SSLV159 - Beam cantilever subjected to a loading of the type marks with arrows static

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 cantilever, embedded at an end and subjected to a loading of static arrow at the other end.

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 Dyears 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

One Considère a beam length 0.35 m according to axis X, embedded at its left end and responsible for a concentrated force F at its right end. The cross section of the beam is a rectangle of width B and height H (in this case: B = H = 0.02 m).

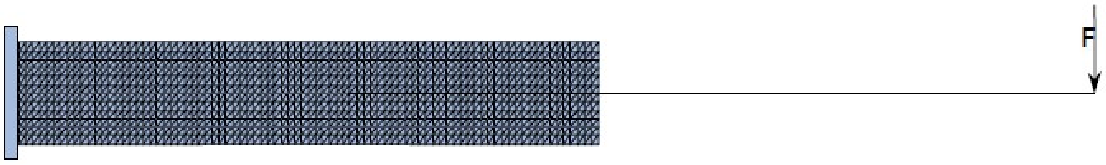

Image 1.1-1: Geometry of the rotor

1.2 Material properties

The beam cantilever has a density of $\rho=7800\,kg/m^3$.
The Young modulus is $E=2.10^{11}\,N\,m^{-2}$ and the Poisson's ratio is $\nu=0,3$.

1.3 Boundary conditions and loadings

The left end of the beam (X = 0.15 m) is fixed, and the right end (X = 0.5 m) is subjected to a concentrated loading directed vertically to the bottom of a value of 500 NR.

2 Reference solution

The reference solution is resulting from a calculation 1D carried out with Code_Aster (cf modeling B). The latter is it even validated compared to solution RDM for a beam cantilever. The analytical solution is equal to:

$$w=\frac{F.L^3}{3.E.J}$$

where F is the concentrated force applied, L is the length of the beam, E is the Young modulus of material, $J=\frac{b.h^3}{12}$ is it moment of inertia of the cross section of the beam.

[1] A. Ghanem, “Contribution to the advanced modeling of the revolving machines in transitory dynamics within the framework Harlequin”, thesis of INSA de Lyon.

3 Modeling A

3.1 Characteristics of modeling

The beam cantilever is of length 0.35 m and extending between X = 0.15 m and X = 0.5 Mr. It is modelled in 3D close to embedding (between 0 and 0.22 m) and continues with a modeling of beam. Connection 1D-3D is carried out in volume by the option `3D_POU_ARLEQUIN` keyword `LIAISON_ELEM` of `AFFE_CHAR_MECA`. The zone of covering extends between positions 0.2 and 0.22 Mr.

The structure is modelled by elements of beam of Timoshenko (`POU_D_T`) and of the linear hexahedral elements (`HEXA8`).

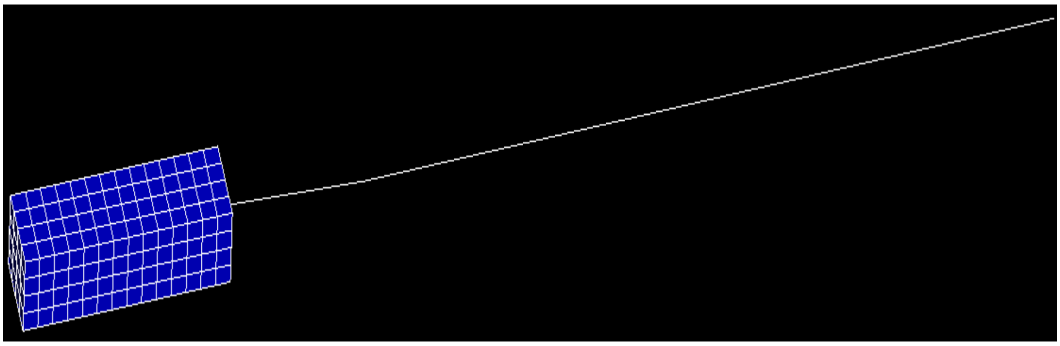

Image 3.1-1: Grid of mixed model 1D-3D

`DYNA_VIBRA` (transitory calculation on physical basis) the dynamic response of the structure, due to a nodal force of 500 calculates NR applied to the level of the node end of the grid 1D (located at X = 0.5 m).

