Computational Structural Mechanics and Dynamics

Assignment 8

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Analyze the following concrete hyperbolic Shell under self-weight. Explain the behavior of all the stresses presented. The thickness is assigned to be 0.1.

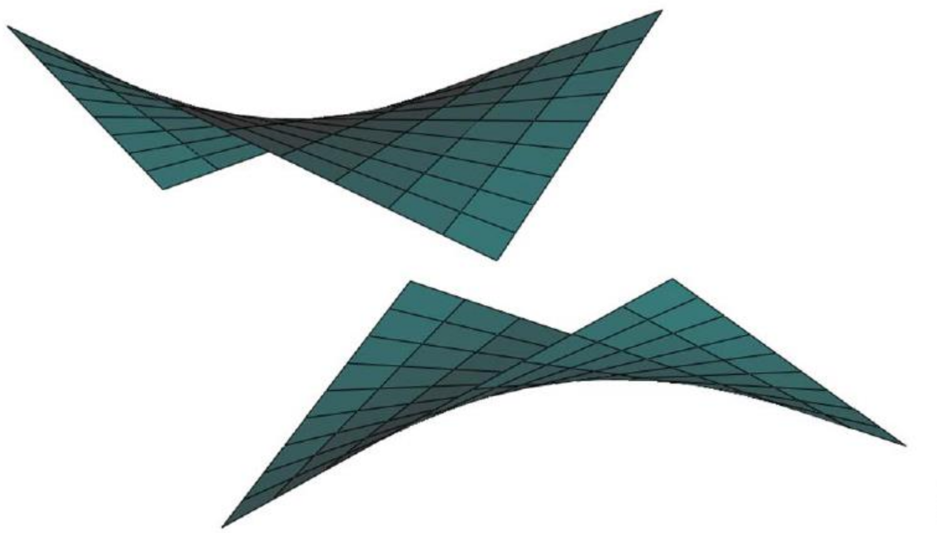

Figure 1

First of all, the Mat-Fem for shells has to be added to problem type on GiD. Afterwards, the geometry of the problem is defined in GiD using the coordinates given by the question. It should be mentioned that the coordinates of each node of the geometry are found by interpolation and imported to Gid as text file. The surfaces of the geometry are defined and the boundary conditions are assigned as fixed with zero displacement and rotation for all the four edges of the geometry, Figure 2.

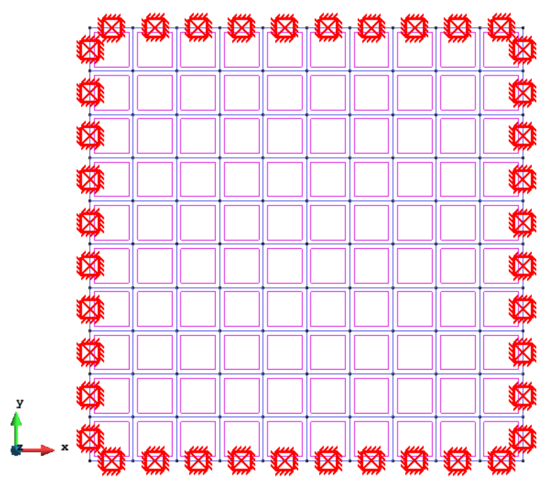

Figure 2 Geometry and boundary conditions of the problem

Triangular mesh with three nodes have been chosen to create the mesh. According to the convergence curve provided by Figure 3, a mesh of size 0.25 is used to mesh the geometry which would obtain 1681 nodes and 3200 elements, Figure 4.

