SSLS121 - Subjected laminated plate with elementary loadings

Summary:

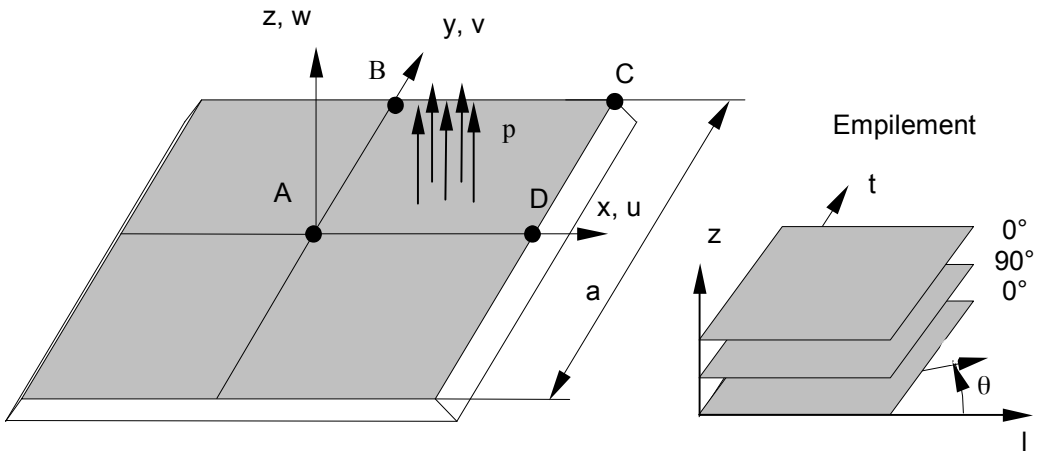
This test represents the quasi-static calculation of a laminated plate, composed of 3 layers of orthotropic material, subjected to 4 elementary loadings.

The plate is modelled in finite elements DST (meshs 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:

$E_l=25\ MPa$ $E_t=1\ MPa$

$G_{lt}=G_{lz}=0.5\ MPa$ $G_{tz}=0.2\ MPa$

$\nu_{lt}=0.25$

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: $Mxx=1$ in the plate
  - Embedding on AD
  - Moment distributed on BC : $MX=1$
- Loading case 2: $Myy=1$ in the plate
  - Embedding on AB
  - Moment distributed on CD : $MY=1$
- Loading case 3: $QX=1$ in the plate
  - Embedding on AD
  - Effort distributed on BC : $FZ=1$
- Loading case 4: $QY=1$ 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

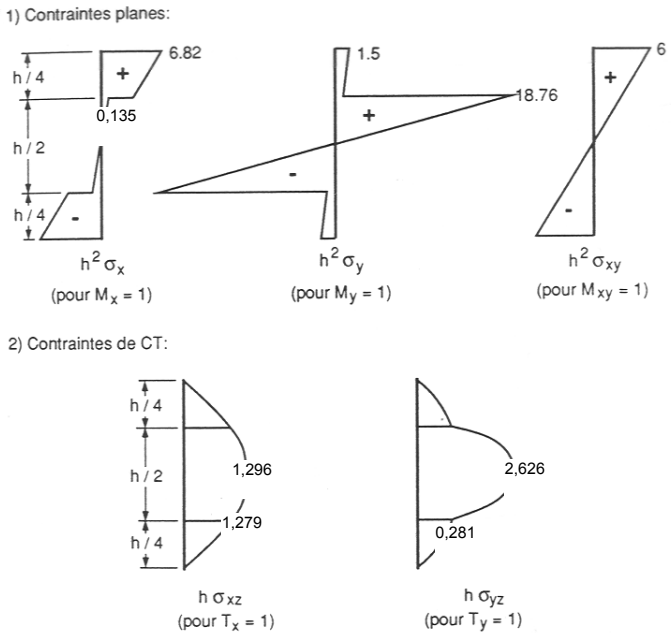
Analytical solution [bib1].

2.2 Results of reference

The results of reference are the following:

Loading case	Constraints		Value (Mpa)	Comments
$Mxx=1$	$SIXX(z=-h/2)$ Lay down 1		– 6.82	Constraint σ_{xx} on the lower skin of layer 1
	$SIXX(z=-h/4)$ sleep	2	– 0,135	Constraint σ_{xx} on the lower skin of layer 2
$Myy=1$	$SIYY(z=-h/2)$ Lay down 1		– 1.5	Constraint σ_{yy} on the lower skin of layer 1
	$SIYY(z=-h/4)$ sleep	2	– 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:



2.3 Uncertainties on the solution

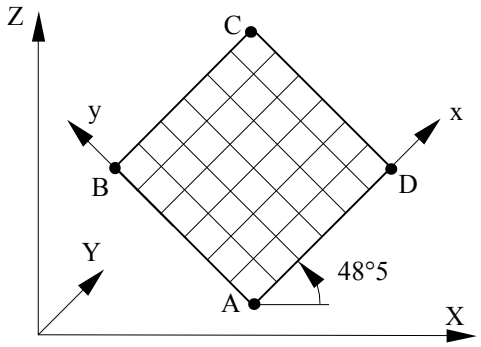
Worthless (analytical solution).

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 meshs and type: 36 QUAD4

3.3 Values tested

Loading case	Identification		Reference
$Mxx=1$	$SIXX(z=-h/2)$	lay	– 6.82
	down 1		
		2	– 0,135
	$SIXX(z=-h/4)$		
	sleep		
$Myy=1$	$SIYY(z=-h/2)$	Lay	– 1.5
	down 1		
	$SIYY(z=-h/4)$	2	– 18.76
	sleep		
$QX=1$	$SIXZ(z=-h/4)$	2	1,279
	sleep		
	$SIXZ(z=0)$ 2 sleep		1,296
$QY=1$	$SIYZ(z=-h/4)$	2	0.28125
	sleep		
	$SIYZ(z=0)$ 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.