Assignment 8.1

The aim of this assignment is to analyze the following concrete hyperbolic Shell under selfweight, explaining the behavior of all the stresses presented.

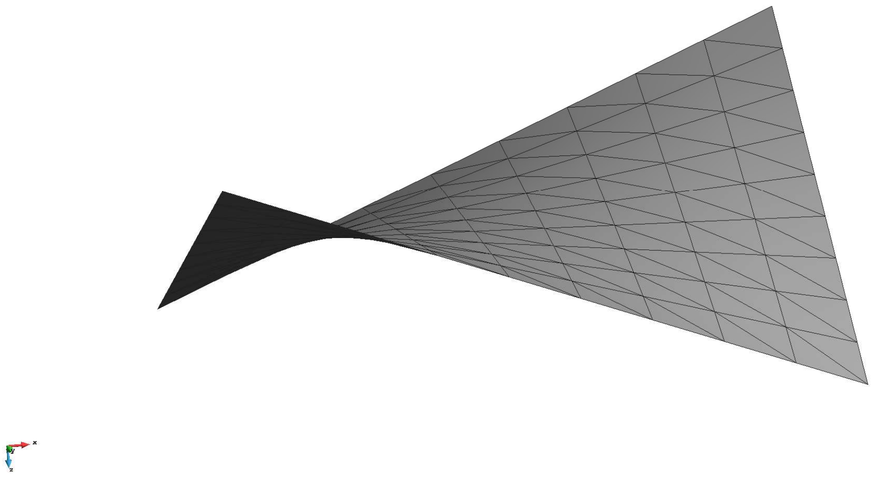


Figure 1.1 – Geometry and Meshing in GiD

Boundary conditions

The types of boundary conditions that are enforced in this problem are the following:

- Displacements Constraints / Linear Constraints: For represent the clamped constraint the Movement in X Y and Z and the rotation in X and Y direction is prevented along the boundary of the plate (Figure 1.2).

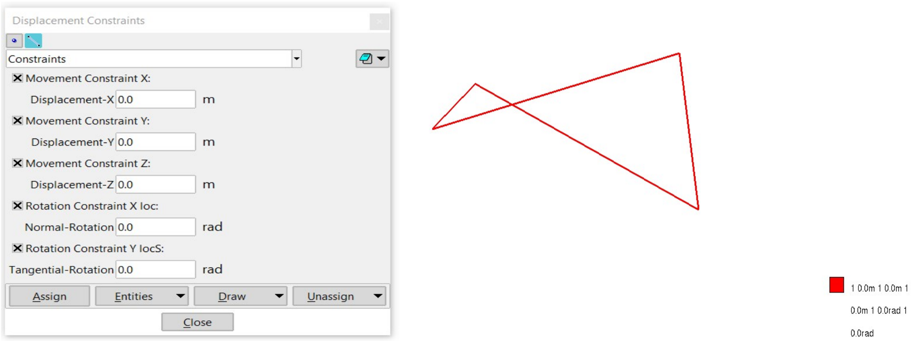


Figure 1.2 – Boundary Conditions

Material

We use a material with the following mechanical characteristics (Figure 1.4):

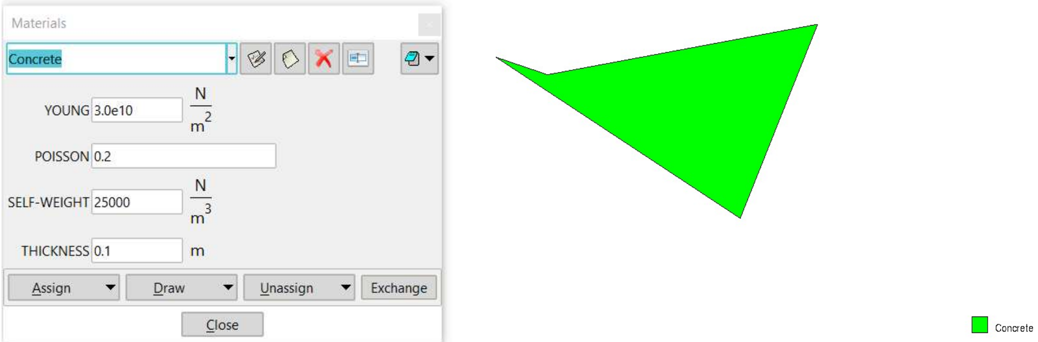


Figure 1.3 – Material

Meshing

A structured mesh will be used I to define the a suitable meshing for the figure. The structure was discretized in a mesh of 162 triangular elements and 100 nodes. To generate each mesh that the problem asks for, we must go to:

- Mesh / Quadratic type: Normal.
- Mesh / Element type: Triangle.
- Mesh / Structured/ Surfaces/ Assign number of cells: Divide the different lines of the surface into the selected parts.

