
SDLL11 - Thin circular ring free-free

Abstract:

This benchmark makes it possible to test the frequencies and the modes of vibration of a circular ring into free-free.

Eight modelizations are carried out, for each one among it one specifies the modelization and the type of mesh tested.

The method of search of the eigenfrequencies used is the method of SORENSEN for the modelizations A, B, C, D, E, F, G , and the method of LANCZOS for the modelization I .

•Modelizations 3D

- Modelization A : net HEXA20
- Modelization B : net HEXA8
- Modelization C : net PENTA15
- Modelization D : net TETRA10

•Modelization POU_C_T

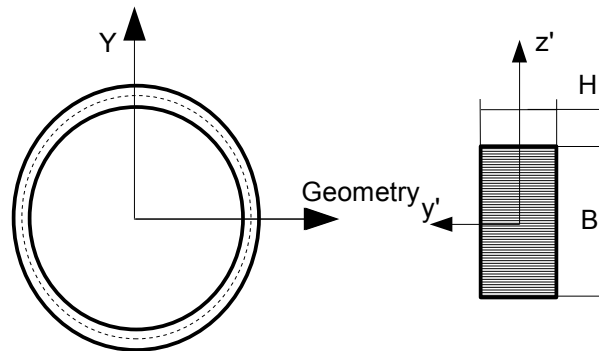
- Modelization E : net SEG2

•Modelizations 2D

- Modelization F : net QUAD8
- Modelization G : net QUAD8
- Modelization I : X net

1 QUAD8 Problem of

1.1 reference



Dimension in (m)

- average Radius of curvature $R=0.1m$
- Thickness: $h=0.005m$
- Width: $b=0.010m$ (perpendicular plane)
- Area: $A=5\times 10^{-5}m^2$
- Main moment of inertia: $I_z=1.042\times 10^{-10}m^4$ $I_y=4.167\times 10^{-10}m^4$
- Twisting moment: $J=2.859\times 10^{-10}m^4$

1.2 Properties of the Elastic

- material
- $E=7.2\times 10^{10}Pa$ Modulus Young
- $\nu=0.3$ Poisson's ratio
- $\rho=2700kg/m^3$ Density

1.3 Boundary conditions and loadings

- Displacements: all the points of the ring are free
- Loading: no

2 Reference solution

2.1 Méthode de calcul used for the reference solution

•Modes of vibration in the plane

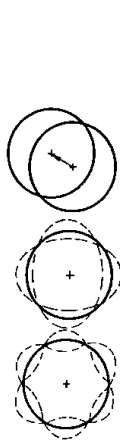
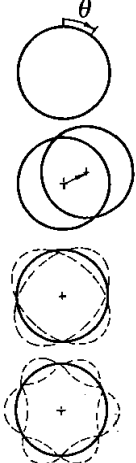
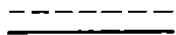

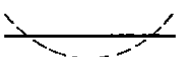
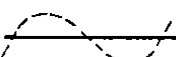
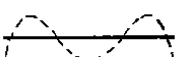
For these modes of vibration, the equation of bending of the curved beams of V. Boussinesq (1883), without extension of neutral fiber leads to:

$$f_i = \frac{1}{2\pi} \sqrt{\left(\frac{i^2(i^2-1)^2}{i^2+1} \times \frac{EI_z}{\rho AR^4} \right)} \quad i=0,1,2,\dots$$

The reference solution is established for thin arcs such as $\alpha R \geq 100 \sqrt{\left(\frac{I_z}{A} \right)}$ with α , angle in the center in radians.

•Modes of vibration except plane

For the transverse modes of vibrations with rectangular section, the solution was established starting from the results of two computer codes, using different formulations.

Eigen modes in the plane (polar coordinates (i, θ))		Eigen modes except Symmetric
$u'_i = i \cos(i\theta)$ plane $v'_i = \sin(i\theta)$	Skew-symmetric $u'_i = i \sin(i\theta)$ $v'_i = -\cos(i\theta)$ $\theta'_i = -\frac{1-i^2}{R} \cos(i\theta)$	
		$i=0$  $i=1$  $i=2$  $i=3$  $i=4$ 
$\theta'_i = -\frac{1-i^2}{R} \sin(i\theta)$		

2.2 reference Variable

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

- *FREQ* : frequency

2.3 Quantity and result of Natural

	Component	reference of the eigen mode		Reference (Hz)
		<i>i</i>	order	
Modes in transverse	<i>FREQ</i>	2	4,5	318.36
		3	6,7	900.46
		4	8,9	1726.55
		5	10,11	2792.21
the Modes plane	<i>FREQ</i>	2	4,5	511.
		3	6,7	1590.
		4	8,9	3184.

