SDLS100 - Study of grids on a plate square thin

Summary:

This three-dimensional problem consists in seeking the frequencies of vibration of a mechanical structure made up of a thin square plate embedded on a side. One studies the influence of the distortion of the grid on the results. This test of Mechanics of the Structures corresponds to a dynamic analysis of a surface model having a linear behavior. It comprises three modelings.

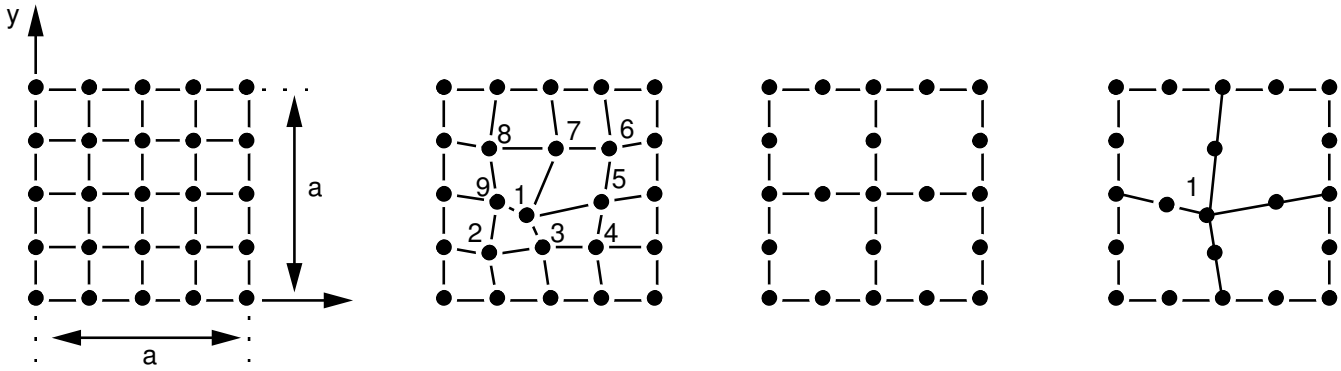
This problem makes it possible to test the element of plate DKT in transverse inflection and the calculation of the Eigen frequencies, either by the method of Lanczos, or by the method of Bathe and Wilson. The first modeling consists in netting finely and regularly the plate by triangles. For the second modeling, the grid is coarser while for the third, it coarse and is distorted.

The first modeling is used as results of reference.

The got results are in concord between them and with those of a card NAFEMS. The effect of distortion of the grid does not appear on the first frequencies of vibration.

1 Problem of reference

1.1 Geometry



Test 1 Test 2 Test 3 Test 4

Square plate:
side $a=10.m$
thickness $t=0.05\,m$

Coordinates of the points (in m):

Test 2			Test 4		
Node	x	y	**Node**	x	y
1	4.0	4.0	1	4.0	4.0
2	2.25	2.25			
3	4.75	2.5			
4	7.25	2.75			
5	7.5	4.75			
6	7.75	7.25			
7	5.25	7.25			
8	2.25	7.25			
9	2.5	4.75			

1.2 Properties of materials

$E=2.10^{11}\ Pa$

$\nu=0.3$

$\rho=8000.kg/m^3$

1.3 Boundary conditions and loadings

Any point P such as $x_p=0$: ($u=v=w=0$, $\theta_y=0$).

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 the card 'Test 16' of the tests of reference published by the NAFEMS.

Card NAFEMS gives the results of reference as well as computation results carried out by using elements of type thin hull of Kirchoff based on a formulation of isoparametric displacement quadratic (degree of freedom of rotation and normal translation to the plate).

2.2 Results of reference

the first 6 clean modes.

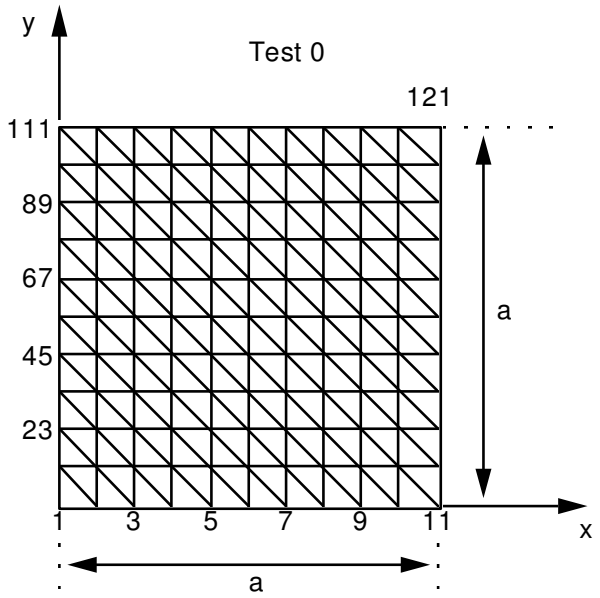
2.3 Bibliographical references

1) F. ABASSIAN, D.J. DAWSWELL, N.C. KNOWLES. Selected Benchmarks for Natural Frequency Analysis. NAFEMS (1987).

