Universitat Politècnica de Catalunya

Master of Science in Computational Mechanics

Computational Structural Mechanics and Dynamics

Practice 4
Shells

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1 Cylindrical tank

Analyze the state of stress of the tank shown in the figure, which is submitted to an internal pressure. Suppose a continuous variation of the thickness of the spherical cupola. Use revolutions shell elements with two nodes and 3D shells elements with three nodes.
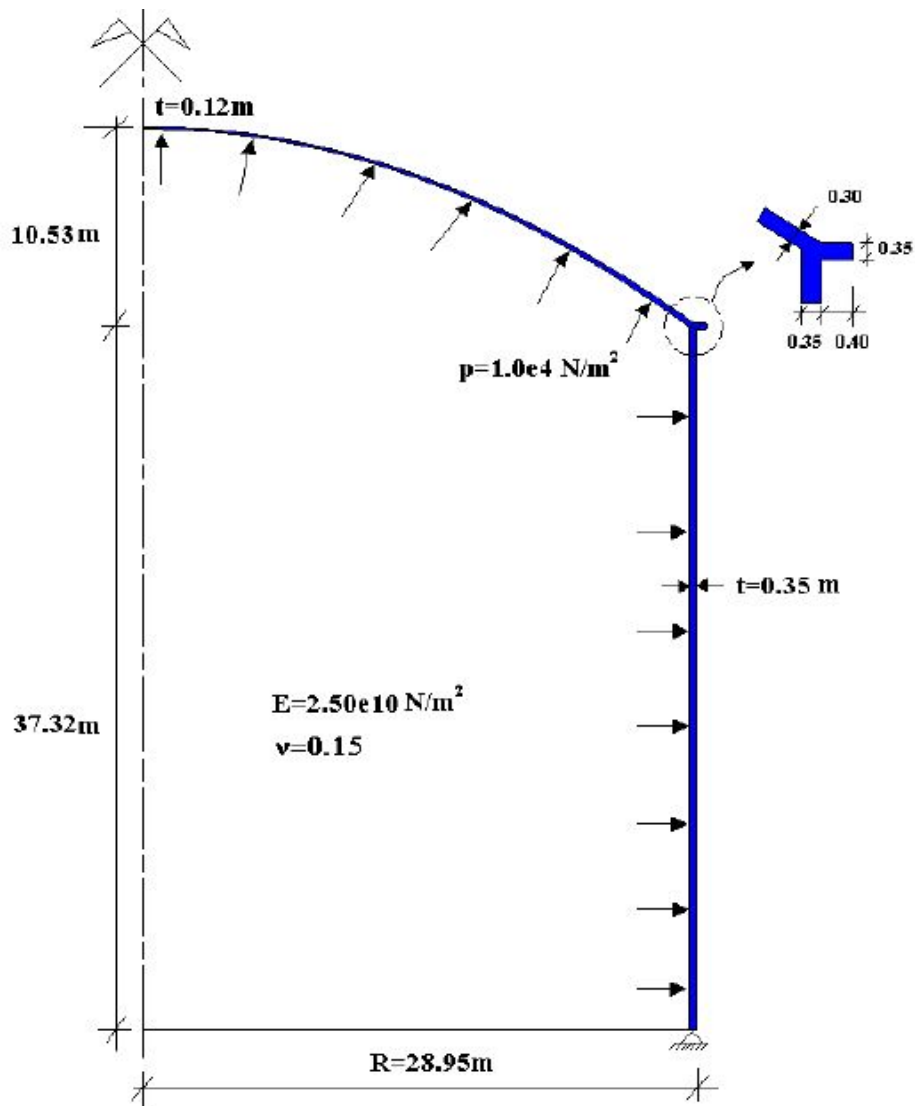

