SDLL147 – Simple vertical beam assembled on a spring subjected to an earthquake

Summary:

This test contributes to the validation of the operator of spectral seismic analysis COMB_SISM_MODAL of *Code_Aster*. It is about one CAS-test of nonregression, relating to the method of Gupta, which considers an at the same time dynamic and quasi-static contribution modes clean in a frequential band to define as a preliminary.

The structure considered is a simple vertical beam assembled on a spring. The values tested are displacements, absolute accelerations and nodal reactions in 4 nodes.

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1 Problem of reference

1.1 Geometry

It is about a 40 height meters beam, of which the lower part (between altitudes 0 and 10 meters) is made up of a stiff material while the upper part (above the dimension 10 meters) is more flexible; the unit is provided with a spring at the lower end (Table 1.1-1).

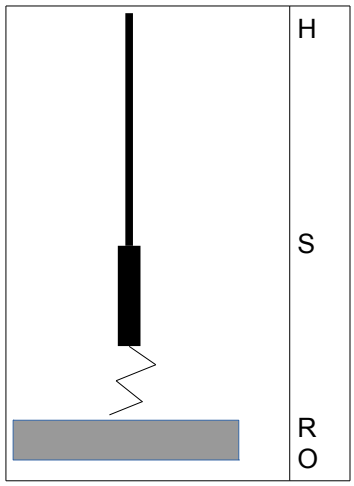

Table 1.1-1 : Simplified model

Coordinates of the points:

Nodes	X (m)	Y (m)	Z (m)
O	0.	0.	-1.
R	0.	0.	0.
S	0.	0.	10.
H	0.	0.	40.

Table 1.1-2 : Coordinates of the nodes

Characteristics of the sections:

	External ray R_{ext} (m)	Thickness E_p (m)	GROUP_MA
to erase	10.	1.	TO ERASE
frame	10.	1.	FRAME

Table 1.1-3 : Characteristics of the sections

1.2 Properties of materials

	Poisson's ratio	Young modulus $(N.m^{-2})$)	Density $(kg.m^{-3})$	GROUP_MA

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to erase	0.2	$3.5\ E+10$	$2.5\ E+03$	TO ERASE
frame	0.2	$3.5\ E+08$	$2.5\ E+03$	FRAME

Table 1.2-1

	Stiffness in X $(N.kg^{-1})$	Stiffness in there $(N.kg^{-1})$)	Stiffness in Z $(N.kg^{-1})$)	Mass (kg)	GROUP_MA
ground	$1.\ E+13$	$1.\ E+13$	$1.\ E+13$	0.	GROUND

Table 1.2-2 : Properties of materials

1.3 Boundary conditions and loadings

Boundary conditions:
Node O : $DX=DZ=0$
Node R : $DRY=0$
All nodes: $DY=DRX=DRZ=0$

Seismic mono-support, identical loadings in the 3 directions:
Reduced damping taken into account: 0.07

