Computational Structural Mechanics & Dynamics

Shell Assignment

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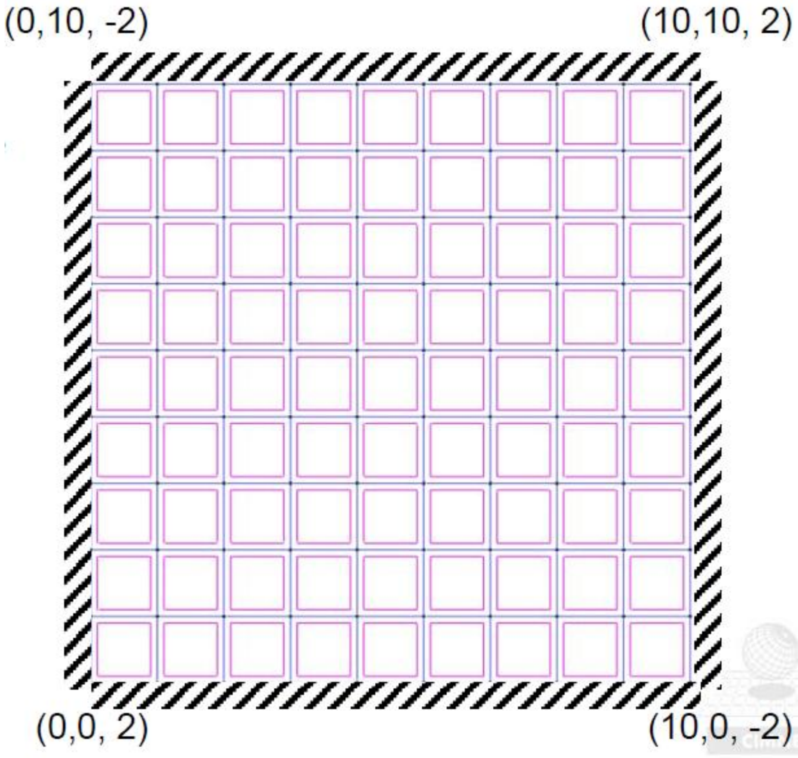
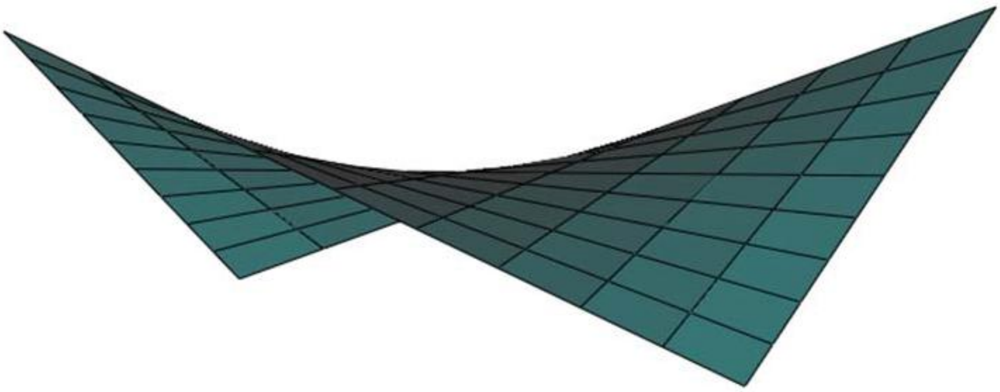
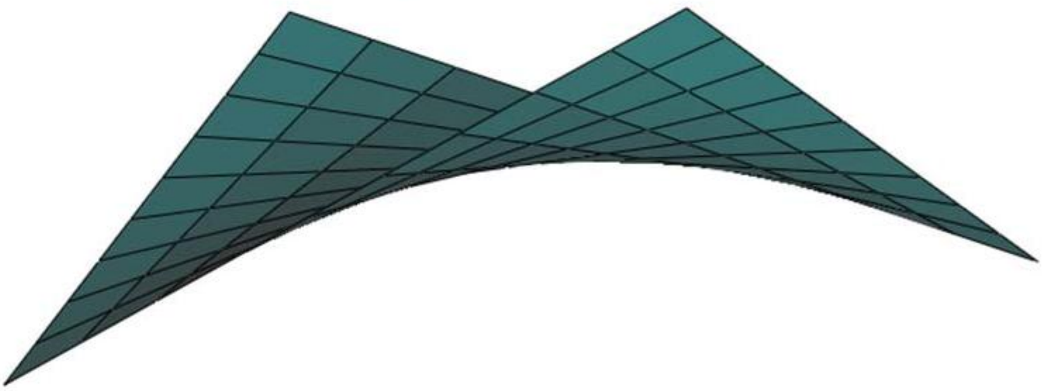
- **Analyze the following concrete hyperbolic Shell under self-weight. Explain the behavior of all the Stresses presented. [t=0.1]**