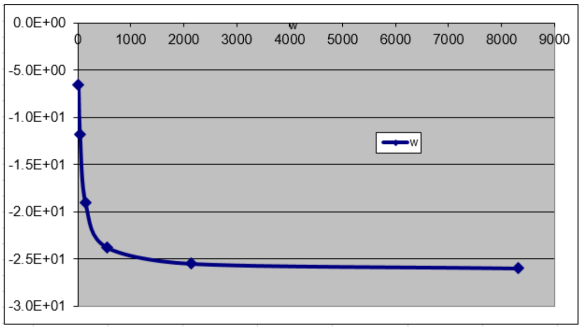

Figure 3 Convergence curve

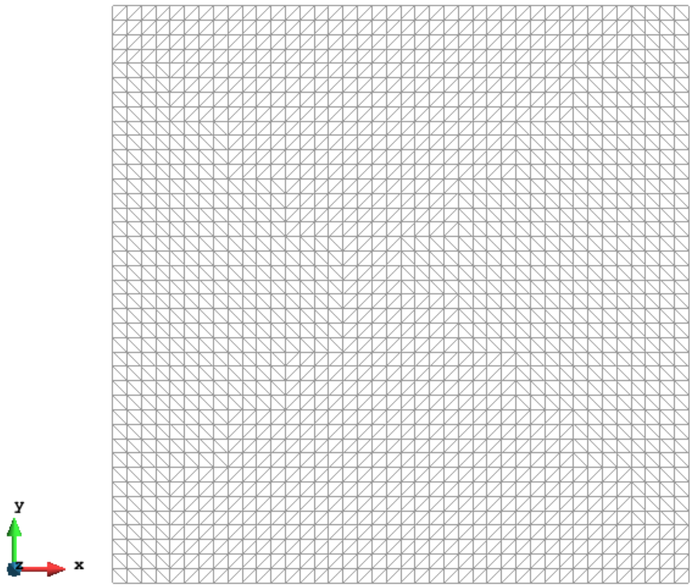

Figure 4 Mesh

After creating the mesh in Gid, we shall import the information to MATLAB to do the post-process. A MATLAB file is created using the option “Write MATLAB input file” in Gid. This file is given as an input to the MATLAB file “Lamina_T_RM.m”. It should be mentioned that the functions provided have two mistakes that has to be corrected before using. One is the variable name “Fixdesp” which has to be changed to “fixnodes” and the other is changing the inputs for the command “fprintf” in “ToGid_Shell.m” from sparse double type to normal double variable using the MATLAB command “full”.

After getting the results using MATLAB we have to open the corresponding files in GiD post process and obtain the displacement, the stress and the force distributions. The results can be found in the following figures.

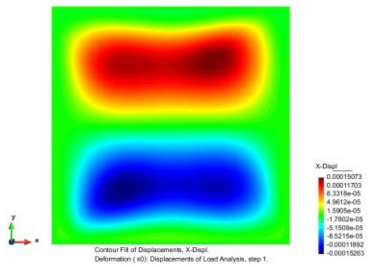

Figure 5 x displacement

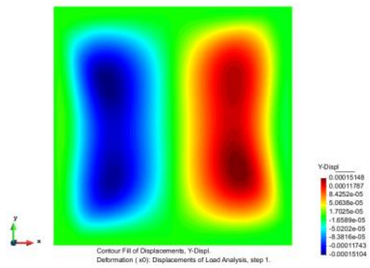

Figure 6 y displacement

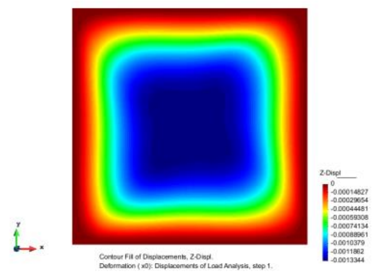

Figure 7 z displacement

Figure 5, Figure 6 and Figure 7 show the displacement distribution in XY plane. As it can be seen the displacement distribution in all direction are symmetric. For displacement in x and y direction we have the maximum value in the center of two halves of the shell in positive and negative. And for displacement in z direction we have the maximum value in the center of the structure. As the structure is loaded under its own weight, the results make complete sense.

