

SSNS105 – Behavior nonlinear of a three-dimensions function of reinforcements

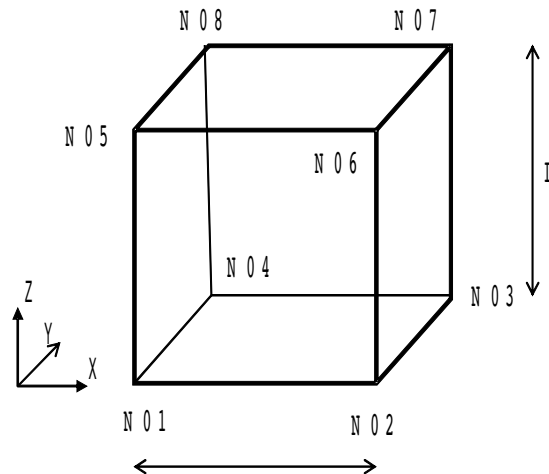
Summarized:

The purpose of this test is to validate the modelizations grille_membrane and grille_excentre for three-dimensions functions of reinforcements. The model of reinforced concrete is subjected to a loading of imposed displacements: ddl_impo. The nonlinear behavior of the three-dimensions functions of reinforcement is modelled by GRILLE_ISOT_LINE for plasticity with isotropic hardening.

1 Problem of reference

1.1 Geometry

One considers a reinforced concrete cube of with dimensions $L = 1\text{ m}$.



The three-dimensions functions of reinforcements belong to the plane defined by the four nodes $N05 - N02 - N03 - N08$.

Two three-dimensions functions of reinforcements are defined: a following local direction X and a following local direction Y .

The rate of reinforcement for each three-dimensions function of reinforcement is of $0.1\text{ m}^2/\text{ml}$ (Section per linear meter).

1.2 Characteristics of the modelizations

the concrete mesh is modelled with an element `HEXA8`.

The modelizations considered for the three-dimensions functions of reinforcement are:

- modelization A (§3): use of `GRILLE_MEMBRANE` with meshes of support `TRIA3`
- modelization B (§4): use of `GRILLE_MEMBRANE` with meshes of support `QUAD4`
- modelization C (§5): use of `GRILLE_EXCENTRE` with meshes of support `TRIA3`

1.3 Properties of the materials

the concrete material is elastic isotropic whose properties are:

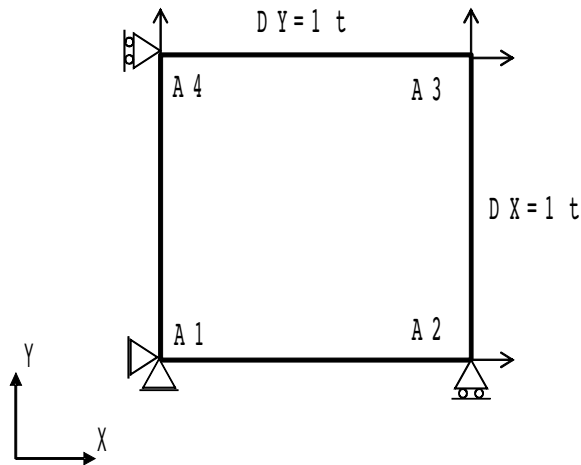
- $E_b = 20000\text{ MPa}$
- $\nu = 0.2$

The constitutive law of reinforcements follows an elastoplastic model whose properties are:

- $E_a = 200000\text{ MPa}$
- $\nu = 0$
- $E_{ecr}^{acier} = 20000\text{ MPa}$
- $\sigma_e^{acier} = 200000\text{ MPa}$

The model `GRILLE_ISOT_LINE` for plasticity with isotropic hardening is used in `STAT_NON_LINE`.

1.4 Boundary conditions and loadings



Boundary conditions:

- Fixed support in $A1$
- $DX = 0$ on the edge $A1 - A4$
- $DY = 0$ on the edge $A1 - A2$
- $DZ = 0$ on the lower surface of cube (N01-N02-N03-N04)

Loading by imposed displacements:

- $DX = 1$ on the edge $A2 - A3$
- $DY = 1 t$ on the edge $A3 - A4$

where t is the parameter of pseudo-TEMPS.

1.5 Initial conditions

At the beginning displacements and the forced are worth zero everywhere.

2 Reference solution

2.1 Method of calculating

the results of reference are got by another Aster computation.

2.2 Quantities and results of reference

One evaluates displacements, the reaction forces with various nodes of the mesh, as well as the value local of stresses for different meshes.