The procedure of modeling and analysis in this problem is done in the following steps:

1. Modeling the Geometry in GID using MAT_FEM GID INTERFACE subroutines (downloaded from cimne.com/Mat-Fem ---> MAT-fem_Shells.gid)

    - First the 4 corners plus the side lines are modeled and then two front node pairs was moved up and down for + and – 2 units. Then the lines are divided to needed parts (10 here) and the surface was modeled and meshed using structured mesh. Before this the material properties and the fixed boundary conditions was assigned to the domain.

    - One should note that the MATLAB program does not comply with quadrilateral elements and works only with triangular mesh.

2. Exporting the Matlab input file from GID.

3. Importing the data file into MATLAB.

4. Editing some error and inconsistencies in the input file.

    - The data file which comes out from MAT_FEM subroutine has some errors which should be fixed before it can be used in the main MATLAB code. Namely some problems in element connectivity and in defining "fixdesp" part.

5. Running the core code in "Lamina_RM" folder, namely Lamina_T_RM.m

6. Saving related ".msh" file from MATLAB outputs.

7. Opening ".msh" file in GID postprocessor part and studying the results.

    - Doing this last part one may observe all deflection and stress results in GID post process part.

➢ Following part would be devoted to observe the modeled shape and check some results obtained from the program.

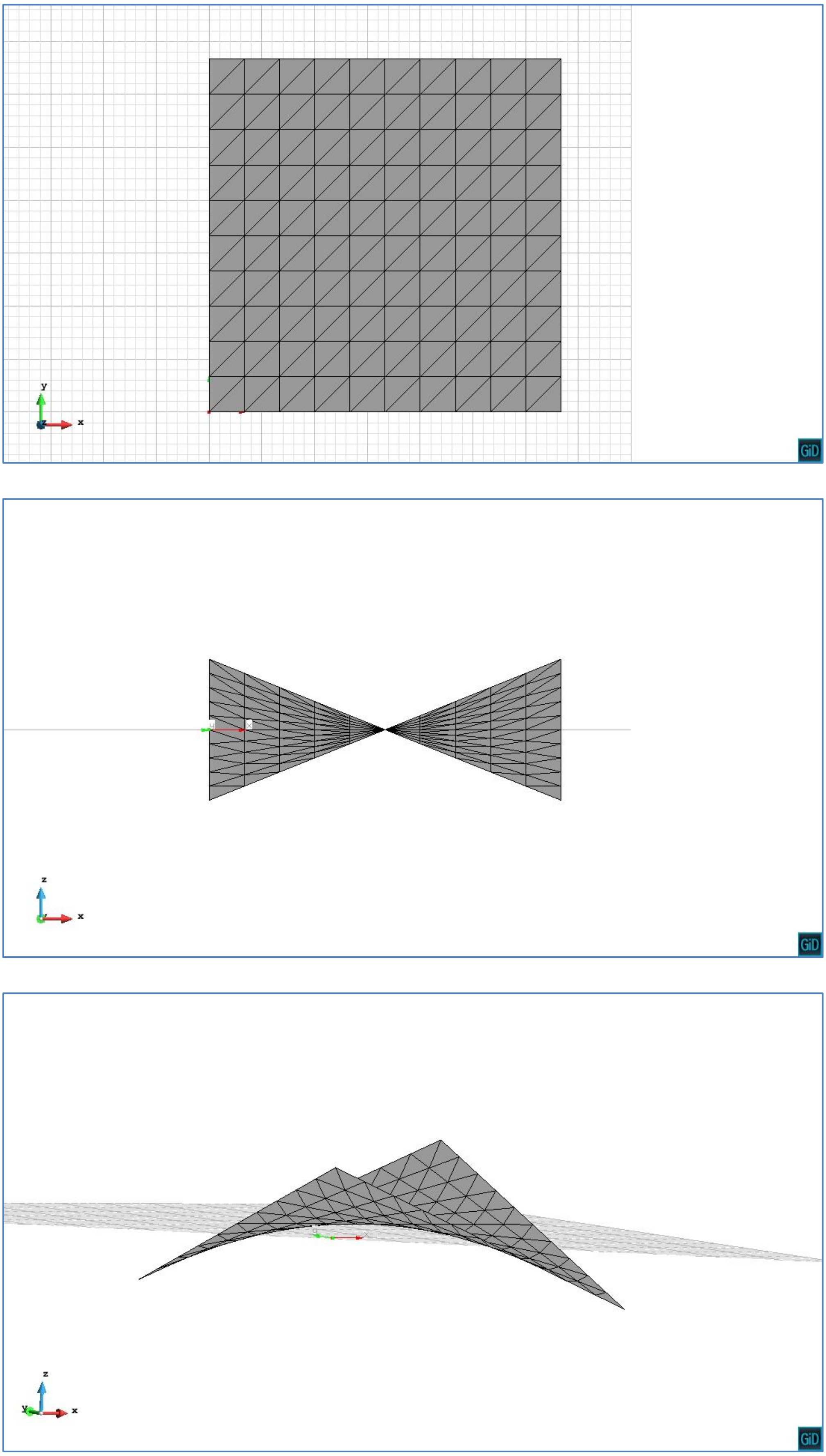


Figure1. Geometry and related mesh.

