SSLP01 – Shearing and flexbeam in its plan

Summary:

In this CAS-test one models the behavior of a shearing and flexbeam in his plan.

Only one modeling is carried out: C_PLAN
1 Problem of reference

1.1 Geometry

Coordinates of the points (m):
A: (0, 6 \cdot 10^{-3})
B: (48 \cdot 10^{-3}, 6 \cdot 10^{-3})
C: (48 \cdot 10^{-3}, -6 \cdot 10^{-3})
D: (0, -6 \cdot 10^{-3})

Geometry of the plate (m):
Thickness: \( h = 0.001 \)
Width: \( L = 0.048 \)
Height: \( H = 0.012 \)

Group of meshes: BORD_CH surface of right-hand side (BC)
Group of meshes: ENCAST surface of left (AD)
Group of meshes: SURF internal surface

1.2 Properties of material

- \( E = 3 \cdot 10^{10} \) Pa
- \( \nu = 0.25 \)

1.3 Boundary conditions and loadings

- Imposed displacement:
  - ENCAST: \( DX = DY = 0 \).
- Loading:
  - Parabolic distribution on the height, constant on the thickness.

<table>
<thead>
<tr>
<th>( Y ) (m)</th>
<th>-0.006</th>
<th>-0.003</th>
<th>0</th>
<th>0.003</th>
<th>0.006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear stress 2D (Pa.m)</td>
<td>0</td>
<td>3.75E6</td>
<td>5.00E6</td>
<td>3.75E6</td>
<td>0</td>
</tr>
</tbody>
</table>
The integration of this constraint on the height $H$ conduit with a constraint resulting from $80 \cdot 10^3 \, Pa.m$ that one notes $P$ in what follows.
2 Reference solution

2.1 Method of calculating

The result of reference was got by analytical calculation with the method of the functions of Airy.

- Plane constraints:

  \[ \sigma_{xx} = \frac{12.\text{Py.}(x-L)}{2.\text{H}^3} \]
  \[ \sigma_{yy} = 0 \]
  \[ \sigma_{xy} = \frac{6.\text{P.}((H^2/4) - y^2)}{2.\text{H}^3} \]

- Displacements:

  \[ u = \frac{12\text{P}}{E\text{H}^3} \left[ y \left( \frac{x^2}{2} - Lx \right) - \left( 1 + \frac{\nu}{2} \right) \frac{y^3}{3} \right] + Ay + B \]
  \[ v = -\frac{12\text{P}\nu}{E\text{H}^3} \frac{y^2}{2} (x-L) + \frac{12\text{P}}{E\text{H}^3} \left[ \frac{-x^3}{3} + \frac{Lx^2}{2} + (1 + \nu) \frac{H^2 x}{4} \right] - Ax + C \]

- Constants \( A, B, C \) depend on the boundary conditions on displacements:

  \[ u(0,0) = v(0,0) = \frac{\partial v}{\partial x}(0,0) = 0 \]
  \[ u(0, -\frac{H}{2}) = v(0, -\frac{H}{2}) = u(0, \frac{H}{2}) = v(0, \frac{H}{2}) = 0 \]

2.2 Results of reference

Displacement according to \( y \) at the point \( x = L; y = 0 \): \( v = 0.3413 \cdot 10^{-3} \ m \)

Constraint according to \( x \) at the point: \( x = 0; y = -H/2 \) \( \sigma_{xx} = 80. \cdot 10^6 \ Pa \)

2.3 Uncertainties

Analytical solution
3 Modeling A

3.1 Characteristics of modeling

Modeling C_PLAN:

- Many nodes: 177
- Many meshes: 80

That is to say:

<table>
<thead>
<tr>
<th>Element</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEG3</td>
<td>32</td>
</tr>
<tr>
<td>QUAD8</td>
<td>48</td>
</tr>
</tbody>
</table>

3.2 Results

<table>
<thead>
<tr>
<th>Points</th>
<th>Size</th>
<th>Reference</th>
<th>Tolerance (relative)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(x = L; y = 0)</td>
<td>(DY)</td>
<td>(3.41 \cdot 10^{-3} \text{ m})</td>
<td>0.023</td>
</tr>
<tr>
<td>(x = 0; y = -H/2)</td>
<td>(SIXX)</td>
<td>(80 \cdot 10^6 \text{ Pa})</td>
<td>0.015</td>
</tr>
</tbody>
</table>
4 Summary of the results

Results obtained in displacement and constraint with modeling _C_PLAN_ are satisfactory.