SSLV160 - Bi--supported beam subjected to a nodal force on its neutral fibre

Summary:

This test makes it possible to validate the connection between models 1D and 3D, within the framework Harlequin (3D_POU_ARLEQUIN) [1].

It is about a model of beam hurled on two supports, subjected to a nodal force.

The results of calculations are compared with those obtained by Code_aster with a model of reference 1D and a mixed model 1D-3D connected with the option 3D_POU. The results coincide perfectly with the reference solutions.
1 Problem of reference

The objective of this case test is to validate the connection Harlequin Beam-3D in Code_Aster.

One compares the results got with those resulting from two modelings in Code_Aster:
- mono-modeling of reference 1D
- mixed modeling of reference 1D-3D with connection 3D_POU

1.1 Geometry

A slim mean structure is considered of length 0.25 m according to axis X and of circular section. It is supported on its two ends located respectively at the positions -0.1 m (support 1) and 0.15 m (support 2). The ray of the section is equal to 0.005 Mr.

![Image 1.1-1: Geometry of the rotor](image)

1.2 Material properties

The bi--supported beam has a density of $\rho = 7800 \text{ kg/m}^3$. The Young modulus is $E = 2 \times 10^{11} \text{ N/m}^2$ and the Poisson's ratio is $\nu = 0.3$.

1.3 Boundary conditions and loadings

The beam rests on two infinitely rigid supports:
- $DX = DY = DZ = 0$ on the level of support 1
- $DX = DY = DZ = 0$ on the level of support 2

Also, the rigid movement of body of rotation according to the axis of the beam is blocked ($DRX = 0$) on all the structure.
2 Reference solution

The reference solution is resulting from a calculation 1D carried out with Code_Aster (cf modeling C).

3 Modeling A

3.1 Characteristics of modeling

The bi-supported structure of length 0.25 m, extending between $X = -0.1$ m and $X = 0.15$ m, are connected in volume in the zone of covering, which extends between the positions 0.0 m and 0.05 m, with a model 3D by the option 3D_POU_ARLEQUIN keyword LIAISON_ELEM of the operator AFFE_CHAR_MECA.

It is modelled by elements of beam of Timoshenko (POU_D_T) and of the linear voluminal elements (PENTA6 and HEXA8).

![Image 3.1-1: Grid of the voluminal model 3D](image)

DYNA_LINE_TRAN calculate the dynamic response of the structure during 3 S, due to a nodal force of a value equal to 100 NR on the node of the grid 3D located at $X = 0.02$ Mr.

3.2 Characteristics of the grid

- Many meshes HEXA8: 150
- Many meshes PENTA6: 50
- Many meshes POU_D_T: 20

<table>
<thead>
<tr>
<th>Identification</th>
<th>Moments of the maximas</th>
<th>Type of reference</th>
<th>Value of reference</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal displacement in Z</td>
<td>2.205 S</td>
<td>‘AUTRE_ASTER’</td>
<td>-0.00033054</td>
<td>7.00%</td>
</tr>
<tr>
<td>Maximum displacement in Z</td>
<td>2.700 S</td>
<td>‘AUTRE_ASTER’</td>
<td>+0.00033065</td>
<td>7.00%</td>
</tr>
</tbody>
</table>

Table 3.3-1: Summary of the results tested

The answers of the models 1D and mixed 1D-3D of the structure are represented on the graph below.
Image 3.3-2: Réponses des modèles 1D et mixtes 1D-3D
4 Modeling B

4.1 Characteristics of modeling

The bi-supported structure of length 0.25 m, extending between $Z = -0.1$ m and $Z = 0.15$ m, is connected in volume in the zone of covering, which extends between the positions 0.0 m and 0.05 m, with a model 3D by the option 3D_POU_ARLEQUIN keyword LIAISON_ELEM of the operator AFFE_CHAR_MECA.

It is modelled by elements of beam of Timoshenko (POU_D_T) and of the linear voluminal elements (PENTA6 and HEXA8).

4.2 Characteristics of the grid

Many meshes HEXA8 150
Many meshes PENTA6 50
Many meshes POU_D_T 20

Table 4.2-1

4.3 Sizes tested and results

The tables below give the digital values tested in this CAS-test. They is displacements minimal and maximum in Z of a node of the grid 3D located at $X = 0.04$ Mr.

<table>
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<tbody>
<tr>
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<td>-0.00033054</td>
<td>7.00%</td>
</tr>
<tr>
<td>Maximum displacement in Z</td>
<td>2.700 S</td>
<td>'AUTRE_ASTER'</td>
<td>+0.00033065</td>
<td>7.00%</td>
</tr>
</tbody>
</table>

Table 4.3-1: Summary of the results tested

Warning: The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.
5 Modeling C

5.1 Characteristics of modeling

The structure is entirely modelled by elements of beam of Timoshenko (POU_D_T). It is supported on the level of its two ends.

DYNA_NON LINE calculate the dynamic response during 3 S, due to a nodal force of a value equal to 100 NR on the node of the grid 3D located at X = 0.02 Mr.

5.2 Characteristics of the grid

Many meshes POU_D_T 25

Table 5.2-1

5.3 Sizes tested and results

The tables below give the digital values tested in this CAS-test. They is displacements minimal and maximum in Z of a node of the grid 3D located at X = 0.04 Mr.

<table>
<thead>
<tr>
<th>Identification</th>
<th>Moments of the maximas</th>
<th>Type of reference</th>
<th>Value of reference</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal displacement in Z</td>
<td>2.2115 S</td>
<td>'NON_REGRESSION'</td>
<td>-0.00033055</td>
<td>7.00%</td>
</tr>
<tr>
<td>Maximum displacement in Z</td>
<td>2.7065 S</td>
<td>'NON_REGRESSION'</td>
<td>+0.00033065</td>
<td>7.00%</td>
</tr>
</tbody>
</table>

Table 5.3-1: Summary of the results tested
6 Summary of the results

The cas-test implements in Code_Aster voluminal connection 1D-3D within the framework Harlequin on the basis of bi-supported slim structure. The results of the resulting mixed model are compared compared to the results got with a model of reference are equivalent 1D and a mixed model 1D-3D connected with the option 3D_POU keyword LIAISON_ELEM of the operator AFFE_CHAR_MECA of Code_Aster.