Computational Structural Mechanics and Dynamics
MSc in Computational Mechanics
Universitat Politecnica de Catalunya

Assignment 8
Shells

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Contents

1. Abstract

In this report are shown and discussed the results of an analysis performed on a shell under its self weight. It will be shown the symmetries, the elements and mesh used for this simulation.

The software used is GiD with the implementation of $MAT - fem_Shells$.

2. Introduction

Analyze the following concrete hyperbolic Shell under self weight.
Explain the behavior of all the Stresses presented.

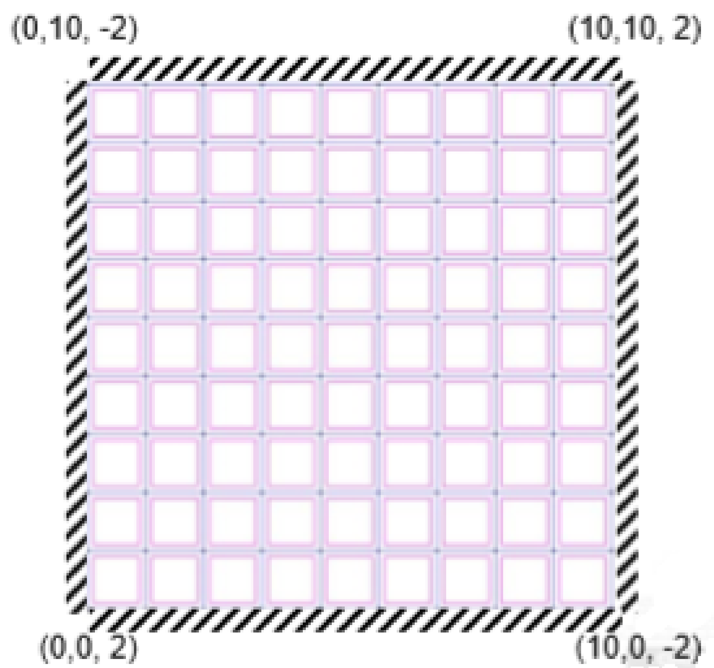

Figure 2.1: Problem Geometry

2.1 Problem description

The data of the problem are the following:

$$
\begin{aligned}
t\ (thickness) &= 0.1 \\
E &= 2.1x10^{11} \\
\gamma &= 78000\frac{N}{m^3} \\
\nu &= 0.2
\end{aligned}
\tag{2.1}
$$

The elements chosen are triangular and the simulation has been run with 400 elements and 202 nodes. The mesh is shown in Figure 2.2.

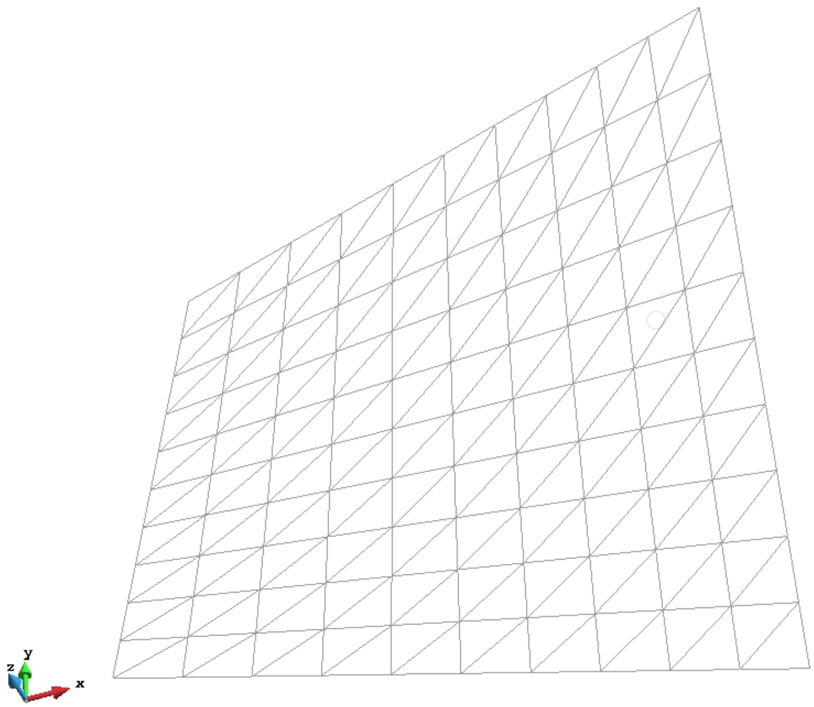

Figure 2.2: Triangular Mesh

3. Results

In this section are shown the results for all of the stresses acting on the shell.