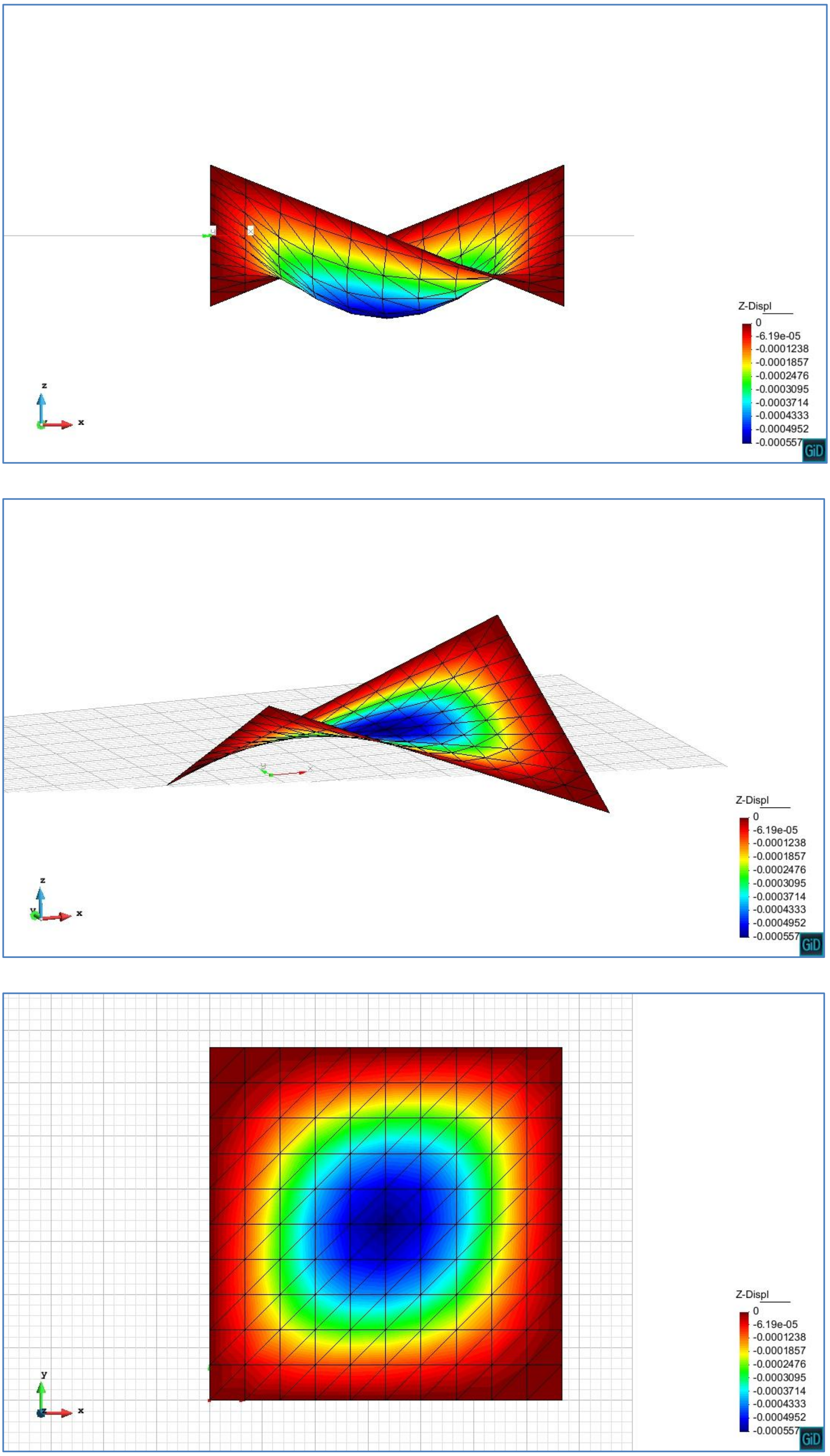


Figure2. Z-Displacement.[3d deformed / 3d not deformed / 2D x-y plane]

