SDLL150 - Clean modes of a beam with offset heart

Summary:

The objective of this test is to validate the calculation of the clean modes for the multifibre beams of Euler-Bernoulli (FOU_D_EM) whatever the position of the reference axis.

The case test validates the good taking into account of offsetting in the calculation of the matrix of rigidity (RIGI_MECA) and that of the matrix of mass (MASS_MECA).
1 Problem of reference

1.1 Geometry

The model is a beam comforts length $5m$ directed according to the axis $X$. The cross-section is in the shape of I, with higher and lower soles of different sizes (Figure 1). (Figure 2).

![Figure 1: Geometry](image1)

![Figure 2: Grid of the beam](image2)

1.2 Properties of materials

The properties of material are indexed in the following table.

<table>
<thead>
<tr>
<th>Material</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young modulus</td>
<td>$2 \times 10^{10} Pa$</td>
</tr>
<tr>
<td>Poisson's ratio</td>
<td>0.25</td>
</tr>
<tr>
<td>Density</td>
<td>9167.0 kg/m$^3$</td>
</tr>
</tbody>
</table>

1.3 Boundary conditions and loading

The beam is embedded with the one of its ends: all the degrees of freedom of node A are blocked.

An effort of $1.E4$ NR is imposed on the node B in direction Z.
2 Reference solution

2.1 Method of calculating

The first calculation was carried out with Code_Aster.

For this calculation, the reference axis is the elastic center of the cross-section, confused with the barycentre $G$ since the section is homogeneous:

$$\vec{OG} = y_G \vec{y} + z_G \vec{z}$$

with:

$$y_G = 0$$
$$z_G = \frac{1}{S} \sum z_{iG} S_i = \frac{1}{0.27 \times 0.05 \times (0.125 \times 3 + 0 - 0.125 \times 2)} = 0.023148148 \text{ m}$$

The reference solution is thus obtained with:

$${\text{COOR\_AXE\_POUTRE}} = (0, 0.023148148)$$

The values of the Eigen frequencies and modal displacements are retained like reference. Indeed, these values should not depend on the position chosen for the reference axis of calculation (keyword COOR\_AXE\_POUTRE of the operator DEFI\_GEOM\_FIBRE).

Note:

Because of nonsymmetry of the cross-section, the point O is not the centre of gravity of the cross-section.
3 Modeling A

3.1 Characteristics of modeling

Modeling used is POU_D_EM.

Calculation is carried out by choosing a reference axis, using keyword COOR_AXE_POUTRE of the operator DEFI_GEOM_FIBRE voluntarily very excentré: \( z_c = 0.5 \, \text{m} \).

3.2 Characteristics of the grid

The grid consists of 2 meshes of the type SEG2.

3.3 Sizes tested and results

Modal calculation:

<table>
<thead>
<tr>
<th>NUME_ORDRE</th>
<th>Component</th>
<th>Value of reference</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FREQ</td>
<td>1.9740586420219</td>
<td>1.E-6</td>
</tr>
<tr>
<td>2</td>
<td>FREQ</td>
<td>3.3155178878428</td>
<td>1.E-6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NUME_ORDRE</th>
<th>Not</th>
<th>Field</th>
<th>Component</th>
<th>Value of reference</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B</td>
<td>DEPL</td>
<td>DY</td>
<td>0.044067411231561</td>
<td>3.E-3</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>DEPL</td>
<td>DY</td>
<td>0.044043066332150</td>
<td>1.E-6</td>
</tr>
</tbody>
</table>
4 Summary of the results

The values of the Eigen frequencies and displacement modal do not depend on the position of the reference axis chosen by the user.