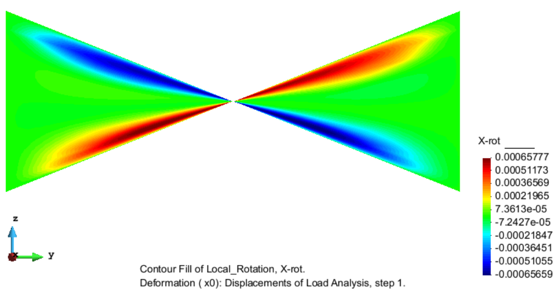

Figure 8 x rotation shown in YZ plane

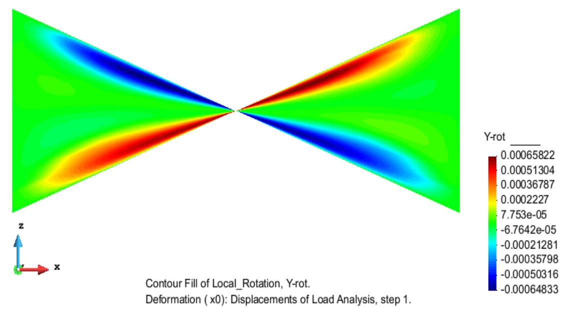

Figure 9 y rotation shown in XZ plane

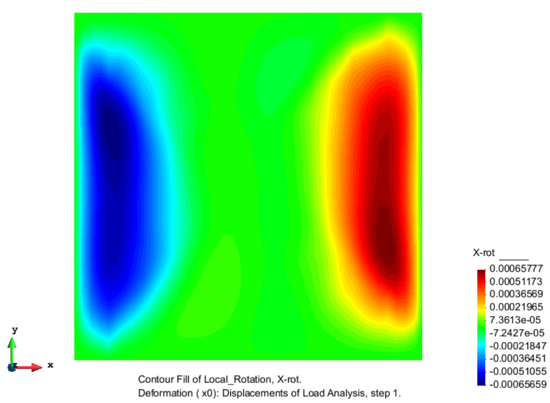

Figure 10 x rotation shown in XY plane

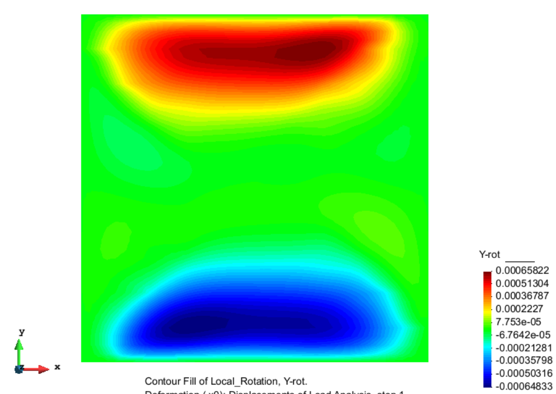

Figure 11 y rotation shown in XY plane

Figure 8 shows the rotation distribution around X in YZ plane and Figure 9 shows the rotation distribution around Y in XZ plane. As it can be seen from figures, the distributions are symmetric and are in agreement with the load and boundary conditions of the structure. It can be mentioned that the maximum rotation happened in the edge of each half of the structure in negative and positive according to Figure 10 and Figure 11.

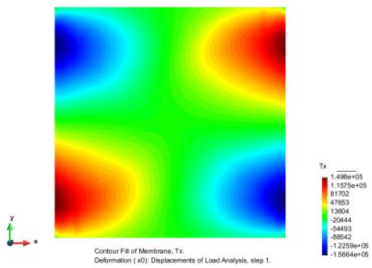

Figure 12 Tx

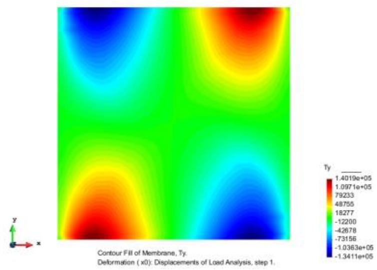

Figure 13 Ty

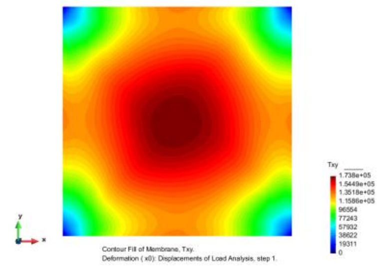

Figure 14 Txy

Figure 12**,** Figure 13 and Figure 14 show the normal forces in x and y direction and the tangential force in XY plane, respectively. As expected all distributions are symmetric. The maximum absolute values for each force can be found in Table 1. As it can be seen in the table the membrane forces are significant and of order 5.

Table 1 Maximum absolute values of membrane force

Tx	Ty	Txy
1.566×10^5	1.4019×10^5	1.738×10^5

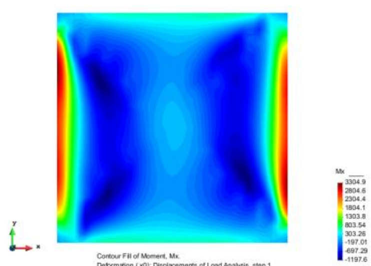

Figure 15 Mx

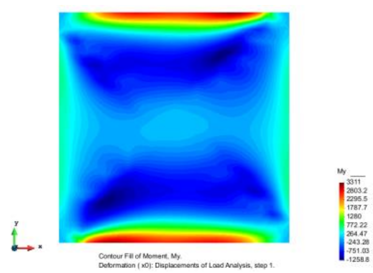

Figure 16 My

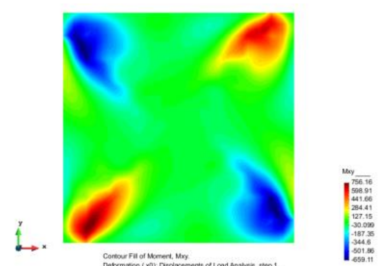

Figure 17 Mxy

Figure 15, Figure 16 and Figure 17 show the bending moment of the structure. They have symmetric distribution as expected and according to the values shown in Table 2, the maximum values for bending moment are not significant compared to that of membrane force previously shown in Table 1.

Table 2 Maximum absolute values of bending moment

Mx	My	Mxy
3304	3311	756

The shear distribution is shown in Figure 18 and Figure 19 that confirms the fact that along edges the shear has a huge value because of the boundary conditions as the boundary conditions in a structure always create exceptions in terms of values for shear. But the other parts of the structure have a lot less value compared to that of membrane force.

This fact shows that the whole structure behaves as a membrane since the effect of membrane forces are more significant compared to all other parameters analyzed.

Figure 18 Qx

Figure 19 Qy