3 Modeling A

3.1 Characteristics of modeling

Fine grid for validation of the reference solution



Cutting:

10 on each side of the rhombus is 200 meshs TRIA3.

Twinge of the element $\frac{a}{10t}=20$.

Limiting conditions:

in all the nodes P side $Xp=0.$:

```
DDL_IMPO: (GROUP_NO: DIMENSION   DX: 0. , DY: 0. , DZ: 0. , DRY
MARTINI: 0. )
```

Name of the nodes: Not 1 = $N1$
Not 121 = $N121$

3.2 Characteristics of the grid

Many nodes:	121
Many meshs and types:	200 TRIA3

3.3 Sizes tested and results

Order of the clean mode	Reference Frequency (Hz)	*Aster* Frequency (Hz)	% difference
1	0,421	0.4178	– 0.8
2	1,029	1.0255	– 0.3
3	2,582	2.5669	– 0.6
4	3,306	3.2733	– 1.
5	3,753	3.7347	– 0.5
6	6,555	6.5236	– 0.5
7		7.3756	
8		7.7332	
9		8.5567	
10		11.1199	
11		11.6474	
12		14.3551	

3.4 Remarks

Calculations carried out by:

```
CALC_MODES
              OPTION = 'PLUS_PETITE'
              CALC_FREQ=_F (NMAX_FREQ = 12)
              SOLVEUR_MODAL=_F (METHOD = 'TRI_DIAG')
```

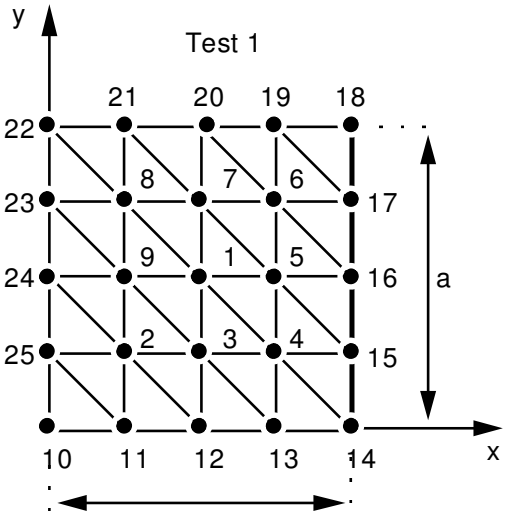
3.5 Contents of the file results

the first 12 Eigen frequencies, clean vectors and modal parameters.

4 Modeling B

4.1 Characteristics of modeling

Element DKT coarser grid



Twinge of the elements: $\frac{a}{4t}=50$.

Limiting conditions:

in all the nodes P side $Xp=0.$:

```
DDL_IMPO: (GROUP_NO: DIMENSION   DX: 0. , DY: 0. , DZ: 0. , DRY
MARTINI: 0. )
```

Name of the nodes: Not 1 = $N1$
Not 25 = $N25$

4.2 Characteristics of the grid

Many nodes:	25
Many meshs and types:	32 TRIA3

4.3 Sizes tested and results

Frequency (Hz)

Order of the clean mode	Reference	Test NAFEMS	*Aster*	% difference
	NAFEMS			
1	0,421	0.4174	0.4165	– 1.07
2	1,029	1,020	1.0301	0.11
3	2,582	2,564	2.5793	– 0.10
4	3,306	3,302	3.2572	– 1.47
5	3,753	3,769	3.7397	– 0.35
6	6,555	6,805	6.4544	– 1.54
	Test 0			
7	7.3756		7.2821	– 1.27
8	7.7332		7.6852	– 0.62
9	8.5567		8.3764	– 2.11
10	11.1199		10.7209	– 3.59
11	11.6474		11.2904	– 3.06
12	14.3531		13.7573	– 4.16

4.4 Remarks

Calculations carried out by:

```
CALC_MODES
              OPTION = 'PLUS_PETITE'
              CALC_FREQ=_F (NMAX_FREQ = 12)
              SOLVEUR_MODAL=_F (METHOD = 'JACOBI')
```

