SDLV401 - Free-free full sphere

Summary:

This three-dimensional test of modal analysis consists in calculating the Eigen frequencies of a full sphere into free-free.

The interest of this test is to evaluate the robustness and the performance of *Code_Aster* in the detection of the rigid modes and multiple frequencies, during the use of voluminal elements.

The reference solution is digital and is obtained using the computation software of structures by finite elements the SAMCEF software.

In this test, one compares the results got with two types of elements:

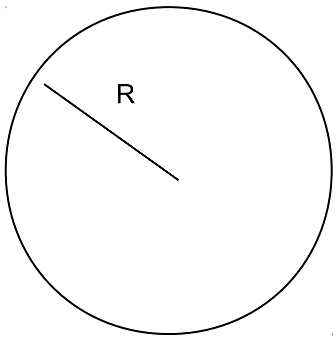
1) the element `HEXA8` (modeling A)
2) the element `HEXA20` (modeling B).

In order to determine the clean elements of this system, the method known as of SORENSEN is used.

1 Problem of reference

1.1 Geometry

Full sphere:



Interior ray $R=0.01\,m$

1.2 Material properties

The linear presumedly elastic material has the following characteristics:

$$E=1.\mathrm{E8}\,Pa$$
$$\nu=0.3$$
$$\rho=10000\,kg/m^3$$

1.3 Boundary conditions and loadings

The studied structure is free in space.

2 Reference solution

2.1 Method of calculating used for the reference solution

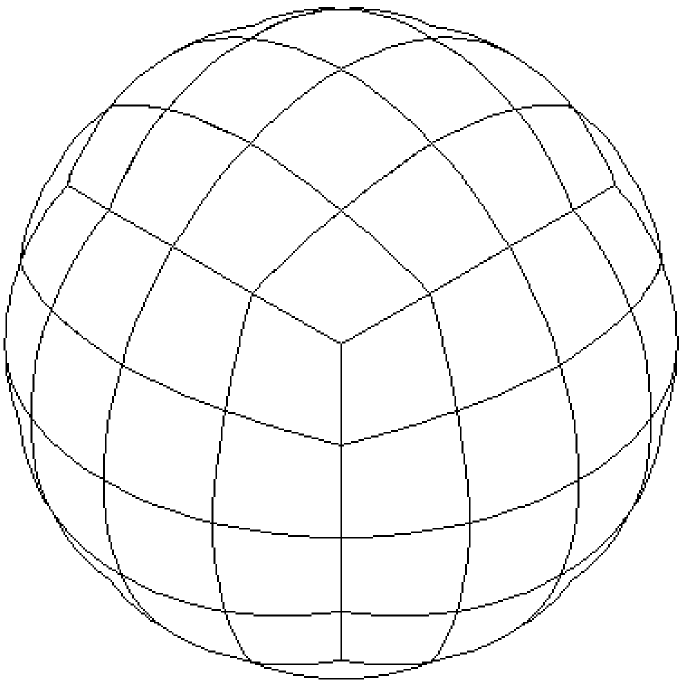
The reference solution is digital: it is obtained with the computation software of structures by finite elements the SAMCEF software.
The method of calculating of the Eigen frequencies is the method known as of SORENSEN (algorithm by default in the operator CALC_MODES).

2.2 Results of reference

The structure presenting six rigid modes, one is interested in the first 10 nonworthless Eigen frequencies.
The following table shows the values of the frequencies obtained (in Hz) according to the degree of the voluminal elements.