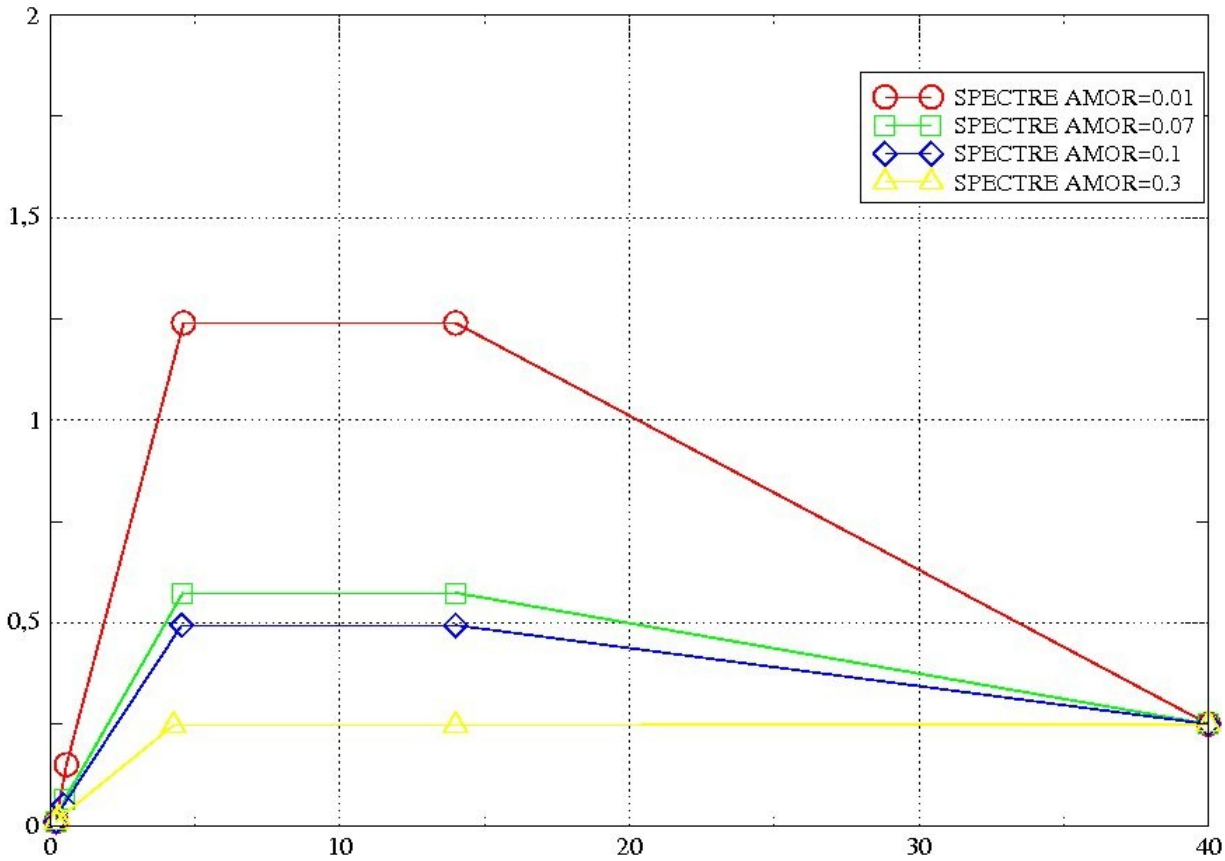

Fig. 1.3-1: Elastic spectrum of answer

X-coordinate: frequency (Hz) /ordinate: acceleration (g)

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2 Reference solution

2.1 Method of calculating

Without object; CAS-test of nonregression

2.2 Sizes and results of reference

Displacements, absolute accelerations and nodal reactions at the points O, R, S and H.

2.3 Uncertainties on the solution

Without object.

2.4 Bibliographical reference

Nothing.

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3 Modeling A

3.1 Characteristics of modeling

Modeling is in beams POU_D_E, more one discrete element of stiffness DIS_T, without mass.

3.2 Characteristics of the grid

Many nodes: 82
Many meshs and types: 81 SEG2.

3.3 Sizes tested and results

3.3.1 Eigen frequencies

Mode	Value of reference (Hz)
1	1.5491943226358
2	3.107551438801
3	9.3245300415725
4	9.5870612490701
5	15.547112609525
6	21.778952588689
7	26.36518615935
8	28.023559687023
9	34.284194672867
10	40.56369329853
11	46.864148730311
12	50.060463212131
13	53.18629486166
14	59.528203850076

Table 3.3.1-1 : Eigen frequencies

3.3.2 spectral mono-support Analyzes

Method of calculating

Base modal comprising the 14 preceding modes ($<60\,Hz$)
Reduced damping of 0.07 for all the modes
Taking into account of the static contribution of the neglected clean modes
Combination of the dynamic modal answers according to the method Gupta (fréquence_1: $14.6\,Hz$, fréquence_2: $40\,Hz$) COMB_MODE=_F (TYPE=' GUPTA')
Quadratic combination of the directional answers

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COMB_DIRECTION=_F (TYPE=' QUAD')
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Table 3.3.2-1 : Method of calculating

Displacements: DEPL (m)

NRœud	component	Reference (m)
H	DX	3.2396432663129E-03
	DY	0.0E+00
	DZ	1.3091056936155E-03
	DRX	0.0E+00
	DRY MARTINI	1.4915675244137E-04
	DRZ	0.0E+00
R	DX	9.4449003235868E-08
	DY	0.0E+00
	DZ	1.5182762043245E-07
	DRX	0.0E+00
	DRY MARTINI	0.0E+00
	DRZ	0.0E+00
S	DX	9.056974877545E-06
	DY	0.0E+00
	DZ	7.2126964195151E-06
	DRX	0.0E+00
	DRY MARTINI	1.6632972701712E-06
	DRZ	0.0E+00
O	DX	0.0E+00
	DY	0.0E+00
	DZ	0.0E+00

Table 3.3.2-2 : displacements

Absolute accelerations: ACCE_ABSOLU ($N.m^{-2}$)

NRœud	component	Reference ($N.m^{-2}$)
H	DX	0.61824985176146
	DY	0.25000000000000
	DZ	0.56926959473828
	DRX	0.0E+00
	DRY MARTINI	0.0936304357433140
	DRZ	0.0E+00
	DX	0.24879675464209

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R	DY	0.25000000000000
	DZ	0.24941080125292
	DRX	0.0E+00
	DRY MARTINI	0.0E+00
	DRZ	0.0E+00
S	DX	0.20128061437786
	DY	0.25000000000000
	DZ	0.22473145378803
	DRX	0.0E+00
	DRY MARTINI	0.011827974442827
	DRZ	0.0E+00
O	DX	0.25000000000000
	DY	0.25000000000000
	DZ	0.25000000000000

Table 3.3.2-3 : absolute accelerations

Nodal reactions: **REAC_NODA** (N)

NRœud	component	Reference (N)
H	DX	3.32338062257E-04
	DY	9326.6031903447
	DZ	9.6944351594654E-08
	DRX	7.7721693252872E+02
	DRY MARTINI	8.6738098496576E-05
	DRZ	0.0E+00
R	DX	6.0472578414485E-05
	DY	9.3266031903447E+03
	DZ	2.6406108097108E-08
	DRX	7.7721693252872E+02
	DRY MARTINI	1.9606618500589E+07
	DRZ	0.0E+00
S	DX	2.8288137175073E-03
	DY	1.8653206380689E+04
	DZ	7.390788273137E-07
	DRX	0.0E+00
	DRY MARTINI	0.0E+00
	DRZ	0.0E+00
O	DX	9.4449003235868E+05
	DY	0.0E+00
	DZ	1.5182762043245E+06

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Table 3.3.2-4 : Nodal reactions

4 Summary of the results

This CAS-test of nonregression makes it possible to validate the method of Gupta of recombination of the modal answers in spectral seismic analysis. The values tested are displacements, absolute accelerations and nodal reactions in 4 nodes of the beam assembled on a spring considered.

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