SDLX03 - Assembly of rectangular plates thin braced

Summary:

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 Mechanics of the Structures corresponds to a dynamic analysis of an assembled structure having a linear behavior. It understands two modelings.

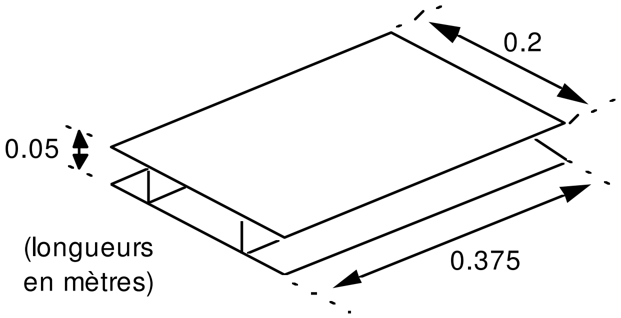
Via this problem, the element of plate is tested DKT as well as the calculation of the frequencies of vibration by the method of Lanczos with detection of the modes of rigid body.

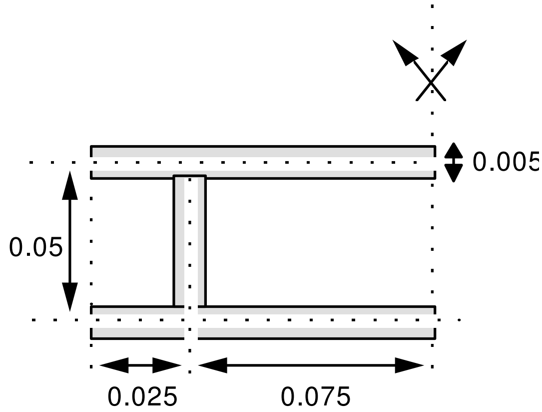
In the second modeling, one tests in more the connection between hulls (keyword LIAISON_COQUE order AFFE_CHAR_MECA).

The got results are in concord with the results given in guide VPCS (average of results got 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





1/2 section transversale

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 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 card SDLX03/89 of guide VPCS.

The reference solution was obtained by experimental study of the frequencies and clean modes of the 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 Eigen frequencies is obtained starting from an accelerometer.

In addition, digital 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 nonworthless Eigen frequencies.

2.3 Uncertainty on the solution

Lower than 4% .

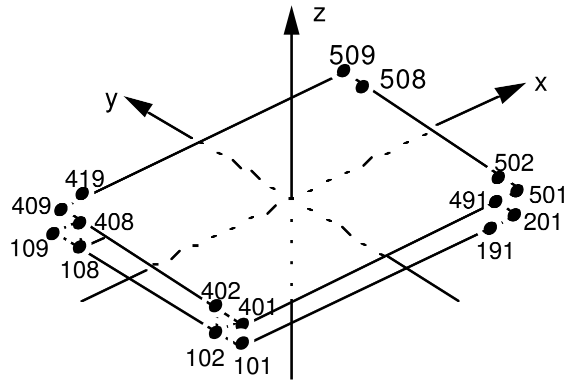
2.4 Bibliographical references

1) Tests carried out by Company METRAVIB (64 Chemin des Mouilles - BP 182 - 69132 Ecully Cedex - France). Report METRAVIB R.D.S n° 1.604.50 (1987).

3 Modeling A

3.1 Characteristics of modeling

Elements of hull DKT



origines des axes = centre de la structure

Cutting:

Plates higher and lower	10 in length 8 in width	==> 160 meshs TRIA3
Vertical plates	10 in length 1 in width	==> 20 meshs TRIA3

Names of the nodes:

Lower plate:	N101,…, N109 N111,…, N119 .... N201,…, N209
Higher plate:	N401,…, N409 N411,…, N419 .... N501,…, N509
Vertical plates:	N102, N112,…, N202 N402, N412,…, N502 N108, N118,…, N208 N408, N418,…, N508

