ZZZZ295 – Validation of the position of the under-points of the plates 2D

Summary:
This test validates the calculation of the position of the under-points of integration in the total reference mark for modeling COQUE_AXIS. An elementary mechanical calculation is carried out in order to allow the creation of a table with CREA_TABLE starting from the result. Only the coordinates of some under-points are tested in the table.

1 Problem of reference

1.1 Geometry

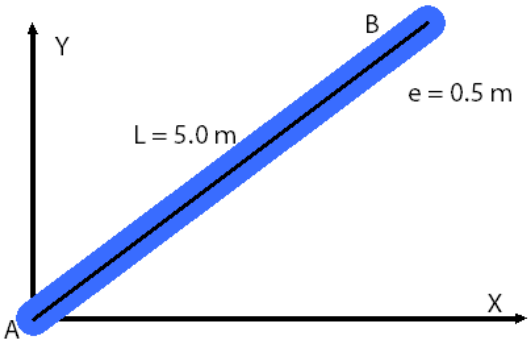


Plate with infinite depth (modeling in 2D):

Length: $L=5.0\,m$

Thickness: $e=0.5\,m$

Coordinates of the points A and B

$X_A=0.0\,;Y_A=0.0$

$X_B=4.0\,;Y_B=3.0$

1.2 Properties of materials

Concrete:

Young modulus: $E=310^{10}\,Pa$

Poisson's ratio: $\nu=0.0$

1.3 Boundary conditions and loadings

On the point A one blocks displacements according to X, Y and rotation around Z :

$U_x^A=0.0\,;U_y^A=0.0\,;DR_z^A=0.0$

On the point B one applies a loading according to Y:

$F_Y=-100.0\,N$

2 Reference solution

2.1 Method of calculating

One calculates the position of the nodes, points of integration and under-points of integration from its cordonnées in the local axes of the plate and the matrix of passage between the local axes and the total axes.

$$T(\alpha)=\begin{bmatrix}\cos(\alpha) & -\sin(\alpha)\\ \sin(\alpha) & \cos(\alpha)\end{bmatrix}$$

For any point of initial coordinates (X,Y) one can calculate his coordinates expressed in the total reference mark (X',Y') after rotation with the following transformation:

$$\begin{bmatrix}X'\\ Y'\end{bmatrix}=T(\alpha)\begin{bmatrix}X\\ Y\end{bmatrix}$$

2.2 Sizes and results of reference

One calculates the positions of the under-points of integration in the total reference mark knowing their positions expressed in the local axes.

Here one a: $\cos(\alpha)=\frac{4}{5}$ and $\sin(\alpha)=\frac{3}{5}$

For a mesh SEG4 of pipe length $L=5m$, the distance points of integration compared to the first node are (vto oir R3.01.01):

Not	x (m)
1	3.3499526089621403
2	1.6500473910378599
3	4.6528407789851318
4	0.34715922101486746

The thickness $EP=0.5m$, is discretized in 4 layers, which makes 12 under-points whose heights compared to the average plan are:

Under-point	z	Under-point	z
1	-0,250	7	0,000
2	-0.1875	8	0.0625
3	-0,125	9	0,125
4	-0,125	10	0,125
5	-0.0625	11	0.1875
6	0,000	12	0,250

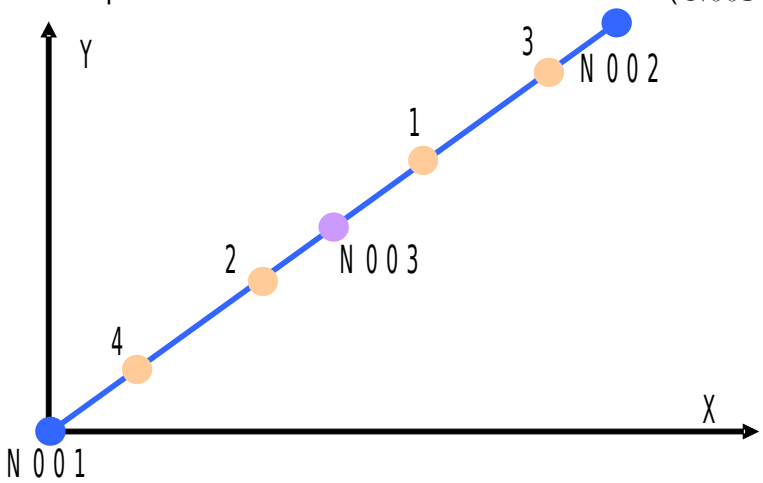
2.3 Uncertainties on the solution

No, exact solution.

