As the assignment corresponding to the shells part of the subject, it is requested to analyze the structural behavior of an hyperbolic shaped concrete roof subjected to its own weight. To do this, the supplied routine coded in MATLAB *Lamina_RM* will be used, as well as GiD program as pre- and post-processor.

First of all, in order to obtain the necessary matrices containing the coordinates of the nodes, elements and boundary conditions, the contour of the figure to be studied is sketched and then the following triangular element mesh is generated:

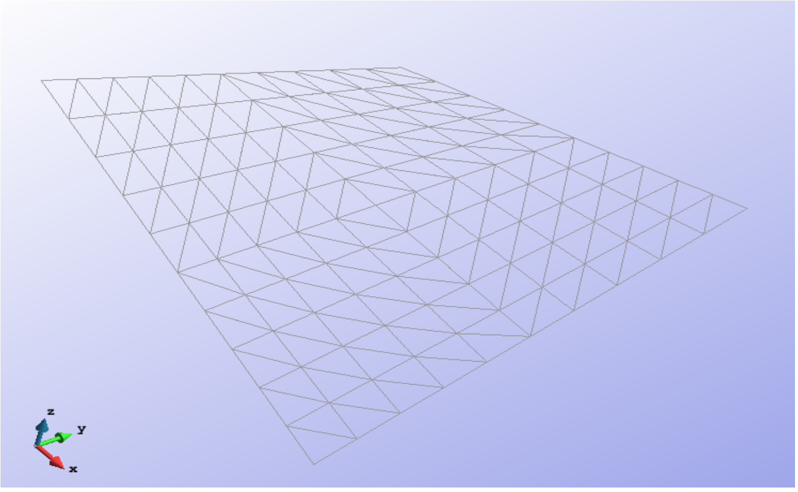

Figure 1: Mesh decomposition into triangular elements of the hyperbolic shell under analysis

The structure is considered clamped all around its contour. Once the data is exported to a file in ASCII code and conveniently entered into a MATLAB routine, then it will be evaluated by the previously mentioned *Lamina_RM* program to obtain the requested results, whose post-process images are shown next:

