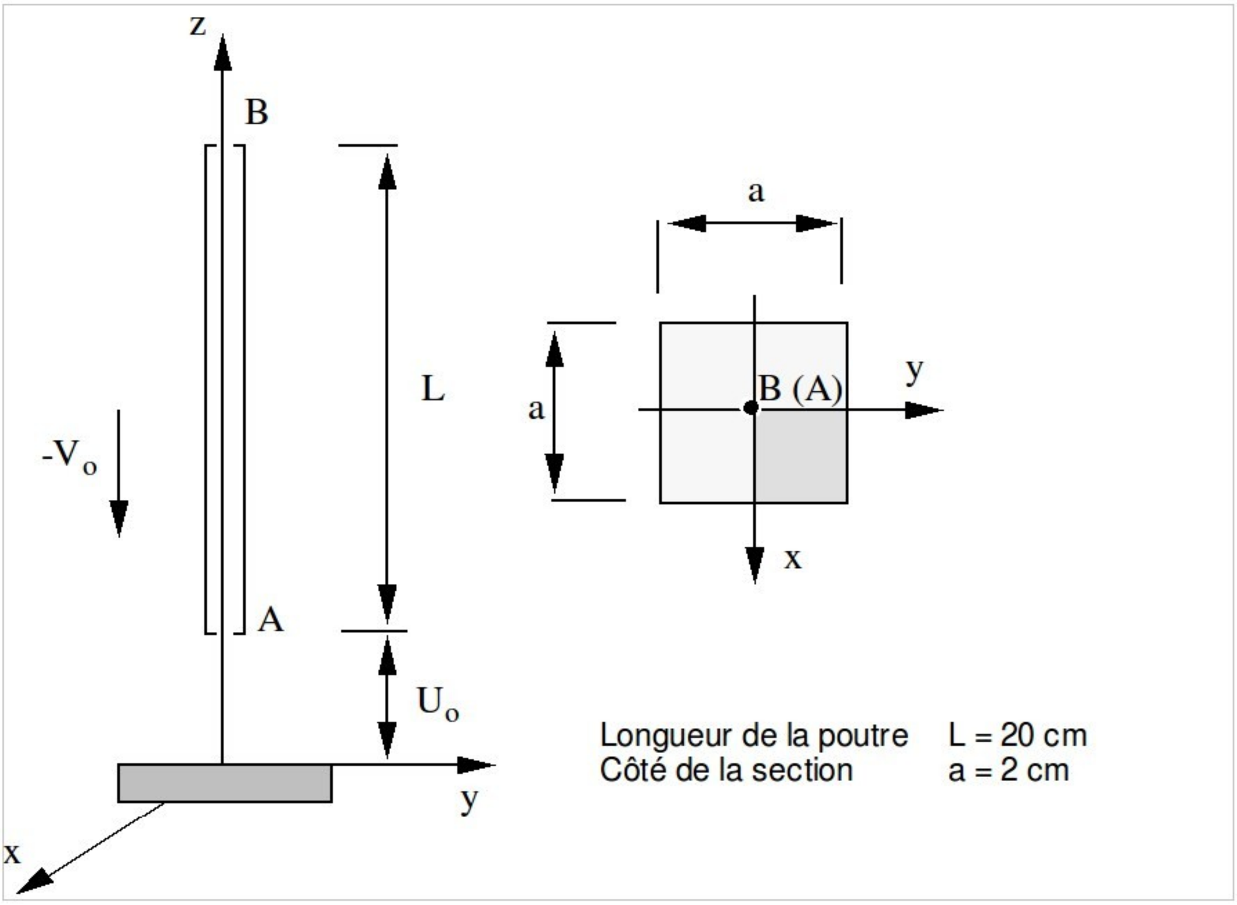
SDNV100 - Impact of a beam on a rigid wall

Abstract

This problem corresponds to a direct transient analysis of a nonlinear system modelled in voluminal elements. A first slender structure (beam) of square section is animated an initial velocity and comes to run up against a rigid wall. Nonthe - linearity comes from the conditions of contact between structure and the wall. This test comprises a reference solution and a modelization.

1 Problem of reference

1.1 Geometry



1.2 Material properties

Beam:	Young modulus:	$E=2.10^{11}\,Pa$
	Poisson's ratio:	$\nu=0.3$
	density :	$\rho=8000\,kg/m^3$
Finite elements of contact:	coefficients of penalization:	$E_n=10^{14}\,Pa$
		$E_t=0$
	coefficient of Coulomb:	$\mu=0$

1.3 Boundary conditions and loadings

the problem is one-way according to z.
One considers a quarter of the beam with the conditions of symmetry: one blocks displacements according to x on the plane $x=0$ and the displacements according to y on the plane $y=0$.