These values are obtained for three times t : formuleformule $t=1$, formula formuleformule $t=2$, formula formuleformule $t=10$.

| Standard | identification of reference | Value of reference | |
|--|-----------------------------|--------------------|-----------|
| | | Time | Value |
| Not formula <i>N05</i> Displacement formulates <i>DZ</i> | "AUTRE_ASTER" | 1 | -7.06E-01 |
| | | 2 | -1.41E+00 |
| | | 10 | -6.50E+00 |
| Not formula <i>N06</i> Displacement formulates <i>DZ</i> | "AUTRE_ASTER" | 1 | -4.81E-01 |
| | | 2 | -9.63E-01 |
| | | 10 | -4.86E+00 |
| Not formula <i>N01</i> Forces Nodal formula <i>DX</i> | "AUTRE_ASTER" | 1 | -6.35E+09 |
| | | 2 | -1.27E+10 |
| | | 10 | -6.33E+10 |
| Not formula <i>N01</i> Forces Nodal formula <i>DY</i> | "AUTRE_ASTER" | 1 | -6.07E+09 |
| | | 2 | -1.21E+10 |
| | | 10 | -6.12E+10 |
| Not formula <i>N01</i> Forces Nodal formula <i>DZ</i> | "AUTRE_ASTER" | 1 | 5.72E+08 |
| | | 2 | 1.14E+09 |
| | | 10 | 4.18E+09 |

Forced in the mesh which models THE GRILLE_MEMBRANE at the Gauss point number 1.

| | Sig _{xx} for meshes of reinforcements directed according to <i>OX</i> | Sig _{xx} for meshes of reinforcements directed according to <i>OY</i> |
|------|--|--|
| Time | Value of reference | Value of reference |
| 1 | 2.94E+10 | 2.00E+11 |
| 2 | 5.88E+10 | 2.20E+11 |
| 10 | 2.15E+11 | 3.80E+11 |

Plasticity cumulated in the mesh which models THE GRILLE_MEMBRANE at the Gauss point number 1.

| | Local variables v_1 for meshes of reinforcements directed according to <i>ox</i> | Local variables v_1 for meshes of reinforcements directed according to <i>oY</i> |
|------|--|--|
| Time | Value of reference | Value of reference |
| 2 | | 9.00E-01 |
| 10 | 6.73E-01 | 4.06E+04 |

Forced in the mesh of concrete HEXA8 to the Gauss point number 1: net *BMAI*

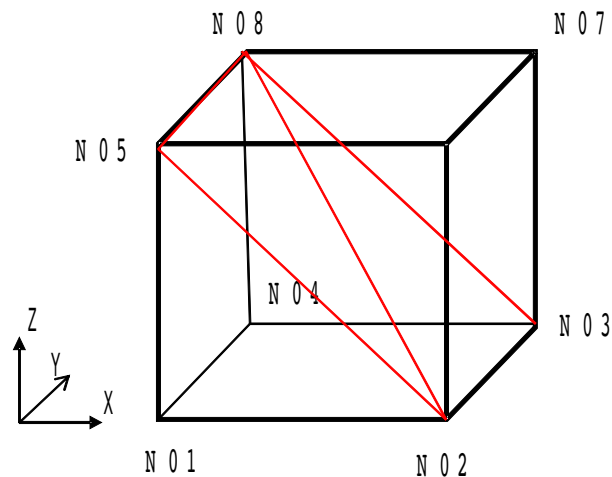
| Time | Stresses Nets HEXA8 point 1 | | | |
|------|-----------------------------|------------------|------------------|------------------|
| | Value of reference | | | |
| | S _{IXX} | S _{IYY} | S _{IZZ} | S _{IXZ} |
| 1 | 2.41E+10 | 2.41E+10 | -3.52E+09 | 3.96E+08 |
| 2 | 4.82E+10 | 4.82E+10 | -7.04E+09 | 7.91E+08 |
| 10 | 2.44E+11 | 2.44E+11 | -2.57E+10 | 2.89E+09 |

3 Modelization A

3.1 Characteristic of the modelization

One uses a voluminal modelization 3D for the concrete and a model `GRILLE_MEMBRANE` for reinforcements whose meshes supports are triangles with 3 nodes.

