SSLX200 – Connection 3D_POU: Simple traction and pure inflection of a embed-free beam

Summary:

The objective of this test is to validate the taking into account of the connection 3D_POU (APFE_CHAR_MECA). This connection allows to establish a connection between a modeling of type beam with modeling of a voluminal type. The cas-test represents a beam:

- A part is modelled with voluminal elements and the other part modelled with elements beams,
- Embedded an end has and free the other end has,
- Subjected has inflection and tractive efforts.

Two types of analyses is carried out:

- Linear static analysis: one tests displacements and the constraints in the case of a loading of traction and inflection,
- Dynamic analysis: the first two modes of inflection are tested.
1 Problem of reference

1.1 Geometry

\[ L = 10. \text{m} \]
\[ b = 3. \text{m} \]
\[ h = 2. \text{m} \]

1.2 Properties of material

- \( E = 200000. \text{Pa} \)  
  Young modulus
- \( \nu = 0.3 \)  
  Poisson's ratio
- \( \rho = 10000 \text{Kg/m}^3 \)  
  Density

1.3 Boundary conditions and loadings

- Boundary conditions
  - Not \( C \) : embedding
  - Not \( B \) : free

- Loadings
  - Traction \( FX = 10. \text{N} \)
  - Pure bending \( MY = 2. \text{N.m} \)
  - Pure bending \( MZ = 3. \text{N.m} \)

1.4 Initial conditions

Without
2 Reference solution

2.1 Method of calculating

2.1.1 Statics

Displacements in $B$

- Simple traction
  \[ u_x = \frac{F_x L}{E S} \]
- Pure inflection
  \[ u_z = \frac{-M_y L^2}{2EI_y} \]
- Pure inflection
  \[ u_y = \frac{M_z L^2}{2EI_z} \]

Maximum constraint in $A$

- Simple traction
  \[ \sigma_x = \frac{F_x}{S} \]
- Pure inflection
  \[ \sigma_x = \frac{-M_y}{2I_y \rho_h} \]
- Pure inflection
  \[ \sigma_x = \frac{-M_z}{2I_z \rho_b} \]

2.1.2 Eigen frequencies in inflection

Mode 1:
\[ f_1 = \frac{3.516}{2L^2 \pi} \sqrt{\frac{EI}{\rho S}} \]
Mode 2:
\[ f_2 = \frac{22.0345}{2L^2 \pi} \sqrt{\frac{EI}{\rho S}} \]

2.2 Sizes and results of reference

2.2.1 Statics

- Displacements ($m$)

<table>
<thead>
<tr>
<th>Not</th>
<th>$DX$</th>
<th>$DY$</th>
<th>$DZ$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$B$</td>
<td>$8.3333 \times 10^{-5}$</td>
<td>$1.6667 \times 10^{-4}$</td>
<td>$-2.5 \times 10^{-4}$</td>
</tr>
</tbody>
</table>
2.2.2 Eigen frequencies in inflection

<table>
<thead>
<tr>
<th>Mode</th>
<th>Frequency Hz</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>0.014449</td>
</tr>
<tr>
<td>2</td>
<td>0.090549</td>
</tr>
</tbody>
</table>

2.3 Uncertainties on the solution

Analytical solution.
3 Modeling A

3.1 Characteristics of modeling

One is used:

- Modeling 3D and POU D E for the beam,
- An element DIS_TR of type POI at the point C ,
- Connection 3D_POU at the point With to connect the beam and the face of volume,
- Connection 3D_POU at the point C to connect the element DIS_TR and the face of volume.

![Image of modeling A]

3.2 Characteristics of the grid

The grid contains 212 nodes and 107 meshes of which:

- 2 SEG2
- 24 SEG3
- 54 QUAD8
- 27 HEXA20.

3.3 Sizes tested and results

- Displacements

<table>
<thead>
<tr>
<th>Identification</th>
<th>Type of reference</th>
<th>Value of reference</th>
<th>Tolerance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B DX</td>
<td>'ANALYTICAL'</td>
<td>$8.3333 \times 10^{-5} m$</td>
<td>0.0001</td>
</tr>
<tr>
<td>B DY</td>
<td>'ANALYTICAL'</td>
<td>$1.6667 \times 10^{-4} m$</td>
<td>0.0001</td>
</tr>
<tr>
<td>B DZ</td>
<td>'ANALYTICAL'</td>
<td>$-2.5 \times 10^{-4} m$</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

- Constraints

<table>
<thead>
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<th>Type of reference</th>
<th>Value of reference</th>
<th>Tolerance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1(5.0,1.5,−1.0) SIXX</td>
<td>'ANALYTICAL'</td>
<td>$-0.3333 N/m^2$</td>
<td>0.0001</td>
</tr>
<tr>
<td>C2(5.0,1.5,1.0) SIXX</td>
<td>'ANALYTICAL'</td>
<td>$1.6667 N/m^2$</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

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- Eigen frequencies

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</thead>
<tbody>
<tr>
<td>1</td>
<td>'ANALYTICAL'</td>
<td>0.014449</td>
<td>2.5</td>
</tr>
<tr>
<td>2</td>
<td>'ANALYTICAL'</td>
<td>0.090529</td>
<td>18.0</td>
</tr>
</tbody>
</table>
4 Summary of the results

This CAS-test with licence to test, in linear statics and dynamics (search for Eigen frequencies), the connection 3D_POU allowing to connect a voluminal modeling with a modeling beam.