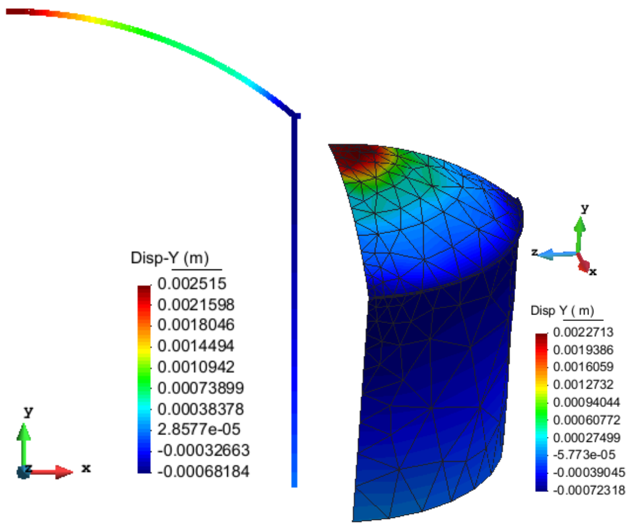
# Practice 4

Xavier Corbella Coll & Walid Ahmad Mirza May 5, 2016

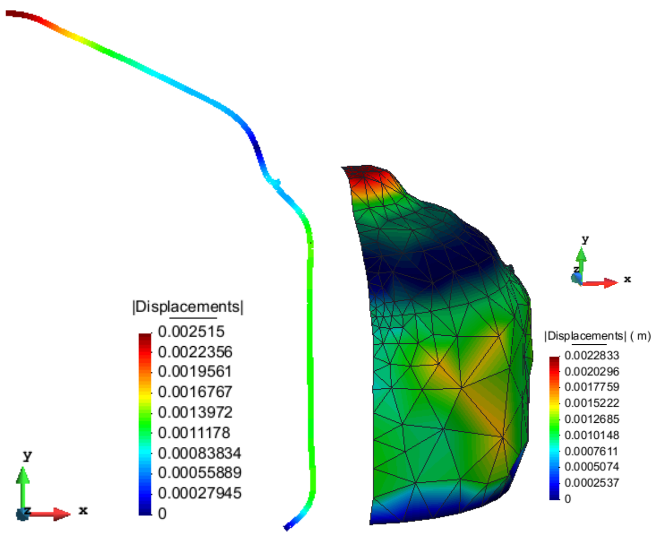
This problem has been solved using two different approaches: a 2D axysimmetric geometry and a 3D model, all them with shell elements. The 3D model was done using the software TDYN, and only 300 nodes could be used. Thus, the results obtained for the 3D model are not converged, and the results obtained for the 2D shell revolution are converged using 300 nodes and are more reliable.

The vertical displacements obtained using both models are depicted in figure 1. As can be seen there, the shape of displacement field is very similar (the hypothesis of axysimmetry of the problem is correct), but the values obtained using revolution shells are larger since a finner and converged mesh is used (see figure 1 for vertical displacements and figure 2 for the deformed view and module of displacement). As is seen in the figures, the upper part of the tank tends to move up due to the internal pressure since it has less thickness than the rest of the tank, but the weight of the joint between upper and lateral parts reduces the deformation of the tank.