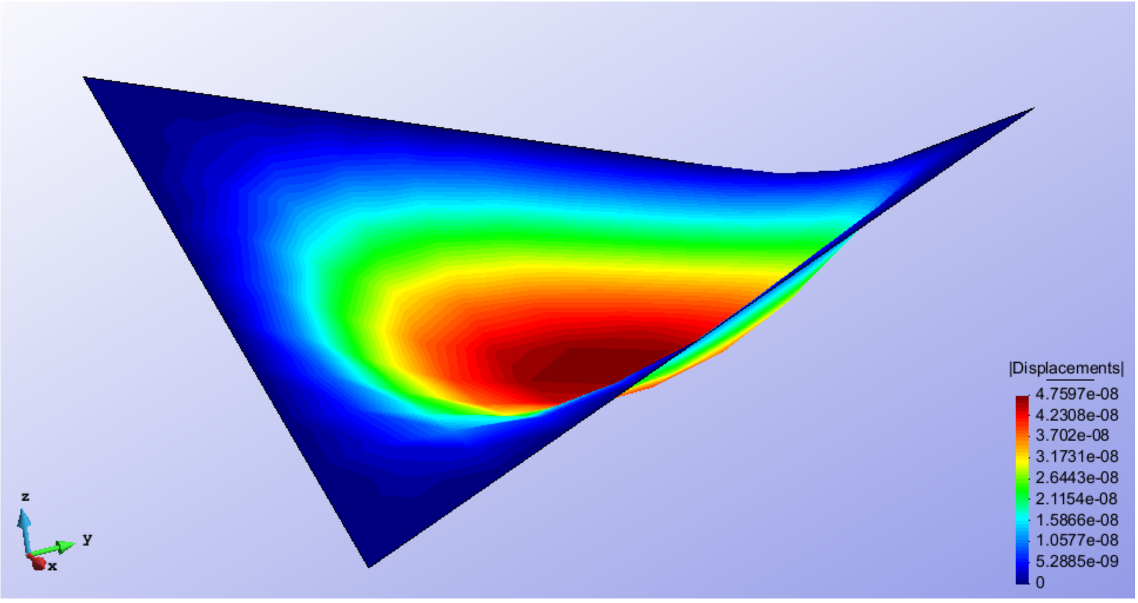

Figure 2: Deformed shape of the contour fill of displacements

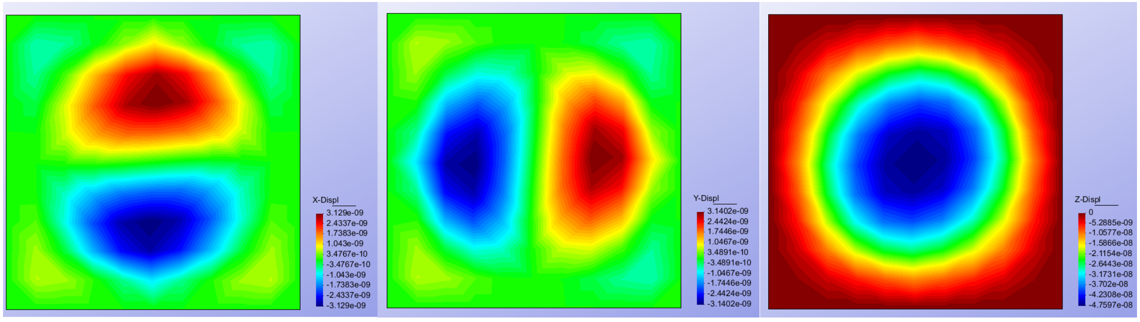

Figure 3: Contour fill of displacements

At first glance it can be observed that, in terms of the displacements, there is a vertical movement of the center of the structure as well as a horizontal displacement along the x-y plane of the cover, that follow a path from the lower points of the geometry towards the higher ones. This displacement is of lower order than the vertical one, and occurs because of the different heights to which the four corners of the roof are, but it is also important, as it will be seen later.

With respect to the rotations, they take place in a very similar way to those that would take place in a squared plate subjected to its own weight. There is an area at mid-distance from the center to the perimeter of the structure, and it is there where the main rotations take place.

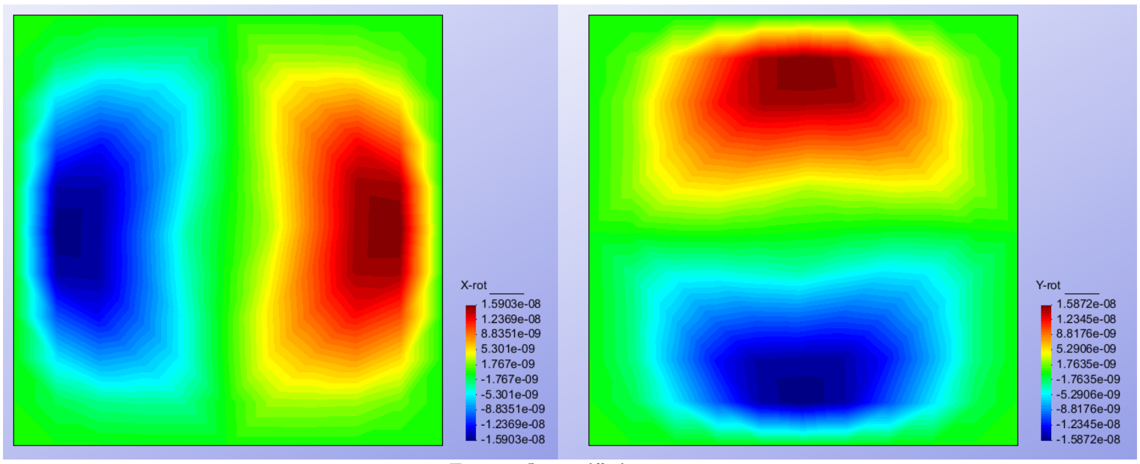

Figure 4: Contour fill of rotations

The following figures are the distributions of three types of stresses over the element: membrane, bending and shear stresses.

Membrane stresses could be considered as axial-like stresses in the beam analysis, and they are produced by the appearance of axial loads in the section of the structure. Such loads are directly related to the previously commented horizontal displacements. The post-process images show an antisymmetric distribution of these stresses over most of the surface, concentrating the positive (tensile) stresses by the higher corners and the negative (compression) stresses around the lower ones. On the other hand, the T_{xy} component is concentrated in the center of the roof.

