SDLX01 - Inflection of a symmetrical gantry

Summary:
This problem plan consists in seeking the frequencies of vibration of a mechanical structure made up of an assembly of beams with rectangular section (symmetrical gantry). This test of mechanics of the structures corresponds to a dynamic analysis of an assembled structure having a linear behavior. It understands only one modeling.

Via this problem, one tests the element of beam of Timoshenko as well as the calculation of the frequencies of vibration by the method of the iterations opposite.

The got results are in very good agreement with those of guide VPCS. The error on the first thirteen frequencies of vibration is lower than 0.2%.
1 Problem of reference

1.1 Geometry

![Diagram of geometry]

Sections droites rectangulaires:
- épaisseur: $h = 0.0048 \text{ m}$
- largeur: $b = 0.029 \text{ m}$
- aire: $A = 1.392 \times 10^4 \text{ m}^2$
- inertie: $I_z = 2.673 \times 10^{10} \text{ m}^4$

Coordinates of the points (in meters):

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>-0.30</td>
<td>0.30</td>
<td>-0.30</td>
<td>0.30</td>
<td>-0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>y</td>
<td>0.0</td>
<td>0.0</td>
<td>0.36</td>
<td>0.36</td>
<td>0.81</td>
<td>0.81</td>
</tr>
</tbody>
</table>

1.2 Material properties

$E = 2.1 \times 10^{11} \text{ Pa}$

$\nu = 0.3$

$\rho = 7800. \text{ kg/m}^3$

1.3 Boundary conditions and loadings

Points $A$ and $B$: embedded ($u = v = 0$, $\theta = 0$).

1.4 Initial conditions

Without object for the modal analysis.
2 Reference solution

2.1 Method of calculating used for the reference solution

The reference solution is that given in the card SDLX01/89 guide VPCS which presents the method of calculating in the following way:

Method of the dynamic stiffness (Theory of the slim beams)

2.2 Results of reference

the first 13 Eigen frequencies.

2.3 Uncertainty on the solution

\( \frac{\Delta f}{f} < 0.5 \% \).

2.4 Bibliographical references

3 Modeling A

3.1 Characteristics of modeling

POU_D_T

![Diagram of A, B, C, D, E, F points]

Cutting:  
- AC and BD: 6 meshes SEG2
- CE and DF: 9 meshes SEG2
- CD and EF: 10 meshes SEG2

Limiting conditions:  
- Problem plan: DDL.IMPO: (ALL: ‘YES’, DZ: 0., DRX: 0., DRY MARTINI: 0.)
- Nodes A and B embedded: (GROUP_NO: AB, DX: 0., DY: 0., DRZ: 0.)

Name of the nodes:  
- Point A = N100
- Point B = N600
- Point C = N200
- Point D = N500
- Point E = N300
- Point F = N400

3.2 Characteristics of the grid

Many nodes: 50
Many meshes and types: 50 SEG2

3.3 Values tested

<table>
<thead>
<tr>
<th>Identification</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 anti</td>
<td>8.8</td>
</tr>
<tr>
<td>2 anti</td>
<td>29.4</td>
</tr>
<tr>
<td>3 sym</td>
<td>43.8</td>
</tr>
<tr>
<td>4 sym</td>
<td>56.3</td>
</tr>
<tr>
<td>5 anti</td>
<td>96.2</td>
</tr>
<tr>
<td>6 sym</td>
<td>102.6</td>
</tr>
<tr>
<td>7 anti</td>
<td>147.1</td>
</tr>
<tr>
<td>8 sym</td>
<td>174.8</td>
</tr>
</tbody>
</table>

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3.4 Remarks

Calculations carried out by:

```
CALC_MODES
  OPTION='AJUSTE'
  CALC_FREQ=_F (FREQ= (5. , 350.),
  NMAX_FREQ=13)
```

3.5 Contents of the file results

The first 13 Eigen frequencies (clean vectors and modal parameters).

4 Summary of the results

Precision lower than 0.2% on all the Eigen frequencies until the 13ème mode.