SDLL104 - Structures primary education and secondary subjected to a random excitation

Abstract:

A principal beam of strong stiffness and important mass (primary structure), embedded at its base, supports in three points of transmission of forces a light and flexible beam (secondary structure).

The primary structure is excited at its base by an acceleration given by its DSP.

The test compares a direct computation of all two structures and a computation chains where the response of the principal beam with the points of connection is used like the energization of the secondary beam.

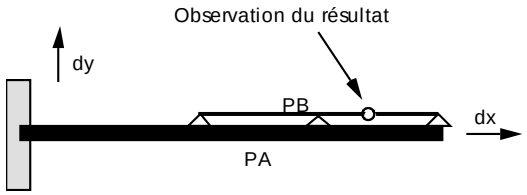
The following features are tested:

- preset analytical interspectral matrix by the function of KANAI-TAJIMI,
- random dynamic response moving absolute motion, imposed acceleration,
- response modal interspectral,
- excitation modal interspectral.

This approach is representative of what is required for the industrial studies: to determine the responses of various secondary structures knowing the response of primary structure.

1 Problem of reference

1.1 Geometry



Beam: PA

Section: $0.1\,mm \times 0.1\,mm$
Length: $3.0\,m$

Beam: PB

Section: $0.001\,mm \times 0.001\,mm$
Length: $2.0\,m$

Ratio of mass enters PB and PA : $0.33\,E-04$

1.2 Material properties

Modulus Young beams A and B :	$E = 2.1\,E+11\,N/m^2$
Poisson's ratio beams A and B :	$\nu = 0.3$
Density beam: PA	$\rho_A = 2000\,kg/m^3$
Density beam: PB	$\rho_B = 1000\,kg/m^3$

1.3 Boundary conditions and loadings

motion is authorized in the plane (DX, DY).

The beam PA is embedded in the support.

The beam PB is connected to the beam PA by three points. In each one, displacements in the meaning DX and DY of the node of PA and the node of PB are identical. Rotations are not dependant.

The interspectral matrix which transmits displacements of structure PA to structure PB in chained computation is of dimension 6 (6 degrees of freedom of transmission).

2 Reference solution

2.1 Method of calculating used for the reference solution

the reference solution is the direct computation of all two structures.

It is supposed that the mass and the stiffness of secondary structure PA do not disturb the behavior of primary structure. Thus chained computation is supposed to be equivalent to direct computation. One can check on the table below that the structure PB modifies the eigenfrequencies of structure little PA.

Calculated eigenfrequencies (Hz)

	PA	PB	PA and PB	
1		6.5711	6.5711	0.
2		10.2655	10.2654	0.001
3	18.3759		18.3759	0.
4		26.2871	26.2871	0.5
		33.2716	33.2716	0.
6		59.1708	59.1708	0.
7		69.4570	69.4571	0.0001
8		105.3094	105.3091	0.0001
9	114.5567		114.5559	0.0007
10		118.9369	118.9376	0.0006

2.2 Results of reference

One observes the spectral concentration of acceleration on the node of the beam PB of X-coordinates $2.4\,m$ (the node $PB25$).

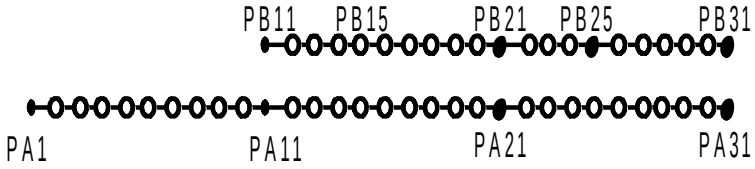
2.3 Bibliographical references

1) C. DUVAL “harmonic Response under random excitation in *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



Elements used: POU_D_T. The characteristics of beam are defined by:

```
          CARELEM = AFFE_CARA_ELEM      (
                                        BEAM:     (          GROUP_MA
:         GRMAPRIM ......

SECTION   :         "RECTANGLE"

CARA              :         ("HZ" "HY")

VALE              :         (0.1 0.1) )
                                                                  …
)         ;
```

The method of calculating asks for the computation of static modes corresponding to the excitation degrees of freedom.

The eigenfrequencies taken into account in computations are all the frequencies in the tape $[0, 35\,Hz]$.

3.2 Characteristics of the mesh

Many nodes:	PA : 31	PB : 21
Number of meshes and types:	PA : 30 SEG2	PB : 20 SEG2

3.3 Quantities tested and Standard deviation

results, average maximum and factor of peak calculated by POST_DYNA_ALEA for the spectrum of Kanai Tajimi:

Quantity tested	Reference	% Tolerance	Standard
Standard deviations	5.522084286	0.001%	Non regression
average Maximum	3.3761135643155	0.001%	Non regression
Factor of peak	18.643183662069	0.001%	Non regression

Comparison of the standard deviations calculated by POST_DYNA_ALEA for the DSP of Kanai Tajimi and with the standard deviation of a realization of signal with GENE_FONC_ALEA:

Quantity tested	Reference	% Tolerance	Standard
Standard deviation	5.522084286	1%	Another Aster (POST_DYNA_ALEA)

Values of the spectral concentration of response in acceleration with the point $PB25$ by direct computation:

Frequency	Node	Reference	% Tolerance	Standard
$5.\ Hz$	PB25	3.6913	0.01	Non regression
$10.\ Hz$	PB25	75.439	0.01	Non regression
$15.\ Hz$	PB25	1.6777	0.01	Non regression
$20.\ Hz$	PB25	1.1367	0.01	Non regression
$25.\ Hz$	Non regression	PB25	0.2927	0.01

Values of the spectral concentration of response in acceleration with the point $PB25$ by chained computation:

Frequency	Node	Reference	% Tolerance	% difference
$5.\ Hz$	PB25	3.6913	1.0	Another Aster
$10.\ Hz$	PB25	75.439	1.0	Another Aster
$15.\ Hz$	PB25	1.6777	1.0	Another Aster
$20.\ Hz$	PB25	1.1367	4.0	Another Aster
$25.\ Hz$	PB25	0.2927	11.0	Another Aster

Of the tests were manually inserted in this modelization in order to validate the creation of interspectrum by means of the couple NOEUD / NOM_CMP for the definition of the number of line and of the number of the column of the interspectrum creates with DEFI_INTE_SPEC.

4 Summary of the results

the got results confirm on the one hand the assumption of equivalence between direct computation and chained computation, on the other hand the good coherence of the calculation algorithm of dynamic response random.

A variation is inevitable between computations of the two methods, that obtained with $25\,Hz$ is nevertheless very high (11%).