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CENTRALE NANTES

Universität Stuttgart

Master of Science in Computational Mechanics

Computational Structural Mechanics and Dynamics

Assignment 8: Shell Elements

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Hyperbolic shell under self-weight loads

Figure (1) shows the XY view of a concrete hyperbolic shell under its self-weight dead load. The shell is clamped to the ground and has a thickness $t = 0.1$ m.

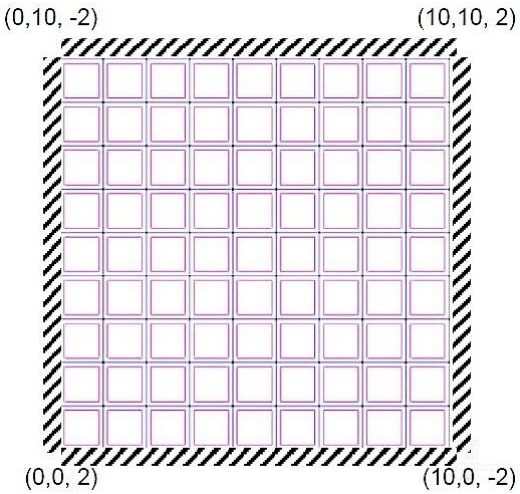


Fig. 1 – Boundary conditions and geometry of the hyperbolic shell

The discretization of the model coincides with the one depicted in Figure(1): 10x10-element structured mesh. An isometric view of the discretized model can be seen in Figure (2)

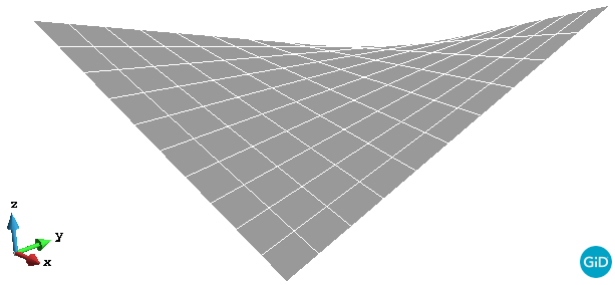


Fig. 2 – Discretized model of the hyperbolic shell

The computation was performed using MATFEM and GiD for pre- and post-processing of the analysis. Figure (3) summarises the results obtained for the displacements in the x, y and z directions. As a suspended structure, the acting compressive and traction forces tend to deform the structure in opposite directions causing ultimately that the maximum displacement in the z direction to occur around the center of the structure. Moreover, the pattern of the displacements u and v can be better understood if the acting local membrane forces are considered (refer to Figure (4)). A view of the deformed shell is depicted in Figure (5).

