TPLS102 – Thick beam in plane stresses – linear temperature variation according to the width

Summarized:

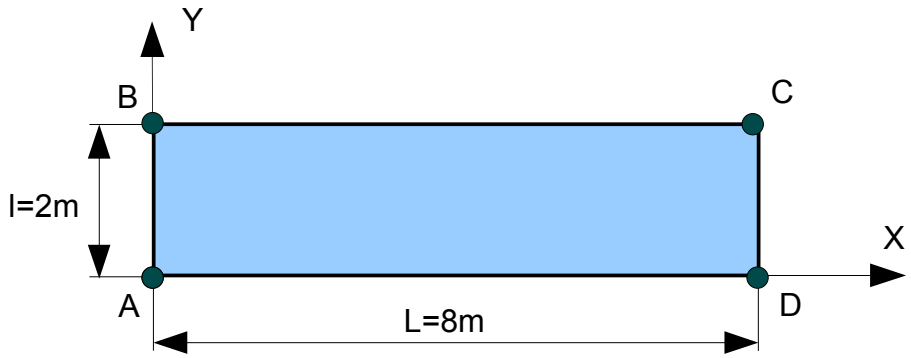
The purpose of this test is to validate the computation of the stresses in a subjected thick beam in plane stresses has a variation in the temperature according to the width.

Modelizations :

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

1 Problem of reference

1.1 Geometry



Thickness = $0.1\mathrm{m}$.

1.2 Properties of the material

the material is elastic isotropic whose properties are:

- $E=20\,000\,Pa$
- $\nu=0.3$
- $\alpha=10^{-5}/°C$

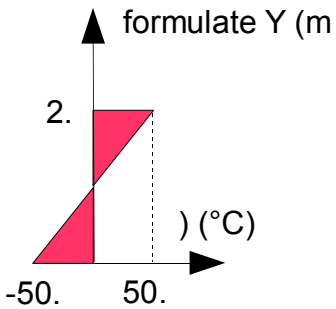
1.3 Boundary conditions and loadings

Boundary conditions:

- On edges AB and CD : $DX=DZ=0$
- On edge BC : $DY=0$

Loading

- the loading applied is a Constant loading of
  - temperature according to X and Z
  - formula along the axis Y : $T(Y)=50\mathrm{Y}-50$



1.4 Initial conditions

Nothing

2 Reference solution

2.1 Method of calculating

the reference solution for computation of the stresses in the beam is given in [1], [2].

2.2 Quantities and results of reference

Forced σ_{xx} , σ_{yy} and σ_{xy} along the axis Y .

$\sigma_{xx}(Y)=-10\mathrm{Y}+10$

$\sigma_{yy}(Y)=0.$

$\sigma_{xy}(Y)=0.$

$Y(m)$	σ_{xx}	σ_{yy}	σ_{xy}
0.0	$10.0\,Pa$	$0.0\,Pa$	$0.0\,Pa$
0.5	$5.0\,Pa$	$0.0\,Pa$	$0.0\,Pa$
1.0	$0.0\,Pa$	$0.0\,Pa$	$0.0\,Pa$
1.5	$-5.0\,Pa$	$0.0\,Pa$	$0.0\,Pa$
2.0	$-10.0\,Pa$	$0.0\,Pa$	$0.0\,Pa$

2.3 Uncertainties on the Analytical

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.

[2] J. PITER, HARTEL H. “Improved thermal stress under evaluating load for simple finite element”, I.J.N.M.E, vol. 15,1507-1515, 1980. Modelization