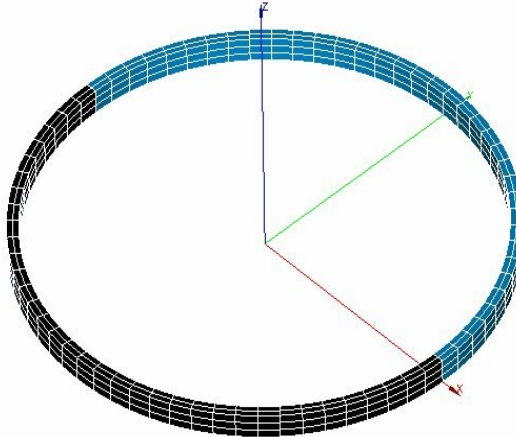
2.4 bibliographical References

- [1] Guides Validation of the Software packages of Computations of Structures: SFM, technical AFNOR, ISBN: 2-12-486611-7

3 Modelization A

3.1 Characteristic of the modelization A

- Modelization 3D



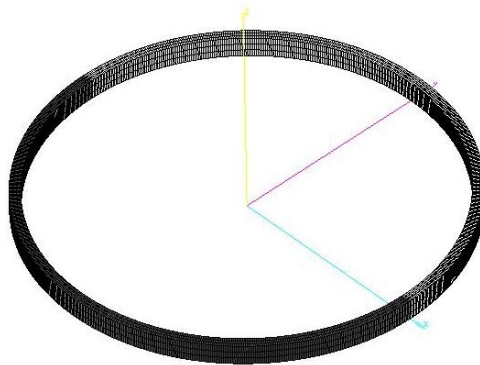
Many nodes 2952
Number of meshes 432 HEXA20

3.2 Quantities tested and Natural

	Component	results of the eigen mode		Reference (Hz)	Tolerance (%)
		<i>i</i>	order		
Modes in transverse	<i>FREQ</i>	2	4,5	318.36	0.1
		3	6,7	900.46	0.3
		4	8,9	1726.55	0.5
		5	10,11	2792.21	0.8
the Modes plane	<i>FREQ</i>	2	4,5	511.	0.7
		3	6,7	1590.	1.4
		4	8,9	3184.	2.3

4 Modelization B

4.1 Characteristic of the modelization B



Modelization 3D :

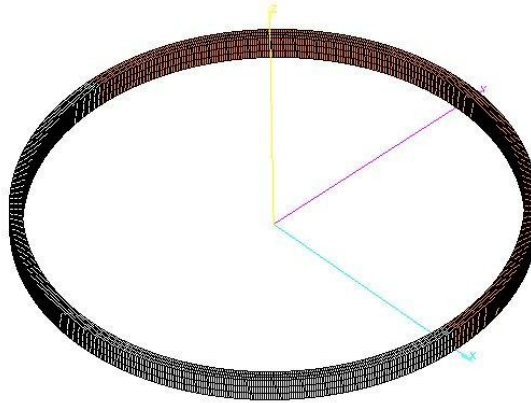
Many nodes 12800
Number of meshes 7200 HEXA8

4.2 Quantities tested and Natural

	Component	results of the eigen mode		Reference (Hz)	Tolerance (%)
		<i>i</i>	order		
Modes in transverse	<i>FREQ</i>	2	4,5	318.36	1.8
		3	6,7	900.46	1.6
		4	8,9	1726.55	1.35
		5	10,11	2792.21	1.
the Modes plane	<i>FREQ</i>	2	4,5	511.	1.7
		3	6,7	1590.	0.4
		4	8,9	3184.	0.8

5 Modelization C

5.1 Characteristic of the modelization C



Modelization 3D :

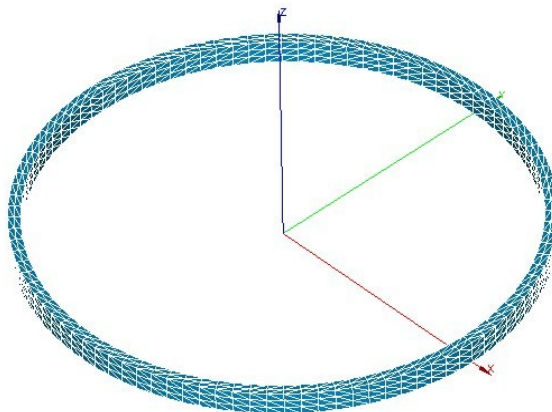
Many nodes 3528
Number of meshes 864 PENTA15

5.2 Quantities tested and Natural

	Component	results of the eigen mode		Reference (Hz)	Tolerance (%)
		<i>i</i>	order		
Modes in transverse	<i>FREQ</i>	2	4,5	318.36	0.1
		3	6,7	900.46	0.2
		4	8,9	1726.55	0.35
		5	10,11	2792.21	0.6
the Modes plane	<i>FREQ</i>	2	4,5	511.	0.7
		3	6,7	1590.	1.4
		4	8,9	3184.	2.3

6 Modelization D

6.1 Characteristic of the modelization D



Modelization 3D :

