

## SSLP117 – Square plate in bending – variable variation in temperature

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### Summarized:

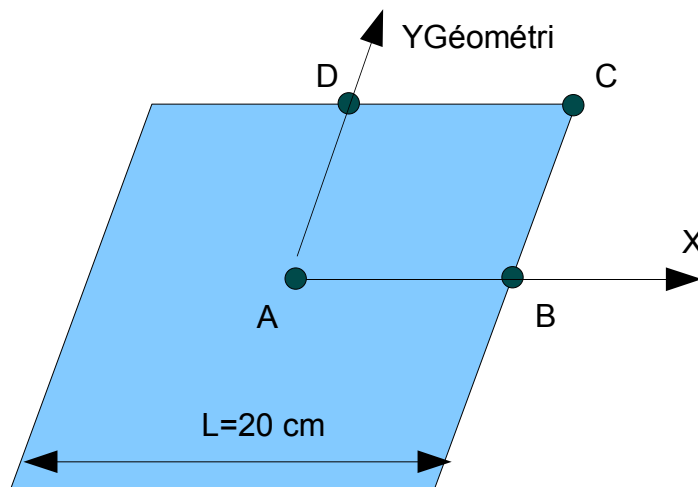
The purpose of this test is to validate the computation of displacements, of the moments and of the stresses in a square plate, simply supported, in subjected bending has a variable variation in temperature.

Modelizations :

- Modelization *A* : DKT with meshes TRIA3
- Modelization *B* : DKT with meshes QUAD4

## 1 Problem of reference

### 1.1



Thickness = 0.25cm .

### 1.2 Properties of the material

the material is elastic isotropic whose properties are:

- $E = 3. \times 10^6 \text{ N/cm}^2$
- $\nu = 0.3$
- $\alpha = 6.5 \times 10^{-6} / ^\circ\text{C}$

### 1.3 Boundary conditions and loadings

Boundary conditions:

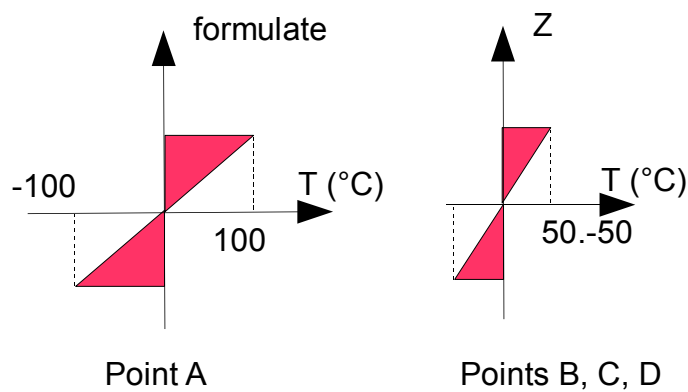
- On edge  $AB$  :  $DY = DRX = 0$
- On edge  $AD$  :  $DX = DRY = 0$
- On edge  $BC$  and  $CD$  :  $DZ = 0$

Loading

- the loading applied is a loading of temperature which varies in the following way:

$$\text{Higher skin: } T(x, y) = 100 - 5|x| - 5|y| + \frac{1}{2}|xy|$$

$$\text{lower Skin: } T(x, y) = -100 + 5|x| + 5|y| - \frac{1}{2}|xy|$$



## 1.4 Initial conditions

Nothing

## 2 Reference solution

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### 2.1 Méthode de calcul

the reference solution is a numerical solution [1].

### 2.2 Quantities and results of reference

- Displacement  $DZ$  in the center of the plate

Not  $A$  :  $DZ=0.14712\text{ cm}$

- Moment  $M_{xx}$  in the center of the plate

Not  $A$  :  $M_{xx}=103.80\text{ N}$

### 2.3 Uncertainties on the numerical

solution Solution

### 2.4 bibliographical References

- [1] M.H. SADR-LAHIDJANI: "Modelization and analyzes plates and subjected elastic thin shells has fields of temperature", Doctorate UTC, 1984.

## 3 Modelization A

### 3.1 Characteristic of the modelization

One uses a modelization `DKT`.

### 3.2 Characteristics of the mesh

The mesh contains 5000 elements of the type `TRIA3`.

### 3.3 Quantities tested and results

One tests displacement along the axis  $Z$  and the moment  $MXX$  in the center of the plate (not  $A$  ).

Standard		identification of reference	Value of reference	Tolerance %
DEPL	$X (cm)$			
$DZ$	0.0	"SOURCE_EXTERNE"	0.14712	0.1 %

Standard		Identification of reference	Value of reference	Tolerance
EFGE_ELNO	$X (cm)$			
$MXX$	1.0	"SOURCE_EXTERNE"	103.80	3.5 %

One tests the stresses on the lower, average and higher skin in 2 layers.

