SSLP300 – Rectangular plate cantilever in inflection-shearing in its plan

Summary:

The objective of this CAS-test is to validate the inflection of a plate in a plan, under the effect of a shearing action. It is about a problem 2D in plane constraints.

1 Problem of reference

1.1 Geometry

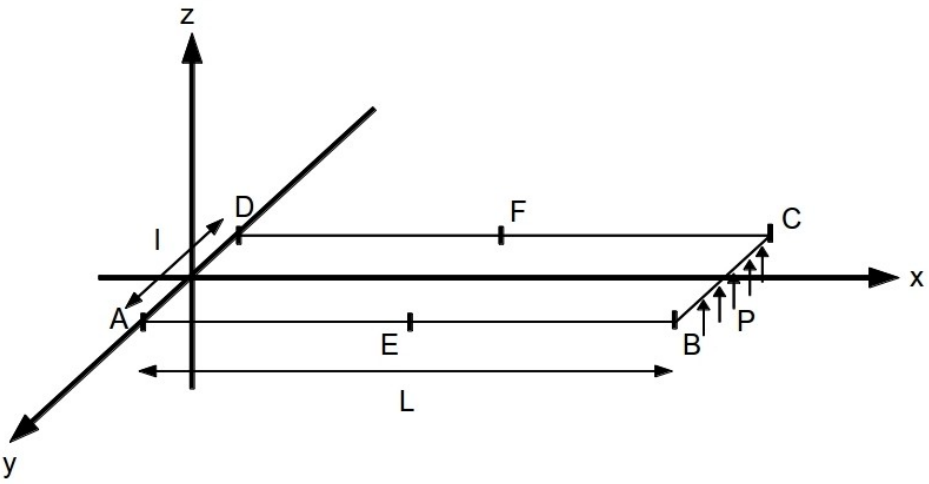

Figure 1.1 Geometry of the problem and system of loading

Not E : medium of AB
Not F : medium of DC
Length: $L=1\,m$
Width: $l=0.1\,m$
Thickness: $h=0.005\,m$

Moment of inertia of section: $I_z=\frac{hl^3}{12}=4.167\,x\,10^{-7}\,m^4$

1.2 Properties of material

Young modulus	$E=2.1\times10^{11}\,Pa$
Poisson's ratio	$\nu=0.3$

1.3 Boundary conditions and loadings

Imposed displacement:

Embedding on the side AD	$DX=0$, $DY=0$

Imposed loading:

Force of resultant P according to y on the side BC	$P=315\,N$ that is to say a surface force $f_y=630\,000\,N.m^{-2}$

2 Reference solution

2.1 Method of calculating used for the reference solution

The field of displacement following the axis y at the end of the plate (segment BC) is given on the assumption of the theory of the beams by:

$u_y^{BC}=\frac{PL^3}{3EI_z}(1+0.98\frac{l^2}{L^2})$ (solution with taking into account of the shearing action in a beam of Timoshenko)

from where $u_y^{BC}=0.00121\,m$

The normal stress field σ_{xx} had with the inflection is given by:

$\sigma_{xx}=\frac{Pl}{2I_z}(L-x)$ on the edge AB

that is to say $\sigma_{xx}=37.8\times10^6(L-x)$

2.2 Results of reference

- Displacements u_y nodes B and C
- Constraints σ_{xx} nodes A , B , E

2.3 Uncertainty on the solution

Analytical solution.

2.4 Bibliographical references

S. Timoshenko. *Resistance of Materials, 1st part*. Polytechnic bookstore CH. Béranger, Paris, 1947, pp 163-168.

3 Modeling A

3.1 Characteristics of modeling A

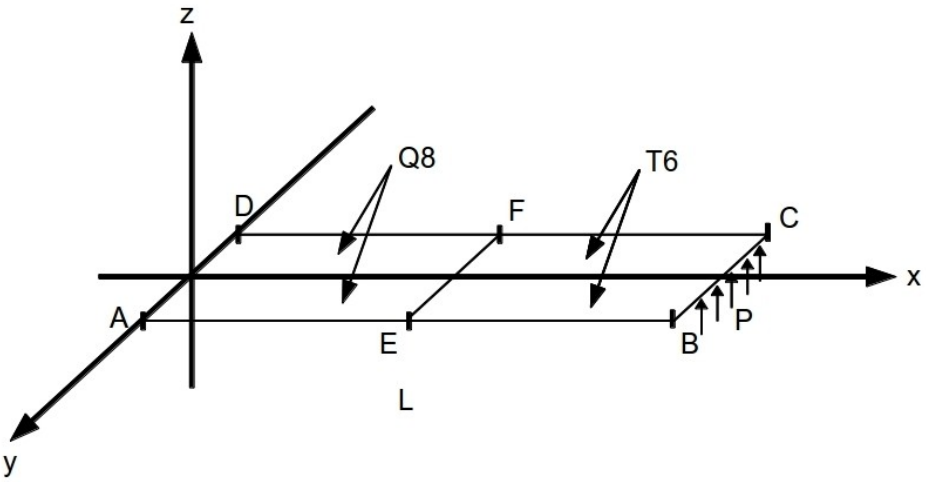

Figure 3.1. Grid of modeling A

Modeling C_PLAN.

3.2 Characteristics of the grid

Many nodes: 185
Many meshs and types: 20 QUAD8 and 40 TRIA6

3.3 Sizes tested and results

Size	Component	Localization	Value of reference	Type of reference	Tolerance (%)
DEPL	DY	B ($N95$)	$1.21\times10^{-3}m$	'ANALYTICAL'	0.4
DEPL	DY	C ($N156$)	$1.21\times10^{-3}m$	'ANALYTICAL'	0.5
SIGM_ELNO	SIXX	A ($N1$)	$3.78\times10^{7}Pa$	'ANALYTICAL'	1.5
SIGM_ELNO	SIXX	B ($N95$)	$0.Pa$	'NON_REGRESSION'	-
SIGM_ELNO	SIXX	E ($N41$)	$1.89\times10^{7}Pa$	'ANALYTICAL'	0.21

3.4 Remarks

The value of the constraint σ_{xx} in B is not significant.

4 Summary of the results

The results are in very good agreement with the analytical solution.