**Màster en Mètodes Numèrics**

# Computational Structural Mechanics and Dynamics

**Assignment 8: Shells**

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

$$\text{Material properties: } \begin{cases} E = 3e10 \\ \nu = 0.2 \\ \rho = 2.5e4 \\ t = 0.1 \end{cases}$$

The simulations are carried out for Reissner Mindlin elements with a 10x10 element mesh and the material properties described above. On all edges, fixed boundary conditions are set by defining zero displacements and rotations. Concrete properties have been assigned to the shell surface and self-weight condition is assured for the calculation.

First, Mat-FEM for shells problemtype is loaded on GiD's interface. Then, the geometry is defined by using the coordinates in the given statement. The shell is meshed by means of a 10x10 triangular element mesh with three nodes. The calculation file is then exported to Matlab so as the code Shell_T_RM_v1_1.m can be run. Then, the post-process files are again exported from Matlab into GiD. The results are presented below.

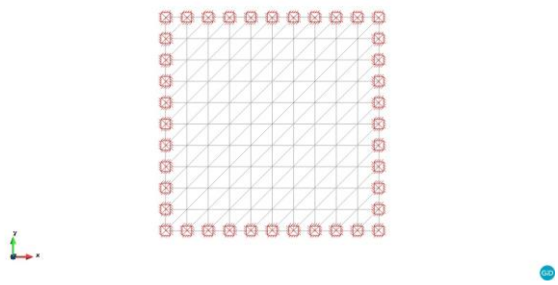

*Figure 1. 3-noded element mesh with boundary conditions.*

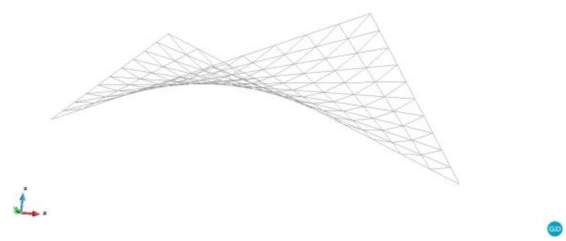

*Figure 2. Oriented twisted view of the shell.*

The displacement distribution, as shown in *Figure 3,* is symmetric. It can be seen how the shell deforms downwards with maximum deflection in the middle point of the structure. It makes sense since the plate is just submitted to self-weight.

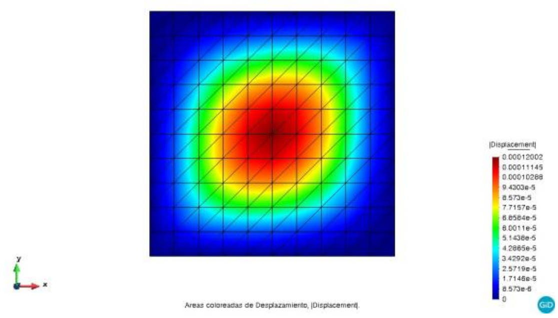


*Figure 3. Modulus of displacement.*

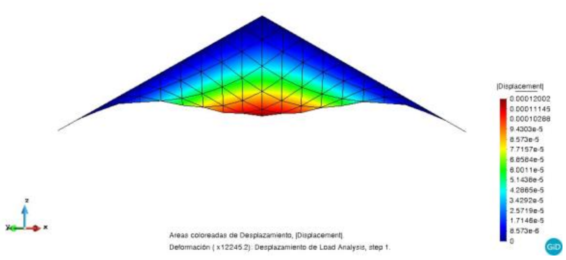


*Figure 4. Modulus of displacement in a deformed Surface view.*

Here below, three types of deformations are shown: tractions (membrane stresses), shear forces and moments. Higher forces are the ones related to membrane effects (tensions along

X, Y and tangential). Where deformations are higher, this is in the centre of the shell, $T_{xy}$ is higher. On the other side, $T_x$ and $T_y$ dominate over the boundaries.

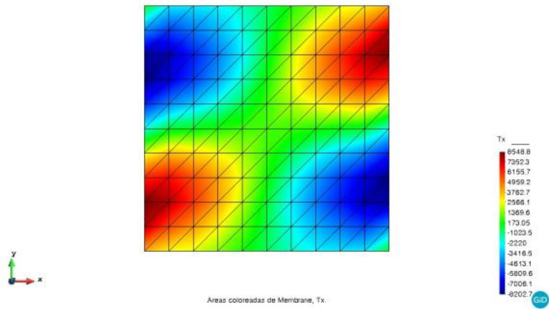


*Figure 5. Tx membrane stress.*

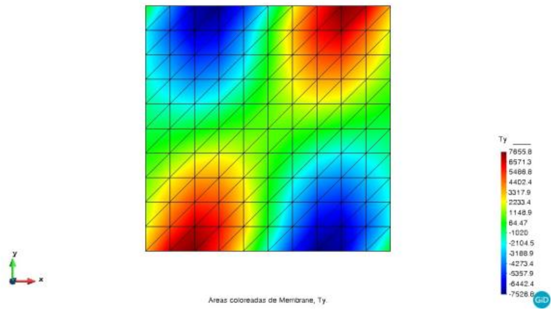


*Figure 6. Ty membrane stress.*

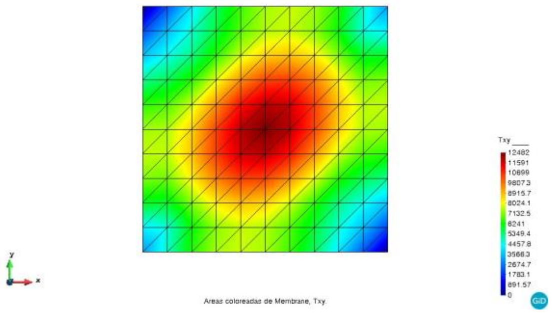


*Figure 7. Txy membrane stress.*

Next there are shown bending moment distribution over the shell. Also display symmetric distribution but the maximum values are not that significant compared to these for the membrane forces shown before.