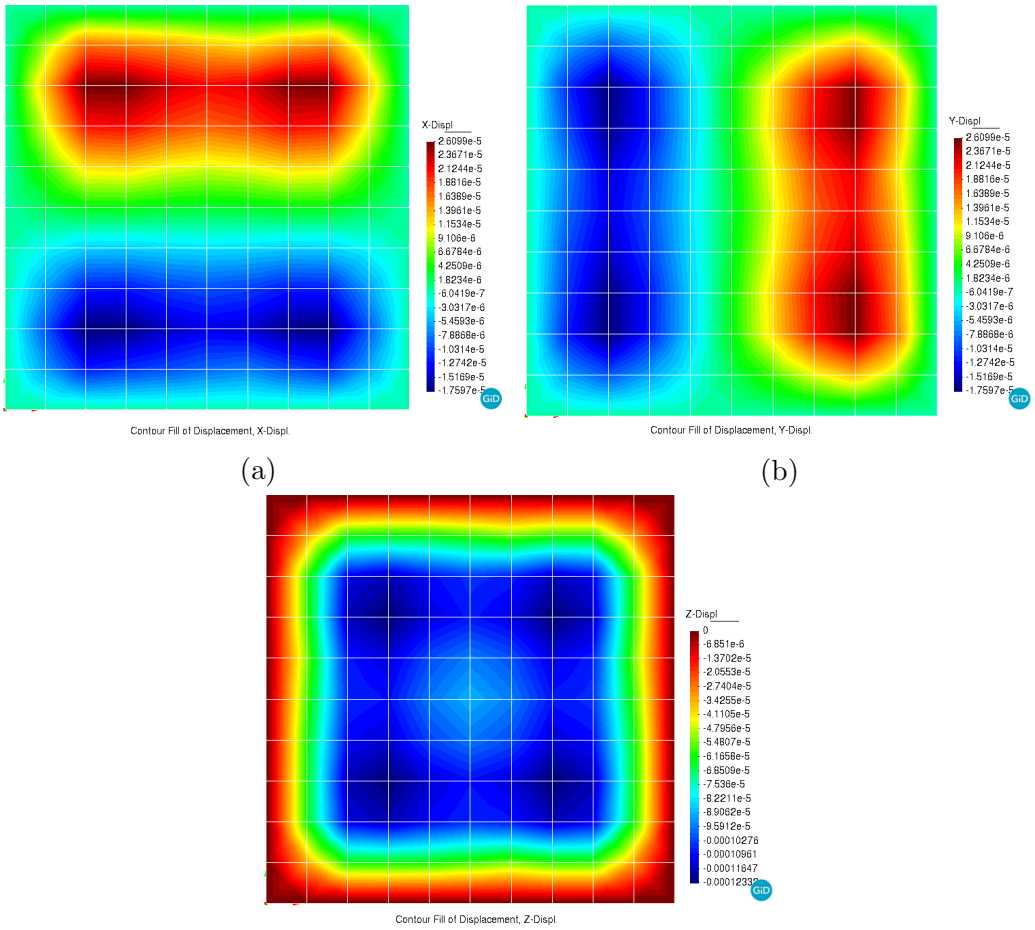


Fig. 3 – Displacement vector fields in the x (a), y (b) and z (c) directions

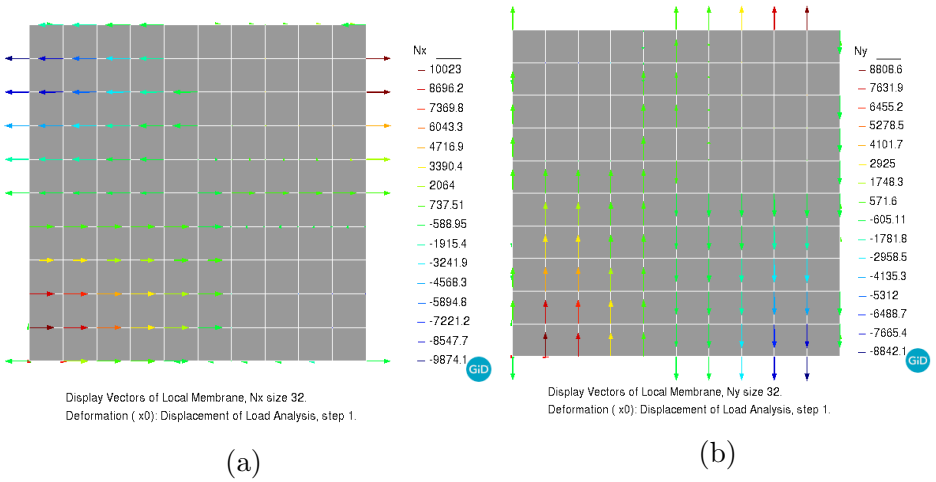


Fig. 4 – Local membrane vector forces in x (a) and y (b) directions

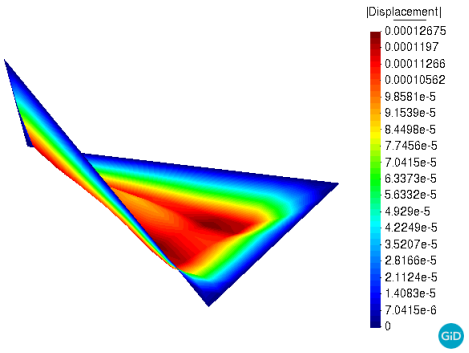
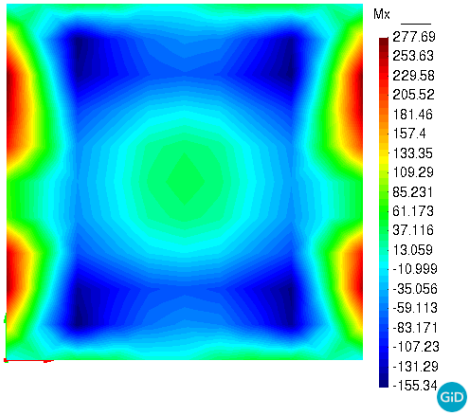
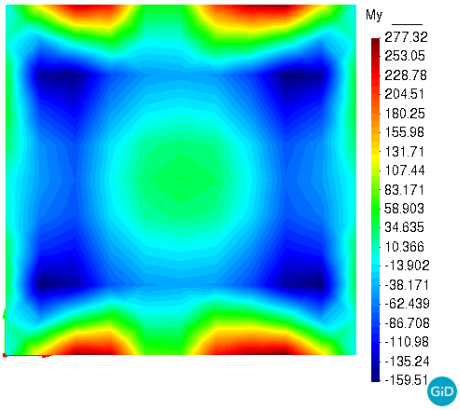


