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# Eigenfrequency Analysis of a Free Cylinder

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## *Introduction*

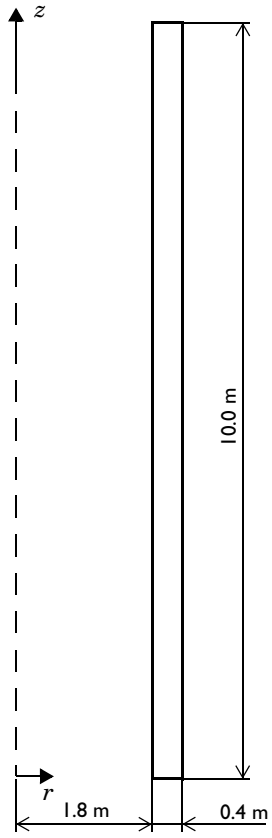
In the following example you will build and solve an axial symmetric model using the Axial Symmetry, Stress-Strain application mode.

This model calculates the eigenfrequencies and mode shapes of an axisymmetric free cylinder. The model is taken from NAFEMS *Free Vibration Benchmarks* (Ref. 1). The eigenfrequencies are compared with the values given in the benchmark report.

## *Model Definition*

The model is NAFEMS Test No 41, "Free Cylinder" described on page 41 in NAFEMS *Free Vibration Benchmarks, Volume 3* (Ref. 1). The Benchmark tests the capability to handle rigid body modes and close eigenfrequencies.

The cylinder is 10 m high with an inner radius of 1.8 m and a thickness of 0.4 m.




**MATERIAL**

Isotropic material with $E = 2.0 \cdot 10^{11}$ Pa and $\nu = 0.3$.

**LOADS**

In an eigenfrequency analysis loads are not needed.

**CONSTRAINTS**

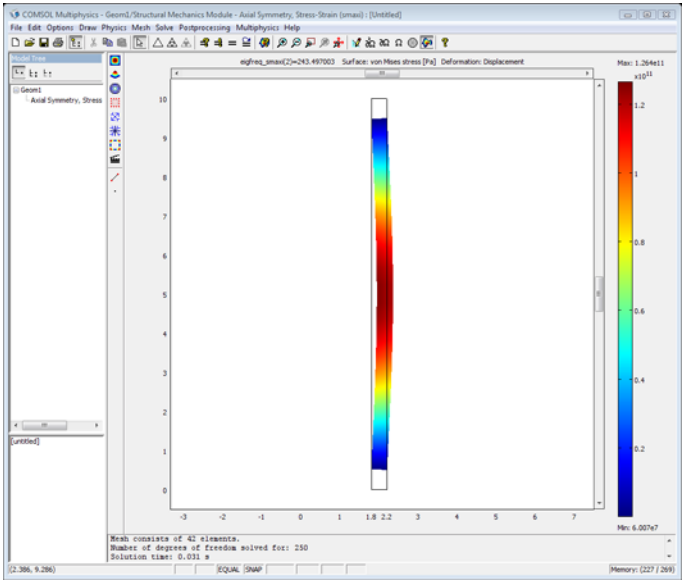
No constraints are applied because the cylinder is free.

## *Results*

The rigid body mode with an eigenvalue close to zero is found. The eigenfrequencies are in close agreement with the target values from the NAFEMS Free Vibration Benchmarks (Ref. 1).

| EIGENFREQUENCY | COMSOL | TARGET (REF. 1) |
|---|---|---|
| $f_1$ | 0 Hz | 0 Hz |
| $f_2$ | 243.50 Hz | 243.53 Hz |
| $f_3$ | 377.44 Hz | 377.41 Hz |
| $f_4$ | 394.30 Hz | 394.11 Hz |
| $f_5$ | 398.00 Hz | 397.72 Hz |
| $f_6$ | 405.75 Hz | 405.28 Hz |

The following plot shows the shape of the second eigenmode:



## *Reference*

1. F. Abassian, D.J. Dawswell, and N.C. Knowles, *Free Vibration Benchmarks, Volume 3*, NAFEMS, Glasgow, 1987.