Computational Structural Mechanics and Dynamics, Assignment 8

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Assignment 8
On "Shell Theory":

a) Analyze the following concrete hyperbolic Shell under self weight. Explain the behavior of all the Stresses presented. t=0.1

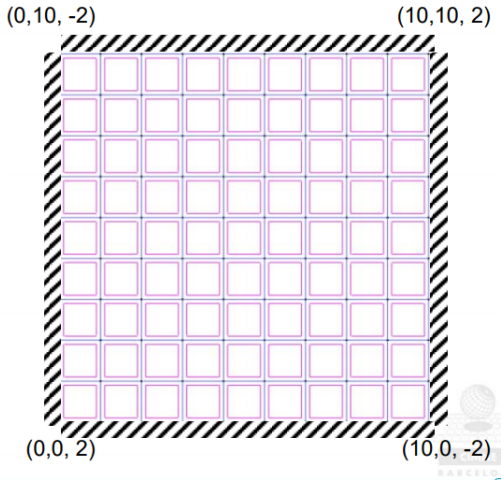
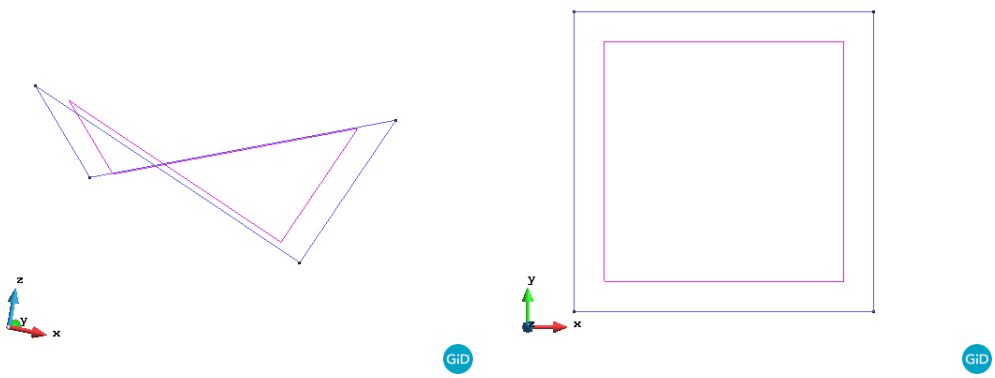


Figure 1: Problem Description

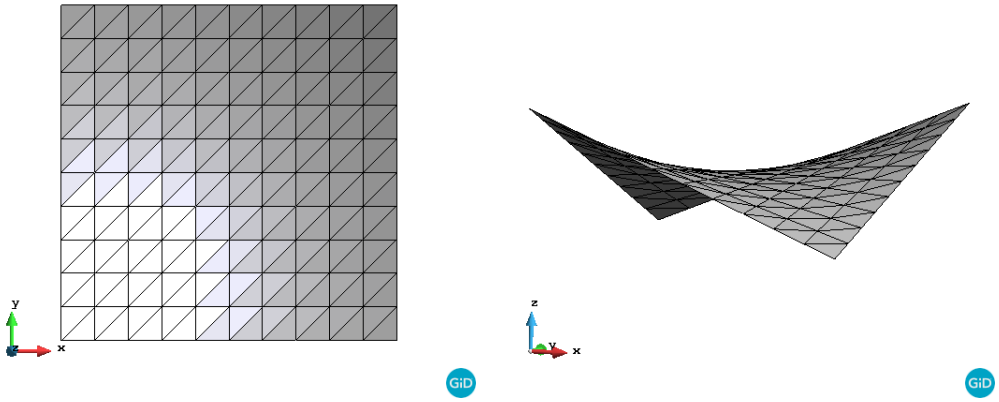
The shell is created in GiD. Note that it is not a plane shell, but a hyperbolic one. The geometry in GiD is shown in figure 2.