It has to be said that this problem could have been simplified considering the symmetry between the upper right corner and the lower left one as shown in Figure 3.1.

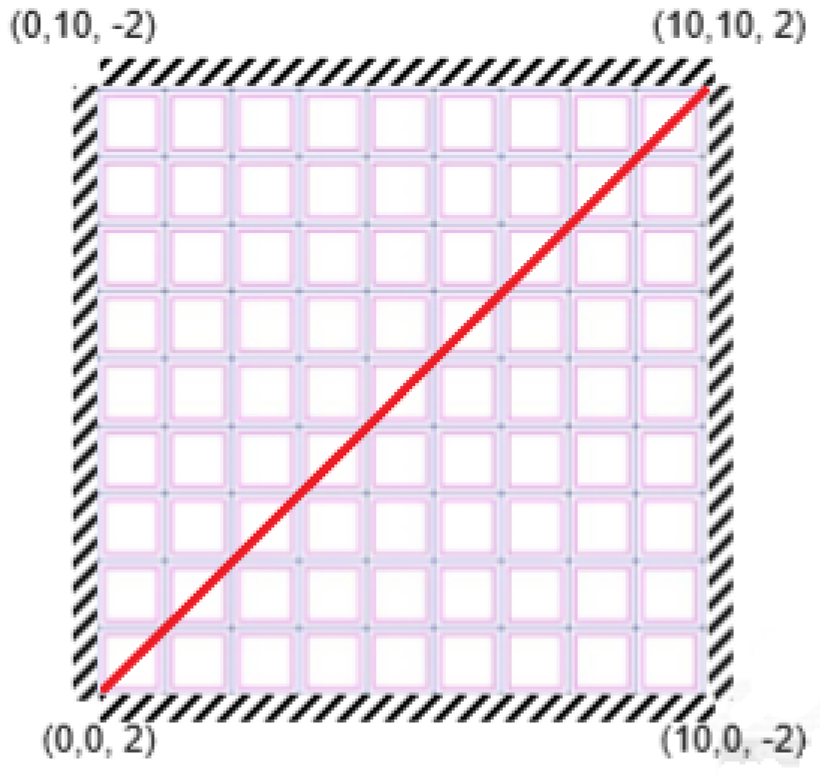

Figure 3.1: Symmetry Line

In fact as a result of the symmetry, the displacements, rotation and stresses will be all symmetric.

If the problem would be computationally more expensive, since the thickness is constant, it could be analyzed considering only half of the shell, imposing the right constraints.

3.1 Displacements

In Figure 3.2 is shown the norm of the displacements field. It can be easily noticed the symmetry previously described.

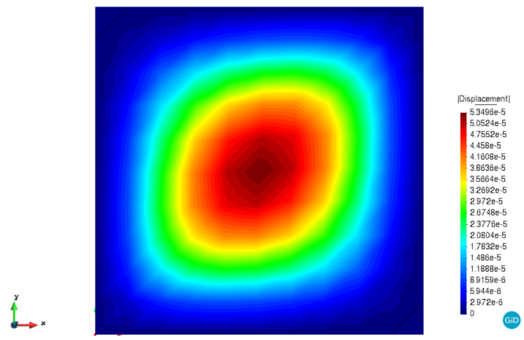

Figure 3.2: Total Displacement

Figure 3.3 shows the displacements along each direction, being able to recognize the symmetry on x and y.

