# ZZZZ234 - Test of the values of reference for the elements beams, bars, cables, discrete.

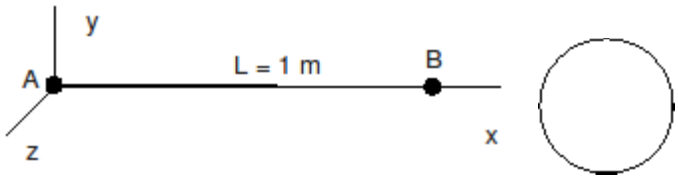
**Summary:**
Validation of the keywords EFFORT_REFE and MOMENT_REFE (Force and Moment of reference for the elements of structure) and of CREA_CHAMP, for following modelings:

- Elements of beam: POU_D_E, POU_D_T, POU_D_TG, POU_D_EM, POU_D_TGM, POU_D_T_GD
- Element of bar: BAR,
- Element of cable: CABLE,
- Discrete elements 3D : DIS_T, DIS_TR,
- Discrete elements 2D : 2D_DIS_T, 2D_DIS_TR.

# 1 Problem of reference

## 1.1 Geometry

Right beam length $L=1$ , of direction $x$ .




Section $r=0,02\ \mathrm{m}$

Material properties:
$E=2.10^{11}\,Pa$
$\nu=0.3$

## 1.2 Boundary conditions and loadings

The boundary conditions and the loadings are detailed during the description of modelings.

# 2 Reference solution

## 2.1 Results of reference

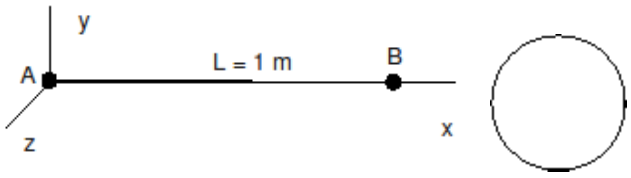
Analytical reference (theory of the beams)

## 2.2 Uncertainty on the solution

None

# 3 Modeling A

## 3.1 Characteristics of modeling




Section $r = 0{,}02\,\mathrm{m}$

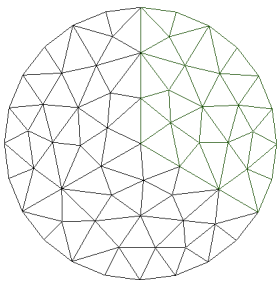
Element BEAM (6 modelings):
- modeling POU_D_T
- modeling POU_D_E
- modeling POU_D_TG
- modeling POU_D_EM
- modeling POU_D_TGM
- modeling POU_D_T_GD

Embedding in $A$ : D $X = DY = DZ = DRX = DRY = DRZ = 0$

Loading in $B$ :
- $FX = 1000\,N$
- $FY = 1100\,N$
- $FZ = 1200\,N$
- $MX = 1300\,N.m$
- $MY = 1400\,N.m$
- $MZ = 1500\,N.m$

## 3.2 Characteristics of the grid

An element SEG2
Grid of the section for the multifibre elements POU_D_EM and POU_D_TGM. The grid is composed of 102 TRIA3 and of 64 nodes.



## 3.3 Sizes tested and results

Modeling POU_D_T :

| Identification | Reference | Test |
|---|---|---|
| Normal effort – Field ELGA | 2.0000E+03 | ANALYTICAL |
| Normal effort – Field ELNO | 2.0000E+03 | ANALYTICAL |
| Normal effort – Field NOEU | 2.0000E+03 | ANALYTICAL |

Modeling POU_D_E :

| Identification | Reference | Test |
|---|---|---|
| Normal effort – Field ELGA | 2.0000E+03 | ANALYTICAL |
| Normal effort – Field ELNO | 2.0000E+03 | ANALYTICAL |
| Normal effort – Field NOEU | 2.0000E+03 | ANALYTICAL |

Modeling POU_D_TG :

| Identification | Reference | Test |
|---|---|---|
| Normal effort – Field ELGA | 2.0000E+03 | ANALYTICAL |
| Normal effort – Field ELNO | 2.0000E+03 | ANALYTICAL |
| Normal effort – Field NOEU | 2.0000E+03 | ANALYTICAL |

Modeling POU_D_EM :

| Identification | Reference | Test |
|---|---|---|
| Normal effort – Field ELGA | -2.220904845E8 | ANALYTICAL |
| Normal effort – Field ELNO | 1.0000E+03 | ANALYTICAL |
| Normal effort – Field NOEU | 1,0000E+003 | ANALYTICAL |

