# SDLS02 - Thin plate rhombus embedded at the edge

**Summary:**

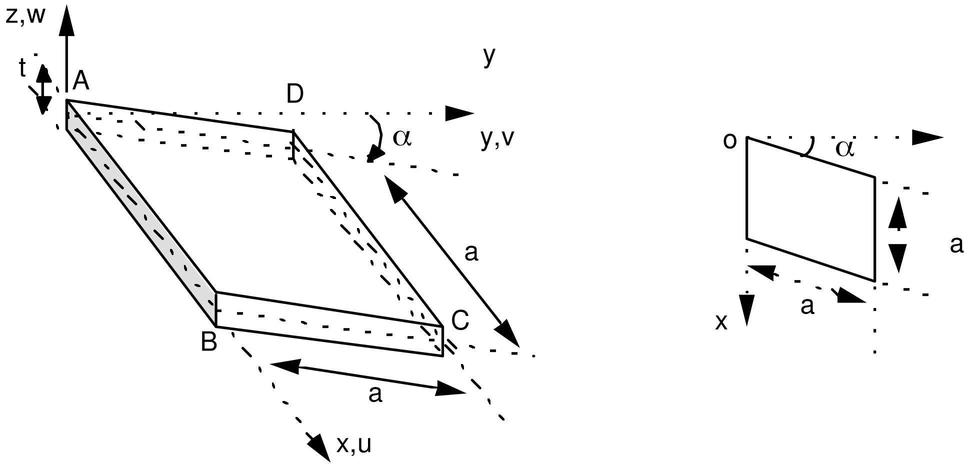
This three-dimensional problem consists in seeking the frequencies of vibration of a mechanical structure made up of a parallelepipedic plate (nonrectangular), embedded on only one side. This test of mechanics of the structures corresponds to a dynamic analysis of a surface model having a linear behavior. It comprises only one modeling.

This problem makes it possible to test the element of plate `DKT` and the calculation of frequencies of vibration by the method of Lanczos.

The results got on the first two Eigen frequencies are in concord with those of guide VPCS.

# 1 Problem of reference

## 1.1 Geometry




Side $a=1.m$ , thickness $t=0.01\,m$ , $\alpha=30°$

**Coordinates of the points** (in $m$ ):

| | $A$ | $B$ | $C$ | $D$ |
|---|---|---|---|---|
| $x$ | 0. | $a$ | $a(1+\sin\alpha)$ | $a\sin\alpha$ |
| $y$ | 0. | 0. | $a\cos\alpha$ | $a\cos\alpha$ |
| $z$ | 0. | 0. | 0. | 0. |

## 1.2 Properties of materials

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

$\nu=0.3$

$\rho=7800.\,kg/m^3$

## 1.3 Boundary conditions and loadings

Side $AB$ embedded:

for any point $P$ such as $y_p=0.$

$u=v=w=0.$
$\theta_x=\theta_y=\theta_z=0.$

## 1.4 Initial conditions

Without object for the modal analysis.

# 2 Reference solution

## 2.1 Method of calculating used for the reference solution

The formula of reference is that given in card SDLS02/89 of the guide VPCS which presents the method of calculating in the following way:

The formulation of M.V. BARTON, for a plate on side, led to:

$$f_i = \frac{1}{2\pi a^2} \lambda_i^2 \sqrt{\frac{E t^2}{12\rho(1-\nu^2)}} \quad i=1,2,...$$

where: $\lambda_i^2 = g(\alpha)$

with, for a Poisson's ratio $\nu=0.3$ and $\alpha=30°$ :

| | $\alpha=30°$ |
|---|---|
| $\lambda_1^2$ | 3,961 |
| $\lambda_2^2$ | 10.19 |

- M.V. Barton mentions the sensitivity of the result to the order of the mode and the angle $\alpha$ .
- This reference solution applies to the thin sections such as: $t/a<0.1$ .
- Coefficients $\lambda_i$ were established with a limited development of an insufficient nature.

## 2.2 Results of reference

The first two clean modes given by:

- the formula of M.V. Barton,
- the average of 5 software packages of calculation by the finite element method.

## 2.3 Uncertainty on the solution

Semi-analytical solution $< 2\%$ .

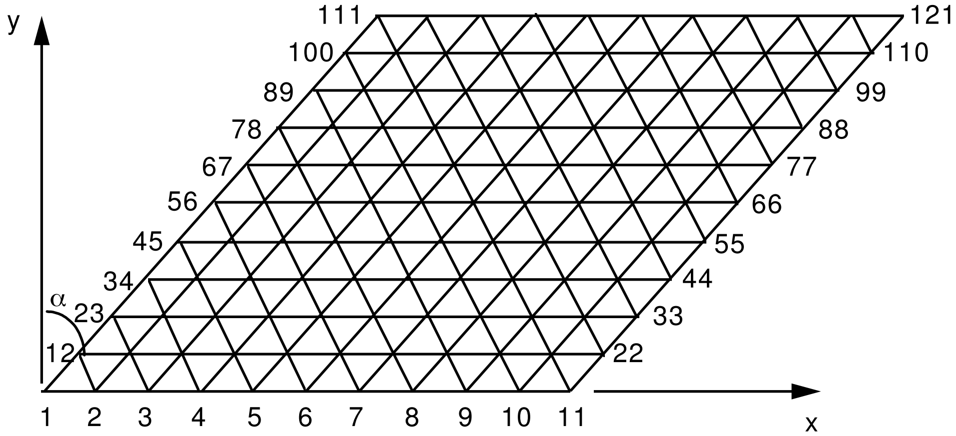
## 2.4 Bibliographical references

1) M.V. BARTON, Vibrations of rectangular and skew cantilever punts. Newspaper of Applied Mechanics, vol. 18, p. 129-134 (1951).

# 3 Modeling A

## 3.1 Characteristics of modeling

**DKT**




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

**Limiting conditions:**

in all the nodes on the side $AB$ :

```
DDL_IMPO: (GROUP_NO: AB DX: 0. , DY: 0. , DZ: 0. , DRX: 0. , DRY
MARTINI: 0. , DRZ: 0.)
```

| | | |
|---|---|---|
| Name of the nodes: | Not $A$ = $N1$ | Not $C$ = $N121$ |
| | Bridge $B$ = $N11$ | Not $D$ = $N111$ |

## 3.2 Characteristics of the grid

| | |
|---|---|
| Many nodes: | 121 |
| Many meshs and types: | 200 TRIA3 |

## 3.3 Sizes tested and results

| Order of the mode proper I | Frequency ( $Hz$ ) Reference (Barton) | Reference (average of 5 codes) | *Aster* | % difference averages codes |
|---|---|---|---|---|
| 1 | 9.8987 | 9.7355 | 9.8402 | 1.08 |
| 2 | 25.4651 | 23.2745 | 23.5790 | 1.31 |

## 3.4 Remarks

Calculations carried out by:

```
CALC_MODES      OPTION = 'PLUS_PETITE'
                CALC_FREQ=_F (NMAX_FREQ= 2)
                SOLVEUR_MODAL=_F (METHOD = 'TRI_DIAG')
```

## 3.5 Contents of the file results

the first 2 Eigen frequencies, clean vectors and modal parameters.

# 4 Summary of the results

Results given by *Code_Aster* are comparable to the results given by other using computer codes of the formulations different for this plate in the shape from parallelogram.