SDLS02 - Thin plate rhombus embedded at the edge

Summary:

This three-dimensional problem consists in seeking the frequencies of vibration of a mechanical structure made up of a parallelepipedic plate (nonrectangular), embedded on only one side. This test of mechanics of the structures corresponds to a dynamic analysis of a surface model having a linear behavior. It comprises only one modeling.

This problem makes it possible to test the element of plate $\text{DKT}$ and the calculation of frequencies of vibration by the method of Lanczos.

The results got on the first two Eigen frequencies are in concord with those of guide VPCS.
1 Problem of reference

1.1 Geometry

![Geometry Diagram]

Side \( a = 1 \, m \), thickness \( t = 0.01 \, m \), \( \alpha = 30^\circ \)

Coordinates of the points (in \( m \)):

<table>
<thead>
<tr>
<th></th>
<th>( A )</th>
<th>( B )</th>
<th>( C )</th>
<th>( D )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x )</td>
<td>0.</td>
<td>( a )</td>
<td>( a (1 + \sin \alpha) )</td>
<td>( a \sin \alpha )</td>
</tr>
<tr>
<td>( y )</td>
<td>0.</td>
<td>0.</td>
<td>( a \cos \alpha )</td>
<td>( a \cos \alpha )</td>
</tr>
<tr>
<td>( z )</td>
<td>0.</td>
<td>0.</td>
<td>0.</td>
<td>0.</td>
</tr>
</tbody>
</table>

1.2 Properties of materials

\[
E = 2.1 \times 10^{11} \, Pa
\]
\[
\nu = 0.3
\]
\[
\rho = 7800. \, kg/m^3
\]

1.3 Boundary conditions and loadings

Side \( AB \) embedded:

for any point \( P \) such as \( y_p = 0 \).

\[
u = v = w = 0.
\]
\[
\theta_x = \theta_y = \theta_z = 0.
\]

1.4 Initial conditions

Without object for the modal analysis.
## 2 Reference solution

### 2.1 Method of calculating used for the reference solution

The formula of reference is that given in card SDLS02/89 of the guide VPCS which presents the method of calculating in the following way:

The formulation of M.V. BARTON, for a plate on side, led to:

\[
f_i = \frac{1}{2\pi a^2} \lambda_i^2 \sqrt{\frac{E t^2}{12 \rho (1 - \nu^2)}}
\]

where:  \( \lambda_i^2 = g(\alpha) \)

with, for a Poisson's ratio  \( \nu = 0.3 \) and  \( \alpha = 30^\circ \):

<table>
<thead>
<tr>
<th>( \lambda_i^2 )</th>
<th>3,961</th>
<th>10.19</th>
</tr>
</thead>
</table>

- M.V. Barton mentions the sensitivity of the result to the order of the mode and the angle  \( \alpha \).
- This reference solution applies to the thin sections such as:  \( t / a < 0.1 \).
- Coefficients  \( \lambda_i \) were established with a limited development of an insufficient nature.

### 2.2 Results of reference

The first two clean modes given by:

- the formula of M.V. Barton,
- the average of 5 software packages of calculation by the finite element method.

### 2.3 Uncertainty on the solution

Semi-analytical solution < 2%.

### 2.4 Bibliographical references

3 Modeling A

3.1 Characteristics of modeling

DKT

Cutting: 10 on each side of the rhombus is 200 meshes TRIA3.

Limiting conditions:

in all the nodes on the side AB:

DDL.IMPO: (GROUP NO: AB DX: 0., DY: 0., DZ: 0., DRX: 0., DRY MARTINI: 0., DRZ: 0.)

Name of the nodes:
Not A = N1
Bridge B = N11
Not C = N121
Not D = N111

3.2 Characteristics of the grid

Many nodes: 121
Many meshes and types: 200 TRIA3
### 3.3 Sizes tested and results

<table>
<thead>
<tr>
<th>Order of the mode proper I</th>
<th>Frequency (Hz)</th>
<th>Reference (Barton)</th>
<th>Reference (average of 5 codes)</th>
<th>Aster</th>
<th>% difference averages codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.8987</td>
<td>9.7355</td>
<td>9.8402</td>
<td>1.08</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>25.4651</td>
<td>23.2745</td>
<td>23.5790</td>
<td>1.31</td>
<td></td>
</tr>
</tbody>
</table>

### 3.4 Remarks

Calculations carried out by:

```plaintext
CALC_MODES
OPTION = 'PLUS_PETITE'
CALC_FREQ=_F (NMAX_FREQ= 2)
SOLVEUR_MODAL=_F (METHOD = 'TRI_DIAG')
```

### 3.5 Contents of the file results

the first 2 Eigen frequencies, clean vectors and modal parameters.
4 Summary of the results

Results given by Code_Aster are comparable to the results given by other using computer codes of the formulations different for this plate in the shape from parallelogram.