3.2 Characteristics of the grid

Many meshs `HEXA20`	224
Many meshs `POU_D_T`	7

Table 3.2-1

3.3 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 = 0.5 Mr.

Identification	Moments of the maximas	Type of reference	Value of reference	Tolerance
Minimal displacement in Z	20 S	`'AUTRE_ASTER'`	-0.00268654	7,00%
Maximum displacement in Z	60 S	`'AUTRE_ASTER'`	+0.00268644	7,00%

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.

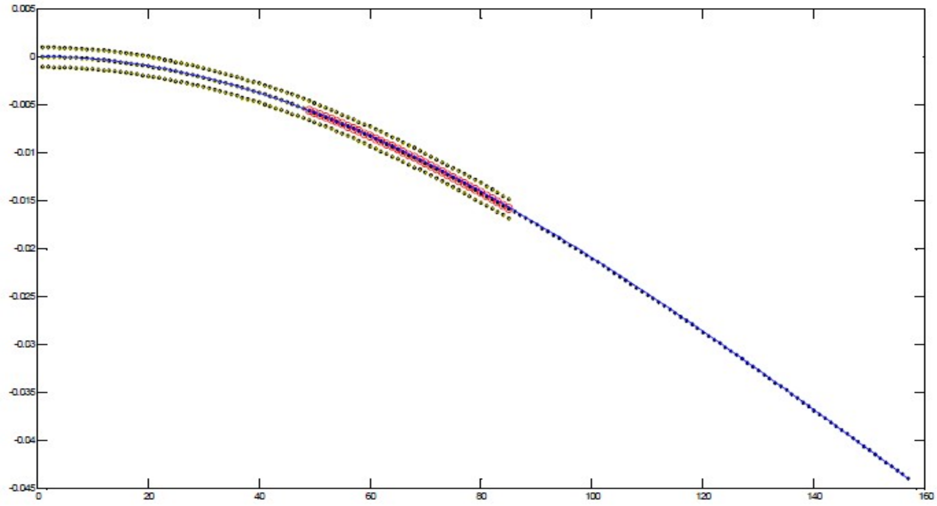

Image 3.3-2 : Answers of the models 1D and mixed 1D-3D

4 Modeling B

4.1 Characteristics of modeling

The beam cantilever of length 0.35 m, extending between X = 0.15 m and X = 0.5 m, are entirely modelled by elements of beam of Timoshenko (`POU_D_T`).

`DYNA_VIBRA` (transitory calculation on physical basis) the dynamic response of the structure, due to a nodal force of 500 calculates NR applied to the level of the node end of the grid 1D (located at X = 0.5 m).

4.2 Characteristics of the grid

`Many meshs POU_D_T`	8

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 = 0.5 Mr.

Identification	Moments of the maximas	Type of reference	Value of reference	Tolerance
Minimal displacement in Z	20 S	`'ANALYTICAL'`	-0.00267968	7,00%
Maximum displacement in Z	60 S	`'ANALYTICAL'`	+0.00267968	7,00%

Table 4.3-1: Summary of the results tested

Solution is of the analytical type exit of calculations RDM.

5 Modeling C

5.1 Characteristics of modeling

The beam cantilever is of length 0.35 m and extending between X = 0.15 m and X = 0.5 Mr. It is modelled in 3D close to embedding (between 0 and 0.22 m) and continues with a modeling of beam. The surface connection is done with the node located at the situation 0.22 m by the option 3D_POU keyword LIAISON_ELEM of AFFE_CHAR_MECA.

The structure is modelled by elements of beam of Timoshenko (POU_D_T) and of the linear hexahedral elements (HEXA8).

DYNA_VIBRA (transitory calculation on physical basis) the dynamic response of the structure, due to a nodal force of 500 calculates NR applied to the level of the node end of the grid 1D (located at X = 0.5 m).

5.2 Characteristics of the grid

Many meshs HEXA20	224
Many meshs POU_D_T	6

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 = 0.5 Mr.

Identification	Moments of the maximas	Type of reference	Value of reference	Tolerance
Minimal displacement in Z	20 S	'AUTRE_ASTER'	-0.00268654	7,00%
Maximum displacement in Z	60 S	'AUTRE_ASTER'	+0.00268644	7,00%

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 beam cantilever. 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.