Mode	Degree 1	Degree 2
1	2.54231 E3	2.47035 E3
2	2.54231 E3	2.47035 E3
3	2.60747 E3	2.47101 E3
4	2.60747 E3	2.47101 E3
5	2.60747 E3	2.47101 E3
6	2.74095 E3	2.61296 E3
7	2.74095 E3	2.61296 E3
8	2.74095 E3	2.61430 E3
9	2.76313 E3	2.61430 E3
10	2.76313 E3	2.61430 E3

3 Modeling A



3.1 Characteristics of modeling A

Grid made up of elements `HEXA8`

3.2 Characteristics of the grid

Many nodes: 417
Number of meshs and type: 160 `HEXA8`

3.3 Sizes tested and results

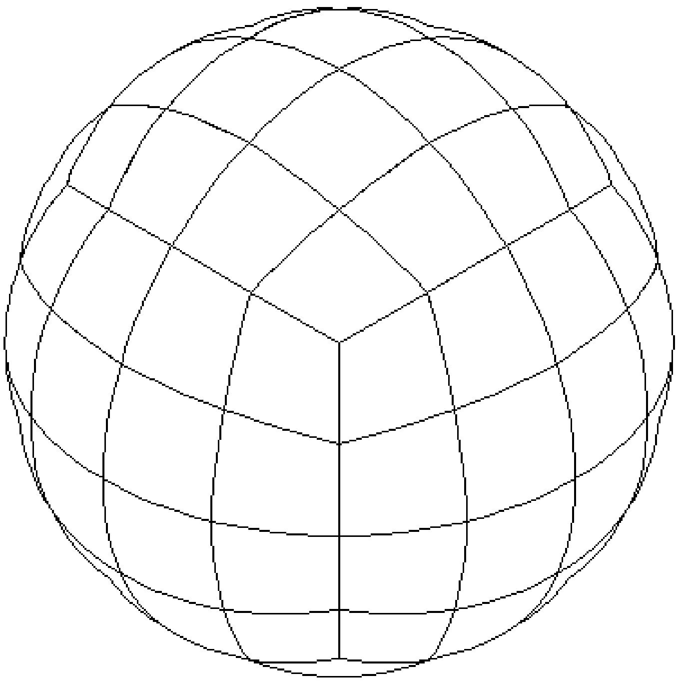
(Frequencies in Hertz)

Identification n° mode	Reference	*Code_Aster*	% difference
1	2.54231 E3	2.54231 E3	| 1 E -6
2	2.54231 E3	2.54231 E3	| 1 E -6
3	2.60747 E3	2.60747 E3	| 1 E -6
4	2.60747 E3	2.60747 E3	| 1 E -6
5	2.60747 E3	2.60747 E3	| 1 E -6
6	2.74095 E3	2.74095 E3	| 1 E -6
7	2.74095 E3	2.74095 E3	| 1 E -6
8	2.74095 E3	2.74095 E3	| 1 E -6
9	2.76313 E3	2.76313 E3	| 1 E -6
10	2.76313 E3	2.76313 E3	| 1 E -6

3.4 Remarks

Code_Aster detect well the 6 modes of rigid body.

4 Modeling B



4.1 Characteristics of modeling B

Grid made up of elements `HEXA20`

4.2 Characteristics of the grid

Many nodes: 815
Number of meshs and type: 160 `HEXA20`

4.3 Sizes tested and results

(Frequencies in Hertz)

Identification n° mode	Reference	*Code_Aster*	% difference
1	2.47035 E3	2.46964	-0,029
2	2.47035 E3	2.46964	-0,029
3	2.47101 E3	2.47084	-0,007
4	2.47101 E3	2.47084	-0,007
5	2.47101 E3	2.47084	-0,007
6	2.61296 E3	2.61344	0,019
7	2.61296 E3	2.61344	0,019
8	2.61430 E3	2.61345	-0,033
9	2.61430 E3	2.61364	-0,025
10	2.61430 E3	2.61364	-0,025

4.4 Remarks

Code_Aster detect well the 6 modes of rigid body.

5 Summary of the results

The got results are excellent since the instantaneous frequency deviations with the reference solution are lower than 0.03% . Moreover, *Code_Aster* detect well the 6 modes of rigid body, which one did not ask to calculate.

To calculate the rigid modes indeed, two possibilities exist. With the option `'BAND'` on the waveband $(0,3000\,Hz)$, one can employ is the method of `'SORENSEN'`, that is to say the method of LANCZOS (`'TRI_DIAG'`) by specifying the option `'MODE_RIGIDE'`.