SDLD23 - System of masses and springs under random excitation

Summary:

This test was part of the batch of dynamic tests envisaged within the framework of the VPCS, batch which officially did not end but which was used as a basis for many cases tests of dynamics of *Code_Aster*.

It comprises a set of eight specific masses and nine springs excited by a random force imposed on one of the masses.

The excitation is of white vibration type. It is given by the spectral concentration of power of the exiting force.

The movement of the excited mass is calculated by a stochastic approach according to various frequential discretizations for the answer.

One also calculates in postprocessing the spectral moments of the answer.

1 Problem of reference

1.1 Geometry

The excitation is a seismic movement of type forces imposed applied to the point $P4$ in the direction dx.

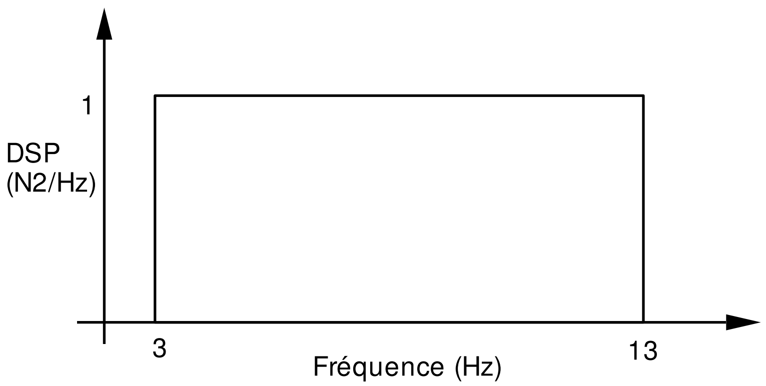
One is interested in the DSP of displacement of the node $P4$.

1.2 Material properties

Specific masses:	$m=10\,Kg$
Elastic springs:	$k=10^5\,N/m$
Shock absorbers:	$c=50\,N/(m/s)$

1.3 Boundary conditions and loadings

The problem is unidimensional in the direction x (1 degree of freedom by mass).
The excitation is a DSP of constant force of level 1, between 3 and 13 Hz.



2 Reference solution

2.1 Method of calculating used for the reference solution

The solution taken for reference is resulting from the test SDLD23 guide VPCS [bib1].

2.2 Results of reference

Peak of the answer to the first Eigen frequency.
Values of the first spectral moments for various discretizations.

2.3 Reference

[bib1] Guide VPCS.

3 Modeling A

3.1 Characteristics of modeling

Discrete element in translation of the type DIS_T

Modeling respects the geometry.

Characteristics of the elements:

With the nodes $P1$ with $P8$: matrices of masses of the type M_T_D_N with $m=10\,Kg$.
Elements of spring: a matrix of stiffness of the type K_T_D_L with $K_x=10^5 N/m$
Elements of damping: a matrix of damping of the type A_T_D_L with $c_x=50\ N/m$

Boundary conditions:

All the degrees of freedom are blocked except the degree of freedom dx .

Modal damping is calculated by the operator of modal calculation, it is reinjected like modal damping in random dynamic calculation.

3.2 Characteristics of the grid

Many nodes: 10
Many meshs and types: 9 SEG2, 10 POI1

3.3 Sizes tested

DSP of displacement to the node $P4$

Identification	Reference	*Aster*	% Difference
ABSOLUTE: $F=5.5259\,Hz$	0.1059E-5	0.1059E-5	0%

Spectral moments for the discretization with regular step 0.25 Hz (40 pas)

Identification	Reference	% Tolerance
Spectral moment n°0	$4.677906\ 10^{-6}$	0.1%
Spectral moment n°1	$1.613654\ 10^{-5}$	0.1%
Spectral moment n°2	$5.580276\ 10^{-4}$	0.1%
Spectral moment n°3	$1.935152\ 10^{-2}$	0.1%
Spectral moment n°4	0.673608	0.1%
Spectral moment n°6	834.63140	0.1%
Spectral moment n°8	$1.1200226\ 10^{6}$	0.1%

Spectral moments for the discretization with regular steps 0,025 Hz (400 pas)

Identification	Reference	% Tolerance
Spectral moment n°0	$3.1750082\ 10^{-7}$	0.1%
Spectral moment n°1	$1.0960802\ 10^{-5}$	0.1%
Spectral moment n°2	$3.803552\ 10^{-4}$	0.1%
Spectral moment n°3	$1.325284\ 10^{2}$	0.1%
Spectral moment n°4	0.4643197	0.1%
Spectral moment n°6	588.14036	0.1%
Spectral moment n°8	8.28816138	0.1%

4 Summary of the results

The preceding tables highlight the importance of the smoothness of the frequential discretization of the DSP answer for the calculation of the spectral moments.

The user can choose the step: the waveband is then discretized in a uniform way and the peaks can be badly represented: it is the case with 40 pas de $0.25\,Hz$, which involves an error of more than 40% at the spectral time.

More one refines the discretization, better is the result.

To avoid refining unnecessarily far from the peaks, one proposes a rather broad discretization by default supplemented by a refinement of 50 points of discretization around each peak.

In the case of this test which understands one peak, this discretization by default makes it possible to about consider the moments spectral with a precision 2% .