Fig. 5 – Deformed shape of the hyperbolic structure

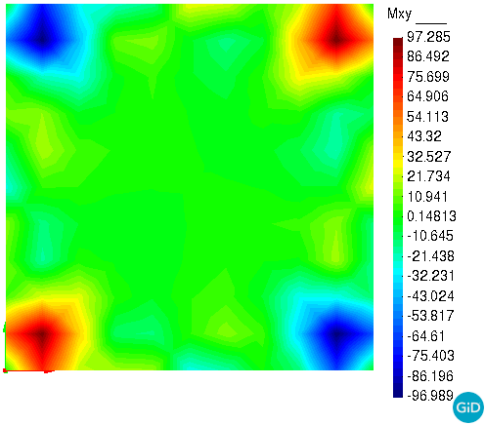
As shown in Figure (6), the highest M_x and M_y develop in the vicinity of the supports on both sides (superior/inferior and left/right) as well as in the area surrounding the center. This distribution can be explained considering that the shell transfers the loads through forces acting in place of its surface.



(a) Local Moment M_x



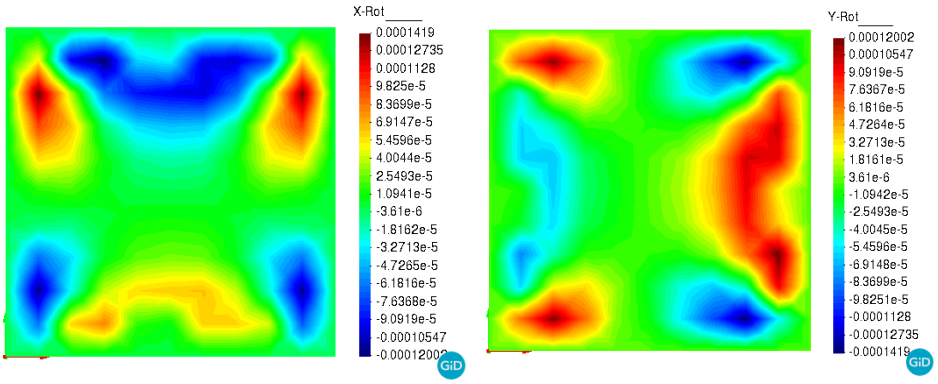
(b) Local Moment M_y



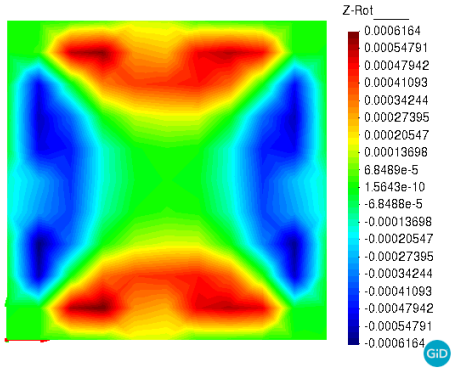
(c) Local Moment M_{xy}

Fig. 6 – Contours of local moments

Contours of the computed rotational strains and the corresponding shear forces are depicted in Figure (7) and (8), respectively.

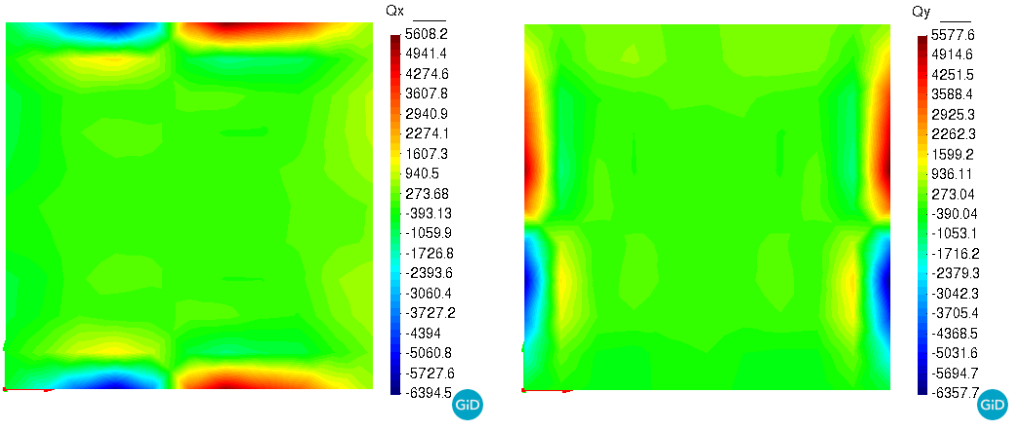


(a) Rotation x (b) Rotation y



(c) Rotation z

Fig. 7 – Contours of rotations



(a) Shear force Q_x (b) Shear force Q_y

Fig. 8 – Contours of shear forces