SDLX302 - Clamped beam and lumped mass subjected to a random force transverse

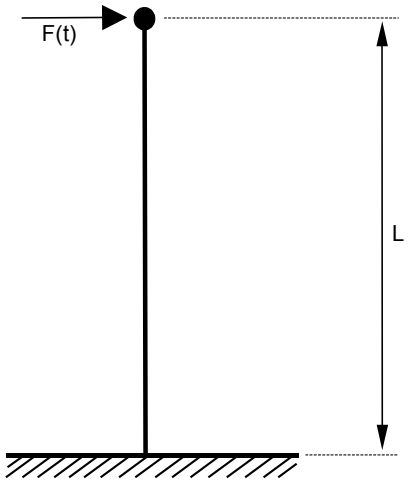
Abstract:

A beam fixed with a lumped mass is subjected to a random force in the transverse direction.

This test validates, using a comparison between codes, the computation of the eigen modes of bending and that of displacement in the frame of a stochastic approach.

1 Problem of reference

1.1 Geometry



Length of the beam	$L=20.0\,m$
Internal diameter	$d=0.388\,m$
Diameter external	$D=0.400\,m$
Lumped mass with the mass	$M=300.\,kg$
top Main moment of inertia	$J=200.\,kg\,m^2$

1.2 Properties of the materials

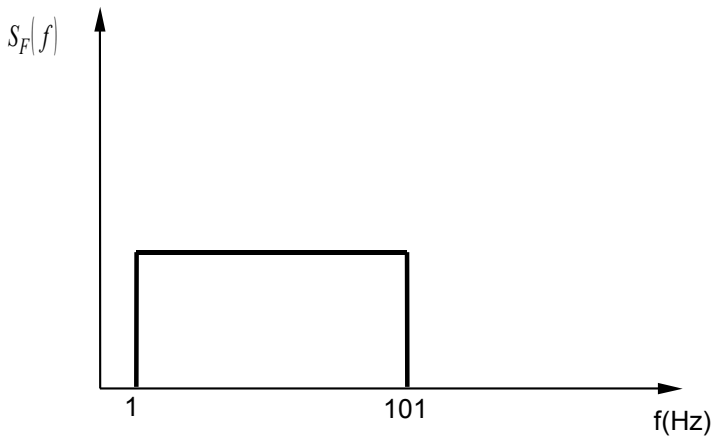
Density of Young	$\rho=7850\,kg.m^{-3}$
the tube Modulus	$E=210.\,E+9\,N.m^{-2}$
Poisson's ratio	$\nu=0.$

1.3 Boundary conditions and loading

the tube is embedded at the base. The mass is free. Motion is authorized in a vertical plan $(DX\,,DRZ)$.

A random force $F(t)$, applied to the lumped mass is compared to a Gaussian steady random process, centered, of type white vibration with restricted tape of $1.\mathrm{Hz}$ with $101.\mathrm{Hz}$. It is characterized by a standard deviation $\sigma_F=1\,kN$, and a unilateral spectral concentration in frequency $S_F(f)$ such as:

$$\forall\, f\in[1\,Hz\,,101\,z]$$
$$S_F(f)=\frac{\sigma_F^2}{100}=10^4\,N^2\,s$$



2 Reference solution

2.1 Method of calculating used for the reference solution

computations are carried out with 8 computer codes, for 10 modelizations. The various modelizations are presented below.

- Castem: 20 beam elements without shears;
- Dynam2D: 20 beam elements without shears;
- PERMAS (1): 20 beam elements without shears;
- Nastran: 20 beam elements without shears;
- SYSTUS (1): 20 beam elements without shears;
- ABAQUS: 20 beam elements with shears;
- MECHANICA: 5 beam elements with shears, convergence with degree 7;
- BEAVER: 10 beam elements with shears;
- SYSTUS (2): 40 beam elements with shears;
- PERMAS (2): 20 beam elements with shears;

The damping reduced ξ 1% are worth on all the modes.

2.2 Results of reference

frequencies.

Value RMS, for displacement at the loose lead of the beam.

2.3 Uncertainty on the solution

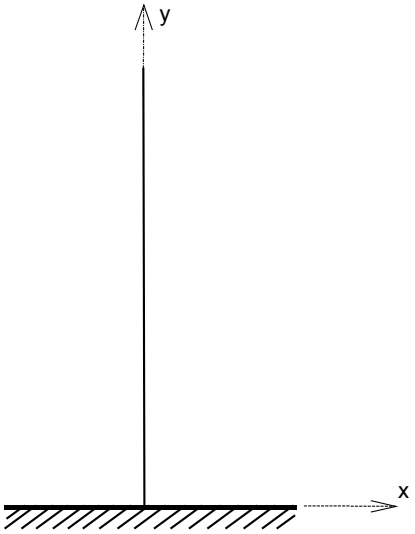
Comparison between codes.

2.4 Bibliographical references

1) IPSI - Day $\Phi^2.AS$ - Flight XVIII, n° 2. Damping in the structural analyzes. June 21st, 1994.

3 Modelization A

3.1 Characteristic of the modelization



Along the beam, we have $DY = DZ = DRX = DRY = 0$.
At the base, all the degrees of freedom are blocked.

3.2 Characteristics of the mesh

The mesh consists of 21 nodes and 20 elements Timoshenko beam.

3.3 Quantities tested and Eigenfrequencies

results of bending

Number of mode	1	2	3	4	5	6	7	8	9	10
Castem	0.70	5.04	14.69	28.78	46.19	66.82	92.74	125.15	163.91	208.81
DYNAM2D/DRAM	0.70	5.04	14.67	28.75	46.18	66.86	92.77	125.05	163.38	208.81
PERMAS (1)	0.70	5.04	14.69	28.78	46.19	66.82	92.74	125.15	163.91	208.81
Nastran	0.70	5.04	14.67	28.75	46.18	66.86	92.78	125.05	163.48	207.70
SYSTUS (1)	0.72	5.13	14.91	29.19	46.83	67.65	93.64	125.95	164.39	208.61
ABAQUS	0.70	5.02	14.57	28.42	45.40	65.17	89.26	118.50	152.33	
MECHANICA	0.70	5.03	14.62	28.54	45.63	65.60	90.21	120.43	155.88	196.01
BEAVER	0.70	5.03	14.59	28.46	45.48	65.35	89.88	120.24	154.40	194.06
SYSTUS (2)	0.70	5.03	14.59	28.42	45.35					
PERMAS (2)	0.70	5.03	14.60	28.48	45.50	65.29	89.59	119.41	138.42	
Mean values	0.70	5.04	14.66	28.66	45.89	66.27	91.51	122.77	157.79	204.69
ASTER	0.70	5.03	14.59	28.43	45.38	65.07	89.17	118.67	153.24	192.40
Variation *Aster*	0.00	0.26	0.48	0.79	1.12	1.81	2.56	3.34	2.88	6.00

Mean values in %

Displacement (m) **: with** $Fx=1000$

CASTEM	DYNAM2D	PERMAS (1)	PERMAS (2)	SYSTUS (1)	ABAQUS	Mean value	ASTER	Variation (%) Value moyenne/ASTER
0.039	0.038	0.041	0.038	0.035	0.039	0.038	0.0344	– 9.4

3.4 Remarks

Of the problems of definition between force interns and forced do not make it possible to compare the results of ASTER with the other codes (bending moment and shears).

4 Summary of the results

the results of modal base are good since the maximum change is to the maximum of 6% on the last frequency.

For the results in displacement we obtain a variation of 9.4.