Universitat Politecnica de Catalunya CIMNE
Master in Computational Mechanics

Computational Structural Mechanics & Dynamics

Assignment 8

Shells

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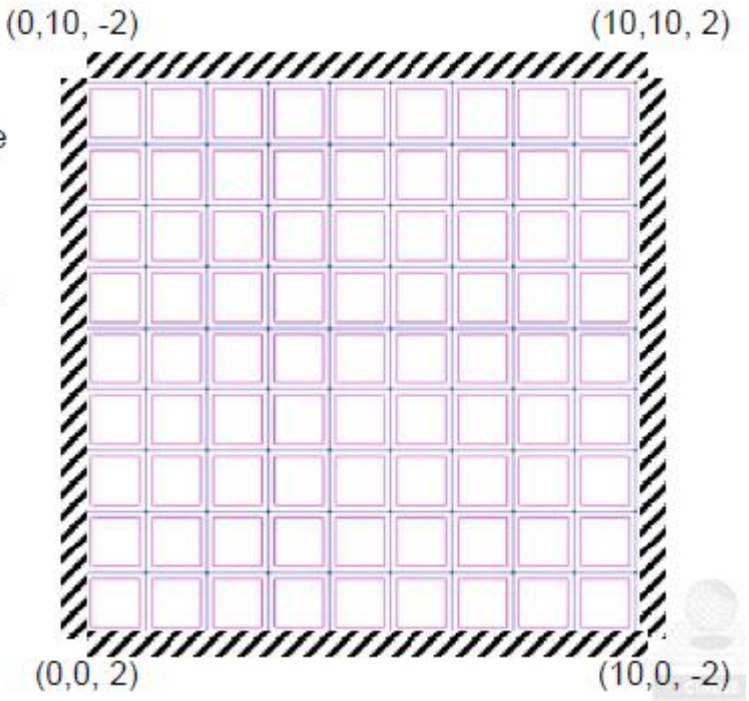
Assignment 8:

Analyze the following concrete hyperbolic Shell under self weight.

Explain the behavior of all the Stresses presented.
t = 0.1

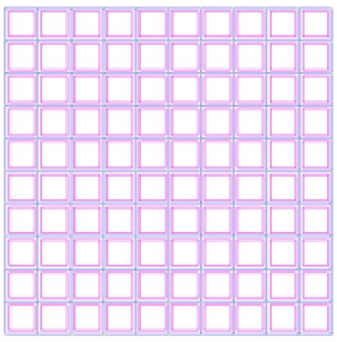


Solution:

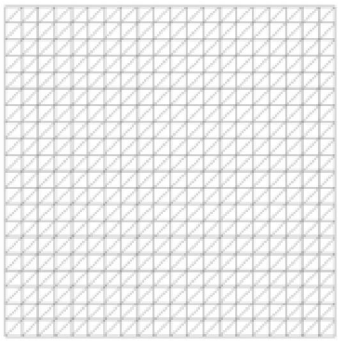
The goal of this assignment is to analyse concrete hyperbolic shell under self-weight. The geometry of the shell has to be created in GiD by loading the 'MAT-FEM Shells' problemtype. The thickness of the hyperbolic shell is 0.1. The shell has been subdivided into the surfaces by using the divide command thus making 10 parts of it horizontally and vertically. The mesh is done by 800 triangular elements having 441 nodes. The boundary conditions imposed on the outer edges of the shell were fixed conditions restricting movements and rotations in all directions.

Now, after creating the geometry in GiD, the Matlab file has to be generated. Then, this generated file is used in the 'RM-Shell' MATLAB code downloaded from MAT-FEM website. After running this code, it generates a result file which can be viewed for the post-process results in GiD.

Shown below are the pictures of the geometry of the shell generated in GiD and the mesh generated for analysing it.



