SDLX302 - Fixed beam and masses concentrated subjected to a transverse random force

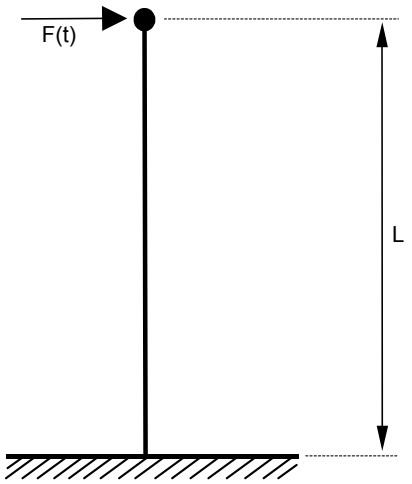
Summary:

A beam fixed with a concentrated mass is subjected to a random effort in the transverse direction.

This test validates, using a comparison between codes, the calculation of the clean modes of inflection and that of displacement within the framework of a stochastic approach.

1 Problem of reference

1.1 Geometry



Length of the beam	$L=20.0\,m$
Internal diameter	$d=0.388\,m$
External diameter	$D=0.400\,m$
Mass concentrated at the top	$M=300.\,kg$
Mass moment of inertia	$J=200.\,kg\,m^2$

1.2 Properties of materials

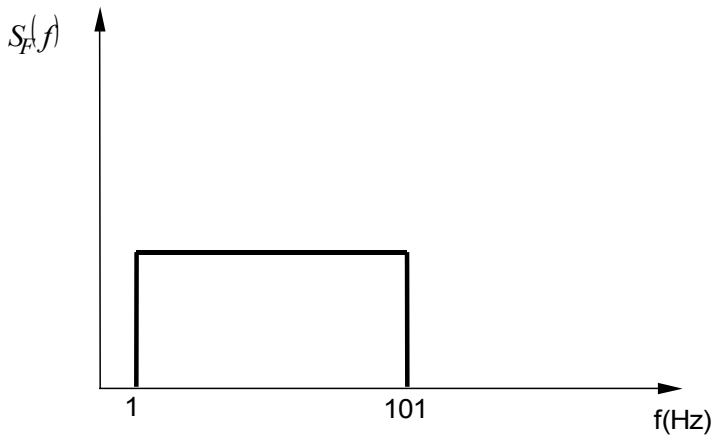
Density of the tube	$\rho=7850\,kg.m^{-3}$
Young modulus	$E=210.\,E+9\,N.m^{-2}$
Poisson's ratio	$\nu=0.$

1.3 Boundary conditions and loading

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

A random effort $F(t)$, applied to the concentrated mass is compared to a Gaussian stationary random process, centered, of type white vibration with band limited 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

Calculations are carried out with 8 computer codes, for 10 modelings. Various modelings are presented below.

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

Reduced damping 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

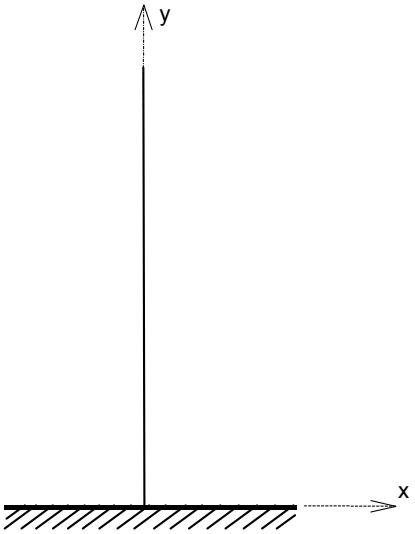
Comparison between codes.

2.4 Bibliographical references

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

3 Modeling A

3.1 Characteristics of modeling



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 grid

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

3.3 Sizes tested and results

Eigen frequencies of inflection

Number of the 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	
Median 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* Median values in %	0.00	0.26	0.48	0.79	1.12	1.81	2.56	3.34	2.88	6.00

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

CASTEM	DYNAM2D	PERMAS (1)	PERMAS (2)	SYSTUS (1)	ABAQUS	Median 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

Problems of definition between effort interns and forced do not make it possible to compare the results of ASTER with the other codes (bending moment and shearing action).

4 Summary of the results

The results of the 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.