3.2 Characteristics of the mesh



Many nodes: 8

Number of meshes:

- 1 mesh `HEXA8` for the concrete
- 2 meshes `TRIA3` for the three-dimensions functions of reinforcements ($N05 - N02 - N08$ and $N08 - N02 - N03$)

Two models `GRILLE_MEMBRANE` are defined for reinforcements (a following local direction X , a following local direction Y)

3.3 Quantities tested and results

| Time | Field | Component | Place | Reference | Tolerance |
|------|-----------|-----------|---|-----------|-----------|
| 1 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO5</i> | -7.06E-01 | 0.10% |
| 1 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO6</i> | -4.81E-01 | 0.10% |
| 1 | FORC_NODA | DX | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -6.35E+09 | 0.10% |
| 1 | FORC_NODA | DY | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -6.07E+09 | 0.10% |
| 1 | FORC_NODA | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | 5.72E+08 | 0.10% |
| 1 | SIEF_ELGA | SIXX | nets: <i>BMA1</i> , point: 1 | 2.00E+11 | 0.10% |
| 1 | SIGM_ELNO | SIXX | nets: <i>BMA1</i> , point: 1 | 2.00E+11 | 0.10% |
| 1 | SIEF_ELGA | SIXX | nets: <i>MA1</i> , point: 1 | 2.94E+10 | 0.10% |
| 1 | SIEF_ELGA | SIXX | nets: <i>MA3</i> , point: 1 | 2.41E+10 | 0.10% |
| 1 | SIEF_ELGA | SIYY | nets: <i>MA3</i> , point: 1 | 2.41E+10 | 0.10% |
| 1 | SIEF_ELGA | SIZZ | nets: <i>MA3</i> , point: 1 | -3.52E+09 | 0.10% |
| 1 | SIEF_ELGA | SIXZ | nets: <i>MA3</i> , point: 1 | 3.96E+08 | 0.10% |

| Urgent | Field | Component | Place | Reference | Tolerance |
|--------|-----------|-----------|--|-----------|-----------|
| 2 | DEPL | DZ | The node is outside the field of definition with a right profile of the EXCLU type node: <i>NO5</i> | -1.41E+00 | 0.10% |
| 2 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO6</i> | -9.63E-01 | 0.10% |
| 2 | FORC_NODA | DX | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -1.27E+10 | 0.10% |
| 2 | FORC_NODA | DY | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -1.21E+10 | 0.10% |
| 2 | FORC_NODA | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | 1.14E+09 | 0.10% |
| 2 | SIEF_ELGA | SIXX | nets: <i>BMA1</i> , point: 1 | 2.20E+11 | 0.10% |
| 2 | SIGM_ELNO | SIXX | nets: <i>BMA1</i> , point: 1 | 2.20E+11 | 0.10% |
| 2 | SIEF_ELGA | SIXX | nets: <i>MA1</i> , point: 1 | 5.88E+10 | 0.10% |
| 2 | SIEF_ELGA | SIXX | nets: <i>MA3</i> , point: 1 | 4.82E+10 | 0.10% |
| 2 | SIEF_ELGA | SIYY | nets: <i>MA3</i> , point: 1 | 4.82E+10 | 0.10% |
| 2 | SIEF_ELGA | SIZZ | nets: <i>MA3</i> , point: 1 | -7.04E+09 | 0.10% |
| 2 | SIEF_ELGA | SIXZ | nets: <i>MA3</i> , point: 1 | 7.91E+08 | 0.10% |
| 2 | VARI_ELGA | V1 | nets: <i>BMA1</i> , point: 1 | 9.00E-01 | 0.10% |
| 2 | VARI_ELNO | V1 | nets: <i>BMA1</i> , point: 1 | 9.00E-01 | 0.10% |