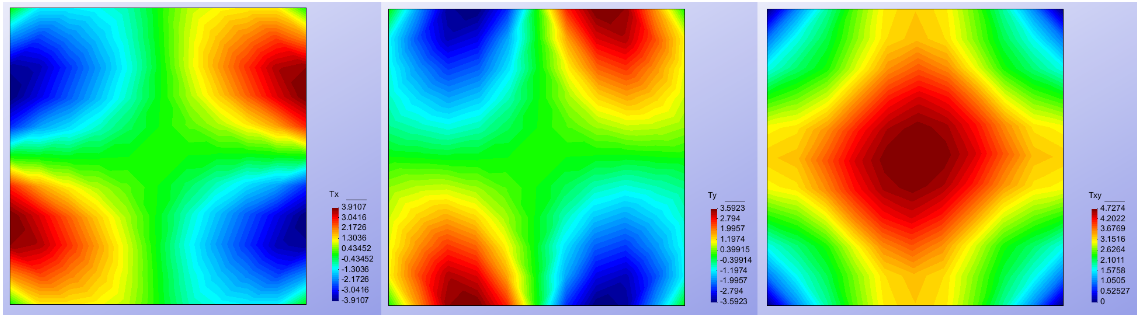

Figure 5: Contour fill of membrane stresses

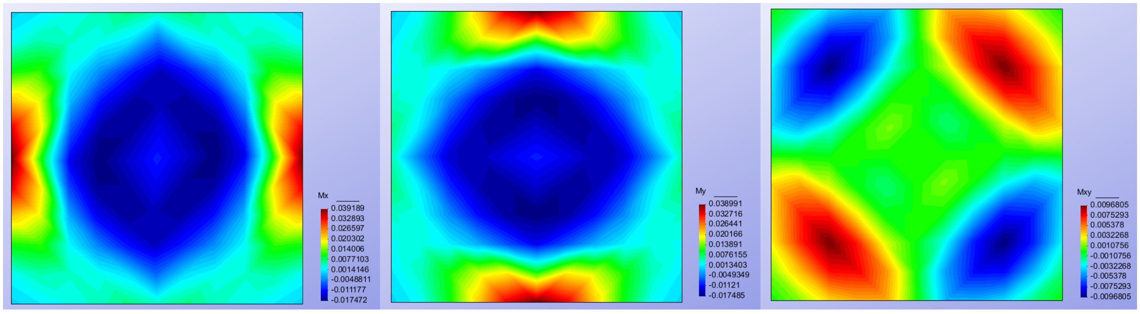

Figure 6: Contour fill of bending stresses

As membrane ones, bending stresses are distributed identically both when considering one axis or the other. They are directly related to the rotation of the structure and they are greater in the places contiguous to the points in which variation of rotation is greater, which are the midpoints of the four sides of the deck. In general, these values are lower than those produced by the other two types of stress.

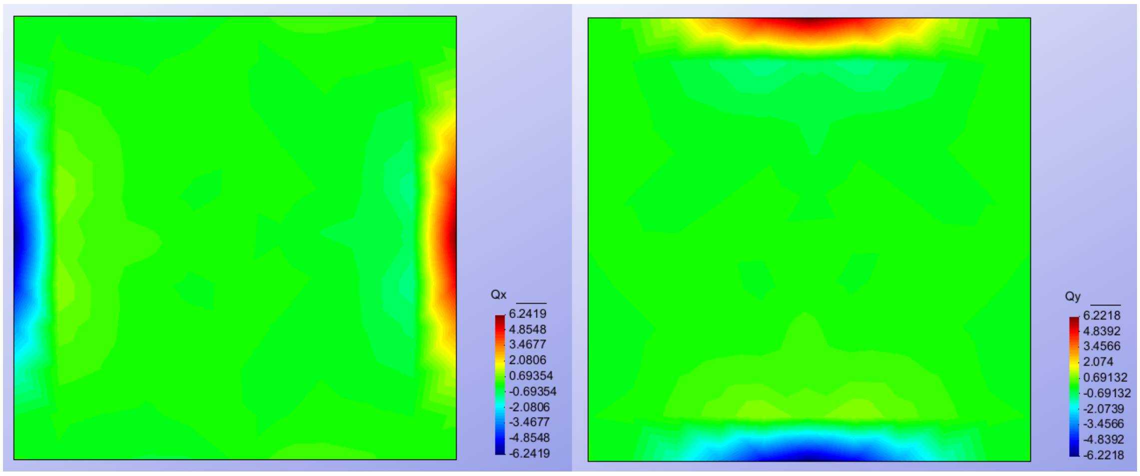

Figure 7: Contour fill of shear stresses

Finally, maximum shear stresses correspond, as well as what happens with bending stresses, to the midpoints of the sides of the roof, and they are also the ones of biggest magnitude. The behavior to this respect would be similar to a bisupported beam subjected to a punctual load at its midpoint.