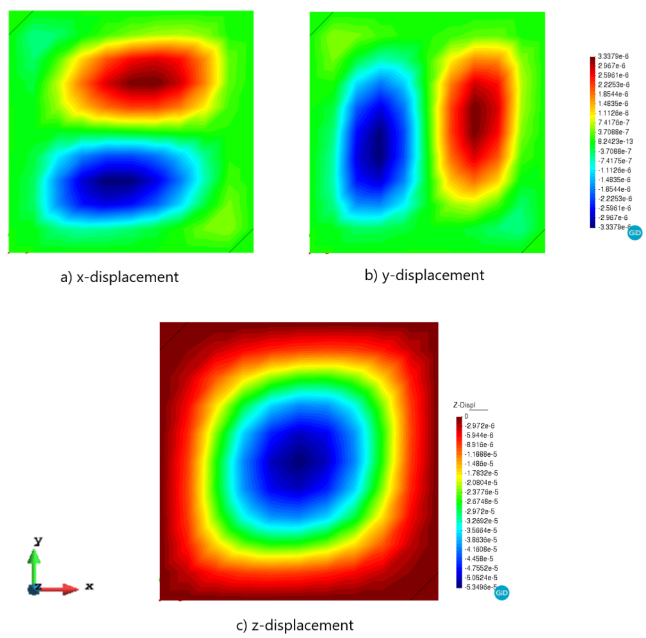

Figure 3.3: Displacements

In these plots can be noticed the displacements along x and y much smaller than the ones along the z direction. This is due to the hyperbolic shape of the shell.

3.2 Rotation

In Figure 3.4 c) is easily seen that the total rotation, described only from the rotation along x and y as the one along z is equal to zero. This is because of the self-weight acting as only vertical load.

Also the rotation plots show the symmetry in behaviours respect to the symmetry line.

