SSLP01 – Shears and flexbeam in its Summarized

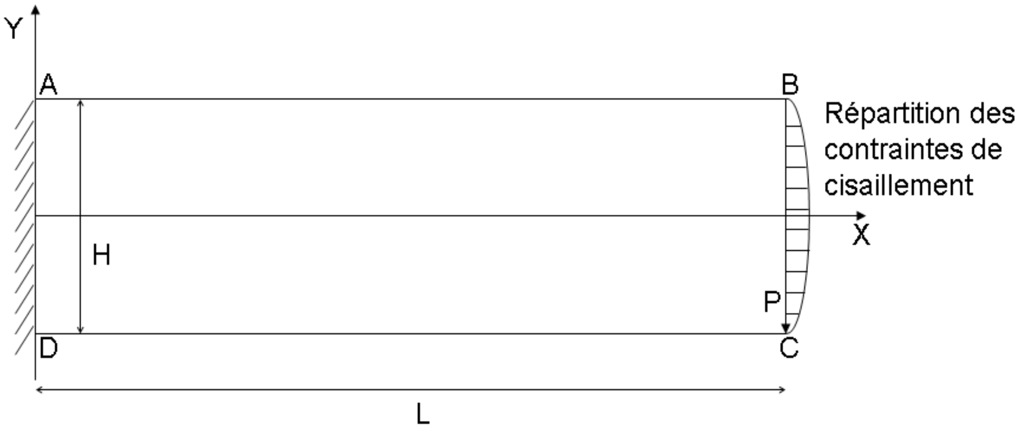
plane:

In this benchmark one models the behavior of a shears and flexbeam in his plane.

Only one modelization is carried out: `C_PLAN`

1 Problem of reference

1.1 Geometry



Coordinated of the points (m):
$A:(0.,6.\cdot 10^{-3})$
$B:(48.\cdot 10^{-3,}6.\cdot 10^{-3})$
$C:(48.\cdot 10^{-3,}-6.\cdot 10^{-3})$
$D:(0.,-6.\cdot 10^{-3})$

Geometry of the plate (m):
Thickness: $h=0{,}001$
Width: $L=0.048$
Height: $H=0.012$

Mesh group: $BORD\_CH$ surface of right (BC)
Mesh group: $ENCAST$ surface of left (AD)
Mesh group: $SURF$ surface intern

1.2 Properties of the material

- $E=3.\cdot 10^{10}\,Pa$
- $\nu=0.25$

1.3 Boundary conditions and loadings

- imposed Displacement:
  - $ENCAST \quad : DX=DY=0.$
- Loading:
  - Parabolic distribution on the height, constant on the thickness.

$Y(m)$	-0,006	-0,003	0	0,003	0,006
Shearing stress 2D ($Pa.m$)	0	3.75E6	5.00E6	3.75E6	0

integration of this stress on the height H leads to a stress resulting from $80.10^3\,Pa.m$ which one notes P in what follows.

2 Reference solution

2.1 Method of calculating

result of reference was obtained by analytical computation with the method of the functions of Airy.

- Plane stresses:

$$\sigma_{xx}=(12.\mathrm{Py}.(x-L))/2.\mathrm{H}^3$$
$$\sigma_{yy}=0$$
$$\sigma_{xy}=6.\mathrm{P}.((H^2/4)-y^2)/2.\mathrm{H}^3$$

- Displacements:

$$u=\frac{12\mathrm{P}}{EhH^3}[y(\frac{x^2}{2}-Lx)-(1+\frac{\nu}{2})\frac{y^3}{3}]+Ay+B$$
$$v=\frac{-12\mathrm{P}\,\nu}{EhH^3}\frac{y^2}{2}(x-L)+\frac{12\mathrm{P}}{EhH^3}[\frac{-x^3}{3}+\frac{Lx^2}{2}+(1+\nu)\frac{H^2x}{4}]-Ax+C$$

- The constants A, B, C depend on the boundary conditions on displacements:

$$u(0{,}0)=v(0{,}0)=\frac{\partial v}{\partial x}(0{,}0)=0$$
$$u(0,-\frac{H}{2})=v(0,-\frac{H}{2})=u(0,\frac{H}{2})=v(0,\frac{H}{2})=0$$

2.2 Results of reference

Displacement according to y point: $x=L\,;\,y=0 \quad v=0.3413\cdot10^{-3}\ m$
Stress according to x with point: $x=0\,;\,y=-H/2 \quad \sigma_{xx}=80.\cdot10^{6}\ Pa$

2.3 Uncertainties

analytical Solution

3 Modelization A

3.1 Characteristic of the modelization

Modelization C_PLAN :

Many nodes	177			
Number of meshes	80	Are:		
			SEG3	32
			QUAD8	48

3.2 Results

Points	Quantity	Reference	Tolerance (relative)
$x=L ; y=0$	DY	$3.41\cdot10^{-3}\quad m$	0.023
$x=0 ; y=-H/2$	$SIXX$	$80.\cdot10^{6}\quad Pa$	0.015

4 Summary of the results

the results obtained in displacement and stress with modelization C_PLAN are satisfactory.