

SSLS121 - Subjected laminated plate with elementary loadings

Summary:

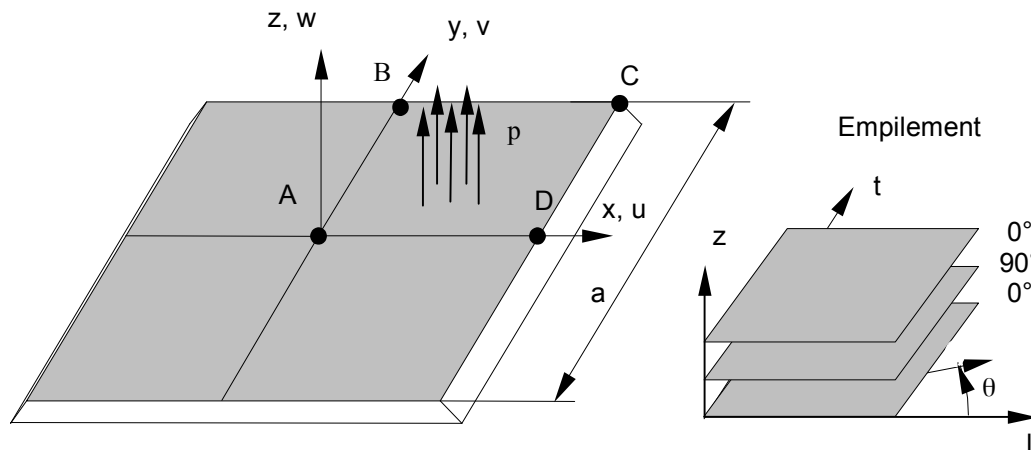
This test represents the quasi-static calculation of a laminated plate, composed of 3 layers of orthotropic material, subjected to 4 elementary loadings.

The plate is modelled in finite elements `DST` (meshes QUAD4), it is located in a plan XZ and tilted of 48.5 degrees compared to X (to check the changes of reference mark).

In this test, the plane constraints and stresses shear transverse, are compared with an analytical reference solution.

1 Problem of reference

1.1 Geometry



Width $a=100\text{mm}$, thickness $h=1\text{mm}$.

1.2 Properties of material

The properties of material constituting each of the three layers of the plate are the following ones:

Orthotropic material:

$$\begin{aligned} E_l &= 25 \text{ MPa} & E_t &= 1 \text{ MPa} \\ G_{lt} &= G_{lz} = 0.5 \text{ MPa} & G_{tz} &= 0.2 \text{ MPa} \\ \nu_{lt} &= 0.25 \end{aligned}$$

Stacking:

- orientation: $[0/90/0]$
- thickness: $[h/4/h/2/h/4]$

1.3 Boundary conditions and loadings

The loadings are applied in order to obtain uniform states of stresses in the plate:

- Loading case 1: $M_{xx} = 1$ in the plate
 - Embedding on AD
 - Moment distributed on BC : $MX = 1$
- Loading case 2: $M_{yy} = 1$ in the plate
 - Embedding on AB
 - Moment distributed on CD : $MY = 1$
- Loading case 3: $Q_X = 1$ in the plate
 - Embedding on AD
 - Effort distributed on BC : $FZ = 1$
- Loading case 4: $Q_Y = 1$ in the plate
 - Embedding on AB
 - Effort distributed on CD : $FZ = 1$

2 Reference solution

2.1 Method of calculating used for the reference solution

Analytical solution [bib1].