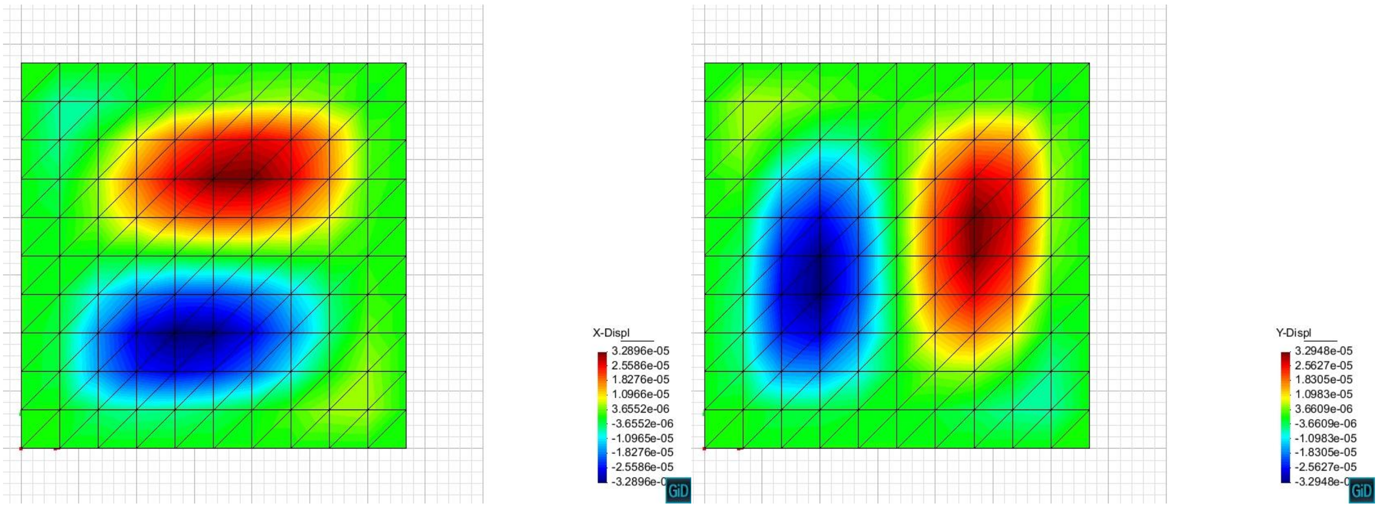


Figure3. (X) and (Y) direction displacement. The axisymmetric response is rational.