Figure 1.1: Problem geometry

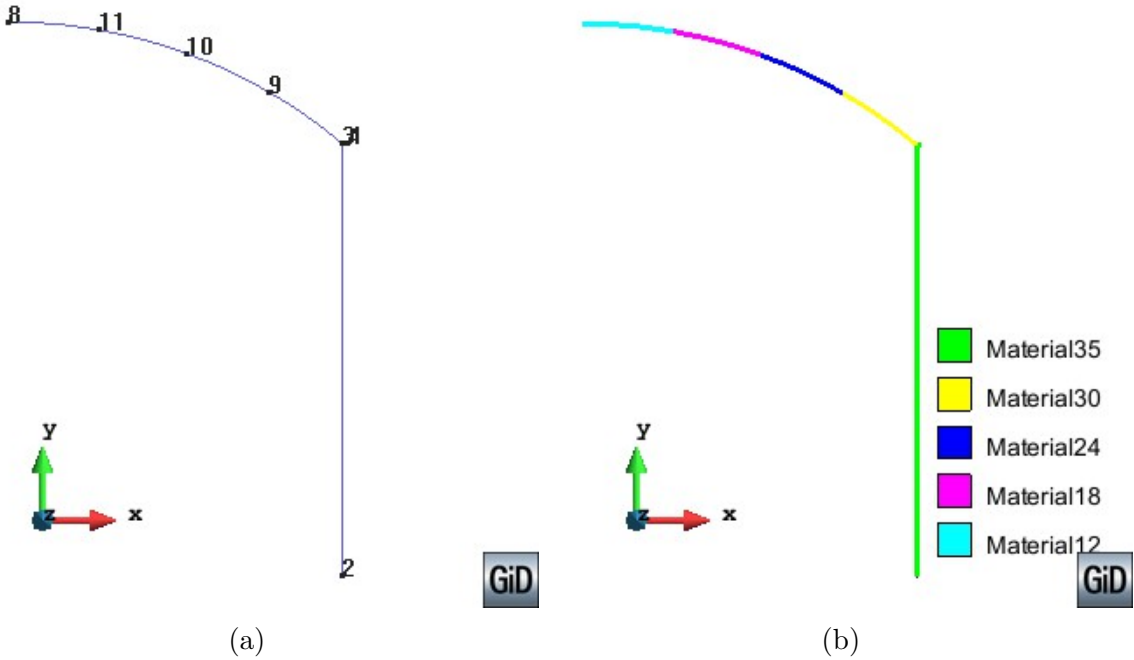## 1.1 Geometry

The following figure shows the model used:

Figure 1.2: Geometry.

In the figure on the right (a) we can see the geometry defined for the model, in the figure on the left (b) it can be seen the four types of materials used in the dome to simulate the change in thickness.

In the next graph (Figure 1.3) it is possible to see the boundary conditions and applied loads. The figure (a) shows the constraints applied in the model and figure (b) shows the direction and position of the applied loads.
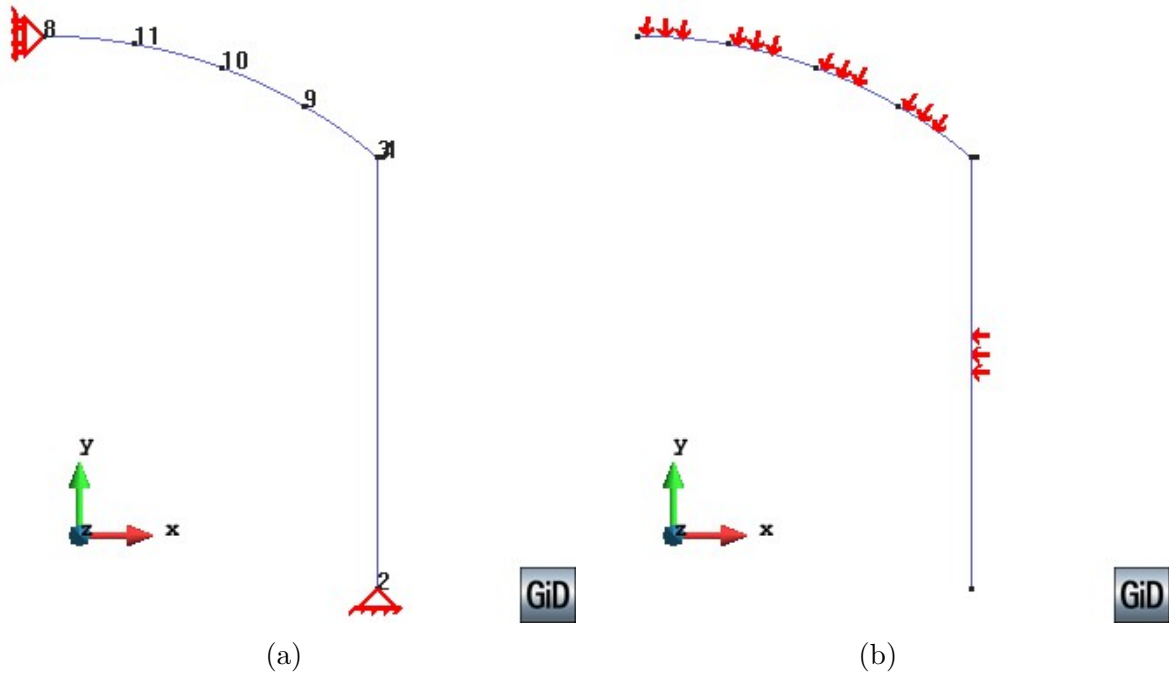
(a)   (b)

Figure 1.3: Boundary conditions and applied loads.