**(a)** Axysimmetric model **(b)** 3D model

**Figure 1:** Vertical displacement

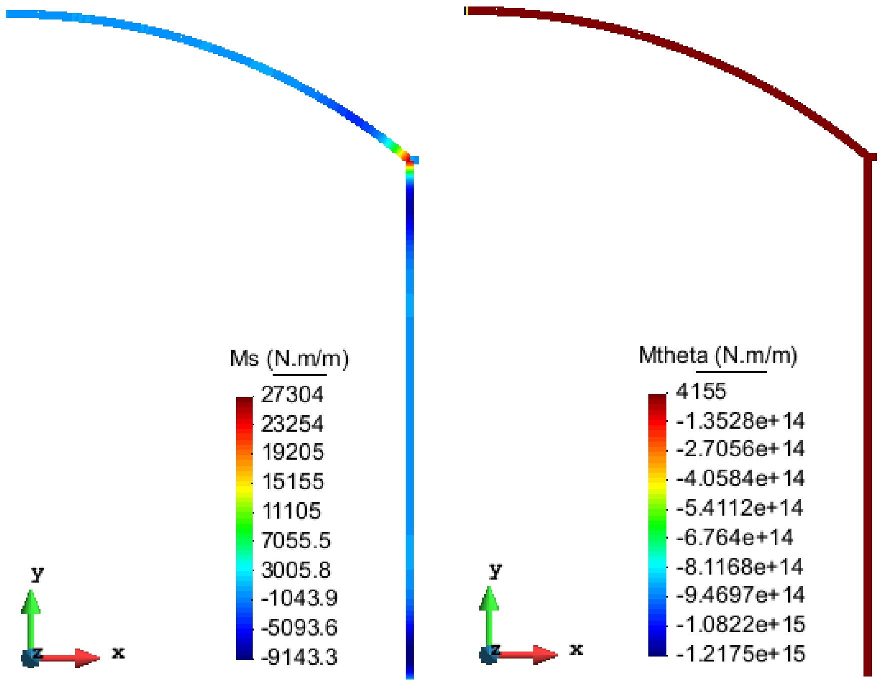



**(a)** Axysimmetric model **(b)** 3D model

**Figure 2:** Deformed configuration

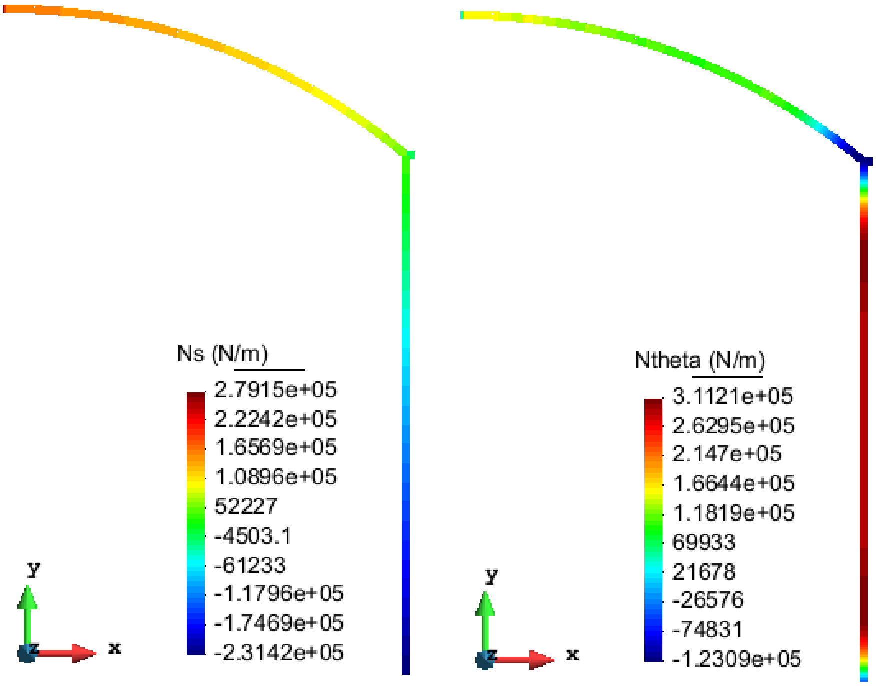
The distribution of stresses in the axysimmetric model can be found below. The results obtained show two critical points: The joint between lateral and upper parts, in which rotations are large (see figure 5b ), and the center of the roof, which has the shortest thickness and larger vertical displacements. The combination of stresses results into compression in the lateral and traction at the upper part of the roof. Since the tank is made of concrete, it is important to control the maximum value of traction at the roof of the tank to avoid failure.

This could be easily done just studying the Von Mises stresses obtained for the 3D model (see figure 6). The results obtained here do not reflect the exact value of maximum stresses obtained since the mesh used is not converged and there are small concentrations of stresses. However, it can be deduced that tractional stresses with a magnitude of MPa are obtained at the central part of the roof. This value of stresses can be close to the tractional yielding stress of some concretes, leading to a possible failure. That could be avoided increasing a little bit the thickness of the roof. For example, if we increase the minimum thickness of the roof to 0.2 m, then the amount of stresses has a magnitude of 0.5 MPa at the roof (see figure 7).



