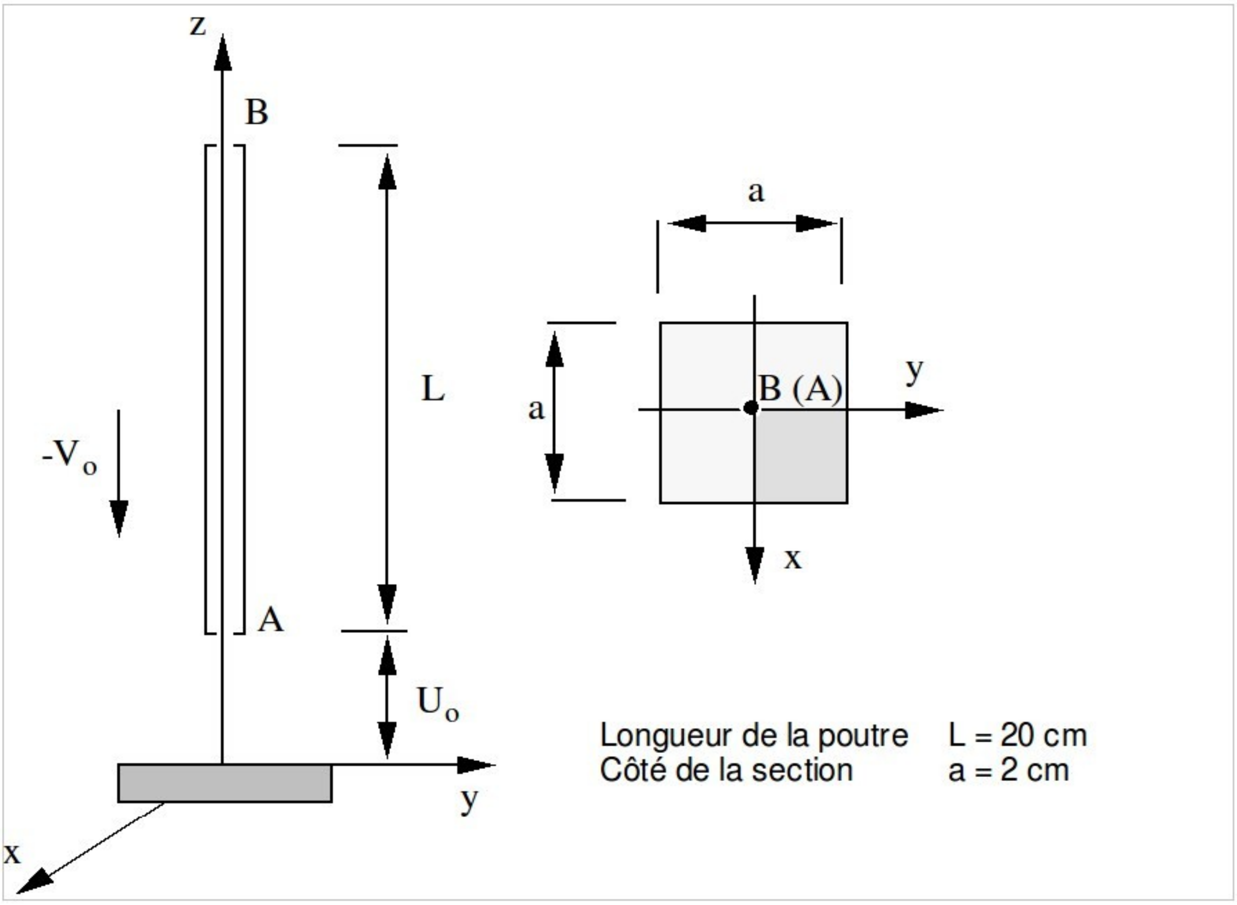
# SDNV100 - Impact of a beam on a rigid wall

## Summary

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

# 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: | $E_n=10^{14}\,Pa$<br>$E_t=0$ |
| | 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: displacements are blocked according to $x$ on the plan $x=0$ and displacements according to $y$ on the plan $y=0$ .