1.2 Post-processing

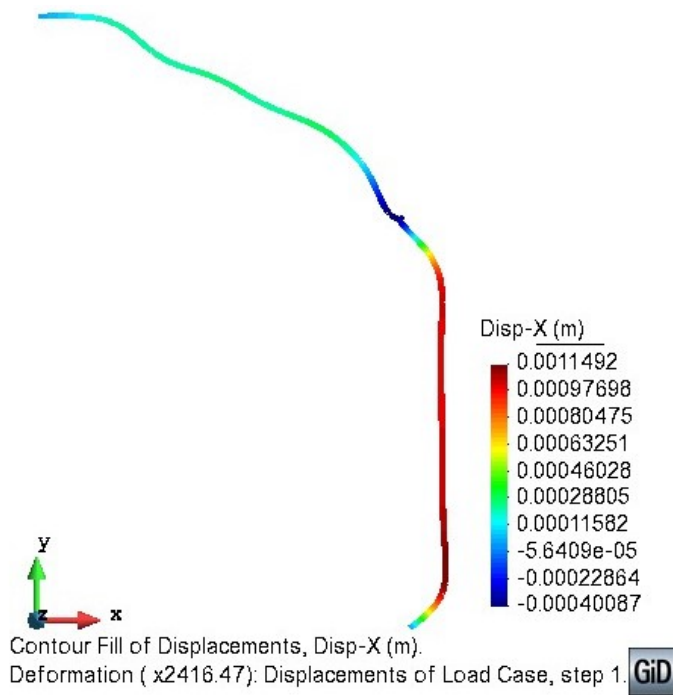The following figures present the post-processed results for this analysis.
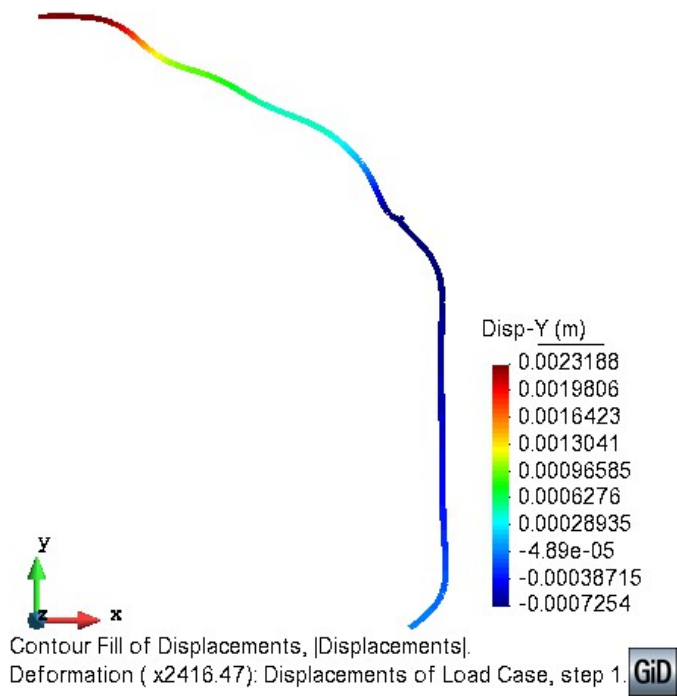

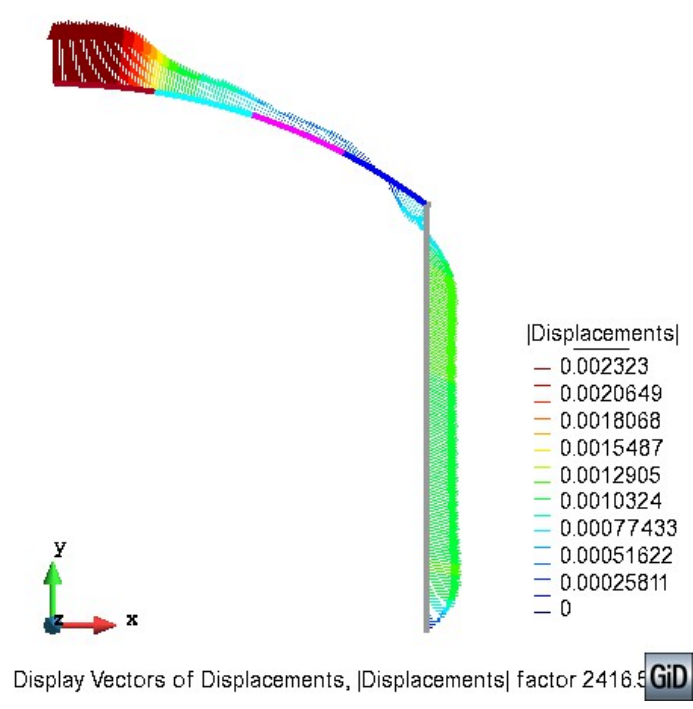Figure 1.4: Displacement in the x-direction

Contour Fill of Displacements, |Displacements|.
Deformation (x2416.47): Displacements of Load Case, step 1.

Figure 1.5: Displacement in the y-direction

Display Vectors of Displacements, |Displacements| factor 2416.5

Figure 1.6: Displacements

Show Min Max of Displacements, |Displacements|.
Deformation (x2416.47): Displacements of Load Case, step 1.
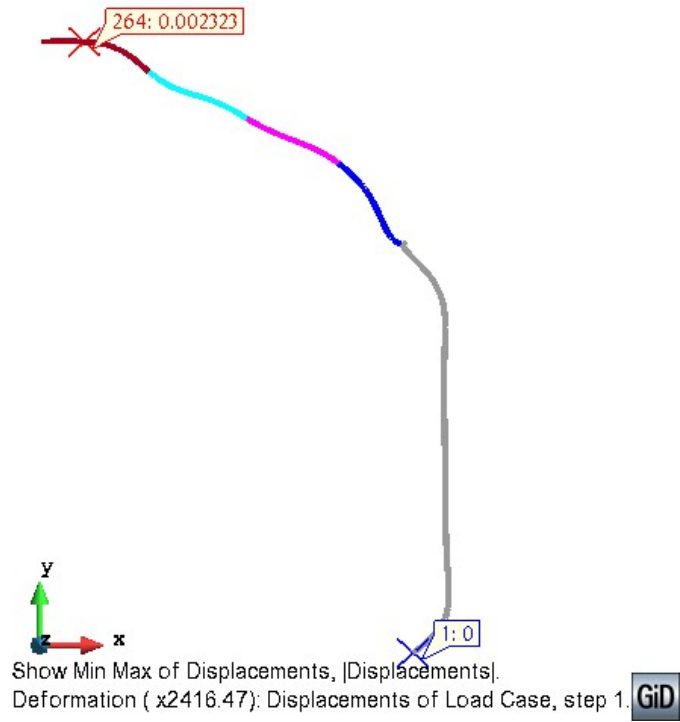
Figure 1.7: Maximum and minimum displacements

Rot-Z (rad)