(a) (b)

Figure 2: Geometry in GiD

Clamped boundary conditions are imposed on all edges. The geometry is meshes using 3-noded triangular elements, with a 10×10 discretization. The mesh is shown in figure 3.



(a) (b)

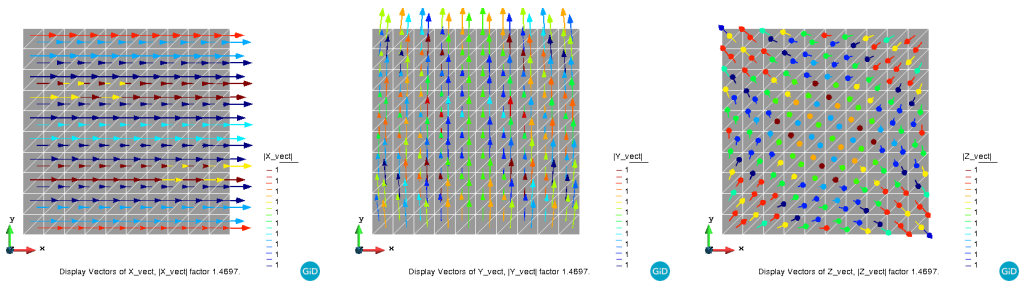
Figure 3: Geometry in GiD

Self weight is considered and the material properties of Concrete are prescribed.

Using the MATLAB code `Lamina_T_RM.m`, one can run the problem. The results obtained are analyzed in the following section.

0.1 Analysis of results

For shell problems, it is important to recall that all stresses are obtained based on the local coordinate system. For this reason, it is worth starting by taking a look at the local vectors X, Y, and Z. See figure 4.



(a) X (b) Y (c) Z

Figure 4: Normalized Vectors X, Y and Z

Note that because of the shape of the shell, the vectors look a bit twisted. Even vector X, which looks straight and aligned, can be proved to have different components in the global Z direction.See figure 5.

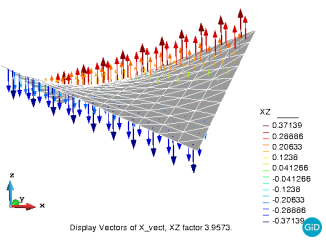
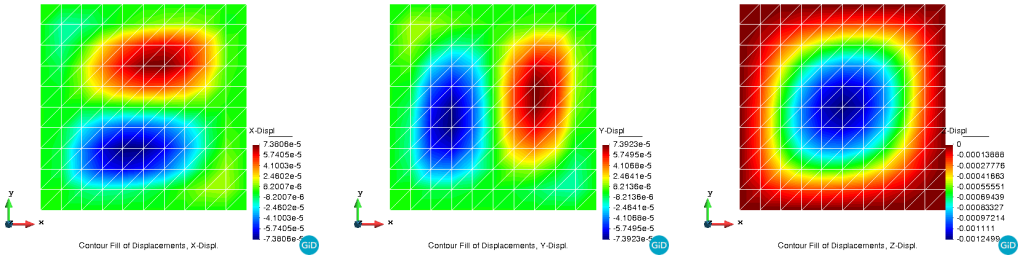


Figure 5: Z component of local vector X

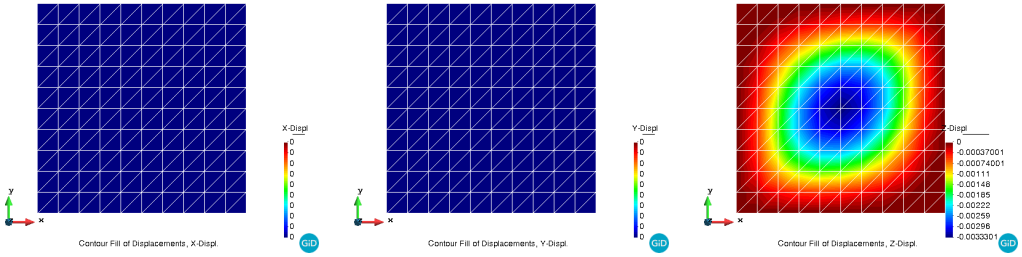
For the analysis of the stress state, it is deemed valuable to compare the parabolic-shaped shell against a plane one. For which the local vectors are perfectly aligned, and also it can be expected that no load will act along to the plane.

