SDLV134 - cyclic Under-structuring: Beam cantilever – presence of free nodes on the axis

Summary:

The scope of application of this test relates to the dynamics of the structures, and more particularly modal calculation by cyclic dynamic under-structuring.

It is a question of calculating the clean modes of an axisymmetric structure (circular beam of section, embedded at its base) by regarding it as a structure with cyclic repetitivity.

The model consists of an angular sector of $60°$ beam, with a grid in voluminal elements hexahedric to which elements are affected 3D. Only the method of dynamic under-structuring cyclic of Craig-Bampton is tested. The method of Mc Neal, such as it is implemented, does not make it possible to take into account free nodes on the axis.

One checks the good progress of calculation by studying relative displacements of the nodes coincide of the skeleton on which is restored the complete result.

1 Problem of reference

1.1 Geometry

Circular beam of section of vertical axis $\vec{z}$:

- Length: $L=0.1\,m$
- Ray: $R=0.01\,m$

1.2 Material properties

$E=2.10^{11}\,Pa$

$\nu=0.3$

$\rho=7\,800\mathrm{kg}/m^{3}$

1.3 Boundary conditions and loadings

Embedding of the face in $z=0$

1.4 Initial conditions

Without object for the modal analysis.

2 Reference solution

2.1 Method of calculating

In this test, one checks that the nodes of the axis have, in the end of beam, all same displacement. Indeed, the movement of the whole of the beam is rebuilt by rotation of the movements of a single sector of 60°. It is thus checked that the 6 nodes coïncidents present on the axis in z=0,1m have same displacement.

2.2 Sizes and results of reference

One carries out the checking for the first mode of traction compression and the first two modes of inflection. The test is carried out on the relative displacement, which must thus be null.

2.3 Uncertainties on the solution

None.

3 Modeling A

3.1 Characteristics of modeling

This structure with cyclic repetitivity is studied using the method of cyclic dynamic under-structuring of CRAIG-BAMPTON.

A basic sector, consisted an angular sector of 60°, is with a grid in hexahèdres.

The modal base used for the sector is made up of 15 clean modes and of **constrained modes** associated with the interfaces.

3.2 Characteristics of the grid

Many nodes: 77.

Many meshs and types: 30 meshs HEXA8

3.3 Sizes tested and results

One gives, for each node of the end of the axis, only the relative displacement calculated, the value of reference in front of, in all the cases, being worthless.

Number of order	Node 1	Node 2	Node 3	Node 4	Node 5	Node 6
2	0.0	0.0	0.0	0.0	0.0	0.0
3	4.08292E-07	4.41513E-06	4.00684E-06	4.08292E-07	4.41513E-06	4.00684E-06
4	4.08304E-07	4.41514E-06	4.00684E-06	4.08304E-07	4.41514E-06	4.00684E-06

4 Summary of the results

The relative displacements, obtained by restitution on a skeleton of the modes calculated by cyclic under-structuring with the method of Craig-Bampton differ from calculation from reference from less 1e-3 %. This test validates the method of under-structuring cyclic in the presence of free nodes of axis.