SDLD29 - Transient masses spring with 8 degrees of freedom and viscous damping nonproportional

Abstract:

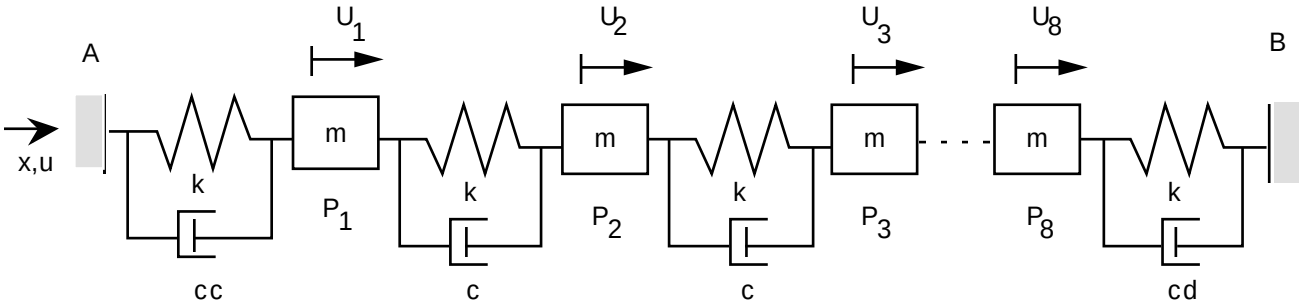
This problem corresponds to a transient analysis by modal recombination of a linear discrete system made up by 8 degrees of freedom. This system has a damping not - proportional. A transitory force of standard crenel is applied into 1 degree of freedom.

In this problem are tested the DISCRET elements with modal masses (M_T_D_N), stiffness matrixes (K_T_D_L) and damping matrixes (A_T_D_L) in a modelization.

The problem has a reference solution suggested by commission VPCS. The variations with *Code_Aster* do not exceed 1,8%.

1 Problem of reference

1.1 Geometry



Point masses: $m_{P_1}=m_{P_2}=m_{P_3}=\ldots\ \ldots=m_{P_8}=m$

Stiffness of connection: $k_{AP1}=k_{P1P2}=k_{P2P3}=\ldots\ \ldots=k_{P8B}=k$

Viscous damping: $C_{P1P2}=c_{P2P3}=\ldots\ \ldots=C_{P7P8}=c$
$C_{AP1}=cc$
$C_{P8B}=cd$

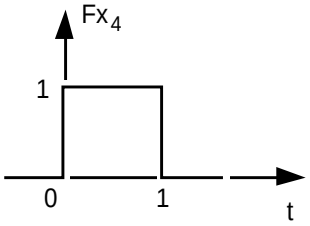
1.2 Material properties

Comes out from elastic translation linear	$k=10^5\,N/m$
Point mass	$m=10\,kg$
Damping of connection	$c=50\,N/(m/s)$
	$cc=250\,N/(m/s)$
	$cd=25\,N/(m/s)$

1.3 Boundary conditions and loadings

Points A and B clamped: $u=0$

Loading: Nonperiodic concentrated force at the point $P4$



Not $P4$ $\quad F_{x_4}=F(t)\ 0\le t\le 1\mathrm{s}$ $\quad F(t)=1\mathrm{N}=constante$
$t>1\mathrm{s}$ $\quad F(t)=0$

1.4 Initial conditions

For $t=0$, in all point: $P_i \quad u=0 \quad \dfrac{du}{dt}=0$.

