SDLX03 - Assembly of braced thin rectangular plates

Summarized:

This three-dimensional problem consists in seeking the frequencies of vibration of a mechanical structure made up of an assembly of plates where one simulated an effect of stiffening. This test of Structural mechanics corresponds to a dynamic analysis of an assembled structure having a linear behavior. It understands two modelizations.

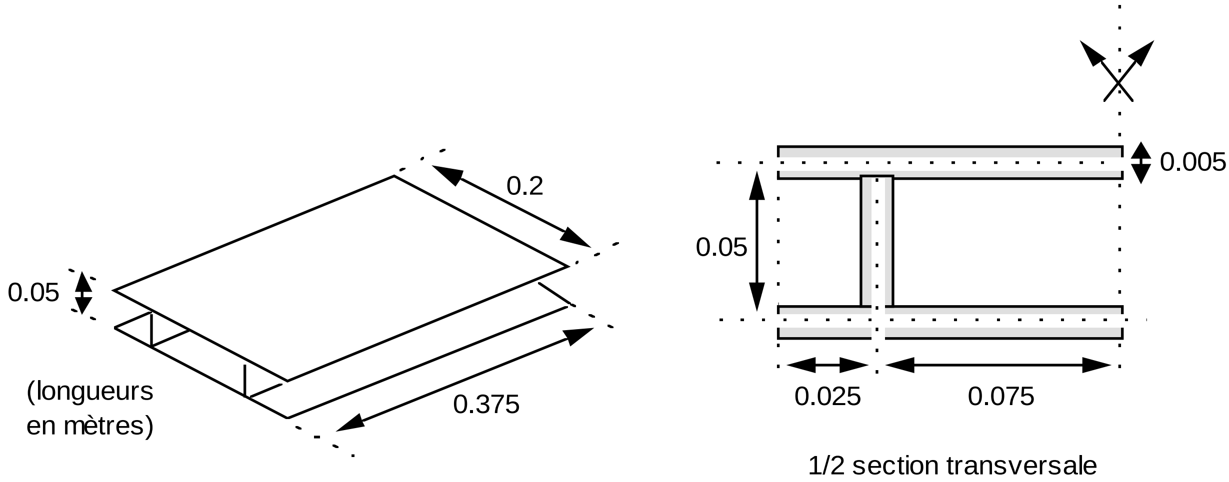
Via this problem, one tests shell element DKT as well as the computation of the frequencies of vibration by the method of Lanczos with detection of the modes of rigid body.

In the second modelization, one tests in more connection between shells (key word LIAISON_COQUE of the command AFFE_CHAR_MECA).

The got results are in concord with the results given in guide VPCS (average of results obtained by various computer codes). The six modes of rigid body were indeed detected.
A comparison with experimental results is also satisfactory.

1 Problem of reference

1.1 Geometry



Thickness of all the plates:	$t=0.005\,m$
Plates higher and lower:	length $a=0.375\,m$ dispatcher $b=0.2\,m$
vertical Plates:	length $a=0.375\,m$ width $b=0.05\,m$

1.2 Properties of the materials

$E=2.1\,10^{11}\,Pa$

$\nu=0.3$

$\rho=7\,800.\,kg/m^3$

1.3 Boundary conditions and loadings

free Structure in any point.

1.4 Initial conditions

Without object for the modal analysis.

2 Reference solution

2.1 Method of calculating used for the reference solution

the reference solution is that given in file SDLX03/89 of guide VPCS.

The reference solution was obtained by experimental study of the frequencies and eigen modes of free structure on a model produced with welded sheets.
The structure suspended by flexible connections is put in vibration by an electrodynamic discharger. The statement of the eigenfrequencies is obtained from an accelerometer.

In addition, the computational simulations, carried out by various computer codes, made it possible to establish "results of reference" for the model finite elements.

2.2 Results of reference

the first 6 non-zero eigenfrequencies.

2.3 Uncertainty on the solution

Lower than 4% .

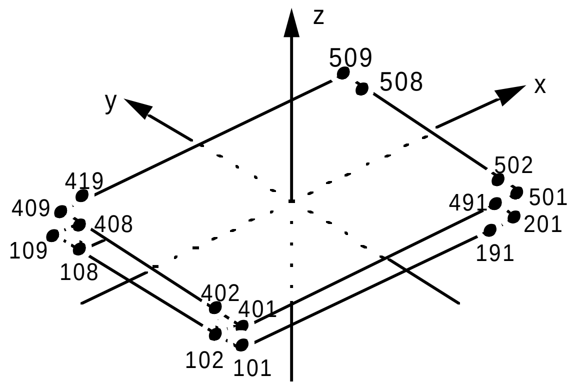
2.4 Bibliographical references

1) Tests carried out by Company METRAVIB (64 Path of Dampings - BP 182 - 69132 Ecully Cedex - France). Ratio METRAVIB R.D.S n° 1.604.50 (1987). Modelization