Geometry of Hyperbolic Shell

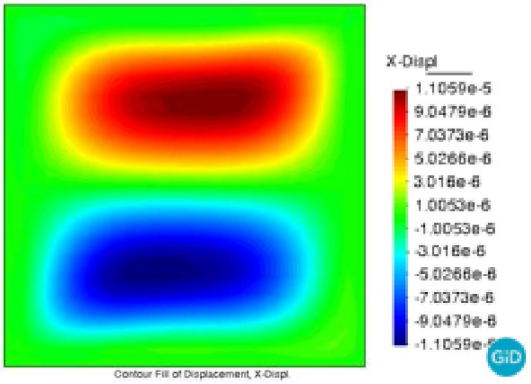


Mesh generated

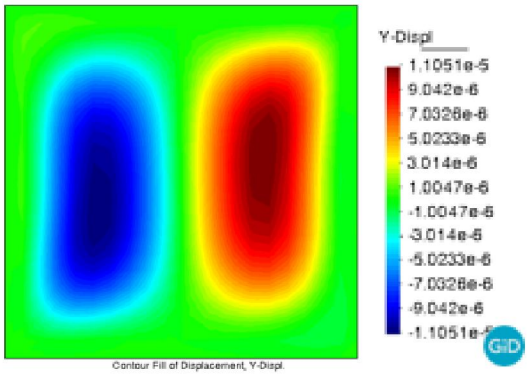
The post-process results for different parameters have been mentioned below.

- **Displacements**:

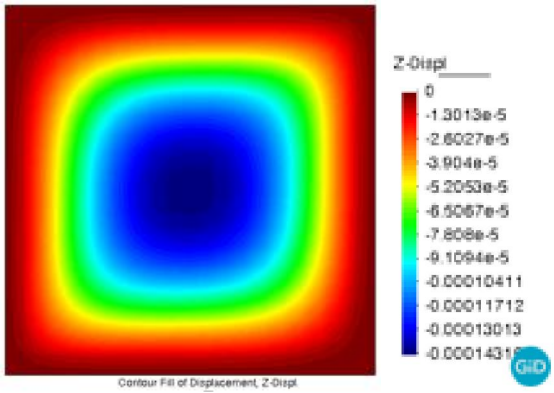
Shown below are the displacement contours in X, Y and Z direction respectively. The symmetry of the figure shows that the displacements in X and Y directions are kind of same, just aligned to the axes respectively. Since, the boundaries of the shell has fixed conditions assigned, hence we observe no displacements at the boundaries and the concentration is seen at the centre.



X Displacement contour for hyperbolic shell



Y Displacement contour for hyperbolic shell

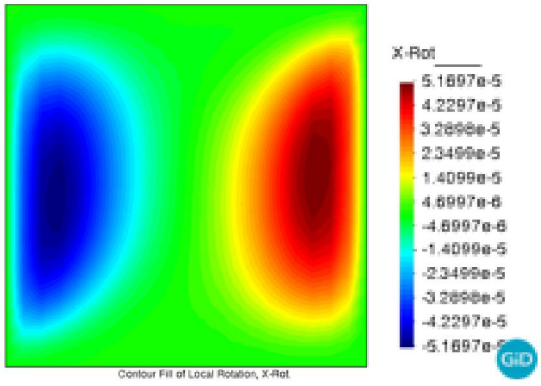


Z Displacement contour for hyperbolic shell

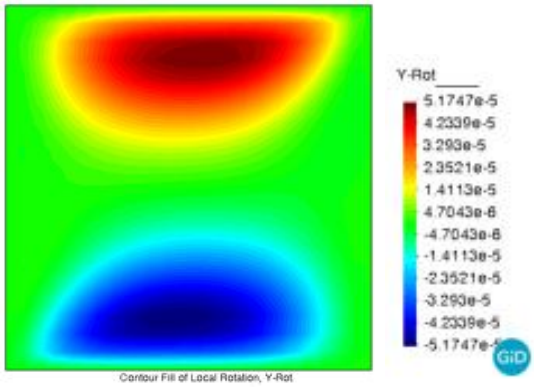
If we refer the Z displacement plot, we can see that due to the self-weight imposed conditions and no external load conditions, the maximum displacement is observed at the centre portion of the shell.

- **Rotations**:

Shown below are the contours of X-rotation and Y-rotation. Because of the symmetry of the figure and given loading conditions, we have negative rotations on one side and similar positive rotations on the other.



