SDNL32 - Impact of a girder hinged on elastic bearing

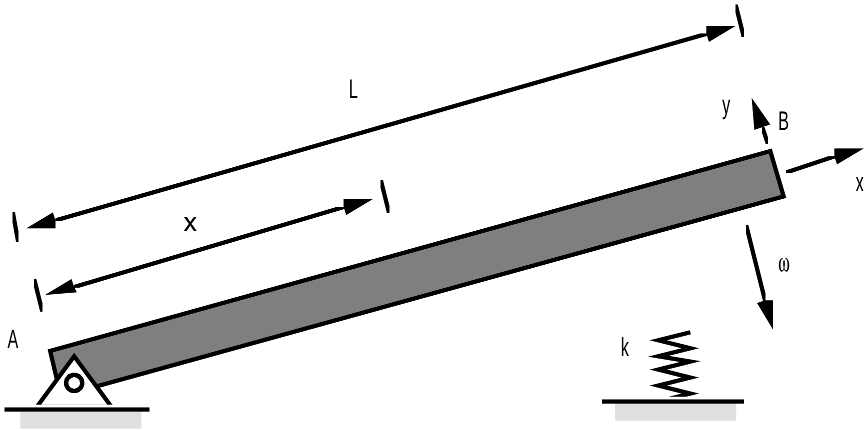
Abstract:

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

There is a modelization 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 $L=0.783\,m$
Strain gauge $x=0.462\,m$

1.2 Material properties

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

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

1.3 Boundary conditions and loadings

With point: A $u=v=0$ (hinge)
With point: B loose lead before impact ($t<0$)

Loading:

Not other 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 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 time with results communicated by J.P. TEASES (Central School of Lyon) using code ANSYS, as well as the code PLEXUS of the French atomic energy agency.

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 to various times (DY).

2.3 Uncertainty on the Average

solution of the results of various codes.

2.4 Bibliographical references

1.J.P.LAINE “Course of dynamics of structures” (TP) Central School Lyon. Modelization

3 A Characteristic

3.1 of the modelization Modelization

POU_D_T. 10

beam elements are used: in all

the nodes: DDL_IMPO

```
                =_F (TOUT=' OUI'   DZ= 0, DRX= 0, DRY= 0) with the node is
outside the field of definition with a right profile of the EXCLU type node:
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(NOEUD A =

```
                A DX= 0, DY= 0) with the node is outside the field of
definition with a right profile of the EXCLU type node:
```

conditions B of shock CHOC=_F

```
(NOEUD_1=
      B OBSTACLE
      = plane 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 eigen modes, time step used. Algorithm $dt=1.\mathrm{E}-5s$
of numerical integration: EULER Characteristics

3.2 of the mesh Many

nodes: 11 Number of meshes
and types: 10 SEG2 Remarks

3.3 Many

modes used for the modal superposition: 10. Quantities

3.4 tested and transverse Displacements

results of the end of the beam for the 12 first time step of computations. Identification

Reference	– 2.66
$k=18000\,N/m$	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 – 2.25
$k=45000\,N/m$	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 Summary

4 of the results One really

notes in concord with this and reference solution () in spite of 1.2% 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 nonlinear thrust stiffest.