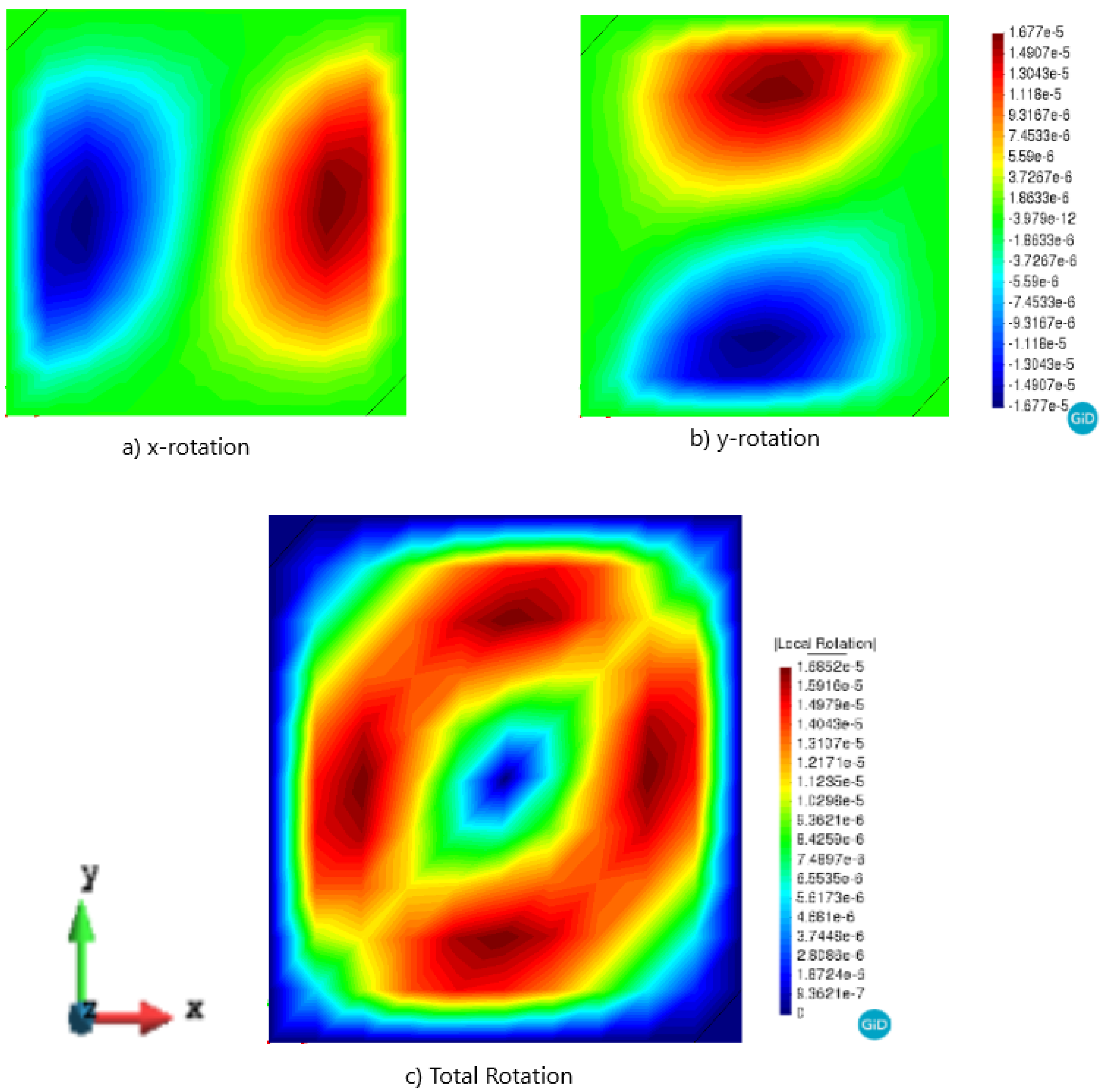

Figure 3.4: Displacements

3.3 Bending Moments and Stresses

In the following plots are shown the stresses associated to the membrane. It can be seen also here the concentration of stresses due to the hyperbolic shape of the shell.