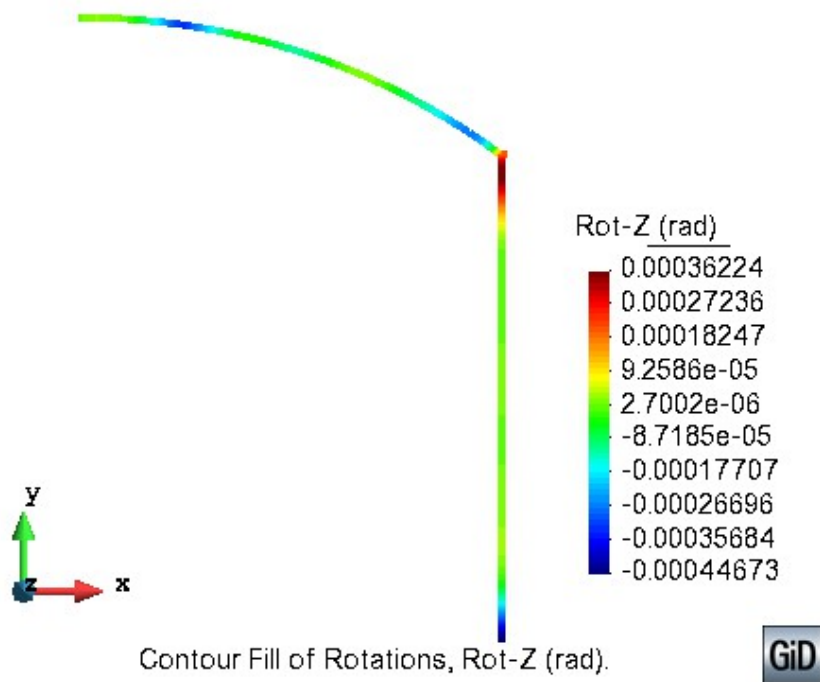| 0.00036224 |
| 0.00027236 |
| 0.00018247 |
| 9.2586e-05 |
| 2.7002e-06 |
| -8.7185e-05 |
| -0.00017707 |
| -0.00026696 |
| -0.00035684 |
| -0.00044673 |

Contour Fill of Rotations, Rot-Z (rad).
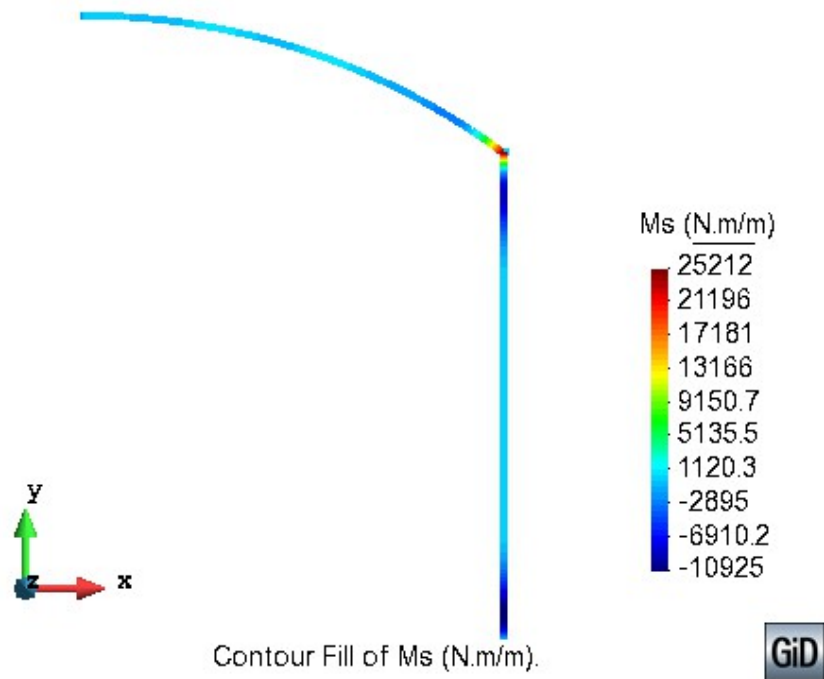
Figure 1.8: Rotations

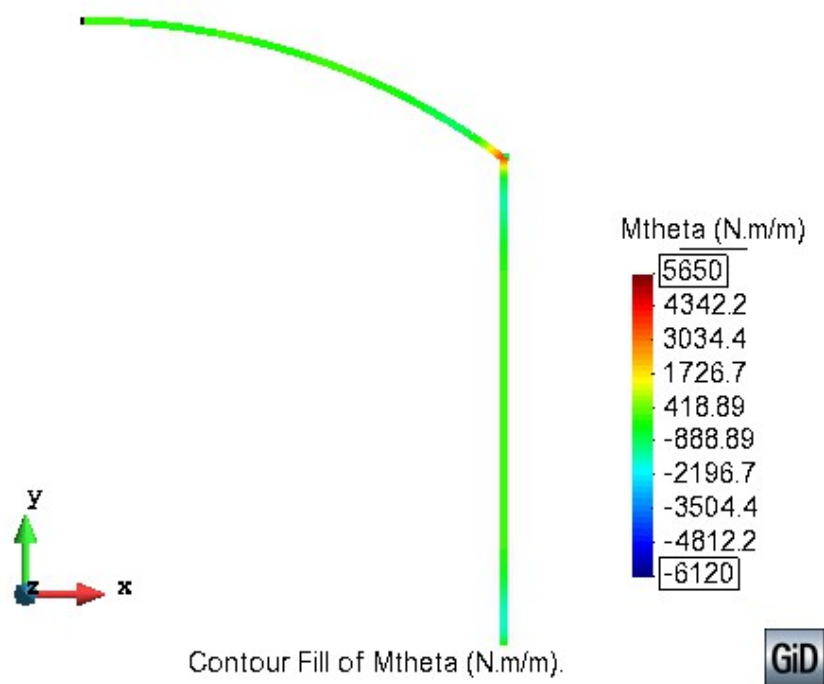Figure 1.9: Momentum in the radial-direction