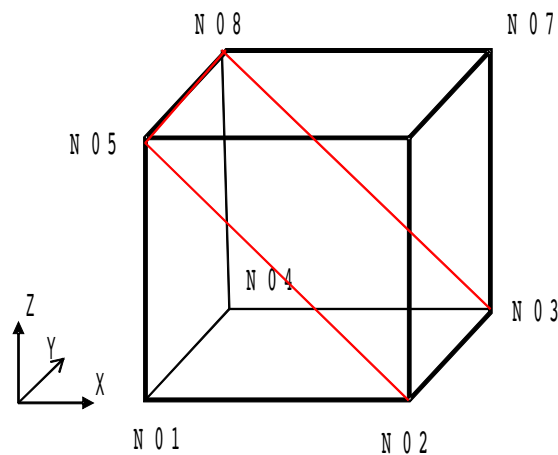
| Urgent | Field | Component | Place | Reference | Tolerance |
|--------|-----------|-----------|---|-----------|-----------|
| 10 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO5</i> | -6.50E+00 | 0.10% |
| 10 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO6</i> | -4.86E+00 | 0.10% |
| 10 | FORC_NODA | DX | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -6.33E+10 | 0.10% |
| 10 | FORC_NODA | DY | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -6.12E+10 | 0.10% |
| 10 | FORC_NODA | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | 4.18E+09 | 0.10% |
| 10 | SIEF_ELGA | SIXX | nets: <i>BMA1</i> , point: 1 | 3.80E+11 | 0.10% |
| 10 | SIGM_ELNO | SIXX | nets: <i>BMA1</i> , point: 1 | 3.80E+11 | 0.10% |
| 10 | SIEF_ELGA | SIXX | nets: <i>MA1</i> , point: 1 | 2.15E+11 | 0.10% |
| 10 | SIEF_ELGA | SIXX | nets: <i>MA3</i> , point: 1 | 2.44E+11 | 0.10% |
| 10 | SIEF_ELGA | SIYY | nets: <i>MA3</i> , point: 1 | 2.44E+11 | 0.10% |
| 10 | SIEF_ELGA | SIZZ | nets: <i>MA3</i> , point: 1 | -2.57E+10 | 0.10% |
| 10 | SIEF_ELGA | SIXZ | nets: <i>MA3</i> , point: 1 | 2.89E+09 | 0.10% |
| 10 | VARI_ELGA | V1 | nets: <i>BMA1</i> , point: 1 | 8.10E+00 | 0.10% |
| 10 | VARI_ELGA | V1 | nets: <i>MA1</i> , point: 1 | 6.73E-01 | 0.10% |
| 10 | VARI_ELNO | V1 | nets: <i>MA1</i> , point: 1 | 6.73E-01 | 0.10% |

4 Modelization B

4.1 Characteristic of the modelization

One 3D uses a voluminal modelization for the concrete and a model `GRILLE_MEMBRANE` for reinforcements whose meshes supports are quadrangles with four nodes.

4.2 Characteristics of the mesh



Many nodes: 8

Number of meshes:

- 1 mesh `HEXA8` for the concrete
- 1 mesh `QUAD4` for the three-dimensions functions of reinforcements (N05-N02-N03-N08)
Two models `GRILLE_MEMBRANE` are defined for reinforcements (a following direction X , a following direction Y)

4.3 Quantities tested and results

| Time | Field | Component | Place | Reference | Tolerance |
|------|-----------|-----------|---|-----------|-----------|
| 1 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO5</i> | -7.06E-01 | 0.10% |
| 1 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO6</i> | -4.81E-01 | 0.10% |
| 1 | FORC_NODA | DX | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -6.35E+09 | 0.10% |
| 1 | FORC_NODA | DY | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -6.07E+09 | 0.10% |
| 1 | FORC_NODA | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | 5.72E+08 | 0.10% |
| 1 | SIEF_ELGA | SIXX | nets: <i>BMA1</i> , point: 1 | 2.00E+11 | 0.10% |
| 1 | SIEF_ELGA | SIXX | nets: <i>MA1</i> , point: 1 | 2.94E+10 | 0.10% |
| 1 | SIEF_ELGA | SIXX | nets: <i>MA3</i> , point: 1 | 2.41E+10 | 0.10% |
| 1 | SIEF_ELGA | SIYY | nets: <i>MA3</i> , point: 1 | 2.41E+10 | 0.10% |
| 1 | SIEF_ELGA | SIZZ | nets: <i>MA3</i> , point: 1 | -3.52E+09 | 0.10% |
| 1 | SIEF_ELGA | SIXZ | nets: <i>MA3</i> , point: 1 | 3.96E+08 | 0.10% |

| Urgent | Field | Component | Place | Reference | Tolerance |
|--------|-----------|-----------|---|-----------|-----------|
| 2 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO5</i> | -1.41E+00 | 0.10% |
| 2 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO6</i> | -9.63E-01 | 0.10% |
| 2 | FORC_NODA | DX | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -1.27E+10 | 0.10% |
| 2 | FORC_NODA | DY | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -1.21E+10 | 0.10% |
| 2 | FORC_NODA | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | 1.14E+09 | 0.10% |
| 2 | SIEF_ELGA | SIXX | nets: <i>BMA1</i> , point: 1 | 2.20E+11 | 0.10% |
| 2 | SIEF_ELGA | SIXX | nets: <i>MA1</i> , point: 1 | 5.88E+10 | 0.10% |
| 2 | SIEF_ELGA | SIXX | nets: <i>MA3</i> , point: 1 | 4.82E+10 | 0.10% |
| 2 | SIEF_ELGA | SIYY | nets: <i>MA3</i> , point: 1 | 4.82E+10 | 0.10% |
| 2 | SIEF_ELGA | SIZZ | nets: <i>MA3</i> , point: 1 | -7.04E+09 | 0.10% |
| 2 | SIEF_ELGA | SIXZ | nets: <i>MA3</i> , point: 1 | 7.91E+08 | 0.10% |
| 2 | VARI_ELGA | V1 | nets: <i>BMA1</i> , point: 1 | 9.00E-01 | 0.10% |