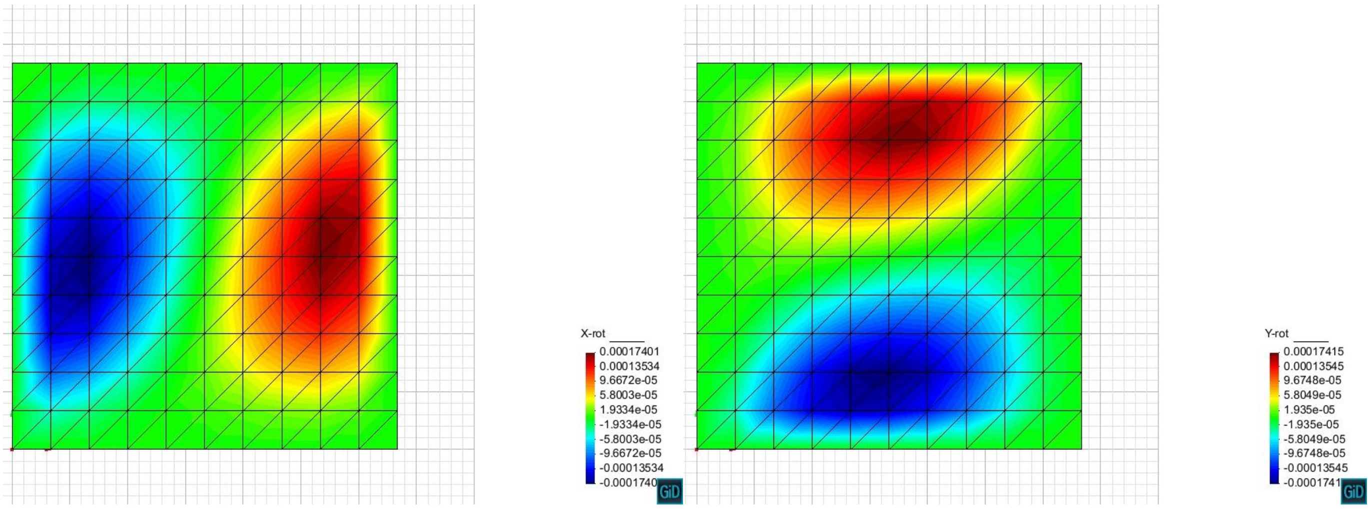
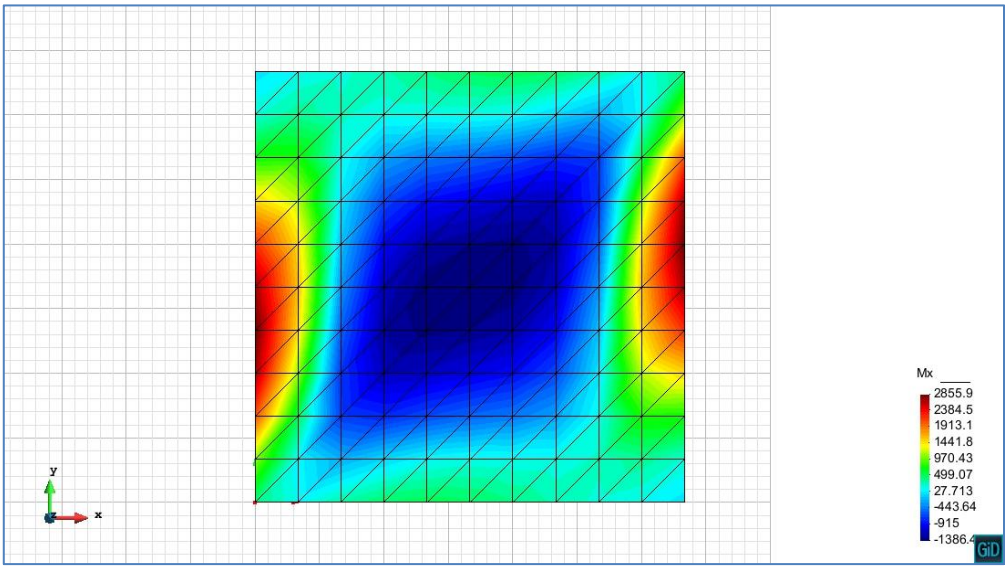
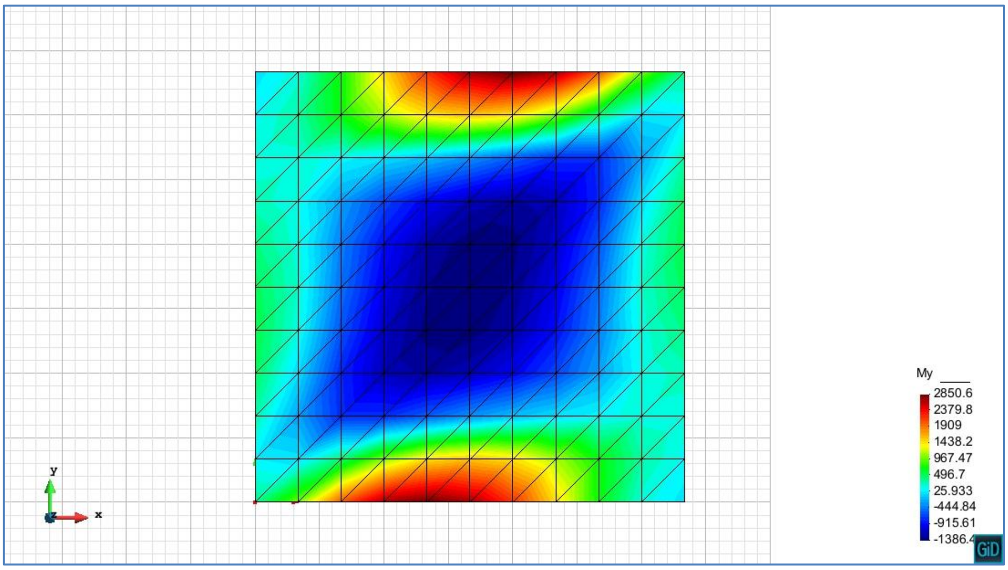