Figure 1.10: Momentum in the theta-direction

Figure 1.11: Axial force in the radial-direction
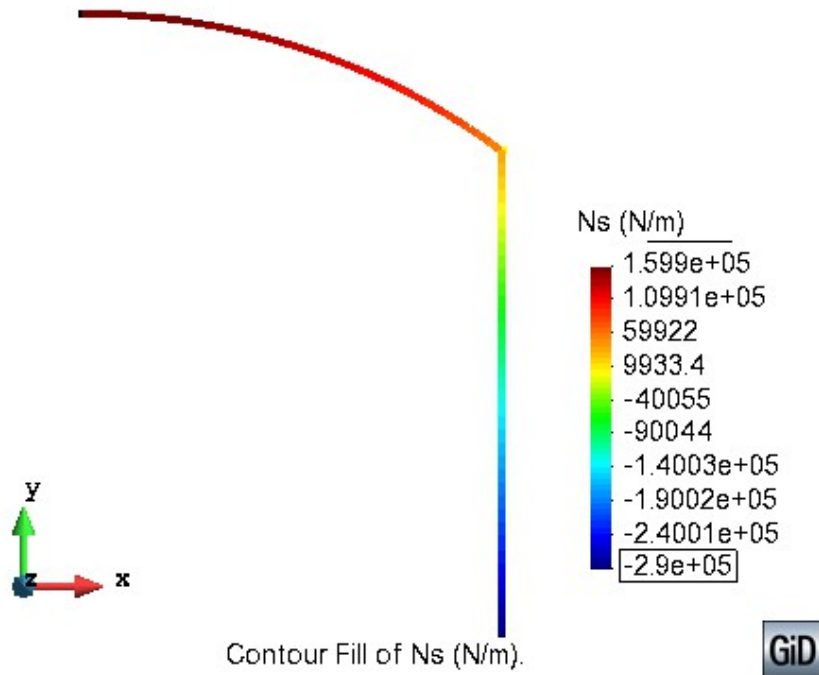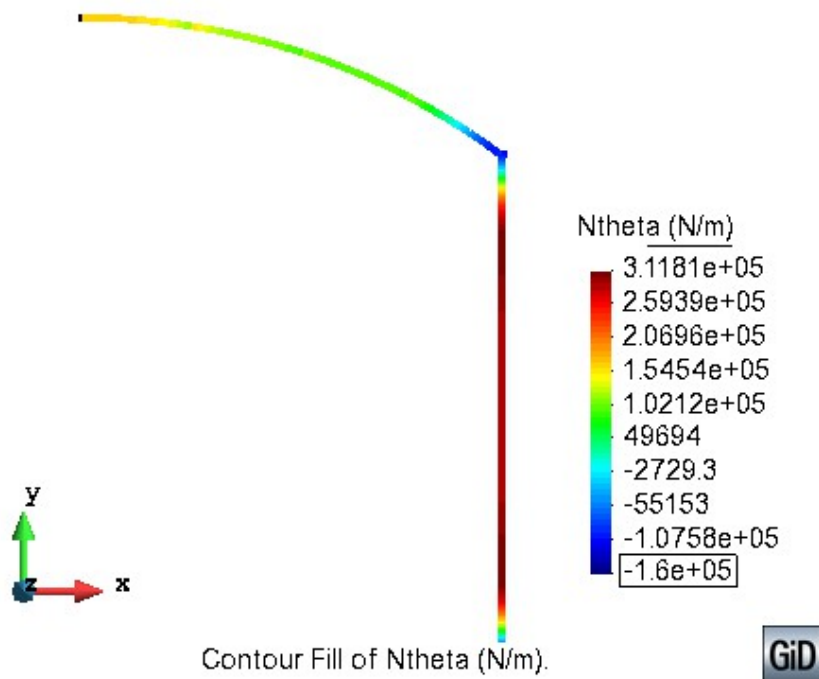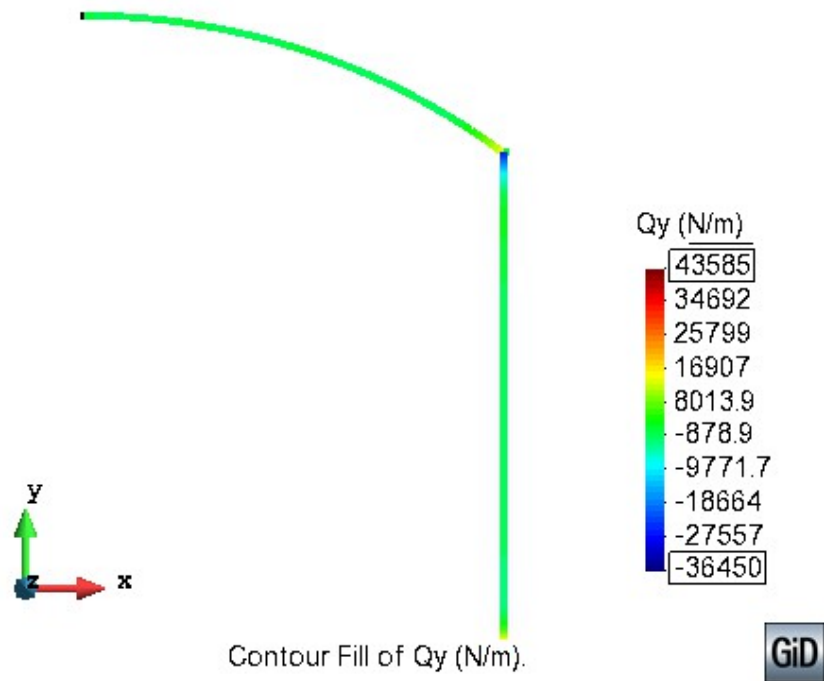

