softening

4 Modeling B

4.1 Characteristics of modeling

The rotor is modelled by quadratic voluminal elements (PENTA1 and HEXA20).

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 taking account or not effect of softening by the stiffness centrifuges (option RIGI_ROTA).

4.2 Characteristics of the grid

Many meshes HEXA20	240
Many meshes PENTA15	240

Table 4.2-1

4.3 Results: comparison enters calculations Code_Aster and ANSYS

The tables below give the digital values tested in this CAS-test. They is the Eigen frequencies of the full cylinder in free-free configuration with the stop and rotation.

Identification	Type of reference	Value of reference	Tolerance
Mode 1	\EXTERNAL'	247,84	2,00%
Mode 2	\EXTERNAL'	247,84	2,00%
Mode 3	\EXTERNAL'	983,03	2,00%
Mode 4	\EXTERNAL'	983,03	2,00%
Mode 5	\EXTERNAL'	2182,21	1,00%
Mode 6	\EXTERNAL'	2182,21	1,00%
Mode 7	\EXTERNAL'	2740,85	1,00%
Mode 8	\EXTERNAL'	3811,07	1,00%
Mode 9	\EXTERNAL'	3811,07	1,00%
Mode 10	\EXTERNAL'	4475,67	1,00%
Mode 11	\EXTERNAL'	5829,53	1,00%
Mode 12	\EXTERNAL'	5829,53	1,00%

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

Identification	Type of reference	Value of reference	Tolerance
Mode 1	\EXTERNAL'	132,11	2,00%
Mode 2	\EXTERNAL'	464,94	1,00%
Mode 3	\EXTERNAL'	831,22	2,00%
Mode 4	\EXTERNAL'	1162,58	1,00%
Mode 5	\EXTERNAL'	2023,86	2,00%
Mode 6	\EXTERNAL'	2352,96	1,00%
Mode 7	\EXTERNAL'	2740,85	1,00%
Mode 8	\EXTERNAL'	3651,42	1,00%
Mode 9	\EXTERNAL'	3977,7	1,00%
Mode 10	\EXTERNAL'	4475,66	1,00%
Mode 11	\EXTERNAL'	5670,2	1,00%
Mode 12	\EXTERNAL'	5993,34	1,00%

Table 4.3-2: Summary of the results tested at the speed of 10000 tr/min without centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	'EXTERNAL'	81,34	4,00%
Mode 2	'EXTERNAL'	414,16	1,00%
Mode 3	'EXTERNAL'	817,27	2,00%
Mode 4	'EXTERNAL'	1148,6	1,00%
Mode 5	'EXTERNAL'	2017,6	2,00%
Mode 6	'EXTERNAL'	2346,7	1,00%
Mode 7	'EXTERNAL'	2740,9	1,00%
Mode 8	'EXTERNAL'	3647,9	1,00%
Mode 9	'EXTERNAL'	3974,1	1,00%
Mode 10	'EXTERNAL'	4472,6	1,00%
Mode 11	'EXTERNAL'	5667,9	1,00%
Mode 12	'EXTERNAL'	5991	1,00%

Table 4.3-3: Summary of the results tested at the speed of 10000 tr/min with centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	'EXTERNAL'	82,14	3,00%
Mode 2	'EXTERNAL'	706,02	2,00%
Mode 3	'EXTERNAL'	747,79	1,00%
Mode 4	'EXTERNAL'	1368,74	1,00%
Mode 5	'EXTERNAL'	1877,79	2,00%
Mode 6	'EXTERNAL'	2535,99	1,00%
Mode 7	'EXTERNAL'	2740,85	1,00%
Mode 8	'EXTERNAL'	3498,73	1,00%
Mode 9	'EXTERNAL'	4151,29	1,00%
Mode 10	'EXTERNAL'	4475,62	1,00%
Mode 11	'EXTERNAL'	5515,33	1,00%
Mode 12	'EXTERNAL'	6161,61	1,00%