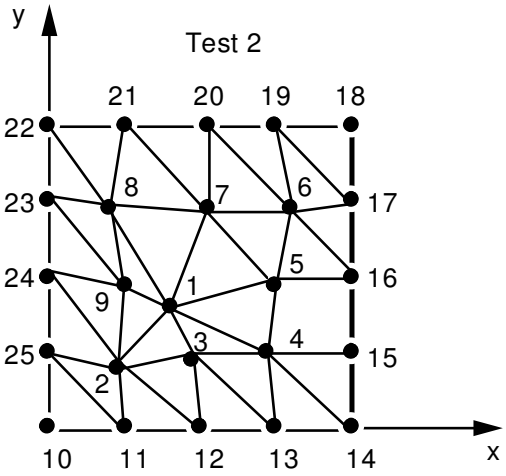
4.5 Contents of the file results

the first 12 Eigen frequencies, clean vectors and modal parameters.

5 Modeling C

5.1 Characteristics of modeling

Element DKT with distorted grid



Twinge of the element: between 50 and 75.

Limiting conditions:

in all the nodes P side $Xp=0.$:

```
DDL_IMPO: (GROUP_NO: DIMENSION   DX: 0. , DY: 0. , DZ: 0. , DRY
MARTINI: 0. )
```

Name of the nodes: Not 1 = $N1$
Not 25 = $N25$

5.2 Characteristics of the grid

Many nodes:	25
Many meshs and types:	32 TRIA3

5.3 Sizes tested and results

Frequency (Hz)

Order of the clean mode	Reference	Test NAFEMS	*Aster*	% difference
	NAFEMS			
1	0,421	0.4174	0.4163	– 1.12
2	1,029	1,020	1.0340	0.49
3	2,582	2,571	2.5644	– 0.68
4	3,306	3,317	3.2539	– 1.58
5	3,753	3,780	3.7433	– 0.26
6	6,555	6,883	6.4898	– 0.99
	Test 0			
7	7.3756		7.2119	– 2.22
8	7.7332		7.6026	– 1.69
9	8.5567		8.3232	– 2.73
10	11.1199		10.7735	– 3.12
11	11.6474		11.2607	– 3.32
12	14.3531		13.3008	– 7.34

5.4 Remarks

Calculations carried out by:

```
CALC_MODES
              OPTION = 'PLUS_PETITE'
              CALC_FREQ=_F (NMAX_FREQ = 12)
              SOLVEUR_MODAL=_F (METHOD = 'TRI_DIAG')
```

5.5 Contents of the file results

the first 12 Eigen frequencies, clean vectors and modal parameters.

6 Summary of the results

% differences/reference

Order of the clean mode	Reference NAFEMS	*Aster* Test 0	*Aster* Test 1	*Aster* Test 2	% diff. Test 0	% diff. Test 1	% diff. Test 2
1	0,421	0.4178	0.4165	0.4163	– 0.76	– 1.07	– 1.12
2	1,029	1.0255	1.0301	1.0340	– 0.34	0.11	0.49
3	2,582	2.5669	2.5793	2.5644	– 0.58	– 0.10	– 0.68
4	3,306	3.2733	3.2572	3.2539	– 0.99	– 1.47	– 1.58
5	3,753	3.7347	3.7397	3.7433	– 0.49	– 0.35	– 0.26
6	6,555	6.5236	6.4544	6.4898	– 0.48	– 1.54	– 0.99

% differences/reference

Order of the clean mode	Reference NAFEMS	*Aster* Test 0	*Aster* Test 1	*Aster* Test 2	% diff. Test 0	% diff. Test 1	% diff. Test 2
7		7.3756	7.2821	7.2119		– 1.27	– 2.22
8		7.7332	7.6852	7.6026		– 0.62	– 1.69
9		8.5567	8.3764	8.3232		– 2.11	– 2.73
10		11.1199	10.7209	10.7735		– 3.59	– 3.12
11		11.6474	11.2904	11.2607		– 3.07	– 3.32
12		14.3551	13.7573	13.3008		– 4.16	– 7.34

- For tests 1 and 2, the quadrangles of card NAFEMS were cut out in triangles.
- Tests 3 and 4 can be carried out by *Aster* (not of quadratic element of hull).
- Until the 9th mode, the error on the frequency is $\leq 2.5\%$.
- The effect of distortion of the grid appears really only on modes 7 and 12.