Displacement



(a) Displacement in X (b) Displacement in Y (c) Displacement in Z

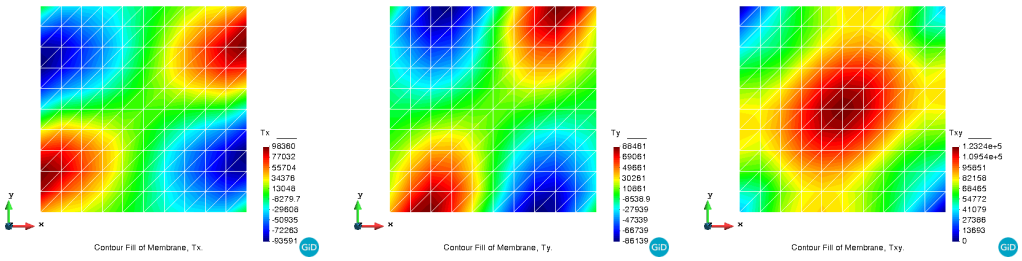
Figure 6: Parabolic Shaped Shell



(a) Displacement in X (b) Displacement in Y (c) Displacement in Z

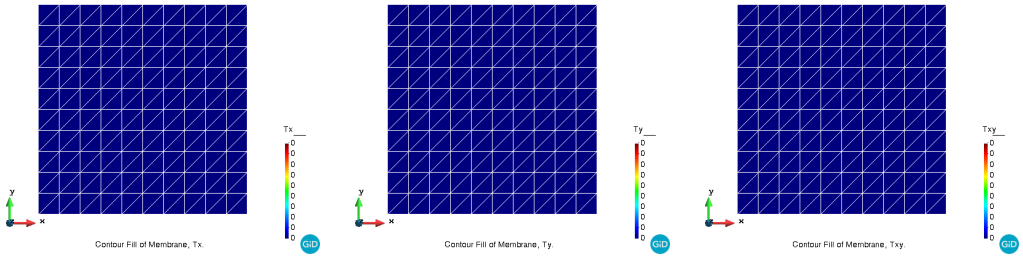
Figure 7: Plane Shell

Membrane



(a) Tx (b) Ty (c) Txy

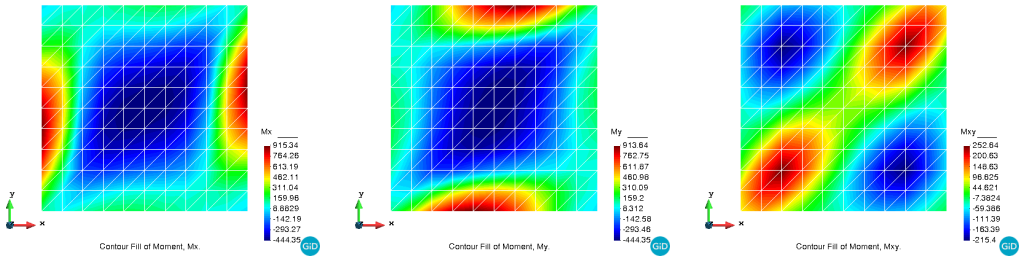
Figure 8: Parabolic Shaped Shell



(a) Tx (b) Ty (c) Txy

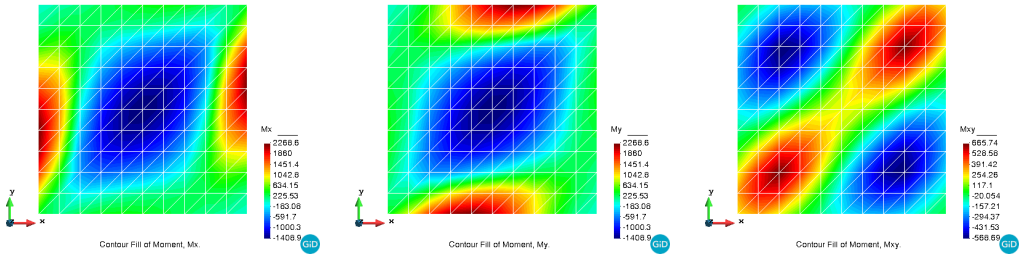
Figure 9: Plane Shell

Moment



(a) Mx (b) My (c) Mxy

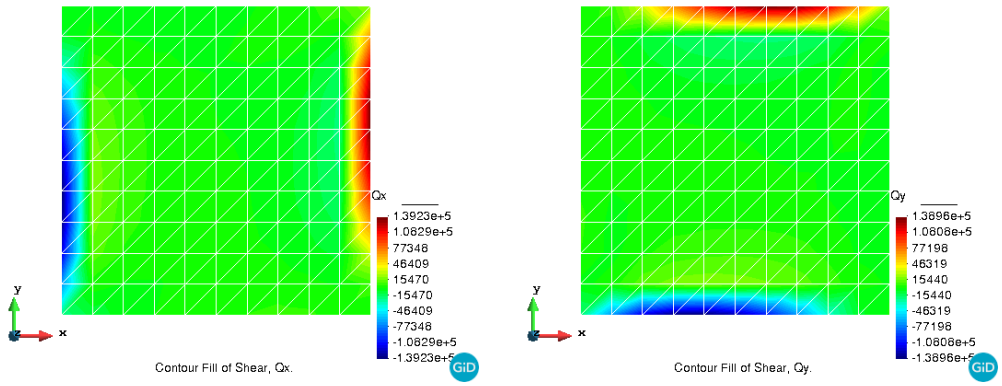
Figure 10: Parabolic Shaped Shell



(a) Mx (b) My (c) Mxy

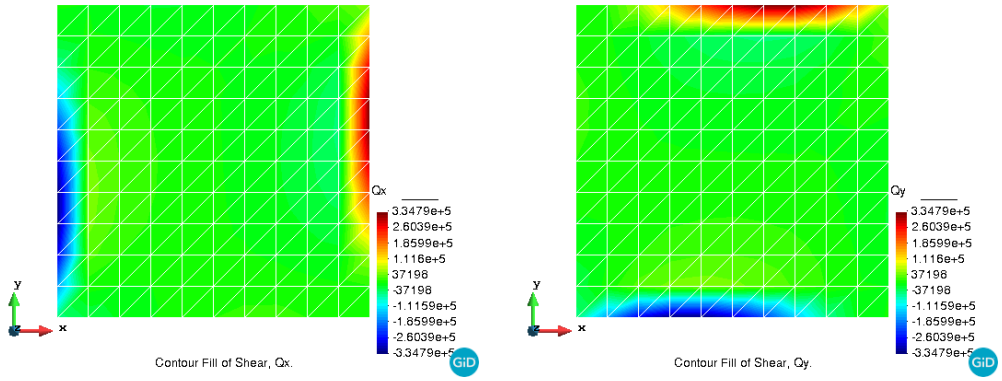
Figure 11: Plane Shell

Shear



(a) Qx (b) Qy

Figure 12: Parabolic Shaped Shell



(a) Qx (b) Qy

Figure 13: Plane Shell

Conclusions: Figures 6, and 7 show that the displacement occur only in the z direction for the plane shell, while they occur in all three directions for the parabolic-shaped one. It is also important to comment that displacements are expressed in the global coordinate system, while stresses are in local coordinates.

Taking a look at the figures for the membrane stress T (Figures 8 and 9), it is clear that this stress is inactive in a planar shell, while it exists in the parabolic-shaped one.

Taking a look at the moments(Figures 10 and 11), it can be said that the pattern is similar between the two configurations, not so much the dimensions. The same observation can be done in the case of Shear (Q).