Table 4.3-4: Summary of the results tested at the speed of 20000 tr/min without centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	\EXTERNAL'	85,33	4,00%
Mode 2	\EXTERNAL'	580,32	1,00%
Mode 3	\EXTERNAL'	651,34	2,00%
Mode 4	\EXTERNAL'	1314,1	1,00%
Mode 5	\EXTERNAL'	1852,8	2,00%
Mode 6	\EXTERNAL'	2511	1,00%
Mode 7	\EXTERNAL'	2740,9	1,00%
Mode 8	\EXTERNAL'	3484,5	1,00%
Mode 9	\EXTERNAL'	4137	1,00%
Mode 10	\EXTERNAL'	4463,2	1,00%
Mode 11	\EXTERNAL'	5506,1	1,00%
Mode 12	\EXTERNAL'	6152,4	1,00%

Table 4.3-5: Summary of the results tested at the speed of 20000 tr/min with centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	\EXTERNAL'	44,64	3,00%
Mode 2	\EXTERNAL'	522,84	2,00%
Mode 3	\EXTERNAL'	1375,94	1,00%
Mode 4	\EXTERNAL'	1621,11	2,00%
Mode 5	\EXTERNAL'	1848,28	1,00%
Mode 6	\EXTERNAL'	2740,85	1,00%
Mode 7	\EXTERNAL'	2937,5	1,00%
Mode 8	\EXTERNAL'	3214	1,00%
Mode 9	\EXTERNAL'	4475,5	1,00%
Mode 10	\EXTERNAL'	4519,1	1,00%
Mode 11	\EXTERNAL'	5219	1,00%
Mode 12	\EXTERNAL'	6511,5	1,00%

Table 4.3-6: Summary of the results tested at the speed of 40000 tr/min without centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	'EXTERNAL'	318,98	4,00%
Mode 2	'EXTERNAL'	419,18	1,00%
Mode 3	'EXTERNAL'	912,12	1,00%
Mode 4	'EXTERNAL'	1522,7	2,00%
Mode 5	'EXTERNAL'	1644,4	1,00%
Mode 6	'EXTERNAL'	2740,9	1,00%
Mode 7	'EXTERNAL'	2839,1	1,00%
Mode 8	'EXTERNAL'	3157,3	1,00%
Mode 9	'EXTERNAL'	4425,6	1,00%
Mode 10	'EXTERNAL'	4462,4	1,00%
Mode 11	'EXTERNAL'	5182,1	1,00%
Mode 12	'EXTERNAL'	6474,7	1,00%

Table 4.3-7: Summary of the results tested at the speed of 40000 tr/min with centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	'EXTERNAL'	30,3	3,00%
Mode 2	'EXTERNAL'	403,97	2,00%
Mode 3	'EXTERNAL'	1407,86	2,00%
Mode 4	'EXTERNAL'	2027,25	1,00%
Mode 5	'EXTERNAL'	2392,12	1,00%
Mode 6	'EXTERNAL'	2740,85	1,00%
Mode 7	'EXTERNAL'	2955,92	1,00%
Mode 8	'EXTERNAL'	3382,46	1,00%
Mode 9	'EXTERNAL'	4475,27	1,00%
Mode 10	'EXTERNAL'	4913,58	1,00%
Mode 11	'EXTERNAL'	4940,14	1,00%
Mode 12	'EXTERNAL'	6878,96	1,00%

Table 4.3-8: Summary of the results tested at the speed of 60000 tr/min without centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	'NON_REGRESSION'	25.2636	0,001%
Mode 2	'EXTERNAL'	753,73	1,00%
Mode 3	'EXTERNAL'	1192	2,00%
Mode 4	'EXTERNAL'	1243,2	1,00%
Mode 5	'EXTERNAL'	1974,1	1,00%
Mode 6	'EXTERNAL'	2740,9	1,00%
Mode 7	'EXTERNAL'	2829,5	2,00%
Mode 8	'EXTERNAL'	3166,6	1,00%
Mode 9	'EXTERNAL'	4362,1	1,00%
Mode 10	'EXTERNAL'	4787,2	1,00%
Mode 11	'EXTERNAL'	4857,5	1,00%
Mode 12	'EXTERNAL'	6796,4	1,00%