Modeling POU_D_TGM :

| Identification | Reference | Test |
|---|---|---|
| Normal effort – Field ELGA | -2.2990566066E8 | ANALYTICAL |
| Normal effort – Field ELNO | 1.0000E+03 | ANALYTICAL |
| Normal effort – Field NOEU | 1,0000E+003 | ANALYTICAL |

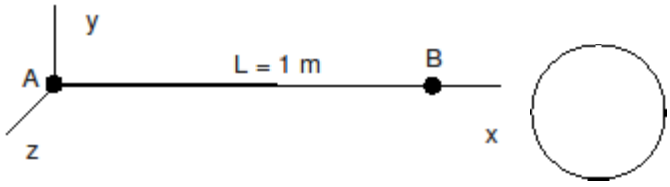
For all modelings, tests ensure to it not regression of the code. They relate to following displacement $Y$ with the node $B$ like on ITER_GLOB for NUME_ORDRE=1.

## 3.4 Remarks

- To converge, the loading of modeling POU_D_T_GD was divided by 100.
- One makes use of this command file to validate the keyword AFFE_SP order CREA_CHAMP. It is checked that one finds well the value affected on one of multifibre fibres of the beam.

# 4 Modeling B

## 4.1 Characteristics of modeling




Section $r=0,02\,\mathrm{m}$

Modeling BAR:

Not $A$ : $DX=DY=DZ=0$
Not $B$ : $DY=DZ=0$

Force in $B$ : $FX=-1000\,N$

## 4.2 Characteristics of the grid

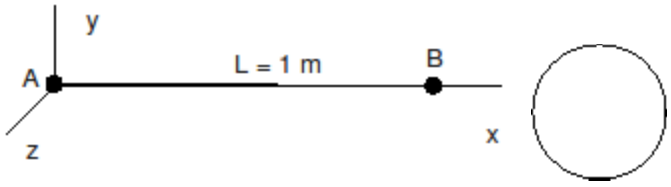
An element SEG2.

## 4.3 Sizes tested and results

| Identification | Reference | Test | Tolerance |
|---|---|---|---|
| Normal effort – Field ELGA | -4.0000E+03 | ANALYTICAL | 0.1 0% |
| Normal effort – Field ELNO | -4.0000E+03 | ANALYTICAL | 0.1 0% |
| Normal effort – Field NOEU | -4.0000E+03 | ANALYTICAL | 0.1 0% |
| $DX$ with the node $B$ | -3,7894E-006 | NON_REGRESSION | 1.0 E-8 (relative) |
| ITER_GLOB for NUME_ORDRE=1 | 1.0000E+00 | NON_REGRESSION | 0,00% |

# 5 Modeling C

## 5.1 Characteristics of modeling




Section $r=0,02\,\mathrm{m}$

Modeling CABLE :

Null displacement in $A$ : $DX=DY=DZ=0$

Force in $B$ : $FX=1000\,N$

## 5.2 Characteristics of the grid

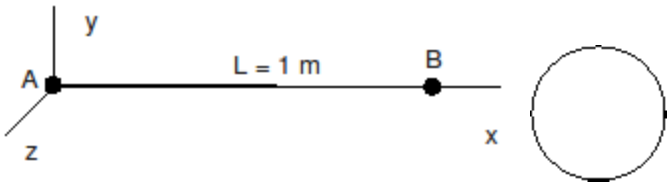
An element SEG2

## 5.3 Sizes tested and results

| Identification | Reference | Test |
|---|---|---|
| Normal effort – Field ELGA | -7.5787E-03 | ANALYTICAL |
| Normal effort – Field ELNO | -7.5787E-03 | ANALYTICAL |
| Normal effort – Field NOEU | -7.5787E-03 | ANALYTICAL |
| $DX$ with the node $B$ | 3.7894E-06 | NON_REGRESSION |
| ITER_GLOB for NUME_ORDRE=1 | 3.0000E+00 | NON_REGRESSION |

# 6 Modeling D

## 6.1 Characteristics of modeling



Section $r=0,02\,\mathrm{m}$

Element DISCRETE 3D , 4 modelings:
- modeling DIS_T : T_L (mesh SEG2)
- modeling DIS_T : T_N (mesh POI)
- modeling DIS_TR : TR_L (mesh SEG2)
- modeling DIS_TR : TR_N (mesh POI)

Modeling DIS_T: T_L ( $AB$ : mesh SEG2)
- Null displacement in $A$ : $DX=DY=DZ=0$
- Force in $B$ : $FY=-1000\,N$

Modeling DIS_T: T_N (mesh POI)
- Worthless rotations in $A$ : $DRX=DRY=DRZ=0$
- Force in $B$ : $FY=-1000\,N$

The grid of this modeling is composed of a mesh POI (not $A$ ) for the discrete element (T_N) and of a mesh SEG2 ( $AB$ ) for the element beam.

