ZZZZ296 – Validation of the position of the under-points of the pipes

Summary:
This test validates the calculation of the position of the under-points of integration in the total reference mark for one modeling TUYAU_3M. All Lbe coordinated ofS under-points are tested.

1 Problem of reference

1.1 Geometry

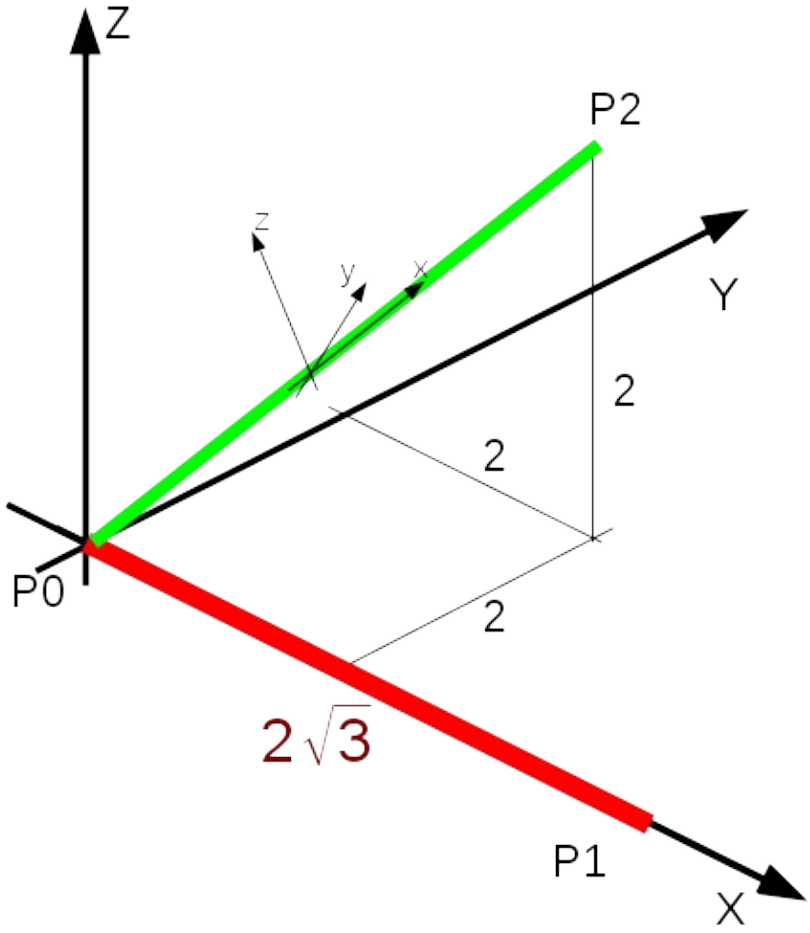

Figure 1.1-a : orientation of the element.

pipeX are directedS in space as indicated on the Figure 1.1-a :
Total coordinates of the points $P0$, $P1$ and $P2$:

$P0=(0.0;0.0;0.0)$
$P1=(2\sqrt{3};0.0;0.0)$
$P2=(2.0;2.0;2.0)$

2 Reference solution

2.1 Method of calculating

The elements supports of the pipes are SEG3 .

- The position of the points of integration along SEG3 is data in [R3.01.01] "Functions of form and points of integration of the finite elements".

```
# Coordinated of the Points of Gauss on LE long of SEG3
LongPoutre = 2.0*pow(3.0,0.5)
xpg = pow(3.0/5.0, 0.5)
Points= {1: LongPoutre*(1.0- xpg)*0.5,
         2: LongPoutre*0.5,
         3: LongPoutre*(1.0+xpg)*0.5,}
```

- The coordinates of the under-points of integration are functionS amongst layers, amongst sectors and of course of the bore and the thickness.

```
# Coordinated of the Under-Points "Nbfibre = (2*Ncou+1) * (2*Nsect+1)"
def CoordFibre(ifib):
    Rint = Rext-Ep
    # index of the coordinates
    numAng = ((ifib-1)%(2*Nsect+1))/(2.0*Nsect)
    numCou = ((ifib-1)/(2*Nsect+1))/(2.0*Ncou)
    there =  (Rint+Ep*numCou)*NP.cos(2.0*NP.pi*numAng)
    Z = -(Rint+Ep*numCou)*NP.sin(2.0*NP.pi*numAng)
    return there, Z
```