Figure4. (X) and (Y) direction rotations. The axisymmetric response is rational.

- As it is obvious in figure 3 and 4, the absolute values for (X) and (Y) direction displacement and rotations are the same. It is indeed one of the anticipations since the geometry has an anti-symmetric nature and the results should have only sign differences not absolute value differences.





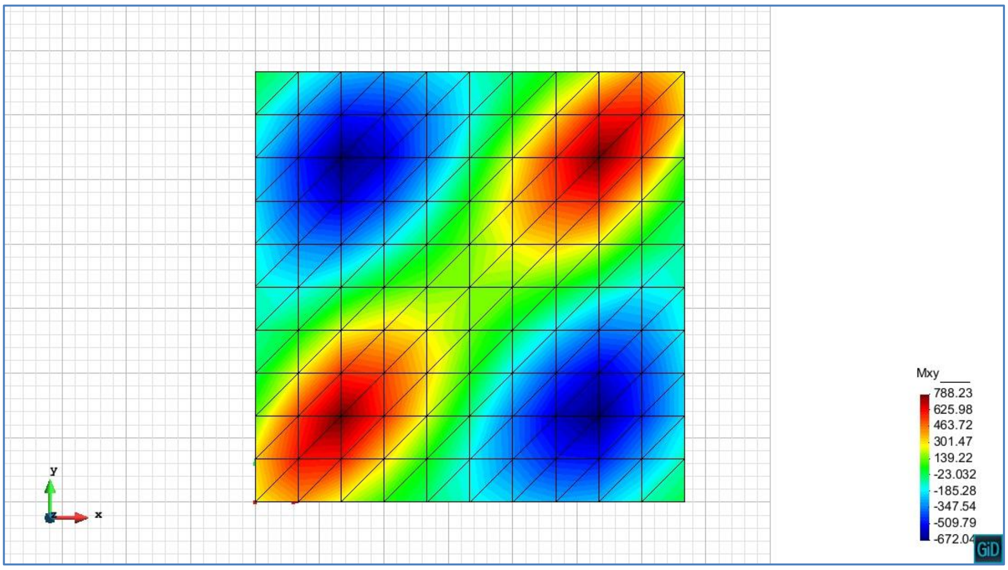


Figure5. Bending stresses

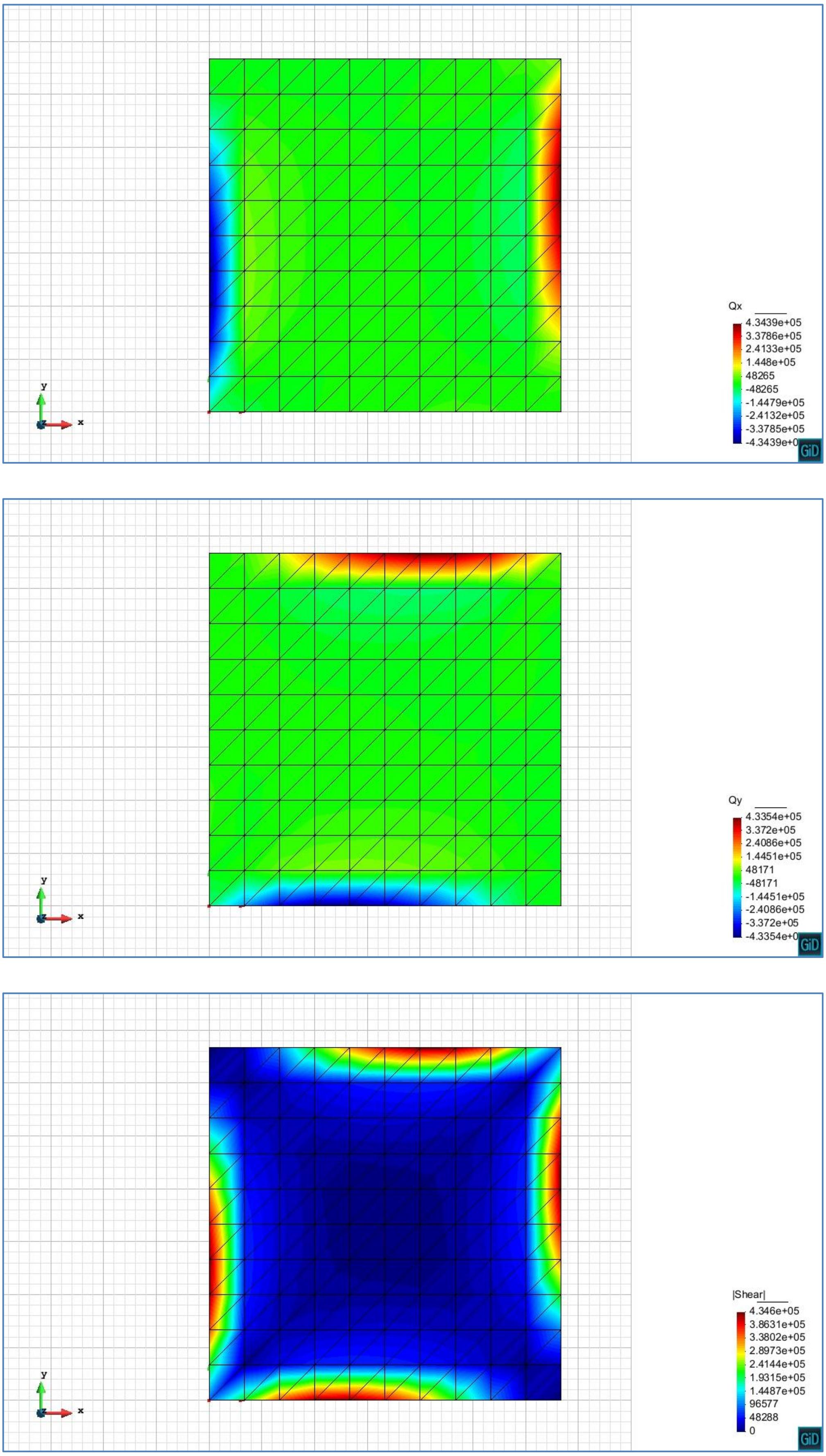


Figure6. Transverse shears stresses