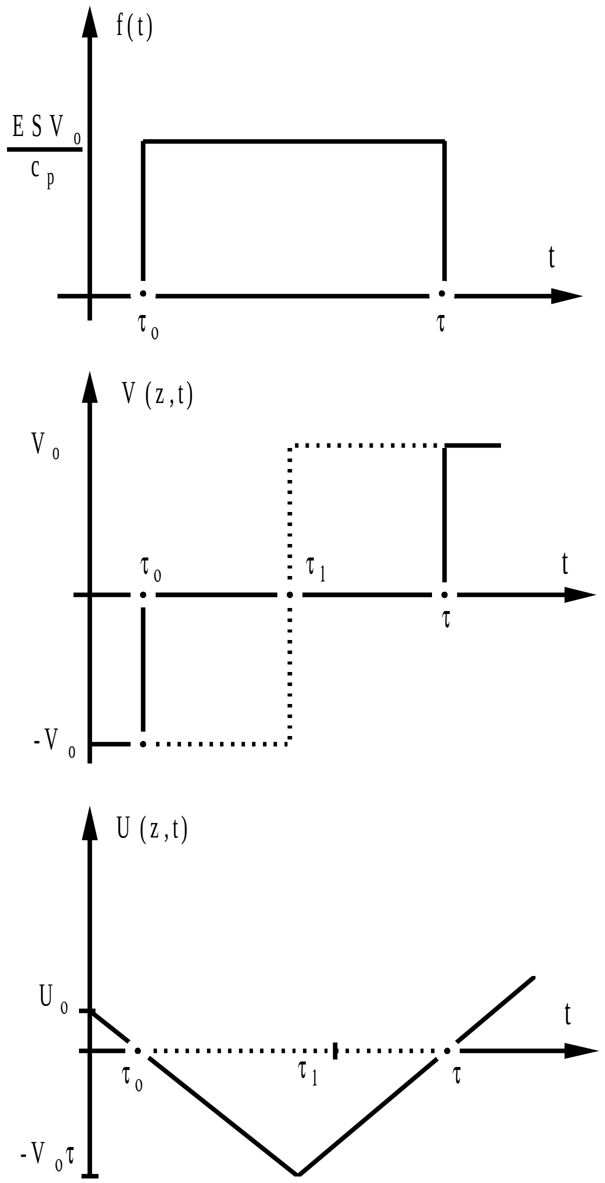
1.4 Initial conditions

A all the nodes of the mesh of the beam are imposed according to the axis z :

initial displacement: $u_0 = 2\,mm$
initial velocity: $v_0 = -100\,m/s$

2 Reference solution

2.1 Method of calculating used for the reference solution



$f(t)$ forces contact in A ;

$V(z,t)$ velocity;

$U(z,t)$ displacement;

$\tau_0 = \frac{U_0}{V_0}$;

$\tau_1 = \tau_0 + \frac{L}{c_p}$;

$\tau - \tau_0 = \frac{2L}{c_p}$ period of shock;

$c_p = \sqrt{\frac{E(1-\nu)}{\rho(1+\nu)(1-2\nu)}}$;

$S = a^2$ section.

.... for point A

———— for point B

2.2 Results of reference

2.3 bibliographical References

1) R.J. GIBERT, "Vibrations of the structures", School of summer of numerical analysis, 1988, (Edition EYROLLES).

3 Modelization A

3.1 Characteristic of the modelization

Discretization 3D of the beam with element HEXA8. The contact beam-wall is modelled by 1 finite element of contact of one thickness null.

The initial conditions and the boundary conditions are imposed via nodes groups:

WALL	(fixed support of the lower nodes of the element of contact)
PLANSYMX	(conditions of symmetry according to x)
PLANSYMY	(conditions of symmetry according to y)
NOBARRE	(initial displacements and velocities).

The mechanical characteristics of the materials are assigned to the groups of meshes:

BAR	(solid material)
CONTACT	(characteristics of the contact)

the parameters of the diagram of NEWMARK are:

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ALPHA = 0.28
DELTA = 0.55
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3.2 Characteristics of the mesh

Many nodes: 88
Number of meshes and types: 21 HEXA8

4 Results of the modelization A

4.1 Values tested

Identification	Reference	*Aster*	% difference
DZ to the point B $t=4.0\mathrm{e}-5\,s$	– 2.0e-3	– 1.999e-3	0.0
DZ at the point B $t=8.0\mathrm{e}-5\,s$	– 1.0e-3	– 0.987e-3	– 1.27
DZ at the point B $t=1.2\mathrm{e}-4\,s$	3.0e-3	2.948e-3	– 1.71
VZ at the point B $t=4.0\mathrm{e}-5\,s$	– 1.0e+2	– 9.999e+2	– 0.005
VZ at the point B $t=8.0\mathrm{e}-5\,s$	1.0e+2	1.052e+2	5.26
VZ at the point A $t=1.2\mathrm{e}-4\,s$	1.0e+2	0.988e+2	– 1.15
VZ at the point B $t=1.2\mathrm{e}-4\,s$	1.0e+2	1.079e+2	7.85

	Time (s)	***Energy*** (J) *Diagram of dissipative Newmark*
ENER_CIN	$t=1.4\mathrm{e}-4\,s$	-2,65620E+02
ENER_TOT	$t=1.4\mathrm{e}-4\,s$	1,21507E+01
TRAV_LIAI	$t=1.4\mathrm{e}-4\,s$	5,92346E-01
DISS_SCH	$t=1.4\mathrm{e}-4\,s$	2,54061E+02

5 Summaries of the results

the accuracy of computation is relatively average what is due to the choice of the coefficients of penalization used to model the contact. The increase in the stiffness of contact improves considerably the field of displacement but generates the important oscillations of the velocity field around the analytical solution.