- Lay down n°1:  $-0.125cm < Z < -0.0417cm$

/Mesh	Lay down	Standard size	of reference	Value of reference	Tolerance
$A(M5200)$	$INF$	$SIXX$	"NON_DEFINI"	9666.036	$10^{-4}\%$
		$SIYY$	"NON_DEFINI"	9664.713	$10^{-4}\%$
		$SIXY$	"NON_DEFINI"	-0.662	$10^{-6}$
	$MOY$	$SIXX$	"NON_DEFINI"	8285.175	$10^{-4}\%$
		$SIYY$	"NON_DEFINI"	8284.039	$10^{-4}\%$
		$SIXY$	"NON_DEFINI"	-0.568	$10^{-6}$
	$SUP$	$SIXX$	"NON_DEFINI"	6904.313	$10^{-4}\%$
		$SIYY$	"NON_DEFINI"	6903.366	$10^{-4}\%$
		$SIXY$	"NON_DEFINI"	-0.473	$10^{-6}$

- n°3 Layer:  $0.0417\text{cm} < Z < 0.125\text{cm}$

/Mesh	Lay down	Standard size	of reference	Value of reference	Tolerance
<i>A(M5200)</i>	<i>INF</i>	<i>SIXX</i>	"NON_DEFINI"	4142.588	$10^{-4}\%$
		<i>SIYY</i>	"NON_DEFINI"	4142.020	$10^{-4}\%$
		<i>SIXY</i>	"NON_DEFINI"	-0.284	$10^{-6}$
	<i>MOY</i>	<i>SIXX</i>	"NON_DEFINI"	2761.725	$10^{-4}\%$
		<i>SIYY</i>	"NON_DEFINI"	2761.346	$10^{-4}\%$
		<i>SIXY</i>	"NON_DEFINI"	-0.189	$10^{-6}$
	<i>SUP</i>	<i>SIXX</i>	"NON_DEFINI"	1380.863	$10^{-4}\%$
		<i>SIYY</i>	"NON_DEFINI"	1380.673	$10^{-4}\%$
		<i>SIXY</i>	"NON_DEFINI"	-0.095	$10^{-6}$

## 4 Modelization B

### 4.1 Characteristic of the modelization

One uses a modelization *DKT*.

### 4.2 Characteristics of the mesh

The mesh contains 2500 elements of the type *QUAD4*.

### 4.3 Quantities tested and results

One tests displacement along the axis  $Z$  and the moment  $MXX$  in the center of the plate (not  $A$  ).

Standard		identification of reference	Value of reference	Tolerance
DEPL	$X (cm)$			
$DZ$	0.0	"SOURCE_EXTERNE"	0.14712	0.1

Standard		Identification of reference	Value of reference	Tolerance
EFGE_ELNO	$X (cm)$			
$MXX$	1.0	"SOURCE_EXTERNE"	103.80	3.5

One tests the stresses on the lower, average and higher skin in 2 layers.

- Lay down n°1:  $-0.125cm < Z < -0.089cm$

/Mesh	Lay down	Standard size	of reference	Value of reference	Tolerance
$A(M2700)$	$INF$	$SIXX$	"NON_DEFINI"	9653.560	$10^{-4}\%$
		$SIYY$	"NON_DEFINI"	9653.560	$10^{-4}\%$
		$SIXY$	"NON_DEFINI"	-0.064	$10^{-6}$
	$MOY$	$SIXX$	"NON_DEFINI"	8274.480	$10^{-4}\%$
		$SIYY$	"NON_DEFINI"	8274.480	$10^{-4}\%$
		$SIXY$	"NON_DEFINI"	-0.055	$10^{-6}$
	$SUP$	$SIXX$	"NON_DEFINI"	6895.400	$10^{-4}\%$
		$SIYY$	"NON_DEFINI"	6895.400	$10^{-4}\%$
		$SIXY$	"NON_DEFINI"	-0.046	$10^{-6}$

- Lay down n°7:  $0.089\text{cm} < Z < 0.125\text{cm}$

/Mesh	Lay down	Standard size	of reference	Value of reference	Tolerance
<i>A(M2700)</i>	<i>INF</i>	<i>SIXX</i>	"NON_DEFINI"	-6895.400	$10^{-4}\%$
		<i>SIYY</i>	"NON_DEFINI"	-6895.400	$10^{-4}\%$
		<i>SIXY</i>	"NON_DEFINI"	-0.046	$10^{-6}$
	<i>MOY</i>	<i>SIXX</i>	"NON_DEFINI"	-8274.480	$10^{-4}\%$
		<i>SIYY</i>	"NON_DEFINI"	-8274.480	$10^{-4}\%$
		<i>SIXY</i>	"NON_DEFINI"	-0.055	$10^{-6}$
	<i>SUP</i>	<i>SIXX</i>	"NON_DEFINI"	-9653.560	$10^{-4}\%$
		<i>SIYY</i>	"NON_DEFINI"	-9653.560	$10^{-4}\%$
		<i>SIXY</i>	"NON_DEFINI"	-0.064	$10^{-6}$



## 5 Summary of the results

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the got results are satisfactory.