CSMD: Assignment 8

Juan Pedro Roldán

February 2018

1 Geometry and boundary conditions

The structure is parabolic and has two symmetry planes defined by the two diagonals (considering the top view of the structure), crossing each other in the geometrical center. We will see how the results are symmetric with respect to both planes and the center.
The applied boundary conditions were zero displacements and rotation in the four edges of the structure, making them clamped boundaries.
The geometry was meshed with 200 triangular elements.

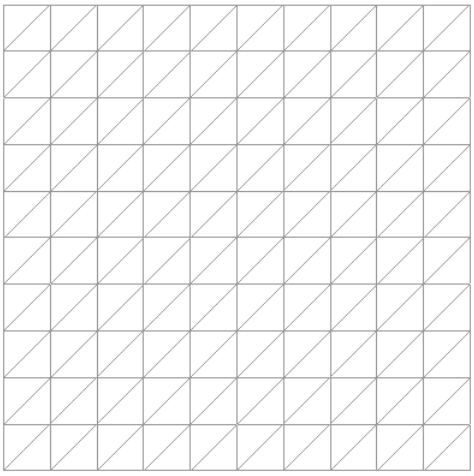

Figure 1: 200 triangular mesh

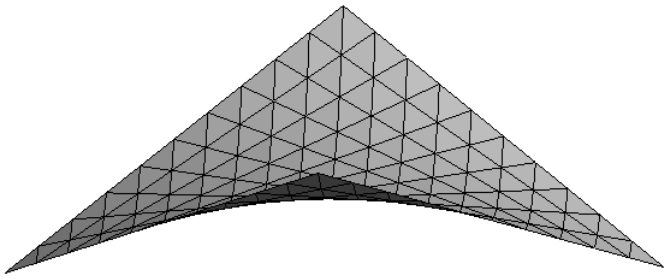

Figure 2: Geometry of the problem with mesh superposed. Notice the twisted shape

2 Results

2.1 Displacements and rotations

We can see that the shell is deforming downwards with maximum deflection in the central point, and the rotations are symmetric, both results are coherent with the geometry.

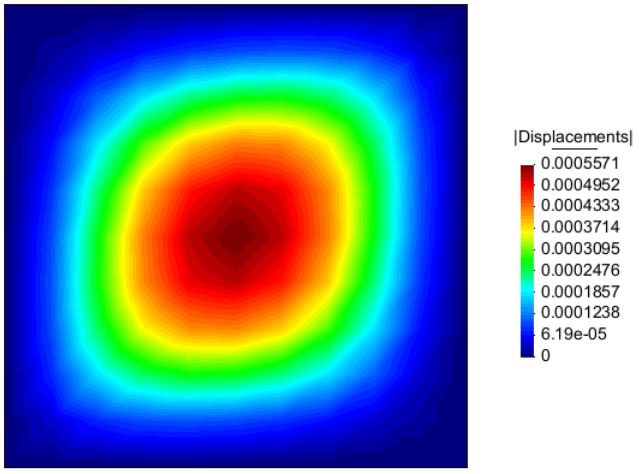

Figure 3: Displacements in absolute values. As expected in a symmetric problem with vertical loading, maximum values are located at the center.

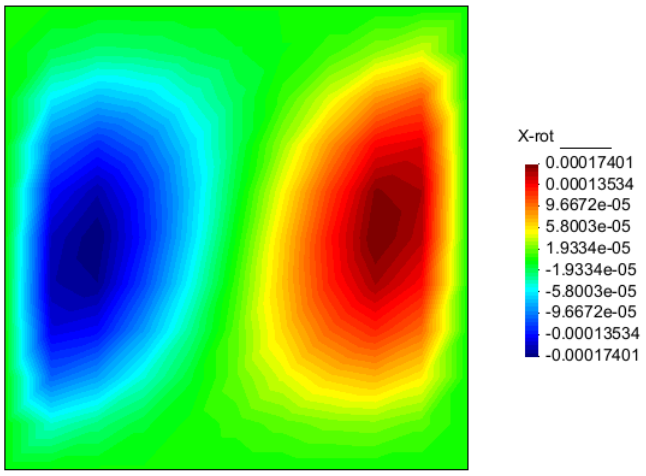

Figure 4: Rotations along X axis. Rotations are zero in the center (symmetry) and close to the boundaries (clamped edgs)