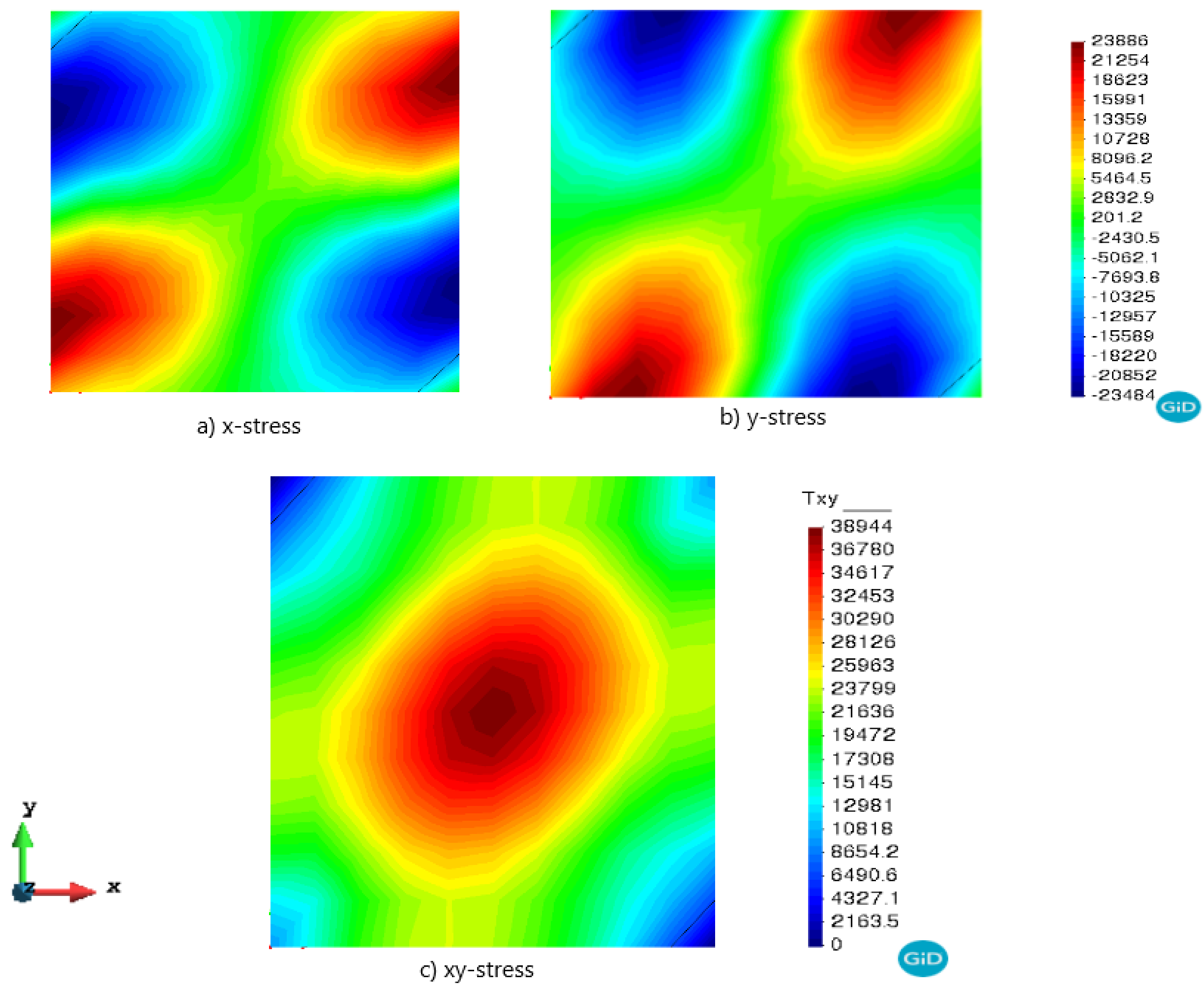

Figure 3.5: Stresses

It can be seen from Figure 3.5 a) and b), that the maximum values of the stresses are close to the edges, due to the constraints where the reaction forces take place. The redistribution along x and y has this two concentration of traction and compression due to the shape of the shell that tends to close itself because of the self-weight and the Dirichlet Boundary Conditions. For the same reason, the stress T_{xy} is concentrated in the middle, being the cross derivative of the displacements.

Regarding the momentum, Figure 3.6, it follows the similar behaviours as the stresses. It goes under traction in the center of the shell because of the type of the problem. Then it presents the same concentration of traction and compression moments due the hyperbolic shape.

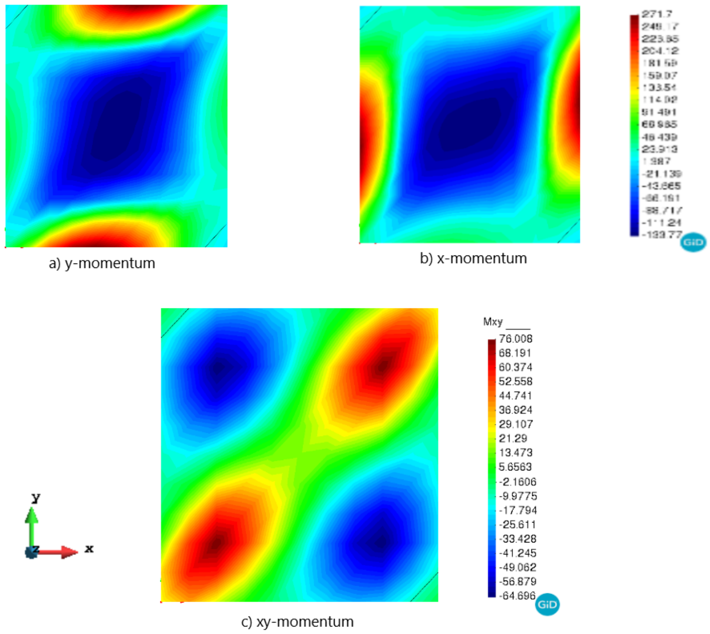

Figure 3.6: Momentum

3.4 Shear Stress

In the following plots are shown the behaviours of the shear stresses of the shell taken into account from the Reissner-Mindlin shell theory. It can be seen in Figure 3.7 that there is an high concentration on the edges, due to the shape of the shell, the Dirichlet BCs on the edges and the physics of the problem.

Due to the symmetry of the problem, the value are equals and with opposite sign.

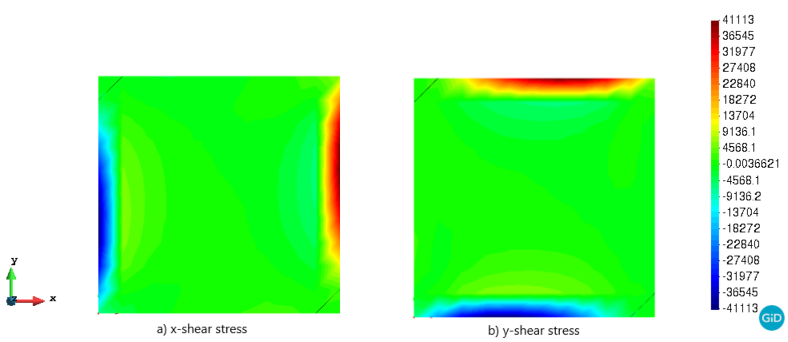

Figure 3.7: Shear stresses