SDLD23 - System of masses and springs under random excitation

Abstract:

This test was part of the batch of dynamic tests envisaged in the frame 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 point 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 power spectral density of the exiting force.

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

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

1 Problem of reference

1.1 Geometry

the excitation is a seismic motion of type forces imposed applied to the point $P4$ in the meaning dx .

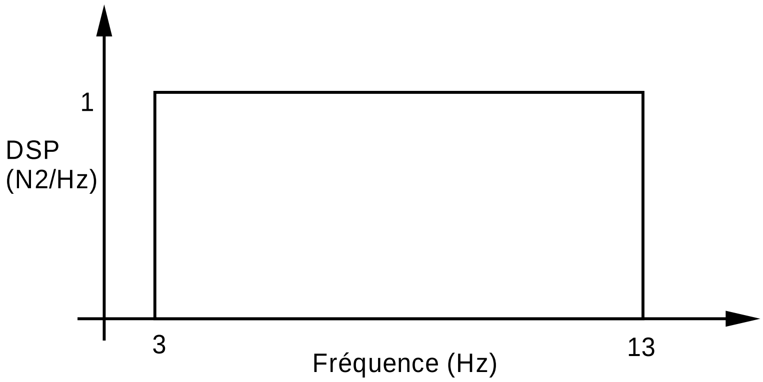
One is interested in the DSP of displacement of the node $P4$.

1.2 Material properties

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

1.3 Boundary conditions and loadings

the problem is unidimensional in the direction x (1 degree of freedom per 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 test SDLD23 of guide VPCS [bib1].

2.2 Results of reference

Peak of the response to the first eigenfrequency.
Values of the first spectral moments for various discretizations.

2.3 Reference

[bib1] Guides VPCS.

3 Modelization A

3.1 Characteristic of the modelization

Discrete element in translation of the type `DIS_T`

The modelization respects the geometry.

Characteristics of the elements:

With the nodes $P1$ with $P8$: mass matrixes of the type `M_T_D_N` with $m=10\,Kg$.
Elements of spring: a stiffness matrix of the type `K_T_D_L` with $K_x=10^5 N/m$
Elements of damping: a damping matrix 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 .

The damping modal is calculated by the operator modal computation, it is reinjected like modal damping in random dynamic computation.

3.2 Characteristics of the mesh

Many nodes: 10
Number of meshes and types: 9 `SEG2`, 10 `POI1`

3.3 Quantities tested

DSP of displacement to the node $P4$

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

spectral Moments for the discretization with regular step 0.25 Hz (40 steps)

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 106	0.1%

spectral Moments for the discretization to regular step 0.025 Hz (400 steps)

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 102	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 Synthesis of results

the preceding tables highlight the importance of the smoothness of the frequential discretization of the DSP response for the computation 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 steps of $0.25\,Hz$, which involves an error of more than 40% at the spectral time.

More one refines the discretization, better is 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 an accuracy 2% .