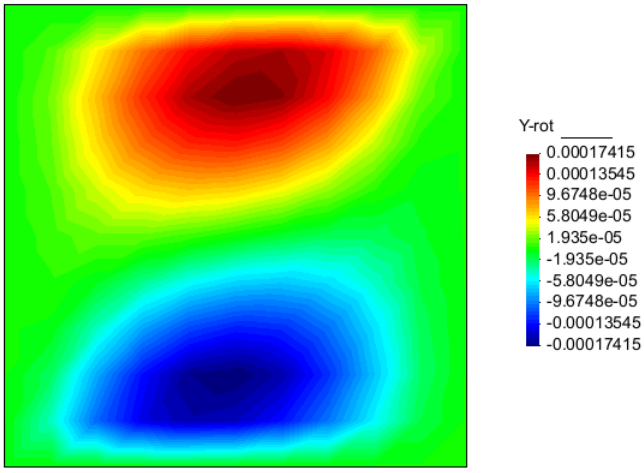

Figure 5: Rotations along Y axis. Rotations are zero in the center (symmetry) and close to the boundaries (clamped edges)

2.2 Forces

The shell can be subjected to three kind of deformations: tractions (membrane behaviour), shear foces and moment. If we compare the three kind of forces (figures 6 to 10) we'll see that the major forces are those related to membrane state (tensions along X, Y and tangential). We can see that while T_x and T_y dominates over the boundaries, T_{xy} is present closer to the center, where deformations are higher.

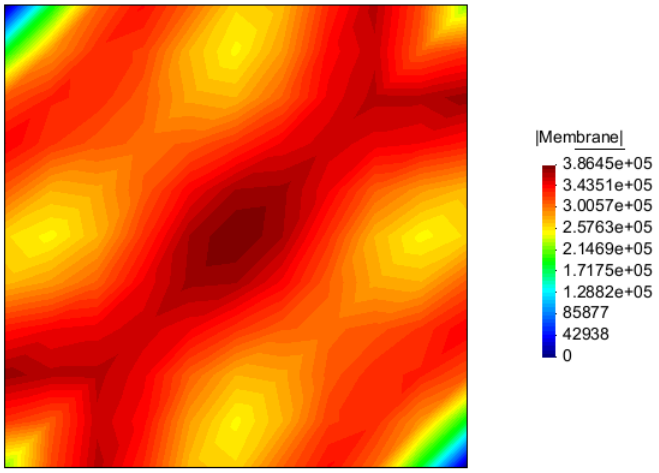

Figure 6: Absolute values of the forces related to membrane state (tensions). T_x and T_y are important in the edges, T_{xy} is present in the center

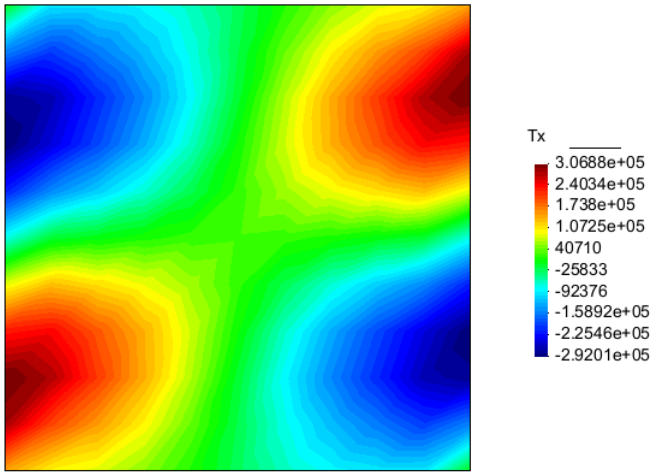

Figure 7: T_x tensions. See how it contributes to the total membrane tension in the vicinities of the edges

