

SDLL100 - Transitory dynamic response of a beam in simple traction

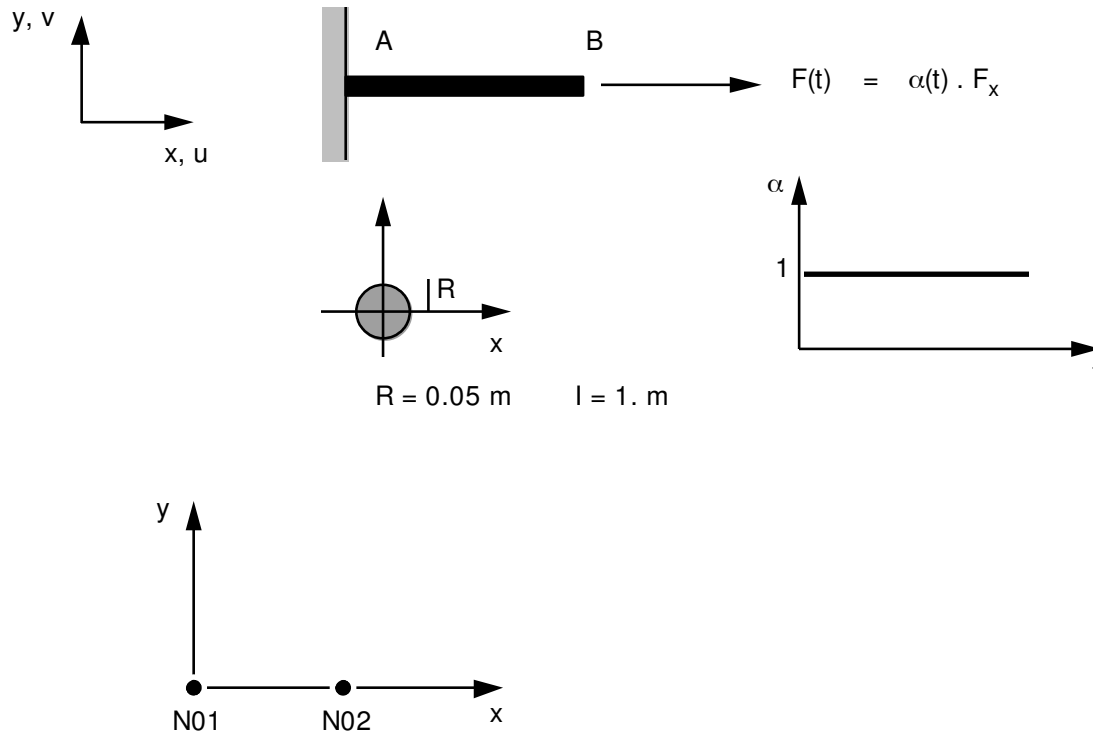
Summary:

This problem-test corresponds to a direct transitory analysis of a deadened linear system or not, made up of a beam in simple traction, subjected to a loading of the Heaviside type applied as from the initial moment.

The problem discretized with a single element of beam has an analytical reference solution.

1 Problem of reference

1.1 Geometry



1.2 Material properties

$$E = 98\,696.044 \text{ MPa}$$

$$\nu = 0.$$

$$\rho = 3 \cdot 10^6 \text{ kg/m}^3$$

Without damping: $C = 0.$ or with damping proportional of Rayleigh: $C = \lambda K + \mu M$, $\lambda = 5 \cdot 10^{-4}$,
 $\mu = -5.$

1.3 Boundary conditions and loadings

Force applied to the node $N02$ in B : $F_x = 1 \cdot 10^6 \text{ N}$

Function $\alpha(t)$ evolution of the loading: $\alpha(t) = 1.$, $t \geq 0.$

1.4 Initial conditions

Initial displacement no one.
Worthless initial speed.

2 Reference solution

2.1 Method of calculating used for the reference solution

- Without damping: the analytical solution of the problem to an element is:

$$x_B(t) = \frac{F_x}{m\omega_0^2} (1 - \cos \omega_0 t)$$
$$m = \frac{1}{3} \rho S I, \quad \omega_0^2 = \frac{3E}{\rho I^2}, \quad T_0 = \frac{2\pi}{\omega_0}$$

where S is the surface of the section (πR^2).