Où:

- Rext and Ep are respectively the ray external and the thickness of the pipe, well informed in the order AFFE_CARA_ELEM.
- Nsect and Ncou are respectively the number of sector and layer, well informed in the order AFFE_CARA_ELEM.

```
CARA = AFFE_CARA_ELEM (
    MODELE=MODEL,
    POUTRE=_F (GROUP_MA=('BEAM','POUTRE0'),
               SECTION='CIRCLE', CARA=('R','EP'), VALE=(10.0,1.0),
               TUYAU_NSEC = 4, TUYAU_NCOU = 2,),
)
```

- The matrix of passage of the pipe $P0P1$ with the pipe $P0P2$ allows to calculate the coordinates of the under-points of the pipe $P0P2$ starting from the preceding formulas.

```
# Stamps Axe_X passage towards Trisecting
un3 = 1.0/pow(3.0,0.5); un2 = 1.0/pow(2.0,0.5); un6 = 1.0/pow(6.0,0.5)
MatPass = NP.array( [[un3, - un2,    - un6],
                     [un3,  un2,    - un6],
                     [un3,  0.0, 2.0*un6]] )
```

For the pipe $P0P1$ coordinates (x, y, z) fibre 'ifib' for the point 'ipt' are given by:

```
X = Points [ipt]
there, Z = CoordFibre(ifib)
```

For the pipe $P0P2$ coordinates (x_t, y_t, z_t) fibre 'ifib' for the point 'ipt' are given by:

```
# According to the Trisecting one
xx = Points [ipt]
yy, zz = CoordFibre (ifib)
xxt, yyt, zzt = NP.dot (MatPass, NP.array ([xx, yy, zz]))
```

2.2 Sizes and results of reference

The coordinates of all the under-points are tested.
To obtain the coordinates oneE table is generated starting from a stress field built at the under-points.

```
CSIEF=CRÉA_CHAMP (TYPE_CHAM='ELGA_SIEF_R', OPERATION="AFFE",
                  MODELE=MODEL,
   AFFE_SP=_F ( CARA_ELEM = CARA,),PROL_ZERO='YES',
   AFFE=_F (TOUT="YES", NOM_CMP=('SIXX',), VALE= ( 0.0, ),),
)

RESU=CRÉA_RESU (TYPE_RESU = "EVOL_NOLI", OPERATION = "AFFE",
                NOM_CHAM='SIEF_ELGA',
               AFFE= _F (CHAM_GD = CSIEF, MODEL = MODEL, CARA_ELEM =CARA,
INST =0.0,),
)
```

The coordinates are then tested using TEST_TABLE.
For example for the coordinate 'X' pipe $P0P1$:

```
TEST_TABLE ( REFERENCE= 'ANALYTICAL' ,
    VALE_CALC=xx, VALE_REFE=xx, NOM_PARA='COOR_X', TABLE=TBEPS0,
    FILTRE=(_F (NOM_PARA='NOT',       VALE_I= ipt,),
            _F (NOM_PARA='SOUS_POINT', VALE_I= ifib,),),
    )
```

2.3 Uncertainties on the solution

No, exact solution.

3 Modeling A

3.1 Characteristics of the grid

The maillage Dbe pipeX is composed of a standard mesh SEG3.

3.2 Characteristics of modeling

Definition of the model:

```
MODEL=AFFE_MODELE (
    MAILLAGE=MAPOU,
    AFFE=_F (TOUT='YES', PHENOMENE='MECHANICAL',
             MODELISATION='TUYAU_3M',),
)
```

Assignment of the characteristics:

- Ray and thickness of the pipe
- Number of sector and number of layer

```
CARA=AFFE_CARA_ELEM (
    MODELE=MODEL,
    POUTRE=_F (GROUP_MA=('BEAM','POUTRE0'),
               SECTION='CIRCLE', CARA=('R','EP'), VALE=(10.0,1.0),
               TUYAU_NSEC = 4, TUYAU_NCOU = 2, ),
)
```

3.3 Values tested and results

All the coordinates of the under-points for the 2 pipes are tested.

4 Summary of the results

The purpose of this test is to check that the positions of the under-points of integration of modeling TUYAU_3M are well calculated.