SDNL32 - Impact of a girder hinged on elastic support

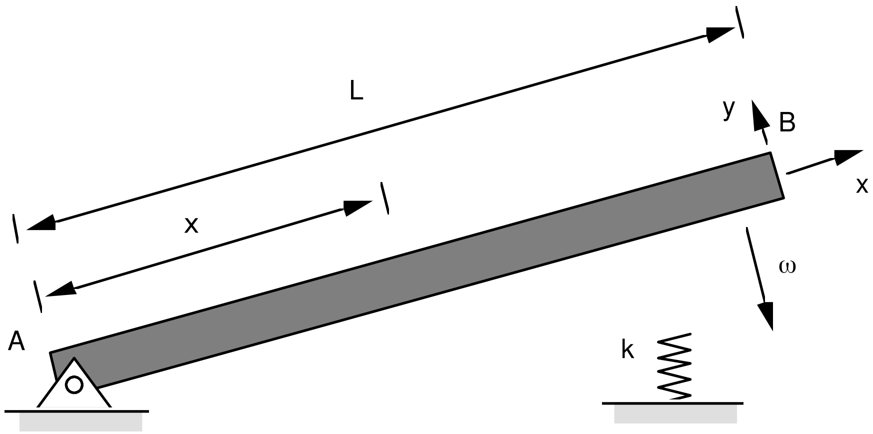
Summary:

This problem corresponds to a transitory analysis by modal superposition of a non-linear system made up of a flexible beam rotulée with one of its ends. It is actuated by a solid rotation movement of body at the initial moment and meeting an elastic thrust with unilateral contact. The problem has a reference solution suggested by Commission VPCS.

There is a modeling with elements `POU_D_T`. The vibratory operator of dynamics is tested. The variations with the reference solution do not exceed 0.8% .

1 Problem of reference

1.1 Geometry



Beam square section:	$c=0.014\,m$
L : length of the beam	$L=0.783\,m$
Gauge of deformation	$x=0.462\,m$

1.2 Material properties

Young modulus:	$E=6.7\,E\,10\,Pa$
Density:	$\rho=2\,400\,kg/m^3$
Poisson's ratio:	$\nu=0.$

Stiffness of the spring: case n°1 $k=18000\,N/m$ case n°2 $k=45\,000\,\mathrm{N}/m$

1.3 Boundary conditions and loadings

At the point A : $u=v=0$ (kneecap)
At the point B : loose lead before impact ($t<0$)

Loading:

Different Pas d' loading.

The effects of gravity are negligible at first approximation.

1.4 Initial conditions

For $t<0$ in any point of X-coordinate x

- $dv/dt=\omega.x$
- $\omega=-3.8\,rd/s$

For $t=0$, $v(L,0)=0$: contact of the loose lead with the spring.

2 Reference solution

2.1 Method of calculating used for the reference solution

The reference solution was established by commission VPCS.

One refers for the moment with results communicated by J.P. TEASES (Central School of Lyon) using code ANSYS, as well as the code PLEXUS of the ECA.

The solution is calculated for an analysis in small displacements.

2.2 Results of reference

Value of transverse displacements of the end of the beam at various moments (DY).

2.3 Uncertainty on the solution

Average of the results of various codes.

2.4 Bibliographical references

1. J.P.LAINE 'Course of dynamics of the structures' (TP) Central School Lyon.

3 Modeling A

3.1 Characteristics of modeling

Modeling POU_D_T.

10 elements of beam are used:

in all the nodes:

```
DDL_IMPO=_F   (TOUT=' OUI' DZ= 0, DRX= 0, DRY= 0)
```

with the node A :

```
(NOEUD= WITH DX= 0, DY= 0)
```

with the node B : conditions of shock

```
CHOC=_F (
      NOEUD_1= B
      OBSTACLE= plan
      ORIG_OBST= (0,783, 0.1, 0. )
      NORM_OBST= (1. , 0. , 0. )
      JEU= 0.1
      RIGI_NOR= 0.
      RIGI_TAN= K
      AMOR_NOR= 0.
      COULOMB = 0.
      )
```

Modal synthesis with 10 clean modes, not of time used $dt=1.\mathrm{E}-5s$.

Digital algorithm of integration: EULER

3.2 Characteristics of the grid

Many nodes: 11
Many meshs and types: 10 SEG2

3.3 Remarks

Many modes used for the modal superposition: 10.

3.4 Sizes tested and results

Transverse displacements of the end of the beam for the first 12 steps of computing time.

Identification	Reference
$k=18000\,N/m$	– 2.66 E-3
	– 4.33 E-3
	– 4.92 E-3
	– 4.78 E-3
	– 3.82 E-3
	– 2.87 E-3
	– 2.71 E-3
	– 3.09 E-3
	– 3.41 E-3
	– 3.36 E-3
	– 2.64 E-3
	– 7.42 E-4
$k=45000\,N/m$	– 2.25 E-3
	– 2.66 E-3
	– 1.96 E-3
	– 1.15 E-3
	– 1.24 E-4
	– 3.64 E-4
	– 2.01 E-3
	– 2.74 E-3
	– 1.89 E-3
	– 3.52 E-4
	+ 1.70 E-3
	+ 4.99 E-3

4 Summary of the results

One really notes in concord with the reference solution (1.2%) and this in spite of the presence of a non-linearity of shock and the use of a method of modal recombination with 1 modal base reduced to 10 modes. The strongest difference is observed for the non-linear thrust stiffest.