X Rotation contour

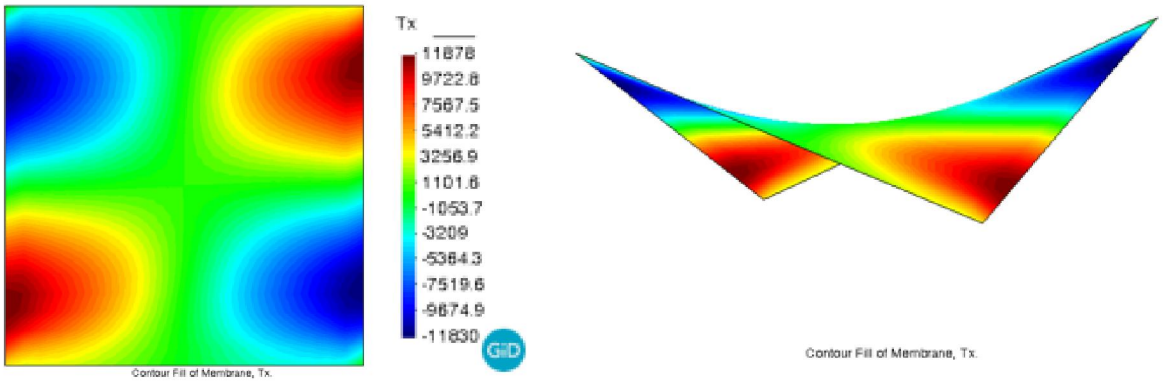


Y Rotation contour

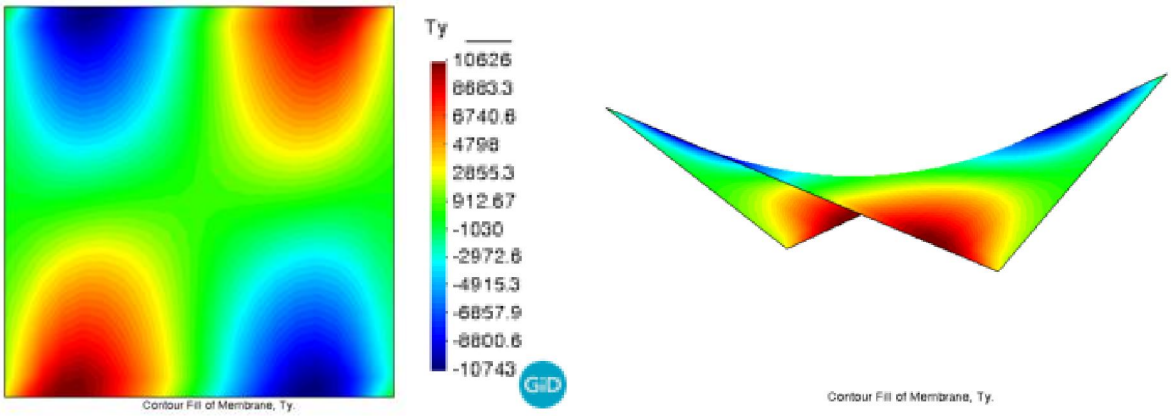
- **Membrane Stress**:

Shown below are the variations of membrane stress. Membrane forces are of significant impact in the shell element, hence entire structure kind of behaves according to the membrane stresses.

As observed in the deformed shape, the compressive stresses are generated at the top portions while the tensile stresses are seen at the bottom corners. The middle of the shell shows no stress concentrations.

