SDLL106 - Beam subjected to a random excitation distributed

Summarized:

An bi--embedded beam is subjected over all its length to a force distributed. The profile of distribution of the force is identical to all the frequencies.

The random motion of this beam is evaluated by a stochastic approach: one determines the power spectral density of displacement in various points of the beam.

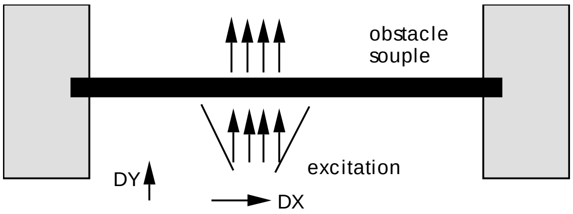
The two possibilities are tested:

- spatial function of the forces applied with interspectrum unit (method 1),
- interspectrum builds directly for the d.o.f. excited (method 2).

This test is an illustration of the response of a structure subjected to a Wind excitation.

1 Problem of reference

1.1 Geometry



Beam:

Square section: $0.001\,m \times 0.001\,m$
Length: $0.8\,m$

One does not take account of the field of gravity.

1.2 Material properties

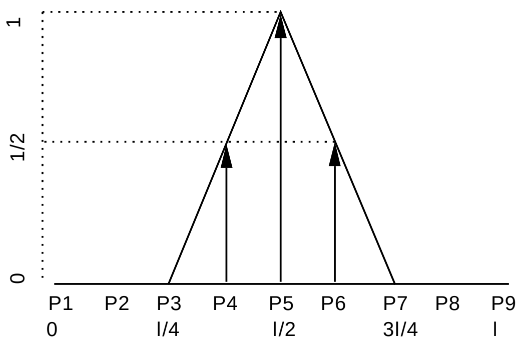
Modulus Young:	$E=2.1\,E+11\,N$
Coefficient of compressibility:	$\nu=0.3$
Density:	$\rho=7000\,kg/m^3$

1.3 Boundary conditions and loadings

the beam is embedded at the two ends.

The degree of freedom DZ is blocked in any point.

The force applied is distributed with the following spatial distribution:



2 Reference solution

2.1 Method of calculating used for the reference solution

The computation direct defines an assembled vector of spatial distribution of the force and applies the spectral concentration of force $G_{FF}(\omega)$ to this distribution (method 1).

The computation broken up defines the excitation as an interspectral matrix of dimension 3 (equal to the number of excited nodes) and applies, in force imposed on the nodes, the following interspectral matrix (method 2):

$$\begin{bmatrix} \frac{1}{4} & \frac{1}{2} & \frac{1}{4} \\ \frac{1}{2} & 1 & \frac{1}{2} \\ \frac{1}{4} & \frac{1}{2} & \frac{1}{4} \end{bmatrix} G_{FF}(\omega)$$

The two results must be identical without any approximation.

2.2 Results of reference

Power spectral density of displacement of the node $P3$ to the frequencies: $4.,6.,8.,10.$ and $12\,Hz$.

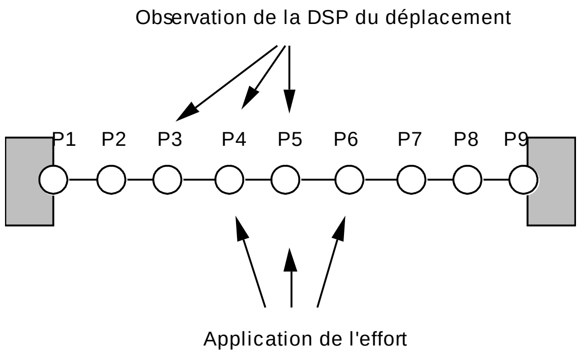
2.3 Bibliographical references

1) C. DUVAL "Dynamic response under random excitation in *the Code_Aster* : theoretical principles and examples of use" - Notes HP-61/92.148

3 Modelization A

3.1 Characteristic of the modelization

Discrete element in translation of the type `DIS_T`



Beam elements: `POU_D_T`

the exiting spectral concentration is a white vibration of level 1.

The first 2 eigen modes were taken into account in computation.

The damping is introduced in the form of modal damping into the operator of dynamic response random. For all the calculation cases, it is taken equal to 5%

3.2 Characteristics of the mesh

Many nodes: 9

Number of meshes and types: 8 `SEG2`

3.3 Remarks

the spectral concentrations are expressed in their physical unit. For a force it will be in N^2/Hz .

3.4 Quantities tested and Spectral concentration

results of displacement at point AM10:

Frequency	Method 1	Method 2%	difference
$4\,Hz$	4.0298E-02	4.0298E-02	0%
$6\,Hz$	9.2971E-02	9.2971E-02	0%
$8\,Hz$	9.5164E-01	9.5164E-01	0%
$10\,Hz$	1.7617E-01	1.7617E-01	0%
$12\,Hz$	2.6695E-02	2.6695E-02	0%

4 Summary of the results

method 1 (spatial distribution of the forces) and the indirect method (by decomposition on the three excited nodes) provide the same one result.

This checking ensures a good coherence of the two methods and the quality of their programming.