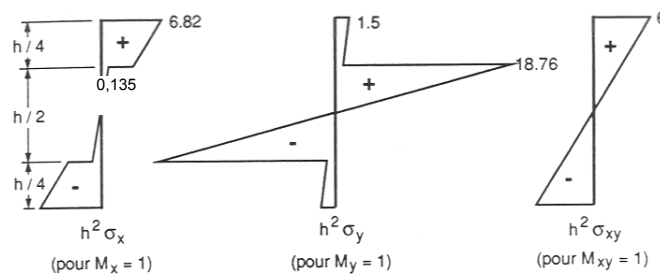
2.2 Results of reference

The results of reference are the following:

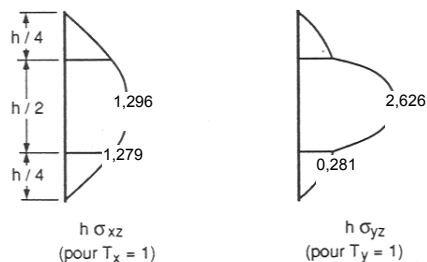
Loading case	Constraints	Value (Mpa)	Comments
$M_{xx} = 1$	$SIXX(z = -h/2)$ Lay down 1	- 6.82	Constraint σ_{xx} on the lower skin of layer 1
	$SIXX(z = -h/4)$ 2 sleep	- 0,135	Constraint σ_{xx} on the lower skin of layer 2
$M_{yy} = 1$	$SIYY(z = -h/2)$ Lay down 1	- 1.5	Constraint σ_{yy} on the lower skin of layer 1
	$SIYY(z = -h/4)$ 2 sleep	- 18.76	Constraint σ_{yy} on the lower skin of layer 2
$QX = 1$	$SIXZ(z = -h/4)$ 2 sleep	1,279	Constraint σ_{xz} on the lower skin of layer 2
	$SIXZ(z = 0)$ 2 sleep	1,296	Constraint σ_{xz} on the average skin of layer 2
$QY = 1$	$SIYZ(z = -h/4)$ 2 sleep	0.28125	Constraint σ_{yz} on the lower skin of layer 2
	$SIYZ(z = 0)$ 2 sleep	2.62625	Constraint σ_{yz} on the average skin of layer 2

The pace of the distribution of the constraints in the thickness of the plate is the following one:

1) Contraintes planes:



2) Contraintes de CT:



2.3 Uncertainties on the solution

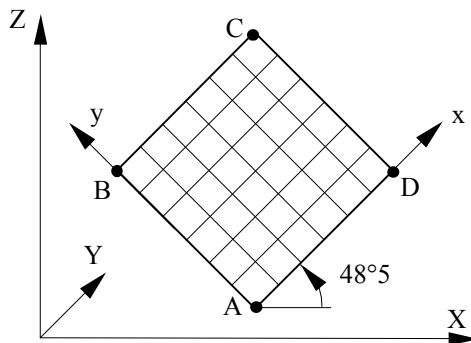
Worthless (analytical solution).

2.4 Bibliographical references

- 1) Dhatt-Batoz "Modeling of the structures by finite elements, Volume 2" Pages 246-250 Hermes Edition.

3 Modeling A

3.1 Characteristics of modeling



Modélisation DST (QUAD4)

- La plaque est située dans le plan $Y = 0.5$
- Point A (0.4 ; 0.5 ; 0.25)

3.2 Characteristics of the grid

Many nodes: 49
Number of meshes and type: 36 QUAD4

3.3 Values tested

Loading case	Identification	Reference
$M_{xx} = 1$	$SIXX(z = -h/2)$ down 1	lay - 6.82
	$SIXX(z = -h/4)$ sleep	2 - 0,135
	$SIYY(z = -h/2)$ down 1	Lay - 1.5
$M_{yy} = 1$	$SIYY(z = -h/4)$ sleep	2 - 18.76
	$SIXZ(z = -h/4)$ sleep	2 1,279
$QX = 1$	$SIXZ(z = 0)$ 2 sleep	1,296
	$SIYZ(z = -h/4)$ sleep	2 0.28125
$QY = 1$	$SIYZ(z = 0)$ 2 sleep	2.62625

4 Summary of the results

The very good agreement of the results with the analytical solution validates the calculation of the constraints for a composite plate in an unspecified reference mark, at various levels thickness.