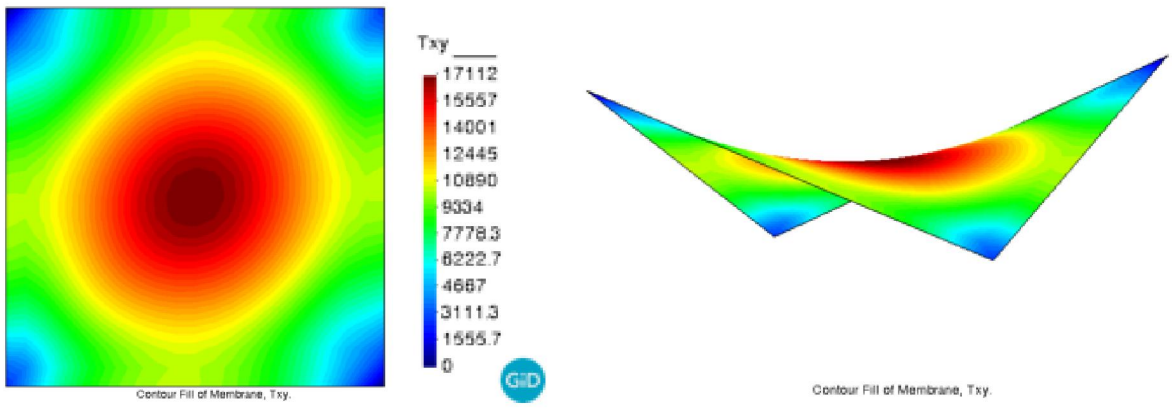


Undeformed and Deformed contours respectively of Membrane Stress Tx



Undeformed and Deformed contours respectively of Membrane Stress Ty

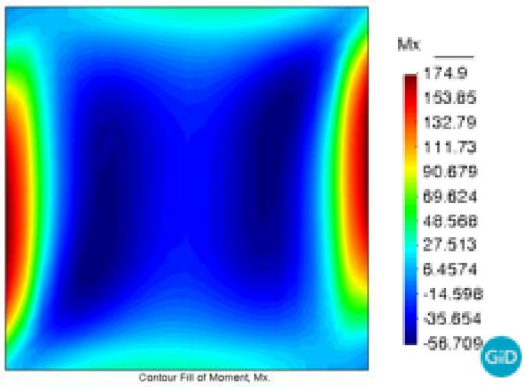
For, the stresses in the XY plane, it is observed that tractions have been created at the centre of the shell while all the corners show no impact of the stress on them.



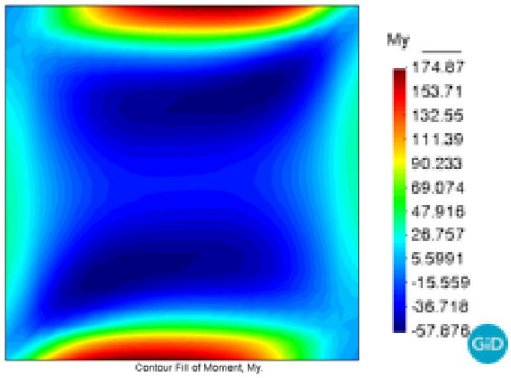
Undeformed and Deformed contours respectively of Membrane Stress Txy

- **Bending Moment**:

The moments along different directions are presented below. Maximum moments are observed at the vertical edges for Mx and along the horizontal edges for My. The middle portion of the shell shows less concentration of moment as the rotation for moment reduces towards the centre.

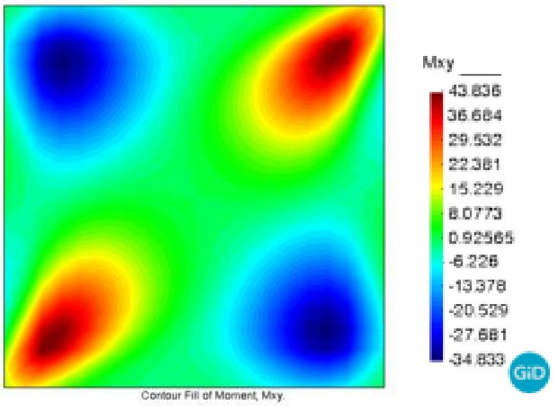


Bending Moment contour for Mx



Bending Moment contour for My

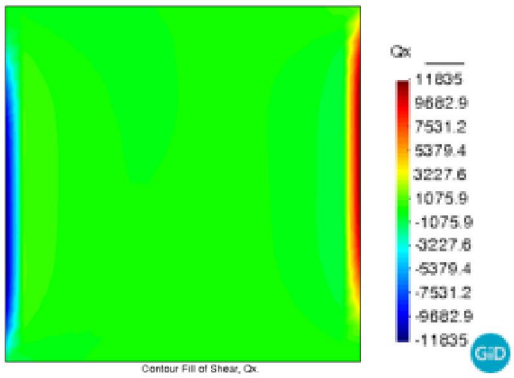
An overall distribution of moments is shown in the Mxy bending moment contour diagram below. The distribution is symmetric because of the geometry.



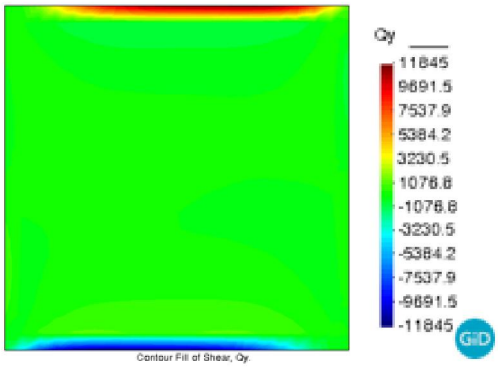
Bending Moment contour for Mxy

- **Shear Stress**:

The shear stress distribution in X and Y direction show below, indicates that as the boundaries of the shell are clamped with fixed conditions, hence the shear stresses are eminent along the boundaries respectively and show negligible distribution at the centre.



Shear Stress distribution in X direction



Shear Stress distribution in Y direction