Figure 1.12: Axial force in the theta-direction

Qy (N/m)

43585
34692
25799
16907
8013.9
-878.9
-9771.7
-18664
-27557
-36450

Contour Fill of Qy (N/m).

GiD

Figure 1.13: Tractions in the y-direction

2 3D Analysis

2.1 Geometry

A 3D model of the problem was built using COMPASS RamSeries.

In the Figure 2.1 (a) the geometry of the model is shown and in the Figure 2.1 (b) the constraints used to comply with the boundary conditions.
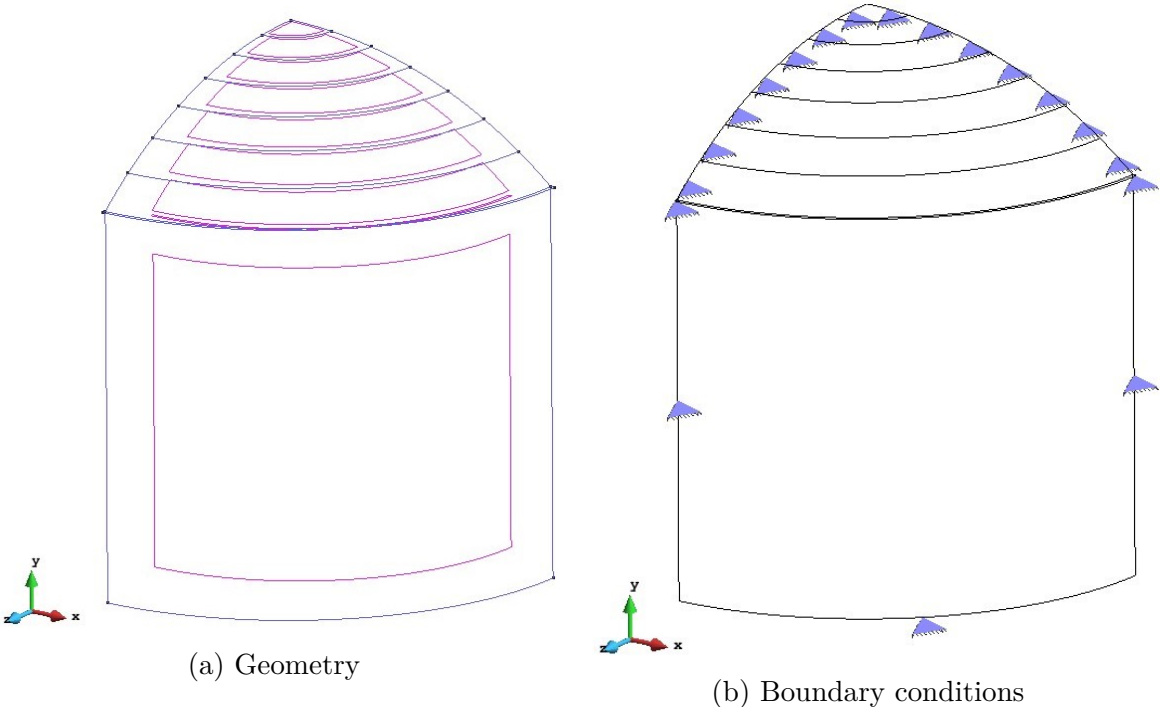

(a) Geometry

(b) Boundary conditions

Figure 2.1

Figure 2.2 (a) shows the discretization used with 3-noded shell elements.