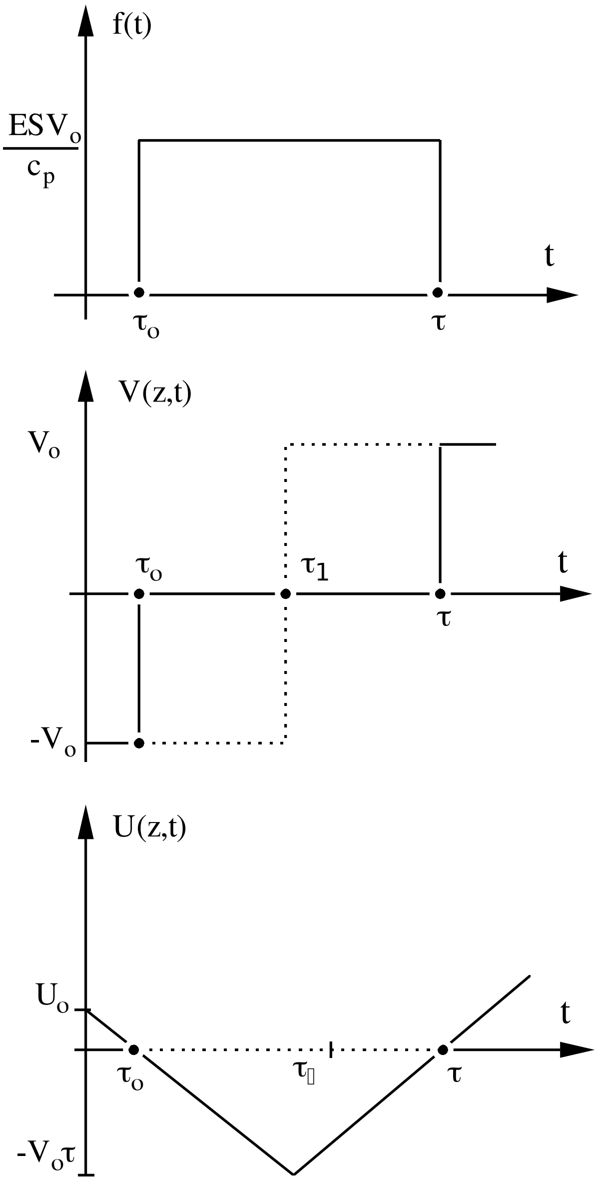
## 1.4 Initial conditions

All the nodes of the mesh of the beam are imposed according to the axis $z$ :

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

# 2 Reference solution

## 2.1 Method of calculating used for the reference solution



$f(t)$ force of contact in $A$ ;

$V(z,t)$ speed;

$U(z,t)$ displacement;

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

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

$\tau-\tau_0=\frac{2L}{c_p}$ duration 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 digital summer of analysis, 1988, (Edition EYROLLES).

# 3 Modeling A

## 3.1 Characteristics of modeling

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

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

| | |
|---|---|
| `WALL` | (embedding 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 speeds). |

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

| | |
|---|---|
| `BAR` | (solid material) |
| `CONTACT` | (characteristics of the contact) |

The parameters of the diagram of NEWMARK are:

```
ALPHA = 0.28
DELTA = 0.55
```

## 3.2 Characteristics of the grid

Many nodes: 88
Many meshs and types: 21 HEXA8

# 4 Results of modeling A

## 4.1 Values tested

| Identification | Reference | *Aster* | % difference |
|---|---|---|---|
| $DZ$ at the point $B$ $t=4.0\mathrm{e}-5s$ | – 2.0e-3 | – 1.999e-3 | 0.0 |
| $DZ$ at the point $B$ $t=8.0\mathrm{e}-5s$ | – 1.0e-3 | – 0.987e-3 | – 1.27 |
| $DZ$ at the point $B$ $t=1.2\mathrm{e}-4s$ | 3.0e-3 | 2.948e-3 | – 1.71 |
| $VZ$ at the point $B$ $t=4.0\mathrm{e}-5s$ | – 1.0e+2 | – 9.999e+2 | – 0,005 |
| $VZ$ at the point $B$ $t=8.0\mathrm{e}-5s$ | 1.0e+2 | 1.052e+2 | 5.26 |
| $VZ$ at the point $A$ $t=1.2\mathrm{e}-4s$ | 1.0e+2 | 0.988e+2 | – 1.15 |
| $VZ$ at the point $B$ $t=1.2\mathrm{e}-4s$ | 1.0e+2 | 1.079e+2 | 7.85 |

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

# 5 Summaries of the results

The precision of calculation 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 field speed around the analytical solution.