3 Modeling A

3.1 Characteristics of the grid

Grid: the grid is made up of a standard mesh **SEG3** with three nœuDS ($N001$, $N002$ and $N003$).



For each mesh, there are 4 points of integration $(1,2,3,4)$

- The group of nodes ENC is composed of the node $N001$
- The group of nodes CHA is composed of the node $N002$

3.2 Characteristics of modeling

Modeling:

```
MO=AFFE_MODELE (
    MAILLAGE=MA,
    AFFE=_F (TOUT=' OUI', PHENOMENE=' MECANIQUE',
       MODELISATION='COQUE_AXIS',),
)
```

Boundary conditions:

```
BLOCAGE=AFFE_CHAR_MECA (MODELE=MO,
    DDL_IMPO=_F (GROUP_NO=' ENC', DX=0.0, DY=0.0, DRZ=0.0,),
)
```

Mechanical loading:

```
CHARGE=AFFE_CHAR_MECA (MODELE=MO,
    FORCE_NODALE=_F (GROUP_NO=' CHA', FX = 0, FY = -100),
)
```

Assignment of the characteristics of the elements:

```
COQUE=AFFE_CARA_ELEM (MODELE=MO,
    COQUE=_F (GROUP_MA= ('HULL'), THICK = 0.5, COQUE_NCOU = 4,),
)
```

3.3 Values tested and results

Coordinate mesh M001	Not integration	under-point	Reference
COOR_X	1	1	2.529962087
COOR_X	1	2	2.567462087
COOR_X	1	3	2.604962087
COOR_X	1	4	2.604962087
COOR_X	1	5	2.642462087
COOR_X	1	6	2.679962087
COOR_X	1	7	2.679962087
COOR_X	1	8	2.717462087
COOR_X	1	9	2.754962087
COOR_X	1	10	2.754962087
COOR_X	1	11	2.792462087
COOR_X	1	12	2.829962087
COOR_Y	1	1	2.209971565
COOR_Y	1	2	2.159971565
COOR_Y	1	3	2.109971565
COOR_Y	1	4	2.109971565
COOR_Y	1	5	2.059971565
COOR_Y	1	6	2.009971565
COOR_Y	1	7	2.009971565
COOR_Y	1	8	1.959971565
COOR_Y	1	9	1.909971565
COOR_Y	1	10	1.909971565
COOR_Y	1	11	1.859971565
COOR_X	1	12	1.809971565
COOR_X	2	1	1.170037913
COOR_X	2	2	1.207537913
COOR_X	2	3	1.245037913
COOR_X	2	4	1.245037913
COOR_X	2	5	1.282537913
COOR_X	2	6	1.320037913
COOR_X	2	7	1.320037913
COOR_X	2	8	1.357537913
COOR_X	2	9	1.395037913
COOR_X	2	10	1.395037913
COOR_X	2	11	1.432537913
COOR_X	2	12	1.470037913
COOR_Y	2	1	1.190028435
COOR_Y	2	2	1.140028435
COOR_Y	2	3	1.090028435
COOR_Y	2	4	1.090028435
COOR_Y	2	5	1.040028435
COOR_Y	2	6	0.990028435
COOR_Y	2	7	0.990028435
COOR_Y	2	8	0.940028435
COOR_Y	2	9	0.890028435
COOR_Y	2	10	0.890028435
COOR_Y	2	11	0.840028435
COOR_X	2	12	0.790028435

The tolerance is fixed at $1.0\mathrm{E}-03$ for all the tests.

4 Summary of the results

The purpose of this test is principal to check if the positions of the under-points of integration of modeling COQUE_AXIS are well calculated.

For this modelings, the found maximum error is of $4.8\mathrm{E}-08\%$.