Modeling DIS_TR: TR_L ( $AB$ : mesh SEG2)
- Embedding in $A$ : $DX=DY=DZ=DRX=DRY=DRZ=0$
- Loading in $B$ :
  - $FX=1000\,N$
  - $FY=1100\,N$
  - $FZ=1200\,N$
  - $MX=1300\,N.m$
  - $MY=1400\,N.m$
  - $MZ=1500\,N.m$

Modeling DIS_TR: TR_N ( $A$ : mesh POI)
- Loading in $B$ :
  - $FX=1000\,N$
  - $FY=1100\,N$
  - $FZ=1200\,N$
  - $MX=1300\,N.m$
  - $MY=1400\,N.m$
  - $MZ=1500\,N.m$

The grid of this modeling is composed of a mesh POI (not $A$ ) for the discrete element (TR_N) and of a mesh SEG2 ( $AB$ ) for the element beam.

## 6.2 Characteristics of the grid

Modelings DIS_T, DIS_TR (T_L, TR_L)
- 1 SEG2

Modeling DIS_T, DIS_TR (T_N, TR_N)
- 1 SEG2
- 1 POI

## 6.3 Sizes tested and results

### 6.3.1 Values tested

Modeling DIS_T/T_L :

| Identification | Reference | Test |
|---|---|---|
| Normal effort – Field ELGA | -4.0000E+03 | ANALYTICAL |
| Normal effort – Field ELNO | -4.0000E+03 | ANALYTICAL |
| Normal effort – Field NOEU | -4,0000E+003 | ANALYTICAL |

Modeling DIS_T/T_N :

| Identification | Reference | Test |
|---|---|---|
| Normal effort – Field ELGA | -4.0000E+03 | ANALYTICAL |
| Normal effort – Field ELNO | -4.0000E+03 | ANALYTICAL |
| Normal effort – Field NOEU | -4,0000E+003 | ANALYTICAL |

Modeling DIS_TR/TR_N:

| Identification | Reference | Test |
|---|---|---|
| Normal effort – Field ELGA | 2.0000E+03 | ANALYTICAL |
| Normal effort – Field ELNO | 2.0000E+03 | ANALYTICAL |
| Normal effort – Field NOEU | 2.0000E+03 | ANALYTICAL |

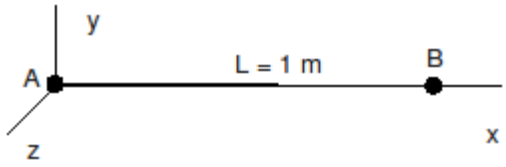
Modeling DIS_TR/TR_N :

| Identification | Reference | Test |
|---|---|---|
| Normal effort – Field ELGA | 2.0000E+03 | ANALYTICAL |
| Normal effort – Field ELNO | 2.0000E+03 | ANALYTICAL |
| Normal effort – Field NOEU | 2.0000E+03 | ANALYTICAL |

For all modelings, tests ensure to it not regression of the code. They relate to following displacement $y$ with the node $B$ like on ITER_GLOB for NUME_ORDRE=1.

# 7 Modeling E

## 7.1 Characteristics of modeling




Element DISCRETE 2D , 4 modelings:
- modeling 2D_DIS_T : T_L (mesh SEG2)
- modeling 2D_DIS_T : T_N (mesh POI)
- modeling 2D_DIS_TR : TR_L (mesh SEG2)
- modeling 2D_DIS_TR : TR_N (mesh POI)

Modeling 2D_DIS_T : T_L
- Null displacement in $A$ : $DX = DY = 0$
- Force in $B$ : $FX = -1000\,N$ , $FY = -1100\,N$

Modeling 2D_DIS_T: T_N
- Force in $B$ : $FX = -1000\,N$

The grid of this modeling is composed of a mesh POI (not $A$ ) for the discrete element (T_N) and of a mesh SEG2 ( $AB$ ) for the discrete element (T_L).

Modeling 2D_DIS_TR: TR_L
- Null displacement in $A$ : $DX = DY = DRZ = 0$
- Force in $B$ : $FX = -1000\,N$ , $FY = -1100\,N$

Modeling 2D_DIS_TR: T_N
- Force in $B$ : $FX = -1000\,N$

The grid of this modeling is composed of a mesh POI (not $A$ ) for the discrete element (TR_N) and of a mesh SEG2 ( $AB$ ) for the discrete element (TR_L).