3 A Characteristic

3.1 of the modelization One uses

a modelization DKT with 3 layers in the thickness. Characteristics

3.2 of the mesh The mesh

contains 2048 elements of the type SORTED 3. Quantities

3.3 tested and results One tests

the stresses on the lower, average and higher skin in two layers. Lay down

- n°1: formulate $-0.05\text{m} < Z < -0.0167\,m$

Identification			of reference Value of reference	Tolerance	"ANALYTIQUE
INF	$X=0.0\text{m}$ $Y=0.0\text{m}$ $Z=-0.05\text{m}$	*SIXX*	" formulates	10.	2.0%
		SIYY	" formulates	0.	0.6
		SIXY	" formulates	0.	0.05
MOY	$X=0.0\text{m}$ $Y=1.0\text{m}$ $Z=-0.0333\text{m}$	*SIXX*	" formulates	0.	0.05
		SIYY	" formulates	0.	0.2
		SIXY	" formulates	0.	0.0035
SUP	$X=0.0\text{m}$ $Y=2.0\text{m}$ $Z=-0.0167\text{m}$	*SIXX*	" formulates	$-10.$	1.5%
		SIYY	" formulates	0.	0.5
		SIXY	" formulates	0.	10^{-6}

- n°3: formulate $0.0167\text{m} < Z < 0.05\text{m}$

Identification			of reference Value of reference	Tolerance	"ANALYTIQUE
INF	$X=4.0\text{m}$ $Y=0.0\text{m}$ $Z=0.0167\text{m}$	*SIXX*	" formulates	10.	1.5%
		SIYY	" formulates	0.	0.5
		SIXY	" formulates	0.	10^{-4}
MOY	$X=4.0\text{m}$ $Y=1.0\text{m}$ $Z=0.0333\text{m}$	*SIXX*	" formulates	0.	10^{-4}
		SIYY	" formulates	0.	10^{-4}
		SIXY	" formulates	0.	10^{-3}
SUP	$X=4.0\text{m}$ $Y=2.0\text{m}$ $Z=0.05\text{m}$	*SIXX*	" formulates	$-10.$	1.5%
		SIYY	" formulates	0.	0.5
		SIXY	" formulates	0.	10^{-4}

4 B Characteristic

4.1 of the modelization One uses

The mesh a modelization DKT with 5 layers in the thickness

4.2 Characteristics of the mesh

contains 1024 elements of the type QUAD4 . Quantities

4.3 tested and results One tests

the stresses on the lower, average and higher skin in two layers. Lay down

- n°2: Standard $-0.03\text{m} < Z < -0.01\text{m}$

identification			of reference Value of reference	Tolerance	"ANALYTIQUE
INF	$X=0.0\text{m}$ $Y=0.0\text{m}$ $Z=-0.03\text{m}$	*SIXX*	" formulates	10.	1.5%
		SIYY	" formulates	0.	0.5
		SIXY	" formulates	0.	10^{-6}
MOY	$X=0.0\text{m}$ $Y=1.0\text{m}$ $Z=-0.04\text{m}$	*SIXX*	" formulates	0.	10^{-6}
		SIYY	" formulates	0.	10^{-6}
		SIXY	" formulates	0.	10^{-6}
SUP	$X=0.0\text{m}$ $Y=2.0\text{m}$ $Z=-0.01\text{m}$	*SIXX*	" formulates	$-10.$	1.5%
		SIYY	" formulates	0.	0.5
		SIXY	" formulates	0.	10^{-6}

- n°5: formulate $0.03\text{m} < Z < 0.05\text{m}$

Identification			of reference Value of reference	Tolerance	"ANALYTIQUE
INF	$X=4.0\text{m}$ $Y=0.0\text{m}$ $Z=0.03\text{m}$	*SIXX*	" formulates	10.	1.5%
		SIYY	" formulates	0.	0.5
		SIXY	" formulates	0.	10^{-6}
MOY	$X=4.0\text{m}$ $Y=1.0\text{m}$ $Z=0.04\text{m}$	*SIXX*	" formulates	0.	10^{-6}
		SIYY	" formulates	0.	10^{-6}
		SIXY	" formulates	0.	10^{-6}
SUP	$X=4.0\text{m}$ $Y=2.0\text{m}$ $Z=0.05\text{m}$	*SIXX*	" formulates	$-10.$	1.5%
		SIYY	" formulates	0.	0.5
		SIXY	" formulates	0.	10^{-6}

5 of the results One notes

for the stress a maximum change σ_{xx} of: 2.0%

- with meshes SORTED 3 1.5%
- with meshes QUAD4 .

A finer mesh in the meaning of the variation in the temperature would make it possible to get better results.