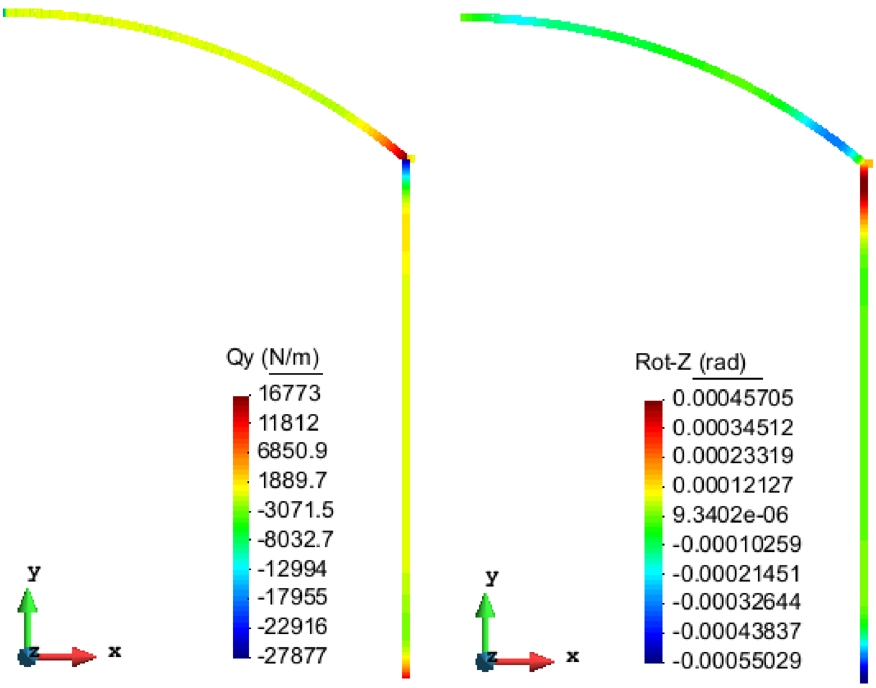

**(a)** Momentum in x **(b)** Momentum in z

**Figure 3:** Moments in axysimmetric model



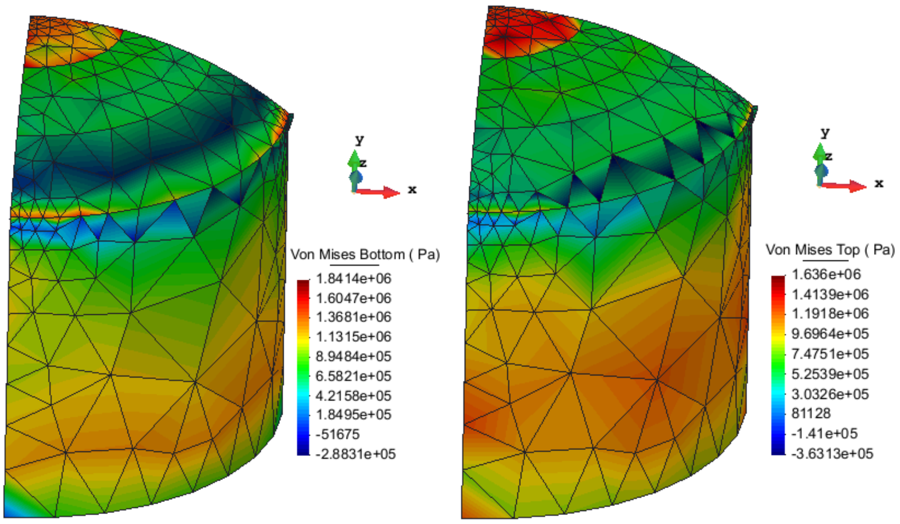

**(a)** Stresses in x　　**(b)** Stresses in z

**Figure 4:** Membrane stresses in axysimmetric model



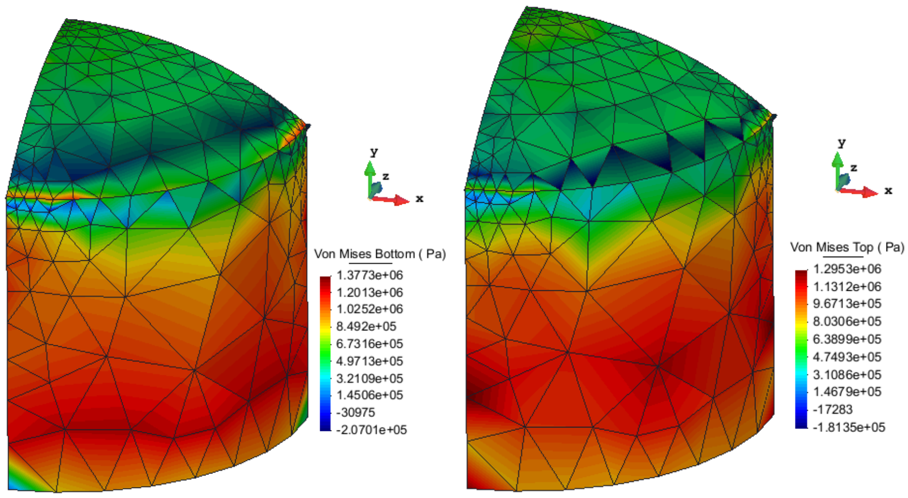

**(a)** Shear force　　**(b)** Rotations

**Figure 5:** Shear force and rotations in axysimmetric model




**(a)** $\sigma_{VM}$ at the bottom **(b)** $\sigma_{VM}$ at the top

**Figure 6:** Von Misses stresses for 3D model




**(a)** $\sigma_{VM}$ at the bottom **(b)** $\sigma_{VM}$ at the top

**Figure 7:** Von Misses stresses for 3D model and increased thickness of the roof