## 7.2 Characteristics of the grid

Modeling 2D_DIS_T, 2D_DIS_TR (T_L, TR_L)
- 1 SEG2

Modeling 2D_DIS_T, 2D_DIS_TR : T_N, TR_N
- 1 POI
- 1 SEG2

## 7.3 Sizes tested and results

Modeling 2D_DIS_T/T_L :

| Identification | Reference | Test |
|---|---|---|
| Normal effort – Field ELGA | 0.0000E+00 | ANALYTICAL |
| Normal effort – Field ELNO | 0.0000E+00 | ANALYTICAL |
| Normal effort – Field NOEU | 0.0000E+00 | ANALYTICAL |
| $DY$ with the node $B$ | -4,1684E-006 | NON_REGRESSION |
| ITER_GLOB for NUME_ORDRE=1 | 0,0000E+000 | NON_REGRESSION |

Modeling 2D_DIS_T /T_N:

| Identification | Reference | Test |
|---|---|---|
| Normal effort – Field ELGA | 0.0000E+00 | ANALYTICAL |
| Normal effort – Field ELNO | 0.0000E+00 | ANALYTICAL |
| Normal effort – Field NOEU | 0.0000E+00 | ANALYTICAL |
| $DY$ with the node $B$ | -4,1684E-006 | NON_REGRESSION |
| ITER_GLOB for NUME_ORDRE=1 | 0,0000E+000 | NON_REGRESSION |

Modeling 2D_DIS_TR /TR_N:

| Identification | Reference | Test |
|---|---|---|
| Normal effort – Field ELGA | -7.0000E+03 | ANALYTICAL |
| Normal effort – Field ELNO | -7.0000E+03 | ANALYTICAL |
| Normal effort – Field NOEU | -7.0000E+03 | ANALYTICAL |
| $DX$ with the node $B$ | -7.5789E-06 | NON_REGRESSION |
| ITER_GLOB for NUME_ORDRE=1 | 0.0000E+00 | NON_REGRESSION |

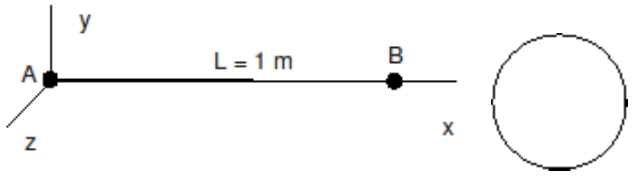
Modeling 2D_DIS_TR /TR_N:

| Identification | Reference | Test |
|---|---|---|
| Normal effort – Field ELGA | -7.0000E+03 | ANALYTICAL |
| Normal effort – Field ELNO | -7.0000E+03 | ANALYTICAL |
| Normal effort – Field NOEU | -7.0000E+03 | ANALYTICAL |
| $DX$ with the node $B$ | -7.5789E-06 | NON_REGRESSION |
| ITER_GLOB for NUME_ORDRE=1 | 0.0000E+00 | NON_REGRESSION |

# 8 Modeling F

This modeling is strictly identical to modeling A, except that one does it in dynamics (operator DYNA_NON_LINE).

## 8.1 Characteristics of modeling




Section $r = 0,02\,\mathrm{m}$

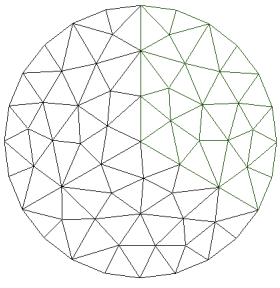
Element BEAM (6 modelings):
- modeling POU_D_T
- modeling POU_D_E
- modeling POU_D_TG
- modeling POU_D_EM
- modeling POU_D_TGM
- modeling POU_D_T_GD

Embedding in $A$ : D $X = DY = DZ = DRX = DRY = DRZ = 0$

Loading in $B$ :
- $FX = 1000\,N$
- $FY = 1100\,N$
- $FZ = 1200\,N$
- $MX = 1300\,N.m$
- $MY = 1400\,N.m$
- $MZ = 1500\,N.m$

## 8.2 Characteristics of the grid

An element SEG2
Grid of the section for the multifibre elements POU_D_EM and POU_D_TGM. The grid is composed of 102 TRIA3 and of 64 nodes.



## 8.3 Sizes tested and results

For all modelings, tests ensure to it not regression of the code. They relate to following displacement $Y$ with the node $B$ like on ITER_GLOB for NUME_ORDRE=1.

# 9 Summary of the results

The got results are very satisfactory.