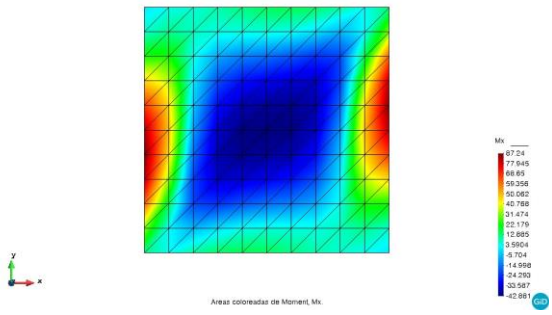


*Figure 8. Mx moment component.*

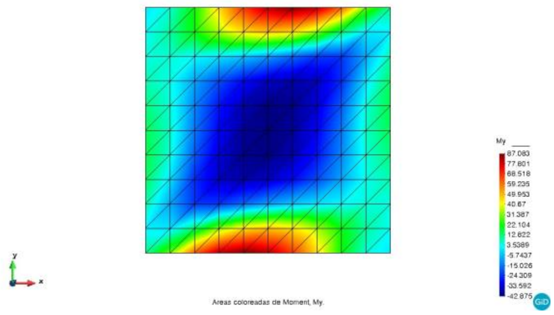


*Figure 9. My moment component.*

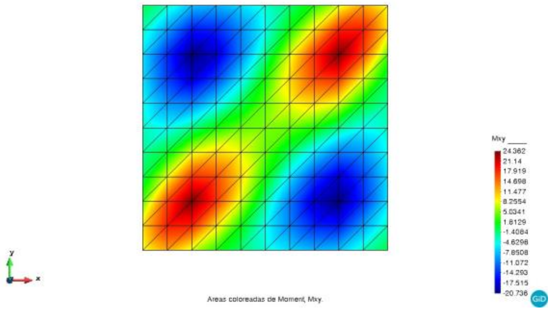


*Figure 10. Mxy moment component.*

Now, the shear stresses are described. It is clearly seen how the highest values are obtained in the edges due to be these ones submitted to boundary conditions. Since the structure is clamped, meaning that edges have zero displacements and rotations prescribed, the edges must hold the structure's own weight and therefore, resulting in a rise of the shear stresses in that zone. They loose relevance as we go far from the edges.

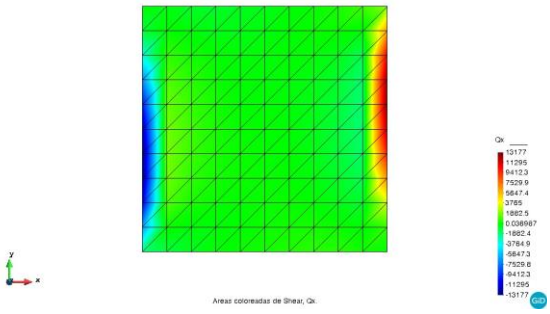


*Figure 11. Qx-shear stress.*

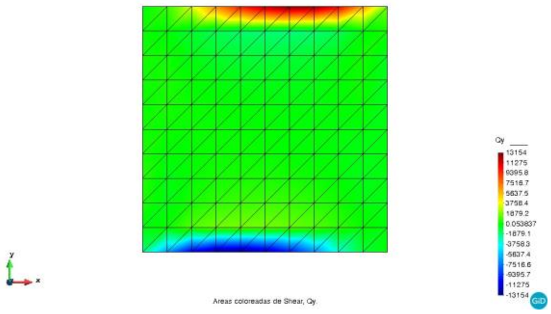


*Figure 12. Qy-shear stress.*

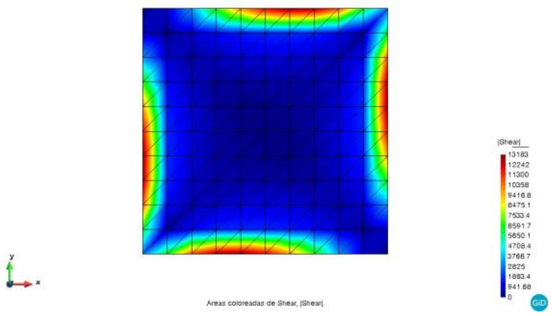


*Figure 13. Shear stress modulus*

The case-problem ended up being a membrane-dominated case in which membrane forces, in terms of magnitude order, are higher than the other resulting forces and thus, leading the case that we set up, a parabolic shell under self-weight.