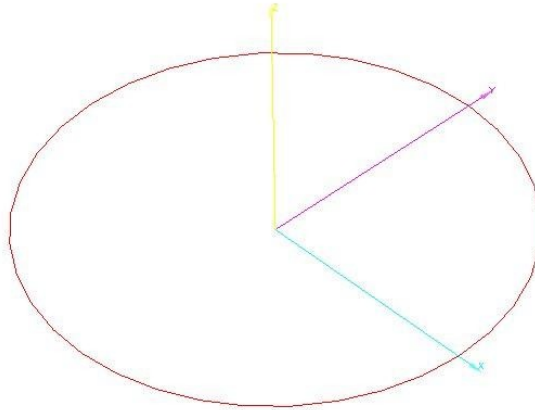
Many nodes 5824
Number of meshes 2728 TETRA10

6.2 Quantities tested and Natural

	Component	results of the eigen mode		Reference (Hz)	Tolerance (%)
		l	order		
Modes in the plane	<i>FREQ</i>	2	4,5	318.36	0.1.0.2.0.4
		3	6,7	900.46	
		4	8,9	1726.55	
		5	10,11	2792.21	0.7
transverse Modes	<i>FREQ</i>	2	4,5	511.	0.25
		3	6,7	1590.	1.1.2.0
		4	8,9	3184.	

7 Modelization E

7.1 Characteristic of the modelization E



Modelization POU_C_T :

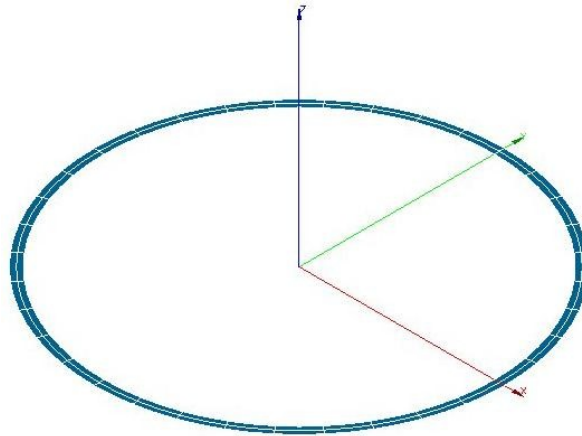
Many nodes	36	
Number of meshes	36	SEG2

7.2 Quantities tested and Natural

	Component	results of the eigen mode		Reference (Hz)	Tolerance (%)
		<i>i</i>	order		
Modes in transverse	<i>FREQ</i>	2	4,5	318.36	0.25
		3	6,7	900.46	0.6
		4	8,9	1726.55	1.1
		5	10,11	2792.21	1.7
the Modes plane	<i>FREQ</i>	2	4,5	511.	0.85
		3	6,7	1590.	1.5
		4	8,9	3184.	2.4

8 Modelization F

8.1 Characteristic of the modelization F



Modelization D_PLAN :

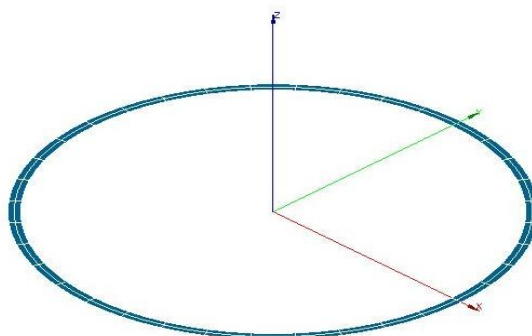
Many nodes 288
Number of meshes 72 QUAD8

8.2 Quantities tested and Natural

	Component	results of the eigen mode		Reference (Hz)	Tolerance (%)
		<i>i</i>	order		
Modes in the Modelization	<i>FREQ</i>	2	4,5	318.36	1.4
		3	6,7	900.46	1.6
		4	8,9	1726.55	1.7
		5	10,11	2792.21	2.0

9 plane G

9.1 Characteristic of the modelization G



Modelization C_PLAN :

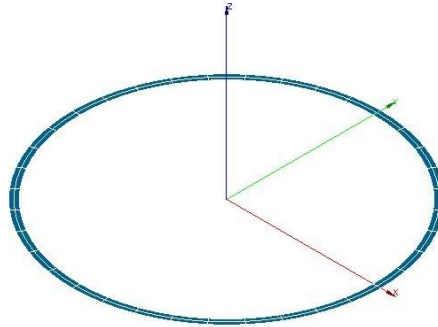
Many nodes 293
Number of meshes 72 QUAD8

9.2 Quantities tested and Natural

	Component	results of the eigen mode		Reference (Hz)	Tolerance (%)
		<i>i</i>	order		
Modes in the Modelization	<i>FREQ</i>	2	4,5	318.36	1.4
		3	6,7	900.46	1.6
		4	8,9	1726.55	1.7
		5	10,11	2792.21	2.0

10 plane I

10.1 Characteristic of the modelization I



Modelization C_PLAN :

Many nodes 293
Number of meshes 72 QUAD8

10.2 Quantities tested and Natural

	Component	results of the eigen mode		Reference (Hz)	Tolerance (%)
		<i>i</i>	order		
Modes in the Summary	<i>FREQ</i>	2	4,5	318.36	1.4
		3	6,7	900.46	1.6
		4	8,9	1726.55	1.7
		5	10,11	2792.21	2.0

11 plane of the results

the got results are satisfactory.