3 A Characteristic

3.1 of the modelization Shell elements

DKT `Cutting`



origines des axes = centre de la structure

: Plates

higher and lower 10 in	length 8 in width ==>	160 meshes SORTED `meshes 3`
vertical Plates 10	in length 1 in width	==> 20 SORTED `3 Names`

of the nodes: Lower

plate: N101	,…, N109 N111 ,…, N119 .... N201 ,…, N209 Plate
higher: N401	,…, N409 N411 ,…, N419 .... N501 ,…, N509 vertical
Plates: N102	, N112,…, N202 N402 , N412,…, N502 N108 , N118,…, N208 N408 , N418,…, N508 Characteristics

3.2 of the mesh Many

nodes: 198 and types: 360	Number of meshes SORTED `3 Quantities`

3.3 tested and Order results

of experimental the Reference	eigen mode Reference	models elements finis* Aster	*% difference*	/models finite elements 7.606
.	584.	± 1% 590.0310	1.03	8.760
.	826.	± 1.5% 829.4009	0.41	9.865
.	855.	± 1.7% 848.1548	– 0.80	10.944
.	911.	± 2% 908.8566	– 0.23	11 1113
	. 1113	. ± 3.6% 1097.6578	– 1.38	12 1144
	. 1136	. ± 4% 1164.0088	2.46	* average

of 5 computer codes Remarks

3.4 Computations

carried out by: MODE

```
_ITER_SIMULTMETHODE      : "TRI_DIAG" OPTION
                         "BANDE' LIST_FREQ      : (1. , 1200.)
DIM_SOUS_ESPACE
                         : 12 Contents
```

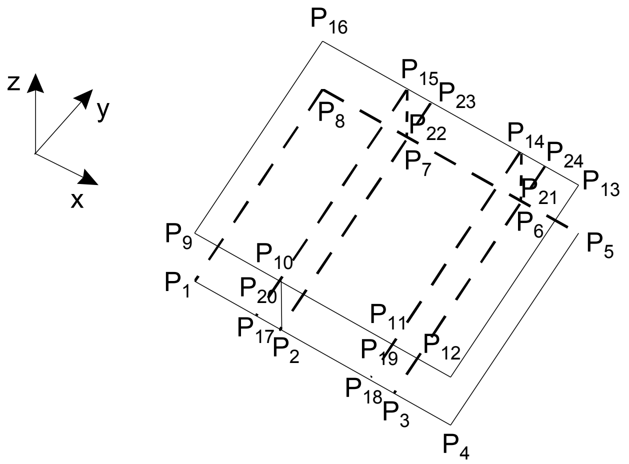
3.5 of the file results

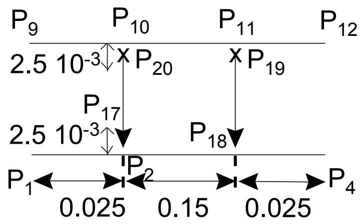
the first 6 non-zero eigenfrequencies (modal eigenvectors and parameters). Modelization

4 B Characteristic

4.1 of the modelization One uses

shell elements DKT `cutting`





vue de face

is done in the following way: There is

1 element enters and P_1 6 elements P_2

enters and P_2 1 element P_3

enters and P_3 1 element P_4

enters and P_{17} 10 elements P_{20}

according to the sides parallel with (for example y $P_4 P_5$) 2

computations are passed: in

- the first computation, one establishes connections of solid body between the lines: and
  - $P_2 P_7$ $P_{17} P_{22}$
  - $P_3 P_6$ and $P_{18} P_{21}$
  - $P_{10} P_{15}$ $P_{20} P_{23}$
  - $P_{11} P_{14}$ via $P_{19} P_{24}$

    factor key word "LIAISON_COQUE " `of the command` AFFE_CHAR_MECA `. in`
- the second computation, one establishes connections of solid body between the nodes in with respect to the above mentioned line couples via factor key word "LIAISON_SOLIDE " `of the command` AFFE_CHAR_MECA . `Characteristics`

4.2 of the mesh Many

nodes: 242	Number
D" elements SORTED `3: 360`	Quantities

4.3 tested and results

the results of 2 computations (one with LIAISON_COQUE , the other with LIAISON_SOLIDE) are identical. One will mention only computation with LIAISON_COQUE . Order

of experimental the Reference	eigen mode Reference	models elements finis* Aster	*% difference*	/models finite elements 7.606
.	584.	± 1% 610.2	4.5	8.760
.	826.	± 1.5% 852.4	3.2	9.865
.	855.	± 1.7% 864.8	1.1	10.944
.	911.	± 2% 923.9	1.4	11 1113
	. 1113	. ± 3.6% 1110.8	– 0.2	12 1144
	. 1136	. ± 4% 1179.5	3.8	* average

of 5 computer codes Remarks

4.4 Computations

carried out by: MODE

```
_ITER_SIMULTMETHODE        : "TRI_DIAG" OPTION
                           "BANDE' LIST_FREQ       : (1. , 1200.)
DIM_SOUS_ESPACE
                           : 12 Contents
```

4.5 of the file results

the first 6 non-zero eigenfrequencies (modal eigenvectors and parameters). Summary

5 of the results For

the modelization A, the results provided by Code_Aster *are* in the interval of dispersion of the codes which made it possible to establish the reference solution VPCS. For

the modelization B, the two ways D" of writing connection between the shells give the same results.