

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

Summary:

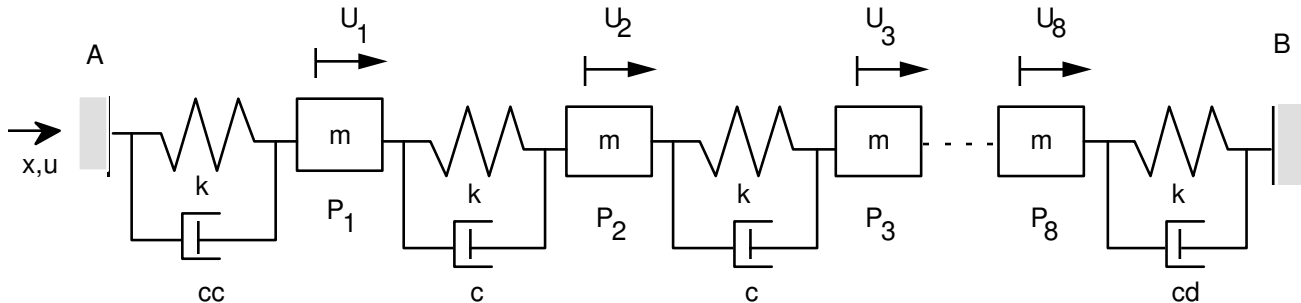
This problem corresponds to a transitory analysis by modal recombination of a linear discrete system made up by 8 degrees of freedom. This system has a damping not - proportional. A transitory force of standard crenel is applied into 1 degree of freedom.

In this problem the elements are tested `DISCRETE` with modal masses (`M_T_D_N`), matrices of rigidity (`K_T_D_L`) and matrices of damping (`A_T_D_L`) in a modeling.

The problem has a reference solution suggested by commission VPCS. Variations with `Code_Aster` do not exceed 1.8%.

1 Problem of reference

1.1 Geometry



Specific masses:

$$m_{P_1} = m_{P_2} = m_{P_3} = \dots = m_{P_8} = m$$

Stiffnesses of connection:

$$k_{AP_1} = k_{P_1P_2} = k_{P_2P_3} = \dots = k_{P_8B} = k$$

Viscous damping:

$$C_{P_1P_2} = C_{P_2P_3} = \dots = C_{P_7P_8} = c$$

$$C_{AP_1} = cc$$

$$C_{P_8B} = cd$$

1.2 Material properties

Spring of elastic translation linear

$$k = 10^5 \text{ N/m}$$

Specific mass

$$m = 10 \text{ kg}$$

Damping of connection

$$c = 50 \text{ N/(m/s)}$$

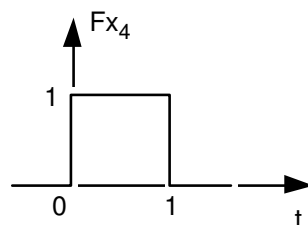
$$cc = 250 \text{ N/(m/s)}$$

$$cd = 25 \text{ N/(m/s)}$$

1.3 Boundary conditions and loadings

Points A and B embedded: $u=0$

Loading: Concentrated force not periodical at the point P4



Not P4

$$F_{x_4} = F(t) \begin{cases} 0 \leq t \leq 1 \text{ s} \\ t > 1 \text{ s} \end{cases}$$

$$F(t) = 1 \text{ N} = \text{constante}$$

$$F(t) = 0$$

1.4 Initial conditions

For $t=0$, in any point P_i : $u=0$, $\frac{du}{dt}=0$.

Code_Aster

Version
default

Titre : SDLD29 - Transitoire masse ressort à 8 degrés de l[...]
Responsable : ALARCON Albert

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Clé : V2.01.029 Révision :
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2 Reference solution

2.1 Method of calculating used for the reference solution

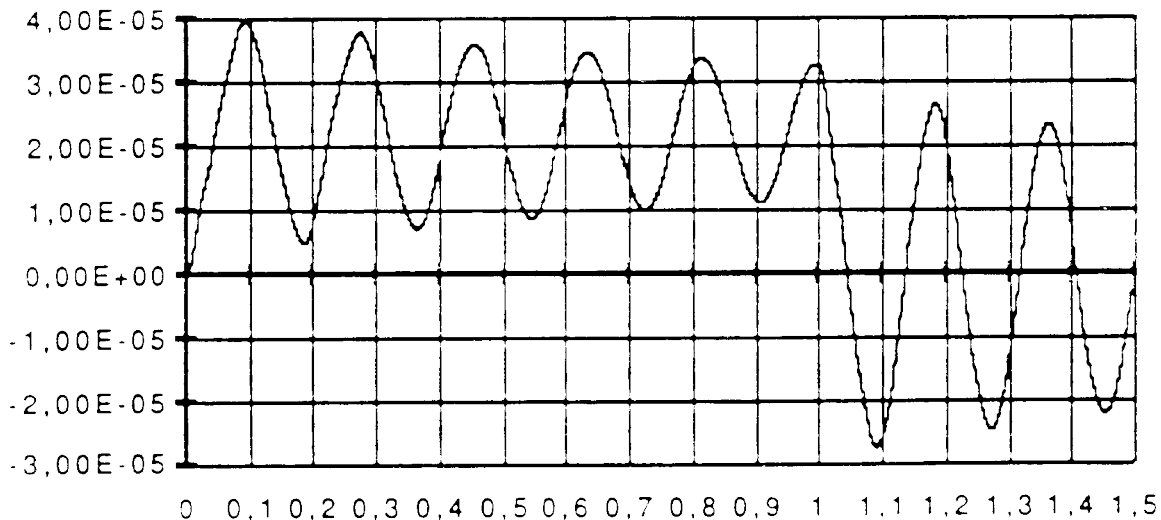
Digital integration (approximate) by the direct method using a diagram of digital integration by finished differences, the step of time used must be sufficiently small to obtain a sufficiently precise solution. With one of the diagrams used (Newmark method improved), the step of appointed time was of 0.001s .

Method of Newmark improved (NEWMARK NR. Mr., "with method of computation for structural dynamics" proceeding ASCE J. Eng. Mech. Div E-3, July 1959, pp 67-94) use the diagram of integration according to:

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

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

Indices n , $n+1$, $n+2$ the calculations carried out at time indicate respectively 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 matrices masses, 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 at 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

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

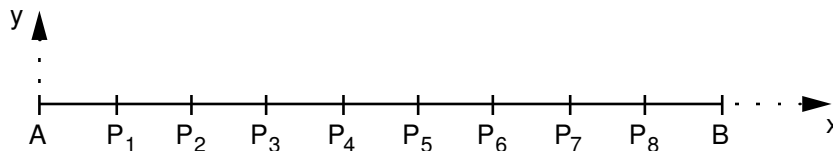
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1. Card SDLD29/90 of commission VPCS

3 Modeling A

3.1 Characteristics of modeling

Discrete element of rigidity in translation



Characteristics of the elements

DISCRETE :	with nodal masses	M_T_D_N
	and matrices of rigidity	K_T_D_L
	and matrices of damping	A_T_D_L

Limiting conditions:

in all the 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)	pas de time used	dt = 1.E - 3 s
	diagram of EULER	

3.2 Characteristics of the grid

Many nodes:	10
Many meshes and types:	9 SEG2

3.3 Sizes tested and results

Time (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

Contents 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 moment 0.91 (2.4%). The differences are primarily due to the fact that the moments of test are given only with 2 significant figures, which does not make it possible to seize sufficiently well the moment of the extremum.