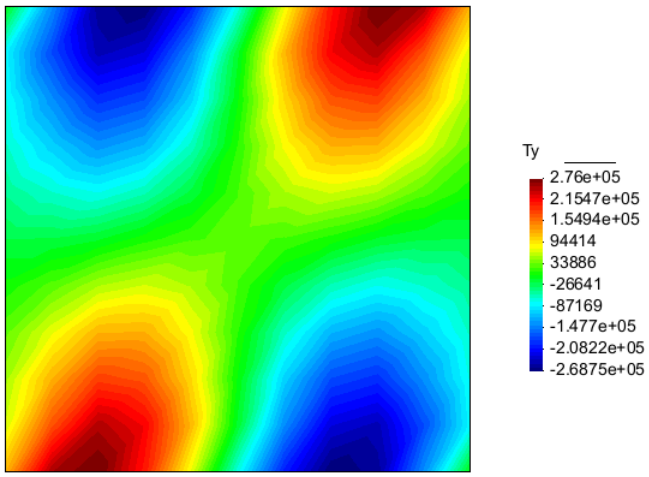

Figure 8: T_y tensions. See how it contributes to the total membrane tension in the vicinities of the edges

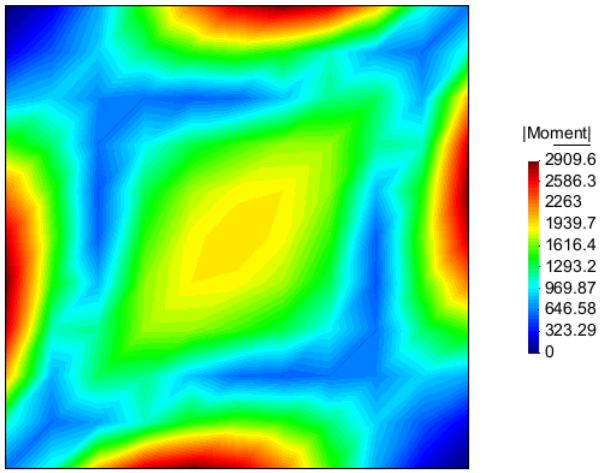

Figure 9: Moment (absolute values)

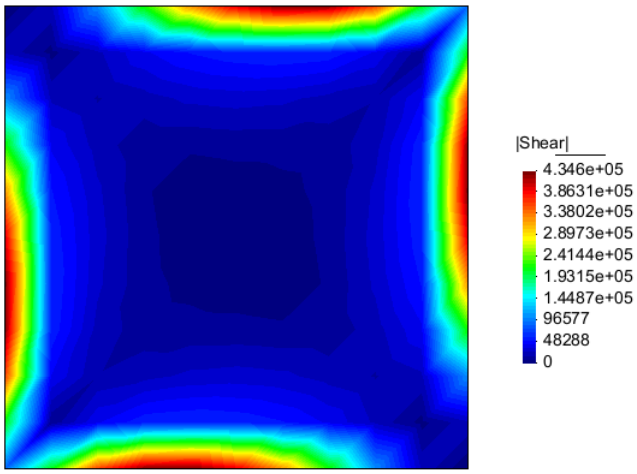

Figure 10: Shear forces (absolute values)

3 Conclusions

The problem is membrane-dominated (membrane forces one order of magnitude greater than the other forces), which makes sense if we take into account that we are modelling a parabolic shell under self-weight: vertical forces are converted

into tractions, as the structure gets stretched downwards. Shear forces are important in the boundaries, but lose relevance as we get far from them.