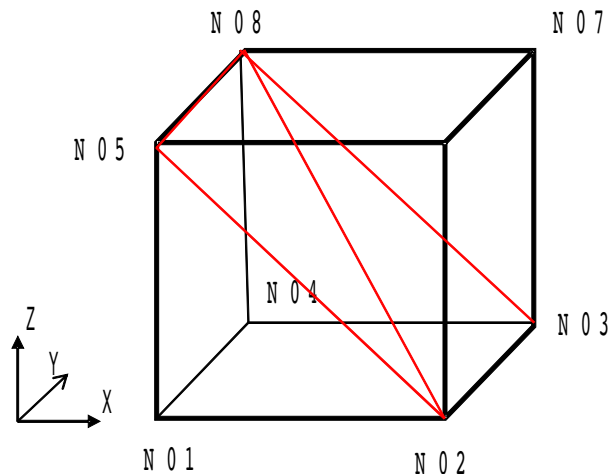
| Urgent | Field | Component | Place | Reference | Tolerance |
|--------|-----------|-----------|---|-----------|-----------|
| 10 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO5</i> | -6.50E+00 | 0.10% |
| 10 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO6</i> | -4.86E+00 | 0.10% |
| 10 | FORC_NODA | DX | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -6.33E+10 | 0.10% |
| 10 | FORC_NODA | DY | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -6.12E+10 | 0.10% |
| 10 | FORC_NODA | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | 4.18E+09 | 0.10% |
| 10 | SIEF_ELGA | SIXX | nets: <i>BMA1</i> , point: 1 | 3.80E+11 | 0.10% |
| 10 | SIEF_ELGA | SIXX | nets: <i>MA1</i> , point: 1 | 2.15E+11 | 0.10% |
| 10 | SIEF_ELGA | SIXX | nets: <i>MA3</i> , point: 1 | 2.44E+11 | 0.10% |
| 10 | SIEF_ELGA | SIYY | nets: <i>MA3</i> , point: 1 | 2.44E+11 | 0.10% |
| 10 | SIEF_ELGA | SIZZ | nets: <i>MA3</i> , point: 1 | -2.57E+10 | 0.10% |
| 10 | SIEF_ELGA | SIXZ | nets: <i>MA3</i> , point: 1 | 2.89E+09 | 0.10% |
| 10 | VARI_ELGA | V1 | nets: <i>BMA1</i> , point: 1 | 8.10E+00 | 0.10% |
| 10 | VARI_ELGA | V1 | nets: <i>MA1</i> , point: 1 | 6.73E-01 | 0.10% |

5 Modelization C

5.1 Characteristic of the modelization

One 3D uses a voluminal modelization for the concrete and a model `GRILLE_EXCENTRE` for reinforcements whose meshes supports are triangles with three nodes.

5.2 Characteristics of the mesh



Many nodes: 8

Number of meshes:

- 1 mesh `HEXA8` for the concrete
- 2 meshes `TRIA3` for the three-dimensions functions of reinforcements (`N05 – N02 – N08` and `N08 – N02 – n03`)

Two models `GRILLE_EXCENTRE` are defined for reinforcements (a following local direction `X`, a following local direction `Y`)

With the boundary conditions described in §1.4 are added the conditions $DRX=0$ $DRY=0$, $DRZ=0$

with nodes `N02-N03-N05-N08`.

