ZZZZ330 – Validation of the computation of potential energy for the beam elements

Summarized:

The purpose of this test is to validate the computation of potential energy for the elements beams following: POU_D_EM , POU_D_TG and POU_D_TGM.

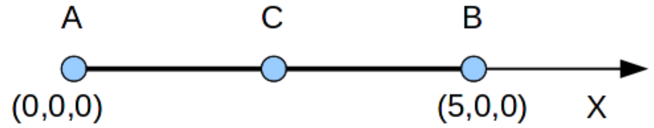
The computation of potential energy is made after a static computation and a modal computation.

Note:

The validation is already made in addition for elements POU_D_E , POU_D_T and POU_C_T .

1 Description

1.1 Geometry



The model is a beam length $5m$ directed according to the axis X. This beam consists of 2 meshes `SEG2`. The cross-section of the beam is rectangular $HY=0,1m$ $HZ=0,2m$.

1.2 Properties of the materials

the properties of the materials are indexed in the following table.

Concrete material	
Young Modulus	$2\times10^{10}\,Pa$
Poisson's ratio	0.25
Density	$9167.0\,kg/m^3$

1.3 Boundary conditions and change

the node A is embedded and the node B is subjected to a nodal force according to Z $1\text{E}+4\,N$.

2 Reference solution

2.1 Method of calculating

In the linear static case:

$E_{pot}=W^{ext}=\frac{1}{2}\sum_{i\in N} D_i F_i^{ext}$ where N is all the nodes of the model.

For a small size it is thus easy to calculate potential energy starting from displacements.

In the case of modal computation:

If Φ is an eigen mode of the problem, eigenfrequency $f=\frac{\omega}{2\pi}$, with K stiffness matrix of M mass matrix then $(K-\omega^2 M)\Phi=0$, D "where $\Phi^T(K-\omega^2 M)\Phi=0$.
If one normalizes the modes compared to the mass matrix M then one A. $\Phi^T K\Phi=\omega^2=(2\pi f)^2$
Or $E_{pot}=\frac{1}{2}\Phi^T K\Phi$. It is thus enough to check that $E_{pot}=2(\pi f)^2$.

2.2 Quantities and results of reference

2.3 Uncertainties on the solution

None.

3 Modelization A

3.1 Characteristic of the modelization

One uses a modelization POU_D_EM .

3.2 Characteristics of the mesh

The mesh contains 2 elements of the type SEG2.

3.3 Quantities tested and static

Computation results:

The value of the component DZ on the N3 node is tested into non regression.

Field	Component	**Value of reference**	**TOTAL**
Tolerance	EPOT_ELEM	229.9766956	1.E-6

Modal computation:

The value of frequency 7 is tested into non regression.

Field	Component	**Value of reference**	**TOTAL**
Tolerance	EPOT_ELEM	88081.5605639	1.E-6

4 Modelization B

4.1 Characteristic of the modelization

One uses a modelization POU_D_TG .

4.2 Characteristics of the mesh

The mesh contains 2 elements of the type SEG2.

4.3 Quantities tested and static

Computation results:

The value of the component DZ on the N3 node is tested into non regression.

Field	Component	**Value of reference**	**TOTAL**
Tolerance	EPOT_ELEM	226.34657911364	1.E-6

Modal computation:

The value of frequency 7 is tested into non regression.

Field	Component	**Value of reference**	**TOTAL**
Tolerance	EPOT_ELEM	96160.162695954	1.E-6

5 Modelization C

5.1 Characteristic of the modelization

One uses a modelization POU_D_TGM .

5.2 Characteristics of the mesh

The mesh contains 2 elements of the type SEG2.

5.3 Quantities tested and static

Computation results:

The value of the component DZ on the N3 node is tested into non regression.

Field	Component	**Value of reference**	**TOTAL**
Tolerance	EPOT_ELEM	230.67091447835	1.E-6

Modal computation:

The value of frequency 7 is tested into non regression.

Field	Component	**Value of reference**	**TOTAL**
Tolerance	EPOT_ELEM	94759.34489198	1.E-6

6 Summary of the results

the values of reference for L” potential energy are found in each modelization for the two different types of computation.