ZZZZ330 – Validation of the calculation of the potential energy for the elements of beams

Summary:

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

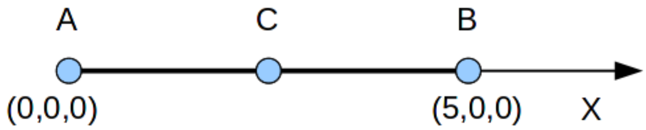
Potential energy is calculated after a static calculation and a modal calculation.

Note:

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

1 Description

1.1 Geometry



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

1.2 Properties of materials

The properties of materials are indexed in the following table.

Material	Concrete
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 of $1E+4N$.

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 the whole of the nodes of the model.

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

In the case of modal calculation:

If Φ is a clean mode of the problem, Eigen frequency $f=\frac{\omega}{2\pi}$, with K matrix of rigidity of M matrix of mass then $(K-\omega^2 M)\Phi=0$, from where $\Phi^T(K-\omega^2 M)\Phi=0$.
If one normalizes the modes compared to the matrix of mass M then one has $\Phi^T K\,\Phi=\omega^2=(2\pi f)^2$.
However $E_{pot}=\frac{1}{2}\Phi^T K\,\Phi$. It is thus enough to check that $E_{pot}=2(\pi f)^2$.

2.2 Sizes and results of reference

2.3 Uncertainties on the solution

None.

3 Modeling A

3.1 Characteristics of modeling

A modeling is used POU_D_EM .

3.2 Characteristics of the grid

The grid contains 2 elements of the type SEG2.

3.3 Sizes tested and results

Static calculation:

The value of the component DZ on the node N3 is tested in nonregression.

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

Modal calculation:

The value of frequency 7 is tested in nonregression.

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

4 Modeling B

4.1 Characteristics of modeling

A modeling is used POU_D_ TG .

4.2 Characteristics of the grid

The grid contains 2 elements of the type SEG2.

4.3 Sizes tested and results

Static calculation:

The value of the component DZ on the node N3 is tested in nonregression.

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

Modal calculation:

The value of frequency 7 is tested in nonregression.

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

5 Modeling C

5.1 Characteristics of modeling

A modeling is used POU_D_ TGM.

5.2 Characteristics of the grid

The grid contains 2 elements of the type SEG2.

5.3 Sizes tested and results

Static calculation:

The value of the component DZ on the node N3 is tested in nonregression.

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

Modal calculation:

The value of frequency 7 is tested in nonregression.

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

6 Summary of the results

The values of reference for the potential energy are found in each modeling for the two different types of calculation.