ZZZZ295 – Validation of the position of the subpoints of the plates 2D

Summarized:
This test validates the computation of the position of the subpoints of integration in the total reference for modelizations COQUE_C_PLAN, COQUE_D_PLAN and COQUE_AXIS. An elementary mechanical computation is carried out in order to allow the creation of an array with CREA_TABLE from result. Only the coordinates of some subpoints are tested in the array.

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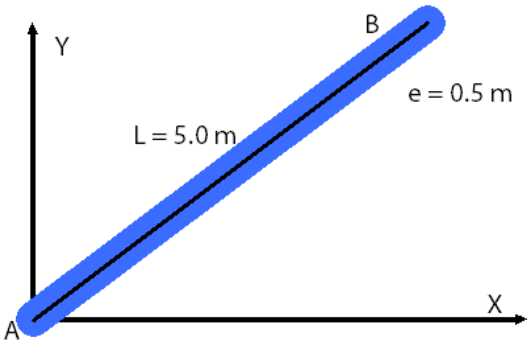
1 Problem of reference

1.1 Geometry



Plates with infinite depth (modelization 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 the materials

Concrete:

Young's 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 :

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

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

$F_Y=-100.0\,N$

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2 Reference solution

2.1 Method of calculating

One calculates the position of the nodes, points of integration and subpoints of integration from its cordonnées in the local axes of the plate and the transition matrix 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 (X',Y') after rotation with the following transformation:

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

2.2 Quantities and results of reference

One calculates the positions of the subpoints of integration in the total reference 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 from the points of integration compared to the first node are (see R3.01.01):

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

thickness $EP=0.5m$, is discretized in 4 layers, which makes 12 subpoints whose heights compared to the average plane are:

Subpoint	z	Subpoint	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.

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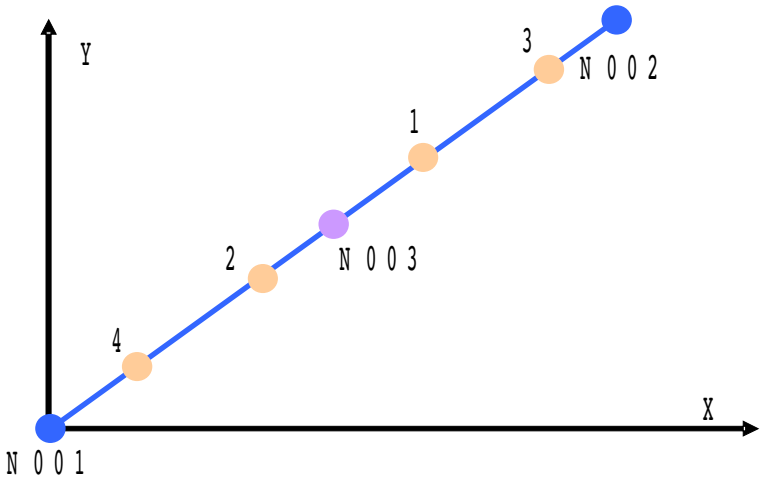
3 Modelization A

3.1 Characteristic of the mesh

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



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

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

3.2 Characteristics of the modelization

Modelization:

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

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= ("COQUE"), EPAIS = 0.5, COQUE_NCOU = 4,),
)
```

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3.3 Values tested and results

Coordinated M001 mesh	not of integration	subpoint	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	the 0.790028435

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

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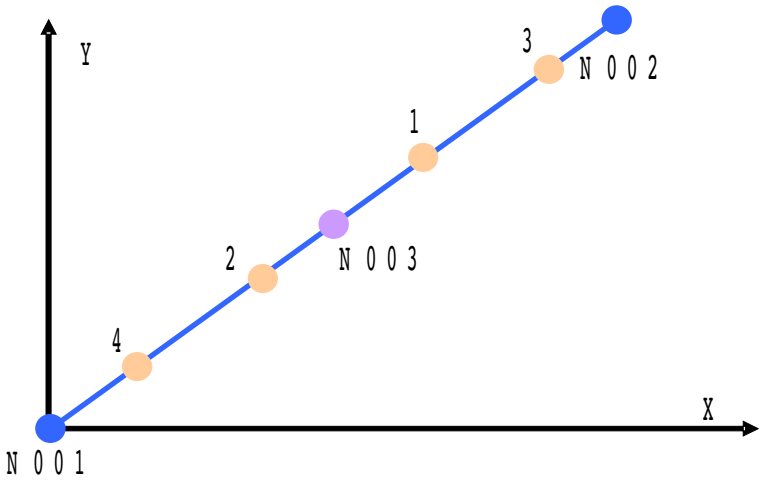
4 Modelization B

4.1 Characteristic of the mesh

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



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

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

4.2 Characteristics of the modelization

Modelization:

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

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= ("COQUE"), EPAIS = 0.5, COQUE_NCOU = 4,),
    )
```

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4.3 Values tested and results

Coordinated M001 mesh	Not of integration	subpoint	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
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COOR_Y	1	7	2.009971565
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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
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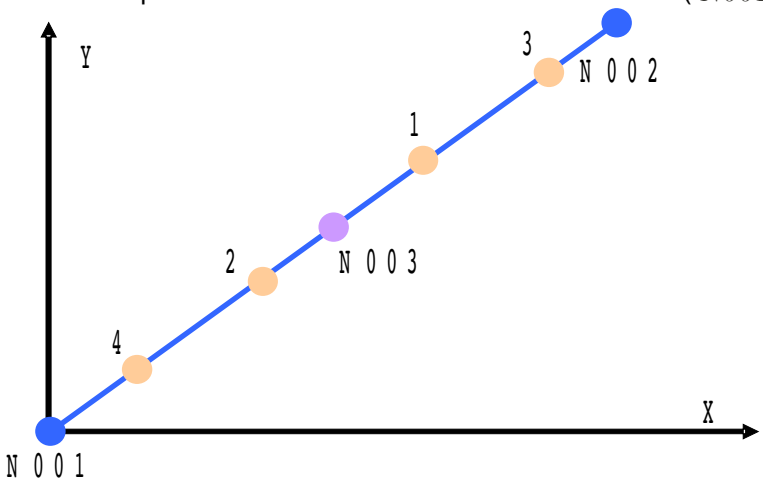
5 Modelization C

5.1 Characteristic of the mesh

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



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

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

5.2 Characteristics of the modelization

Modelization:

```
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= ("COQUE"), EPAIS = 0.5, COQUE_NCOU = 4,),
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```

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5.3 Values tested and results

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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
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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
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6 The purpose of summary of the results

This test is principal to check if the positions of the subpoints of integration of modelizations COQUE_C_PLAN, COQUE_D_PLAN and COQUE_AXIS are well calculated.

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

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