

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

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### 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

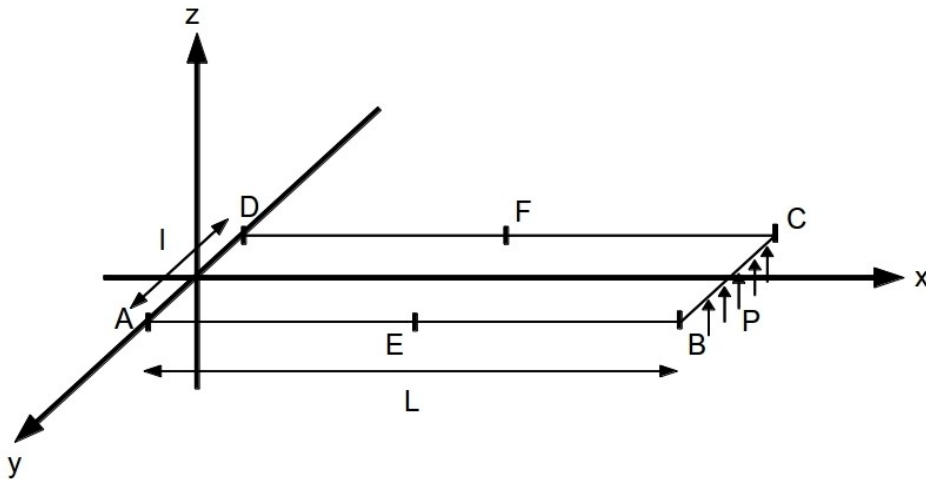


Figure 1.1 Geometry of the problem and system of loading

Not E : medium of  $AB$

Not F : medium of  $DC$

Length:  $L=1\text{ m}$

Width:  $l=0.1\text{ m}$

Thickness:  $h=0.005\text{ m}$

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

### 1.2 Properties of material

Young modulus	$E=2.1 \times 10^{11} \text{ Pa}$
Poisson's ratio	$\nu=0.3$

### 1.3 Boundary conditions and loadings

Imposed displacement:

Embedding on the side $AD$	$DX=0$ , $DY=0$
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Imposed loading:

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

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### 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:

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

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

The normal stress field  $\sigma_{xx}$  had with the inflection is given by:

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

that is to say  $\sigma_{xx} = 37.8 \times 10^6 (L - x)$

### 2.2 Results of reference

- Displacements  $u_y$  nodes  $B$  and  $C$
- Constraints  $\sigma_{xx}$  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

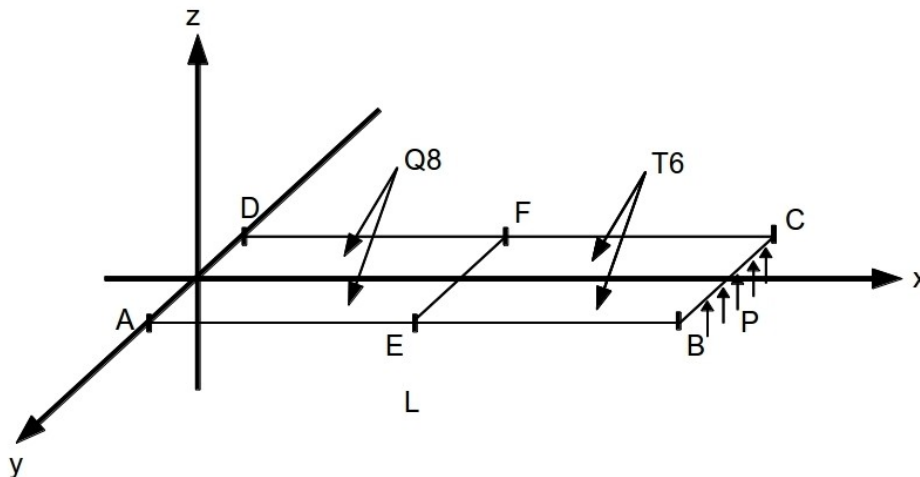


Figure 3.1. Grid of modeling A

Modeling C\_PLAN.

### 3.2 Characteristics of the grid

Many nodes: 185  
Many meshes 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 )	$1.21 \times 10^{-3} m$	'ANALYTICAL'	0.4
DEPL	DY	C ( N156 )	$1.21 \times 10^{-3} m$	'ANALYTICAL'	0.5
SIGM_ELNO	SIXX	A ( N1 )	$3.78 \times 10^7 Pa$	'ANALYTICAL'	1.5
SIGM_ELNO	SIXX	B ( N95 )	0. Pa	'NON_REGRESSION'	-
SIGM_ELNO	SIXX	E ( N41 )	$1.89 \times 10^7 Pa$	'ANALYTICAL'	0.21

### 3.4 Remarks

The value of the constraint  $\sigma_{xx}$  in B is not significant.

## 4 Summary of the results

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