SDLL147 – Simple vertical beam assembled on a spring subjected to a Summarized

seisme:

This test contributes to the validation of the seismic operator of analysis spectral COMB_SISM_MODAL of *Code_Aster*. It is about a benchmark of non regression, relating to the method of Gupta, which considers an at the same time dynamic and quasi-static contribution eigen modes in a frequential tape 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.

1 Problem of reference

1.1 Geometry

It acts of 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 group is provided with a spring at the lower end (Table 1.1-1).

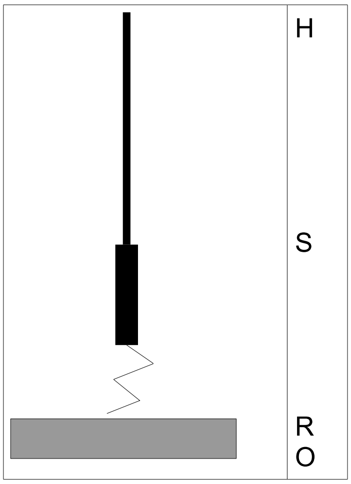

Table 1.1-1 : Model simplified

Coordinated 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

Characteristic of the sections:

	External radius R_{ext} (m)	Thickness E_p (m)	GROUP_MA
basemat	10.	1.	TO ERASE
frame	10.	1.	FRAME

Table 1.1-3 : Characteristics of the sections

1.2 Properties of the materials

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

basemat	0.2	$3.5\ E+10$	$2.5\ E+03$	TO ERASE
built	0.2	$3.5\ E+08$	$2.5\ E+03$	FRAME

Table 1.2-1

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

Table 1.2-2 : Properties of the materials

1.3 Boundary conditions and loadings

Boundary conditions:
The node is outside the field of definition with a right profile of the EXCLU type node: O $DX=DZ=0$
The node is outside the field of definition with a right profile of the EXCLU type node: R $DRY=0$
All nodes: $DY=DRX=DRZ=0$

