

## SSLS121 - Plate stratified subjected to elementary loadings

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### Summarized:

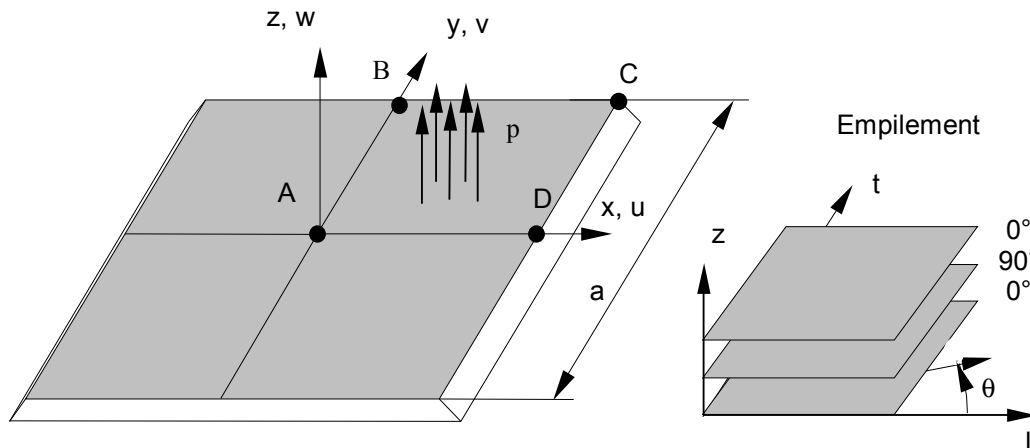
This test represents the quasi-static computation of a laminated plate, composed of 3 layers of orthotropic material, subjected to 4 elementary loadings.

The plate is modelled in finite elements `DST` (meshes QUAD4), it is located in a plane  $XZ$  and is inclined of 48,5 degrees compared to  $X$  (to check the changes of reference).

In this test, the plane stresses and the shearing stresses 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 the material

the properties of the 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:

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

### 1.3 Boundary conditions and loadings

the loadings are applied in order to obtain uniform stress states in the plate:

- Loading case 1:  $M_{xx} = 1$  in the plate
  - Fixed support at  $AD$
  - Time distributed on  $BC$ :  $M_X = 1$
- Loading case 2:  $M_{yy} = 1$  in the plate
  - Fixed support at  $AB$
  - Time distributed on  $CD$ :  $M_Y = 1$
- Loading case 3:  $Q_X = 1$  in the plate
  - Fixed support on  $AD$
  - Force distributed on  $BC$ :  $F_Z = 1$
- Loading case 4:  $Q_Y = 1$  in the plate
  - Fixed support on  $AB$
  - Force distributed on  $CD$ :  $F_Z = 1$

## 2 Reference solution

### 2.1 Method of calculating used for the analytical reference solution

Solution [bib1].

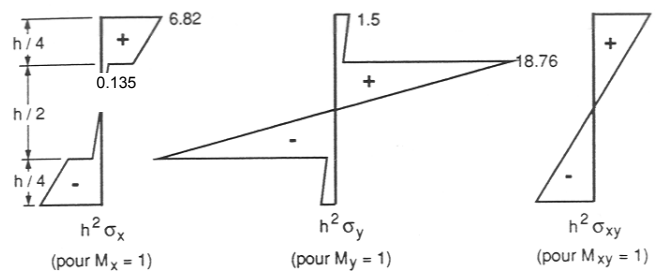
### 2.2 Results of reference

the results of reference are the following:

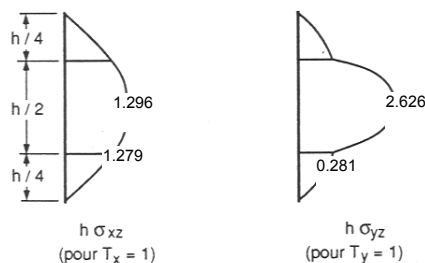
Loading cases	Forced	Value (Mpa)	Comments
$M_{xx} = 1$	$SIXX(z = -h/2)$ Lay down 1	- 6.82	Stress $\sigma_{xx}$ on the lower skin of layer 1
	$SIXX(z = -h/4)$ lays down 2	- 0.135	Stress $\sigma_{xx}$ on the lower skin of layer 2
$M_{yy} = 1$	$SIYY(z = -h/2)$ Lay down 1	- 1.5	Forced $\sigma_{yy}$ on the lower skin of layer 1
	$SIYY(z = -h/4)$ lay down 2	- 18.76	Stress $\sigma_{yy}$ on the lower skin of layer 2
$QX = 1$	$SIXZ(z = -h/4)$ Lay down 2	1.279	Stress $\sigma_{xz}$ on the lower skin of layer 2
	$SIXZ(z = 0)$ Lay down 2	1.296	Stress $\sigma_{xz}$ on the average skin of the layer 2
$QY = 1$	$SIYZ(z = -h/4)$ Lay down 2	0.28125	Stress $\sigma_{yz}$ on the lower skin of layer 2
	$SIYZ(z = 0)$ Lay down 2	2.62625	Stress $\sigma_{yz}$ on the average skin of layer 2

the pace of the distribution of the stresses in the thickness of the plate is the following one:

1) Contraintes planes:



2) Contraintes de CT:



### 2.3 Uncertainties on the solution

Null (analytical solution).

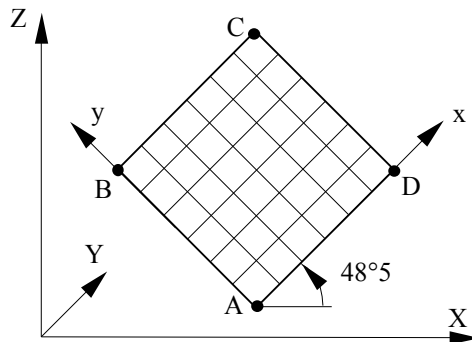
### 2.4 Bibliographical references

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

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

## 3 Modelization A

### 3.1 Characteristic of the modelization



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 mesh

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

### 3.3 Values tested

Loading case	Identification	Reference
$M_{xx} = 1$	$SIXX (z = -h/2)$ lay down 1	- 6.82
	$SIXX (z = -h/4)$ 2	layer - 0.135
$M_{yy} = 1$	$SIYY (z = -h/2)$ Layer 1	- 1.5
	$SIYY (z = -h/4)$ layer 2	- 18.76
$QX = 1$	$SIXZ (z = -h/4)$ Layer 2	1.279
	$SIXZ (z = 0)$ Layer 2	1.296
$QY = 1$	$SIYZ (z = -h/4)$ Layer 2	0.28125
	$SIYZ (z = 0)$ Layer 2	2.62625

## 4 Summary of the results

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