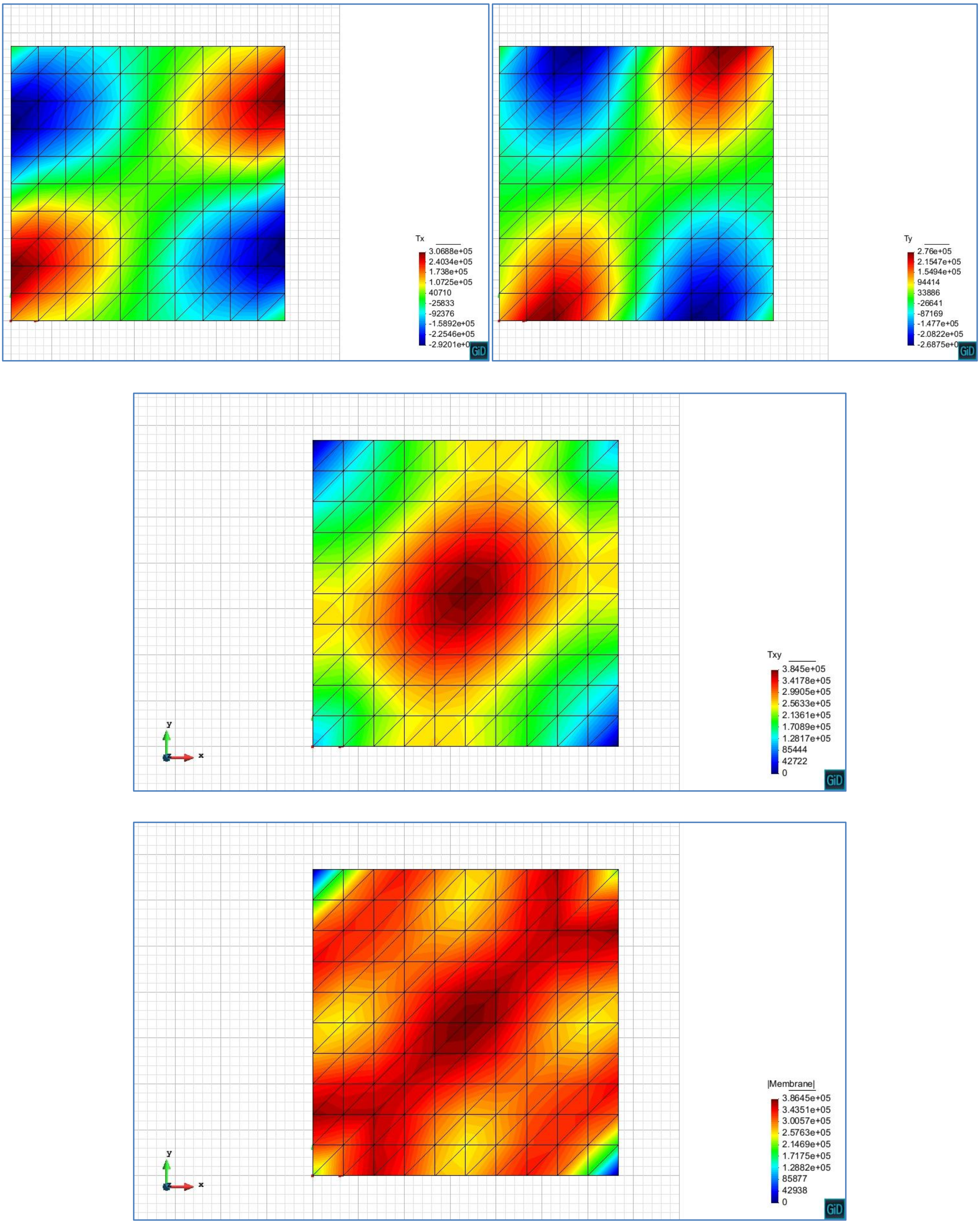


Figure7. Membrane stresses.

- Due to the fixed boundary conditions as it was expected we can see in **Figure 5 and 6** that the maximum Bending and Shear stresses has occurred on the boundaries, since the transverse (shear) and flexural (bending) rigidity of shell structures are not dominant compared to membrane effect of them and also they need rigid supports to pass these stresses to them.

- As it is shown in **Figure7** the membrane rigidity is distributed all over the domain and fits the majority of stiffness duty in shell behavior. Also the anti-symmetric nature of this problem is clear in all figures, as it was predicted.

- Also one may compare the absolute values of shear and bending stresses in this shell structure (4.3 e5 for shear and 2.8 e2 for bending). This result clearly proves that shells are really not structures for tolerating bending and a good way of using these types of elements are when the engineer could do the geometry and boundary conditions that profit more from membrane and then shear effects of shells.