3.2 Characteristics of the grid

Many nodes:	198
Many meshs and types:	360 TRIA3

3.3 Sizes tested and results

Order of the clean mode	Experimental reference	Reference models finite elements*	*Aster*	% difference/model 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

3.4 Remarks

Calculations carried out by:

```
CALC_MODES
                OPTION = 'BAND',
                CALC_FREQ=_F (FREQ = (1. , 1200.)),
                SOLVEUR_MODAL=_F (METHOD = 'TRI_DIAG',
                                  DIM_SOUS_ESPACE = 12)
```

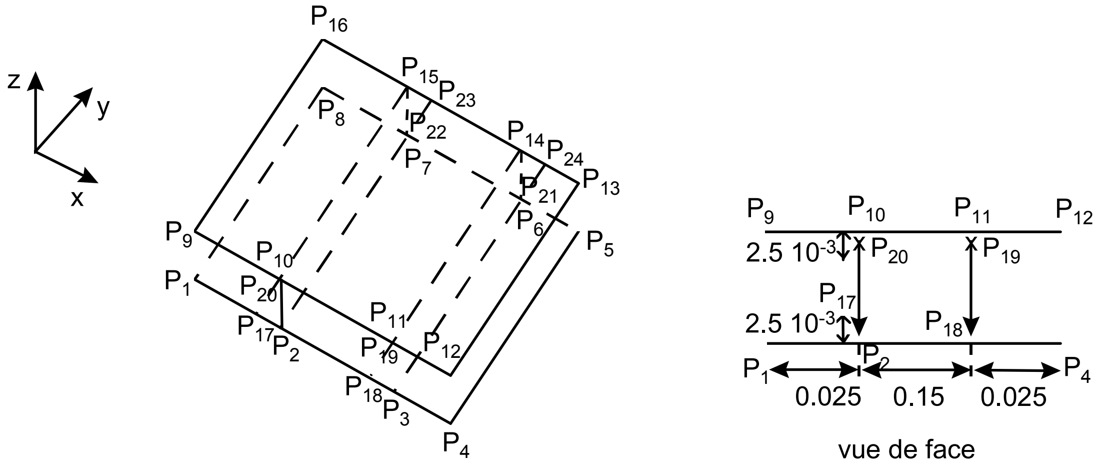
3.5 Contents of the file results

The first 6 nonworthless Eigen frequencies (clean vectors and modal parameters).

4 Modeling B

4.1 Characteristics of modeling

Elements of plate are used DKT



Cutting is done in the following way:

One has	1	element enters P_1 and P_2
	6	elements enters P_2 and P_3
	1	element enters P_3 and P_4
	1	element enters P_{17} and P_{20}
	10	elements according to the sides parallel with y ($P_4 P_5$ for example)

2 calculations are passed:

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

  via the keyword factor 'LIAISON_COQUE' order AFFE_CHAR_MECA.
- in the second calculation, one establishes connections of solid body between the nodes in with respect to the above mentioned line couples via the keyword factor 'LIAISON_SOLIDE' order AFFE_CHAR_MECA.

4.2 Characteristics of the grid

Many nodes:	242
Many elements TRIA3 :	360

4.3 Sizes tested and results

Results of 2 calculations (one with LIAISON_COQUE, the other with LIAISON_SOLIDE) are identical. One will mention only calculation with LIAISON_COQUE.

Order of the clean mode	Experimental reference	Reference models finite elements*	*Aster*	% difference/model 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

4.4 Remarks

Calculations carried out by:

```
CALC_MODES
            OPTION = 'BAND',
            CALC_FREQ=_F (FREQ = (1. , 1200.)),
            SOLVEUR_MODAL=_F (METHOD = 'TRI_DIAG',
                              DIM_SOUS_ESPACE = 12)
```

4.5 Contents of the file results

The first 6 nonworthless Eigen frequencies (clean vectors and modal parameters).

5 Summary of the results

For the modeling A, 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 modeling B, the two ways of writing the connection between the hulls give the same results.