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

Summary:

A principal beam of strong rigidity and important mass (primary structure), embedded at its base, supports in three points of transmission of efforts 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 calculation of the whole of the two structures and a calculation chains where the response of the principal beam to the points of connection is used like the excitation of the secondary beam.

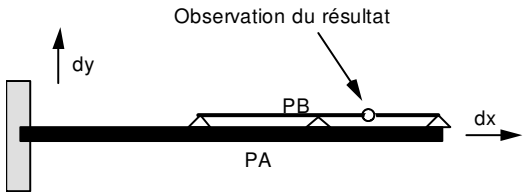
The following features are tested:

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

This approach is representative of what is required for the industrial studies: to determine the answers of various secondary structures knowing the answer of the 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: $2.0\,m$

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

1.2 Material properties

Young modulus 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

The movement is authorized in the plan (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 direction DX and DY node of PA and of the node of PB are identical. Rotations are not dependent.

The matrix interspectrale which transmits displacements of the structure PA with the structure PB in chained calculation 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 calculation of the whole of the two structures.

It is supposed that the mass and the rigidity of the secondary structure PA do not disturb the behavior of the primary structure. Thus chained calculation is supposed to be equivalent to direct calculation. One can check on the table below that the structure PB modify little the Eigen frequencies of the structure PA.

Calculated Eigen frequencies (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 X-coordinates $2.4\,m$ (the node $PB25$).

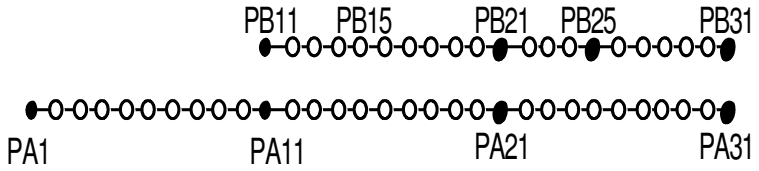
2.3 Bibliographical references

1) C. DUVAL “harmonic Answer under random excitation in *Code_Aster* : theoretical principles and examples of use” - Notes HP-61/92.148

3 Modeling A

3.1 Characteristics of modeling

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   :         'RIGHT-ANGLED'

CARA                :         ('HZ' 'HY')

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

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

The Eigen frequencies taking into account in calculations are all the frequencies in the band $[0, 35\,Hz]$.

3.2 Characteristics of the grid

Many nodes:	PA : 31	PB : 21
Many meshs and types:	PA : 30 SEG2	PB : 20 SEG2

3.3 Sizes tested and results

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

Size tested	Reference	% Tolerance	Type
Standard deviation	5.522084286	0,001%	Non Régression
Average maximum	3.3761135643155	0,001%	Non Régression
Factor of peak	18.643183662069	0,001%	Non Régression

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:

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

Values of the spectral concentration of response in acceleration to the point $PB25$ by direct calculation:

Frequency	Node	Reference	% Tolerance	Type
$5.\ Hz$	PB25	3.6913	0.01	Non Régression
$10.\ Hz$	PB25	75,439	0.01	Non Régression
$15.\ Hz$	PB25	1.6777	0.01	Non Régression
$20.\ Hz$	PB25	1.1367	0.01	Non Régression
$25.\ Hz$	PB25	0.2927	0.01	Non Régression

Values of the spectral concentration of response in acceleration to the point $PB25$ by chained calculation:

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

Tests were manually inserted in this modeling in order to validate the creation of interspectre by using the couple NODE / NOM_CMP for the definition of the number of the line and number of the column of the interspectre creates with DEFI_INTE_SPEC.

4 Summary of the results

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

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