Analogously to what was done in the 2D model, the changes of the thickness in the dome were simulated with the use of different materials. This can be seen in the figure 2.2 (b)
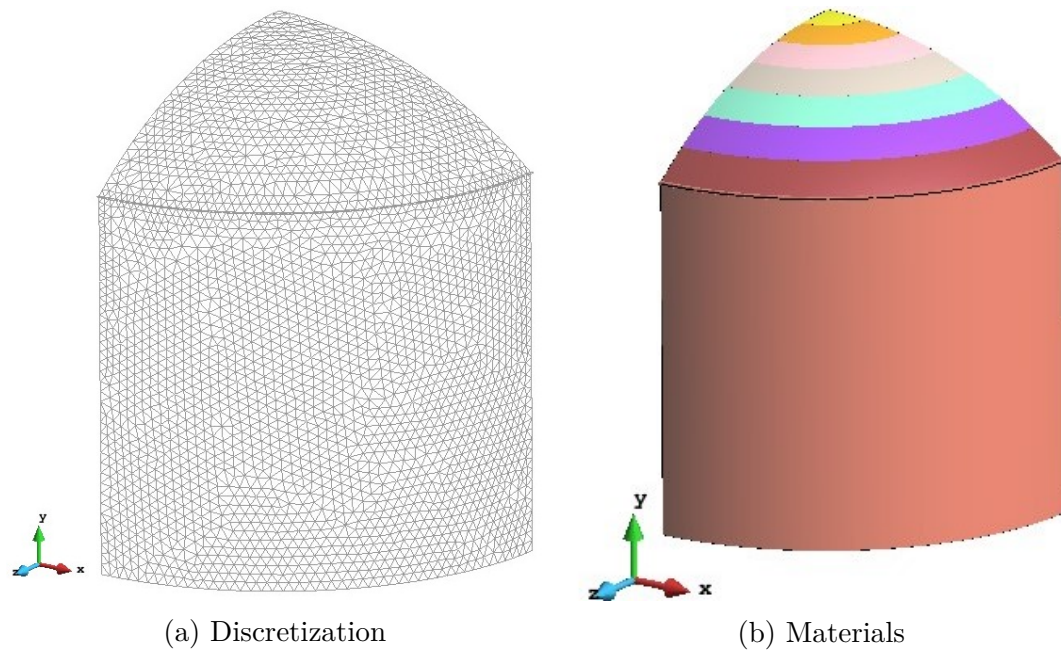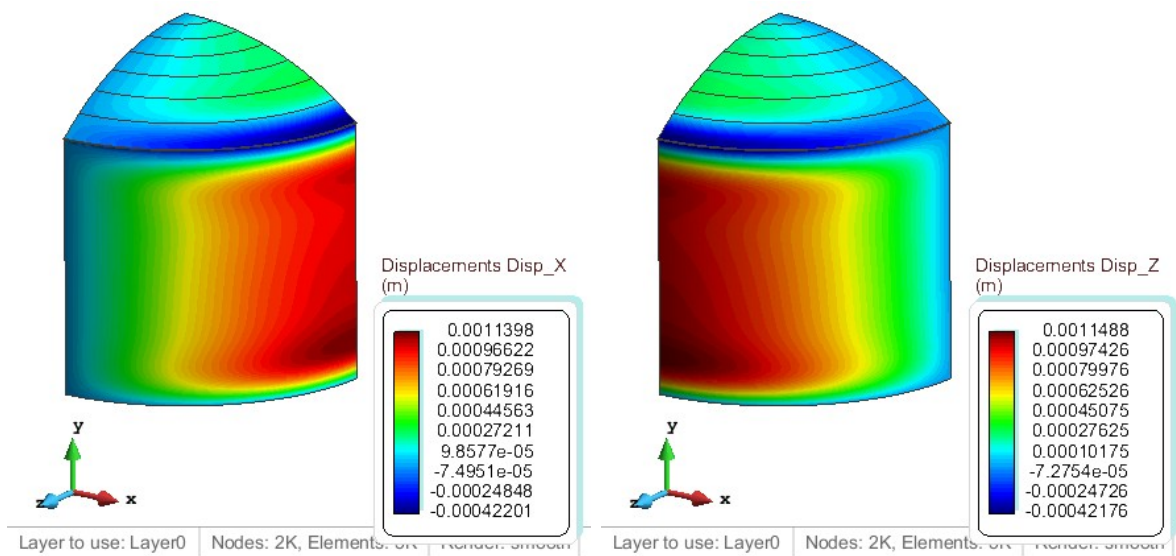
(a) Discretization

(b) Materials

Figure 2.2

2.2 Post-processing

The contours of the displacement distributions are represented in the Figure 2.3 and Figure 2.4.

(a) Displacement in the x-direction
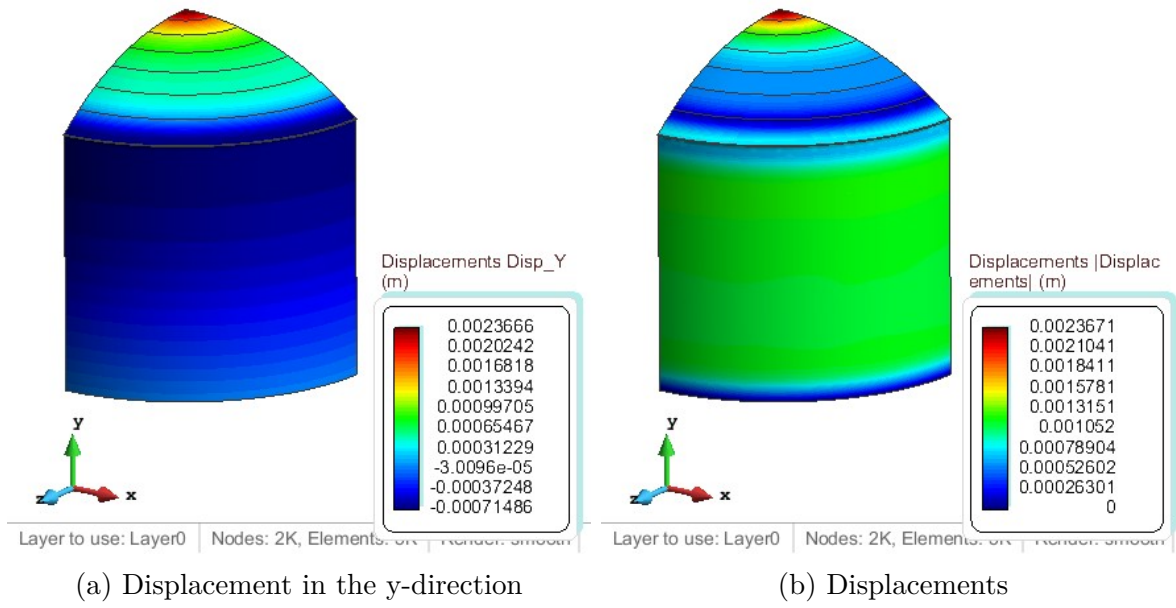
(b) Displacement in the z-direction

Figure 2.3

(a) Displacement in the y-direction

(b) Displacements

Figure 2.4

If we compare with the results of Figure 1.4, Figure 1.5 and, Figure 1.6 it can be seen that the results are equivalent.