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

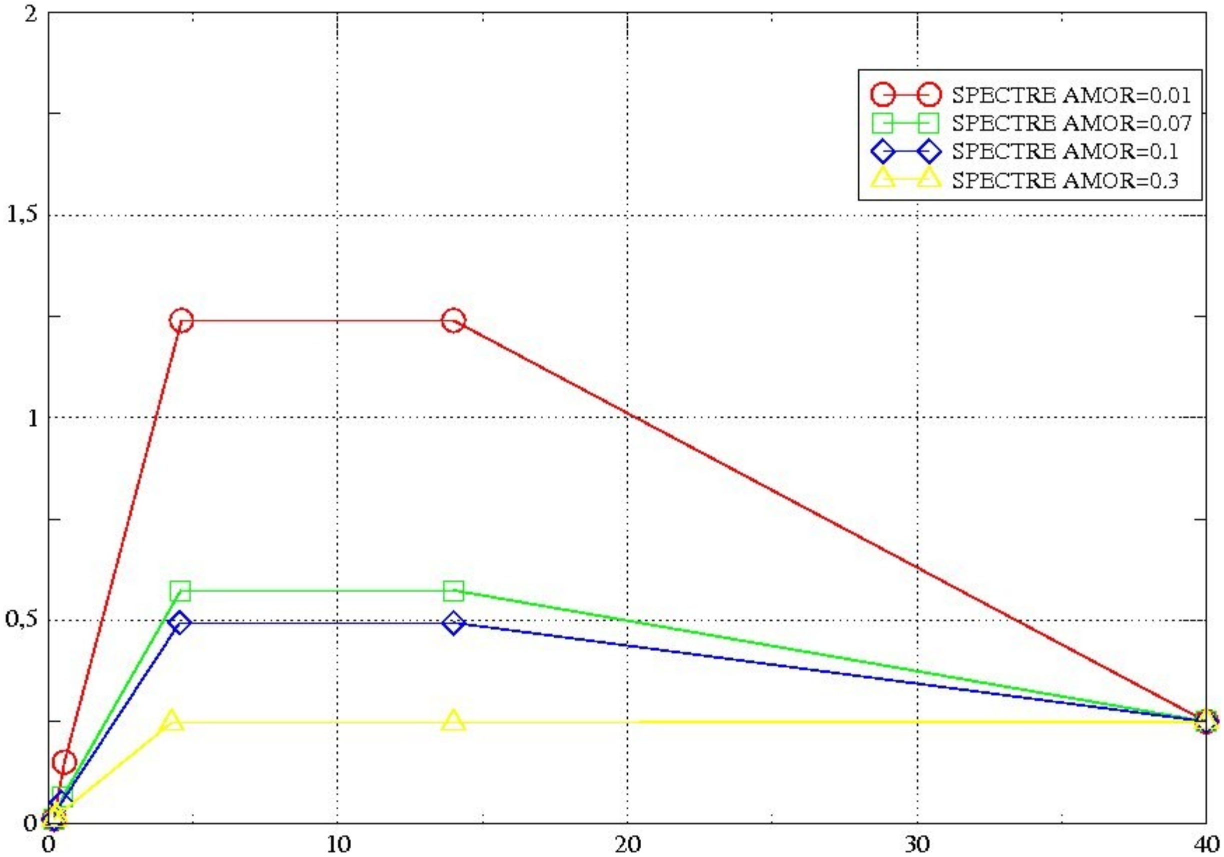

fig. 1.3-1: Elastic response sprectrum

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

2 Reference solution

2.1 Method of calculating

Without object; benchmark of non regression

2.2 Quantities and results of reference

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

2.3 Uncertainties on the solution

Without object.

2.4 Bibliographical reference

Nothing.

3 Modelization A

3.1 Characteristic of the modelization

The modelization is out of beams POU_D_E, plus a discrete DIS_T, massless element of stiffness.

3.2 Characteristics of the mesh

Many nodes: 82
Number of meshes and types: 81 SEG2.

3.3 Quantities tested and results

3.3.1 Eigenfrequencies

Value of reference	Mode (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 : Eigenfrequencies

3.3.2 Analyzes spectral mono-bearing

Method of calculating

Modal base comprising the 14 preceding modes ($<60\ Hz$)
Reduced damping of 0.07 for all the modes
Taken into account of the static contribution of the eigen modes neglected
Combination of the dynamic modal responses according to the method Gupta (fréquence_1: $14.6\ Hz$, fréquence_2: $40\ Hz$) COMB_MODE=_F (TYPE=' GUPTA')
quadratic Combination of directional responses

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COMB_DIRECTION=_F (TYPE=' QUAD')
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Table 3.3.2-11 : Method of calculating

Displacements: DEPL (m)

Node	component	Reference (m)
H	DX	3.2396432663129E-03
	DY	0.0E+00
	DZ	1.3091056936155E-03
	DRX	0.0E+00
	DRY	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	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	1.6632972701712E-06
	DRZ	0.0E+00
O	DX	0.0E+00
	DY	0.0E+00
	DZ	0.0E+00

Table 3.3.2-22 : absolute accelerations

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

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

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

Table 3.3.2-33 : absolute accelerations

nodal Reactions: **REAC_NODA** (N)

Node	component	Reference (N)
H	DX	3.32338062257E-04
	DY	9326.6031903447
	DZ	9.6944351594654E-08
	DRX	7.7721693252872E+02
	DRY	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	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	0.0E+00
	DRZ	0.0E+00
O	DX	9.4449003235868E+05
	DY	0.0E+00
	DZ	1.5182762043245E+06

Table 3.3.2-44 : Nodal reactions

4 Summary of the results

This benchmark of non regression makes it possible to validate the method of Gupta of recombination of the modal responses 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.