- With damping: the analytical solution of the problem to an element is:

$$x_B(t) = \frac{F_x}{m\omega_0^2} \left[1 - \exp\left(-\frac{\mu + \lambda\omega_0^2}{2} \cdot t\right) \cdot \left(\frac{\mu + \lambda\omega_0^2}{2\omega_1} \sin(\omega_1 t) + \cos(\omega_1 t) \right) \right]$$

λ, μ damping coefficient proportional $C = \lambda K + \mu M$

$$\omega_1 = \frac{\sqrt{(4 - 2\lambda\mu)\omega_0^2 - \mu^2 - \lambda^2\omega_0^4}}{2}$$

2.2 Results of reference

Displacement x_B with $t = \frac{i T_0}{10}$ $i = 1, \dots, 10$

with: $T_0 = \frac{2\pi}{\omega_0}$

2.3 Uncertainty on the solution

Analytical solution.

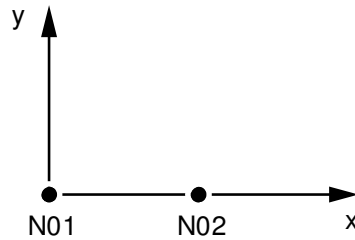
Note:

The reference solution corresponds to the solution obtained with the discretization to an element and by keeping a matrix masses full. That makes it possible to validate the algorithm but it is not the solution of the physical problem.

3 Modeling A

3.1 Characteristics of modeling

POU_D_T



Cutting: *N01* *N02* 1 mesh SEG2

Limiting conditions: DDL_IMPO with the node *N01* :

DX: 0. , DY: 0. , DZ: 0. , DRX: 0, DRY MARTINI: 0,
DRZ: 0

Pas de time: 10^{-5} s.
Integration NEWMARK $\alpha=0.25$, $\delta=0.5$
Integration WILSON $\theta=1.4$

3.2 Characteristics of the grid

Many nodes: 2
Many meshes and types: 1 mesh SEG2

3.3 Sizes tested and results

Without damping:

Moment in dryness.	Reference	Aster NEWMARK	% difference	Aster WILSON	% difference
2.E-3	2.4638E-04	2.4519E-04	0.5	2.4424E-04	0.86
4.E-3	8.9141E-04	8.8948E-04	1.93	8.8794E-04	0.38
6.E-3	1.6887E-03	1.6868E-03	0.11	1.6852E-03	0.20
8.E-3	2.3337E-03	2.3325E-03	0.05	2.3316E-03	0.09
1.E-2	2.5801E-03	2.5801E-03	0.03	2.5801E-03	0
1.2E-2	2.3337E-03	2.3349E-03	0.05	2.3359E-03	0.09
1.4E-2	1.6887E-3	1.6906E-03	0.43	1.6922E-03	0.21
1.6E-2	8.9141E-04	8.9334E-04	0.21	8.9489E-04	0.4
1.8E-2	2.4638E-04	2.4758E-04	0.48	2.4854E-04	0.87
2.E-2	0.0000	3.1989E-09	-	9.3188E-09	-

With damping:

Moment in dryness.	Reference	Aster NEWMARK	% difference	Aster WILSON	% difference
2.E-3	2.3775E-04	2.3662E0-4	0.47	2.3572E-04	0.85
4.E-3	8.3189E-04	8.3015E-04	0.21	8.2877E-04	0.37
6.E-3	1.5307E-03	1.5290E-03	0.11	1.5277E-03	0.2
8.E-3	2.0704E-03	2.0694E-03	0.04	2.0686E-03	0.09
1.E-2	2.2721E-03	2.2721E-03	0.	2.2720E-03	0,004
1.2E-2	2.0976E-03	2.0984E-03	0.04	2.0991E-03	0.07
1.4E-2	1.6488E-03	1.6501E-03	0.08	1.6511E-03	0.14
1.6E-2	1.1164E-03	1.1176E-03	0.11	1.1186E-03	0.2
1.8E-2	7.0165E-04	7.0241E-04	0.11	7.0302E-04	0.19
2.E-2	5.4263E-04	5.4266E-04	0,005	5.4269E-04	0.01

3.4 Remarks

After the first two steps of time, the solution with damping is obtained with an error lower than 0.2% .

4 Summary of the results

The two algorithms give a solution with an error lower than 0.2% reference solution after the first two steps of time.

This problem requires a step of time of integration of 10^{-5} s .