5.3 Quantities tested and results

| Time | Field | Component | Place | Reference | Tolerance |
|------|-----------|-----------|---|-----------|-----------|
| 1 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO5</i> | -7.06E-01 | 0.10% |
| 1 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO6</i> | -4.81E-01 | 0.10% |
| 1 | FORC_NODA | DX | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -6.35E+09 | 0.10% |
| 1 | FORC_NODA | DY | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -6.07E+09 | 0.10% |
| 1 | FORC_NODA | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | 5.72E+08 | 0.10% |
| 1 | SIEF_ELGA | SIXX | nets: <i>MA1</i> , point: 1 | 2.94E+10 | 0.10% |
| 1 | SIEF_ELGA | SIXX | nets: <i>MA3</i> , point: 1 | 2.41E+10 | 0.10% |
| 1 | SIEF_ELGA | SIZZ | nets: <i>MA3</i> , point: 1 | -3.52E+09 | 0.10% |
| 1 | SIEF_ELGA | SIXZ | nets: <i>MA3</i> , point: 1 | 3.96E+08 | 0.10% |

| Urgent | Field | Component | Place | Reference | Tolerance |
|--------|-----------|-----------|---|-----------|-----------|
| 2 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO5</i> | -1.41E+00 | 0.10% |
| 2 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO6</i> | -9.63E-01 | 0.10% |
| 2 | FORC_NODA | DX | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -1.27E+10 | 0.10% |
| 2 | FORC_NODA | DY | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -1.21E+10 | 0.10% |
| 2 | FORC_NODA | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | 1.14E+09 | 0.10% |
| 2 | SIEF_ELGA | SIXX | nets: <i>MA1</i> , point: 1 | 5.88E+10 | 0.10% |
| 2 | SIEF_ELGA | SIXX | nets: <i>MA3</i> , point: 1 | 4.82E+10 | 0.10% |
| 2 | SIEF_ELGA | SIZZ | nets: <i>MA3</i> , point: 1 | -7.04E+09 | 0.10% |
| 2 | SIEF_ELGA | SIXZ | nets: <i>MA3</i> , point: 1 | 7.91E+08 | 0.10% |
| 2 | VARI_ELGA | V1 | nets: <i>BMA1</i> , point: 1 | 9.00E-01 | 0.10% |

| Urgent | Field | Component | Place | Reference | Tolerance |
|--------|-----------|-----------|---|-----------|-----------|
| 10 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO5</i> | -6.50E+00 | 0.10% |
| 10 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO6</i> | -4.86E+00 | 0.10% |
| 10 | FORC_NODA | DX | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -6.33E+10 | 0.10% |
| 10 | FORC_NODA | DY | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -6.12E+10 | 0.10% |
| 10 | FORC_NODA | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | 4.18E+09 | 0.10% |
| 10 | SIEF_ELGA | SIXX | nets: <i>MA1</i> , point: 1 | 2.15E+11 | 0.10% |
| 10 | SIEF_ELGA | SIXX | nets: <i>MA3</i> , point: 1 | 2.44E+11 | 0.10% |
| 10 | SIEF_ELGA | SIZZ | nets: <i>MA3</i> , point: 1 | -2.57E+10 | 0.10% |
| 10 | SIEF_ELGA | SIXZ | nets: <i>MA3</i> , point: 1 | 2.89E+09 | 0.10% |
| 10 | VARI_ELGA | V1 | nets: <i>BMA1</i> , point: 1 | 8.10E+00 | 0.10% |
| 10 | VARI_ELGA | V1 | nets: <i>MA1</i> , point: 1 | 6.73E-01 | 0.10% |

Elastic design

| Urgent | Field | Component | Place | Reference | Tolerance |
|--------|-----------|-----------|---|-----------|-----------|
| 1 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO5</i> | -7.06E-01 | 0.10% |
| 1 | DEPL | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO6</i> | -4.81E-01 | 0.10% |
| 1 | FORC_NODA | DX | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -6.35E+09 | 0.10% |
| 1 | FORC_NODA | DY | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | -6.07E+09 | 0.10% |
| 1 | FORC_NODA | DZ | the node is outside the field of definition with a right profile of the EXCLU type node: <i>NO1</i> | 5.72E+08 | 0.10% |
| 1 | SIEF_ELGA | SIXX | nets: <i>MA1</i> , point: 1 | 2.94E+10 | 0.10% |
| 1 | SIEF_ELGA | SIXX | nets: <i>MA3</i> , point: 1 | 2.41E+10 | 0.10% |
| 1 | SIEF_ELGA | SIZZ | nets: <i>MA3</i> , point: 1 | -3.52E+09 | 0.10% |
| 1 | SIEF_ELGA | SIXZ | nets: <i>MA3</i> , point: 1 | 3.96E+08 | 0.10% |

6 Synthesis

the various modelizations of this case test validates the behavior `GRILLE_MEMBRANE` and `GRILLE_EXCENTRE` for a complete structure.