Problem Data

In this section we specify some data necessary for the analysis:

General Data (Figure 1.4):

- Problem title: AS8
- Consider self-weight: Yes

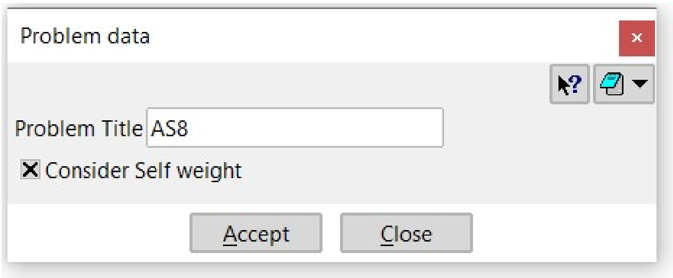
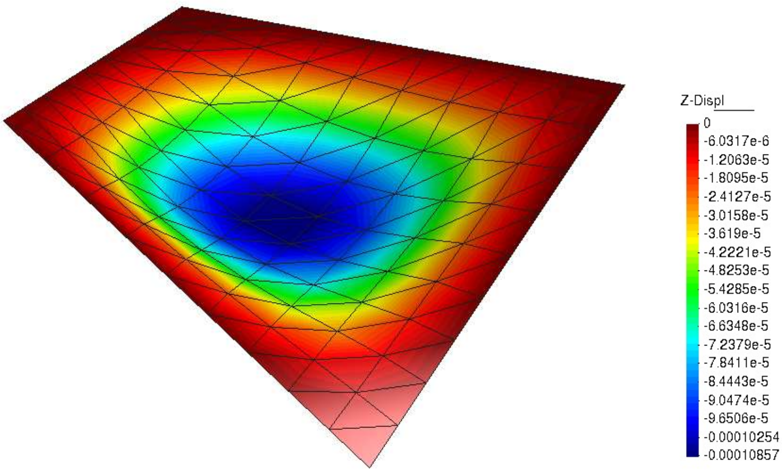


Figure 1.4– Problem data

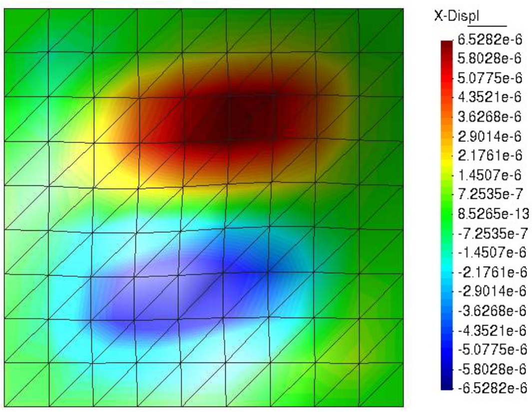
Results and Discussions

Displacements

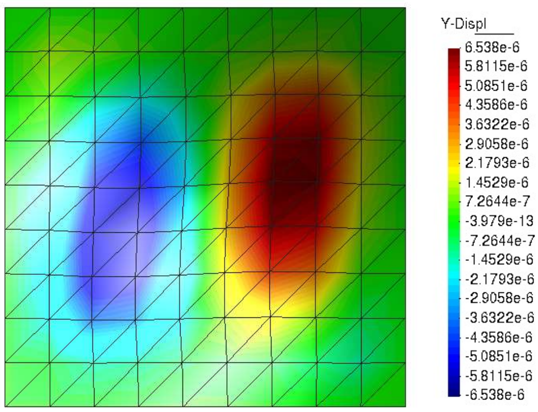
Deformed shape (Z displacements)