Table 4.3-9: Summary of the results tested at the speed of 60000 tr/min with centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	'EXTERNAL'	22,87	3,00%
Mode 2	'EXTERNAL'	324,76	3,00%
Mode 3	'EXTERNAL'	1232,12	2,00%
Mode 4	'EXTERNAL'	2685,47	1,00%
Mode 5	'EXTERNAL'	2723,22	2,00%
Mode 6	'EXTERNAL'	2740,85	1,00%
Mode 7	'EXTERNAL'	2975,62	1,00%
Mode 8	'EXTERNAL'	3864,9	1,00%
Mode 9	'EXTERNAL'	4474,95	1,00%
Mode 10	'EXTERNAL'	4678,51	1,00%
Mode 11	'EXTERNAL'	5333,42	1,00%
Mode 12	'EXTERNAL'	7016,01	1,00%

Table 4.3-10: Summary of the results tested at the speed of 80000 tr/min without centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	'EXTERNAL'	347,74	4,00%
Mode 2	'EXTERNAL'	860,69	3,00%
Mode 3	'EXTERNAL'	1089	1,00%
Mode 4	'EXTERNAL'	1573,6	1,00%
Mode 5	'EXTERNAL'	2303,1	1,00%
Mode 6	'EXTERNAL'	2501,1	2,00%
Mode 7	'EXTERNAL'	2740,9	1,00%
Mode 8	'EXTERNAL'	3493,5	1,00%
Mode 9	'EXTERNAL'	4271,8	1,00%
Mode 10	'EXTERNAL'	4532,4	1,00%
Mode 11	'EXTERNAL'	5111,3	1,00%
Mode 12	'EXTERNAL'	6912,5	1,00%

Table 4.3-11: Summary of the results tested at the speed of 80000 tr/min with centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	'EXTERNAL'	18,35	3,00%
Mode 2	'EXTERNAL'	269,68	3,00%
Mode 3	'EXTERNAL'	1087,57	2,00%
Mode 4	'EXTERNAL'	2514,15	2,00%
Mode 5	'EXTERNAL'	2740,85	1,00%
Mode 6	'EXTERNAL'	3346,6	1,00%
Mode 7	'EXTERNAL'	3583,26	1,00%
Mode 8	'EXTERNAL'	4378,54	1,00%
Mode 9	'EXTERNAL'	4433,54	1,00%
Mode 10	'EXTERNAL'	4474,55	1,00%
Mode 11	'EXTERNAL'	5776,87	1,00%
Mode 12	'EXTERNAL'	6751,4	1,00%

Table 4.3-12: Summary of the results tested at the speed of 100000 tr/min without centrifugal softening

Identification	Type of reference	Value of reference	Tolerance
Mode 1	`EXTERNAL`	528,71	5,00%
Mode 2	`EXTERNAL`	682,12	2,00%
Mode 3	`EXTERNAL`	1425	1,00%
Mode 4	`EXTERNAL`	1903,3	1,00%
Mode 5	`EXTERNAL`	2172,1	2,00%
Mode 6	`EXTERNAL`	2631,5	1,00%
Mode 7	`EXTERNAL`	2740,8	1,00%
Mode 8	`EXTERNAL`	3819,7	1,00%
Mode 9	`EXTERNAL`	4152,7	1,00%
Mode 10	`EXTERNAL`	4206,7	1,00%
Mode 11	`EXTERNAL`	5434,8	1,00%
Mode 12	`EXTERNAL`	6590,2	1,00%

Table 4.3-13 : Summary of the results tested at the speed of 100000 tr/min with centrifugal softening

5 Summary of the results

The cas-test implements the rotation of a full cylinder 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.