(a) Axial force in x-direction

(b) Axial force in y-direction

Figure 2.5

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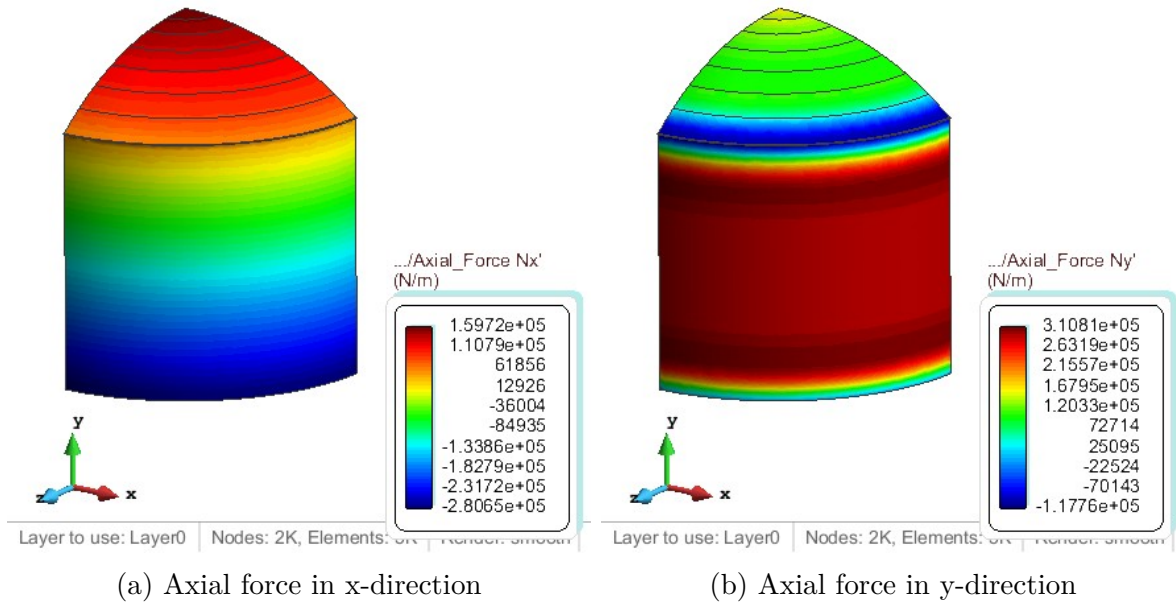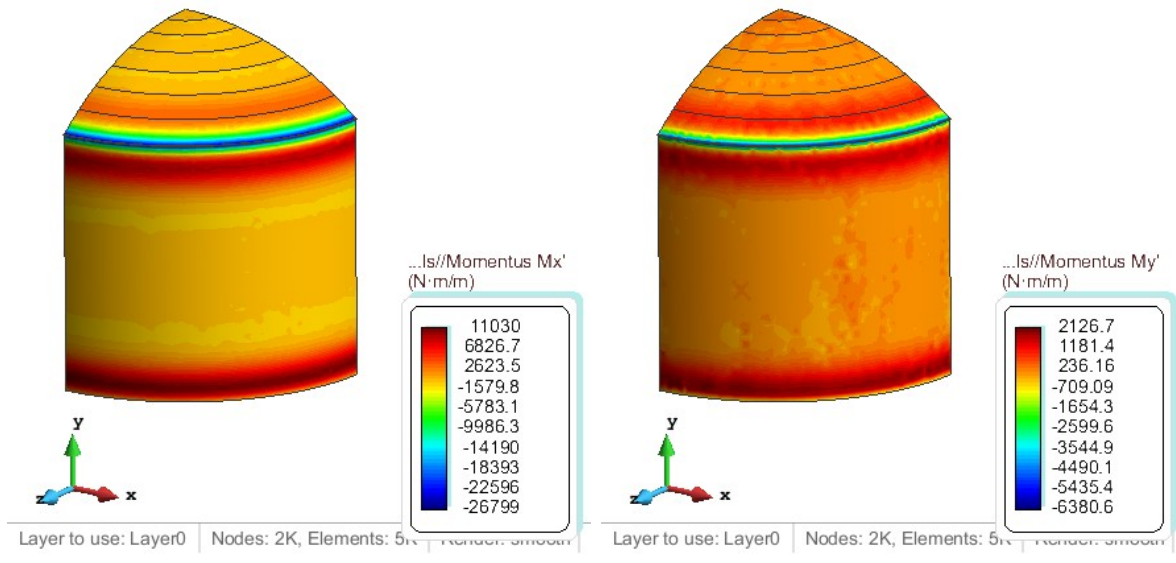
(a) Momentum in the x-direction   (b) Momentum in the y-direction

Figure 2.6