X displacements



Y displacements

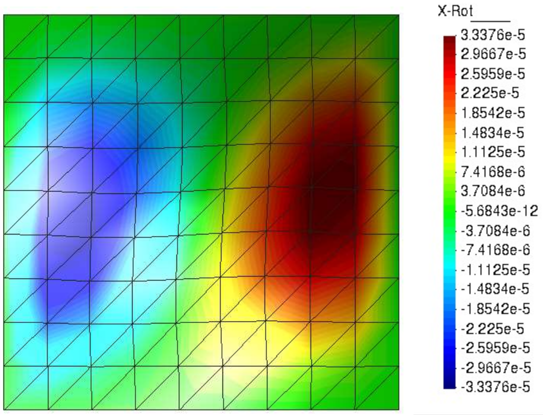


As for the displacements, it can be seen that the vertical displacement in the z direction increases as we approach the center of the shell, being null in its boundary due to the clamped configuration.

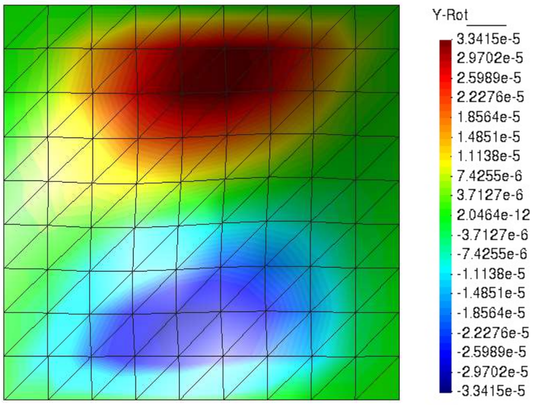
In the case of displacements in "x" and "y" we can observe that they are very small and parallel to its axis, with opposite sign value.

Rotations

Rotations around X direction



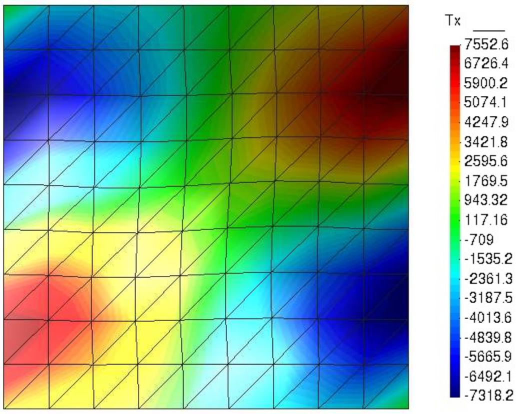
Rotations around Y direction



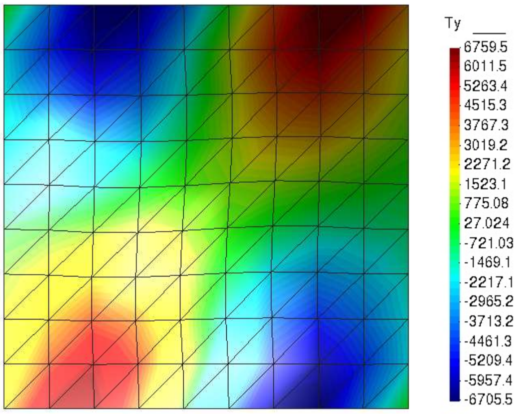
Rotations occur perpendicularly to their corresponding x and y axes, the values are practically equal values and in the opposite direction.