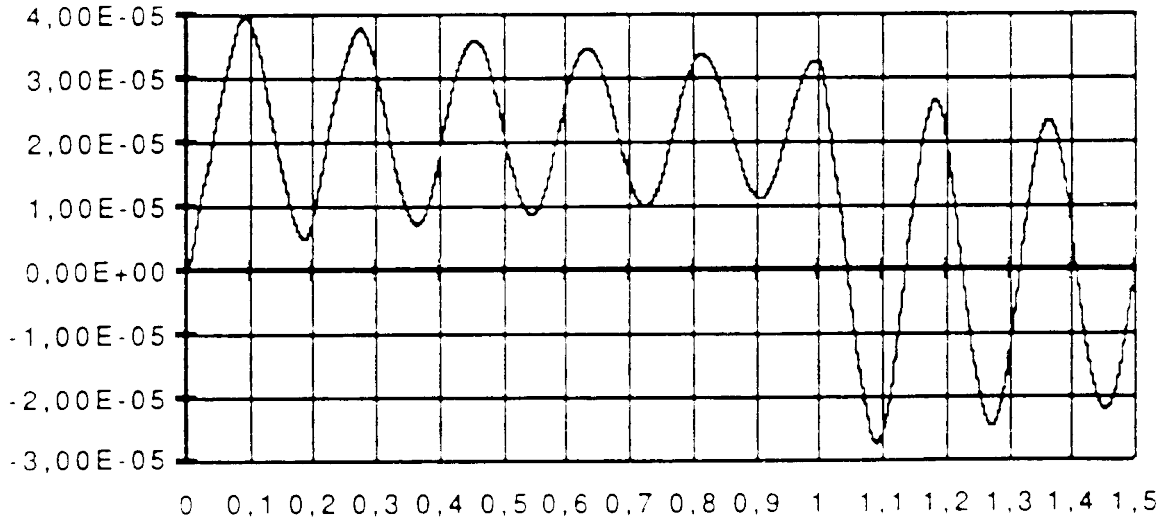
2 Reference solution

2.1 Method of calculating used for the reference solution

numerical integration (approximate) by the direct method using a diagram of numerical integration by finite differences, time step used must be sufficiently small to obtain a sufficiently precise solution. With one of the diagrams used (Newmark method improved), time step retained was of $0.001\mathrm{s}$.
Method of Newmark improved (NEWMARK N. structural Mr., "A method of computation for dynamics" proceeding ASCE J. Eng. Mech. Div E-3, July 1959, pp 67-94) use the diagram of integration according to:

$$\left[\frac{1}{\Delta t^2}[M]+\frac{1}{2\Delta t}[C]+\frac{1}{3}[K]\right](u_{n+2})$$
$$=\frac{1}{3}\left([P_{n+2}]+[P_{n+1}]+[P_n]\right)+\left[\frac{2}{\Delta t^2}[M]-\frac{1}{3}[K]\right](u_{n+1})+\left[\frac{1}{\Delta t^2}[M]+\frac{1}{2\Delta t}[C]-\frac{1}{3}[K]\right](u_n)$$

The indices n $n+1$, $n+2$ respectively indicate the computations carried out at time t_n, $t_{n+1}=t_n+\Delta t$ and $t_{n+2}=t_n+2\Delta t$, where Δt is the increment of appointed time. $[M]$, $[C]$ and $[K]$ are respectively the mass matrixes, damping and stiffness, (u) is the vector displacement and (P) the vector forces associated.



Point 4: displacement according to time

2.2 Results of reference

Displacement to the point $P4$ according to time, confer graph above.

2.3 Uncertainty on the solution

- position of the extremas: $\Delta t<0.015$
- maximum amplitude: $\Delta u/u<0.5\%$

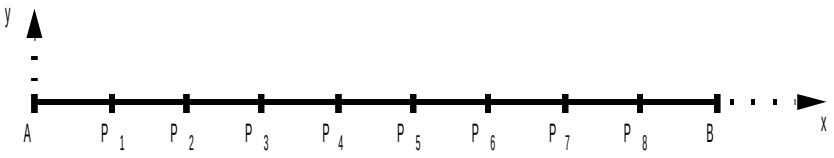
2.4 Bibliographical references

1.Card-indexes SDLD29/90 of commission VPCS

3 Modelization A

3.1 Characteristic of the modelization

Discrete element of stiffness in translation



Characteristics of the DISCRET

elements:	with nodal masses and limiting K_T_D_L and	M_T_D_N stiffness matrixes damping matrixes

A_T_D_L Conditions:

in all nodes	DDL_IMPO=_F (TOUT=' OUI' DY= 0. , DZ= 0.)
with the nodes ends	(GROUP_NO= AB DX= 0.)

Names of the nodes:

Not A = $N1$ $P_1 = N2$
Not B = $N10$ $P_2 = N3$
$P_8 = N9$

modal Recombination with all the modes (8) time step used $dt = 1.\mathrm{E}-3\ s$
diagram of EULER

3.2 Characteristics of the mesh

Many nodes: 10
Number of meshes and types: 9 SEG2

3.3 Quantities tested and Time

results (s)	Reference
0.09	3.97 E-5
0.18	5.10 E-6
0.27	3.77 E-5
0.36	7.30 E-6
0.45	3.59 E-5
0.54	8.81 E-6
0.63	3.47 E-5
0.72	1.01 E-5
0.81	3.36 E-5
0.91	1.11 E-5
0.99	3.27 E-5

3.4 Remarks

Contained of the file results: displacements.

4 Summary of the results

One obtains a relatively good agreement between the calculated solution and solution VPCS (<0.7%) except at time 0.91 (2.4%). The differences are primarily due to the fact that times of test are given only with 2 significant figures, which does not make it possible to seize sufficiently well the time of the extremum.