Membrane Stresses

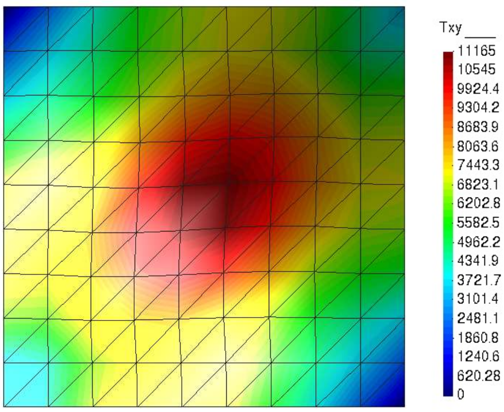
Membrane Stresses Tx



Membrane Stresses Ty



Membrane Stresses Txy

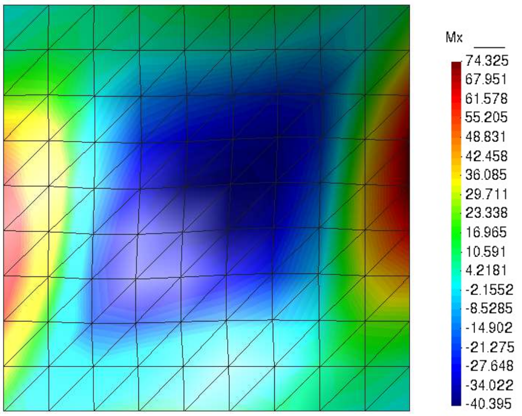


Due to the hyperbolic geometry of the Shell the membrane stresses in x and y direction occur at opposite corners perpendicular to the corresponding plane. the values of these are zero in the center, so the stresses Txy are maximum in these points.

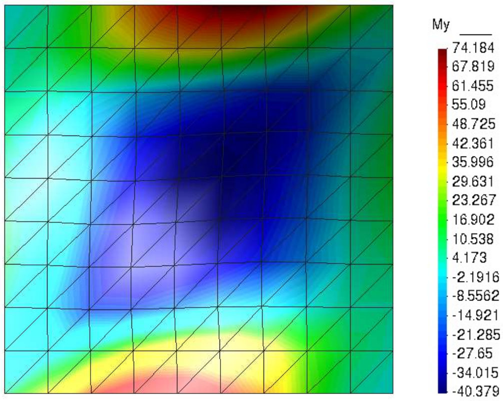
It is worth mentioning how the lower points of the shell are subjected to compressive stress, while the upper parts are under traction and the axial stress at the center of the sell is close to zero in both directions.

<u>Moments</u>

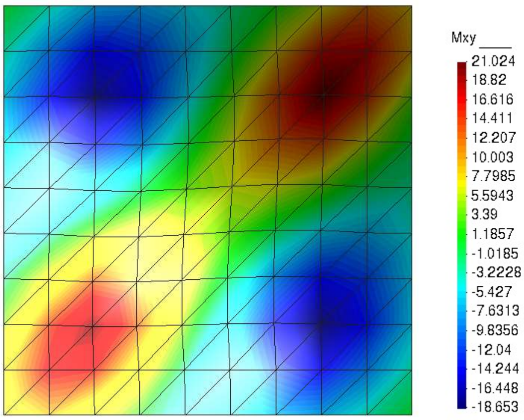
Mx Moments



My Moments



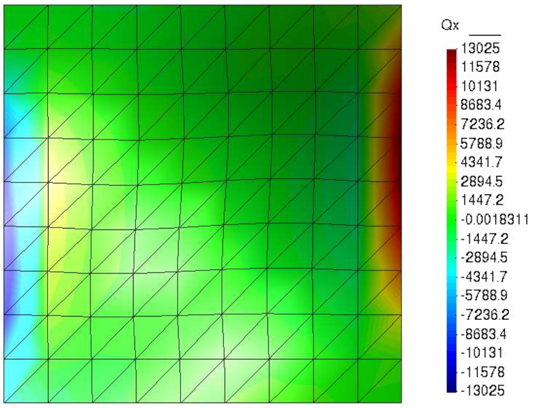
Mxy Moments



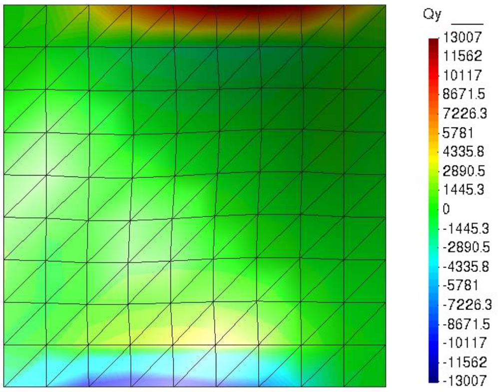
"Mx" and "My" diagrams present the highest concentrations at the edges, since the self-weight of the shell generates a torque perpendicular to the boundary conditions
The doubly ruled surface explain why the moment it is positive at the edges and negative at the center similar to a beam clamped in both sides. In the case of the moments "Mxy" they will naturally be concentrated in the corners symmetrically, although the hyperbolic geometry slightly distorts this appreciation.

Shear

Shear Qx



Shear Qy



The shear stresses are zero all over the surface and only appear at the edges perpendicular to their planes, due to the effects of the boundary reactions.