Computational Structural Mechanics and Dynamics

As8 Shell

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Shell

Analyze the following concrete hyperbolic Shell under self weight. Explain the behavior of all the Stress presented. $t = 0.1$.

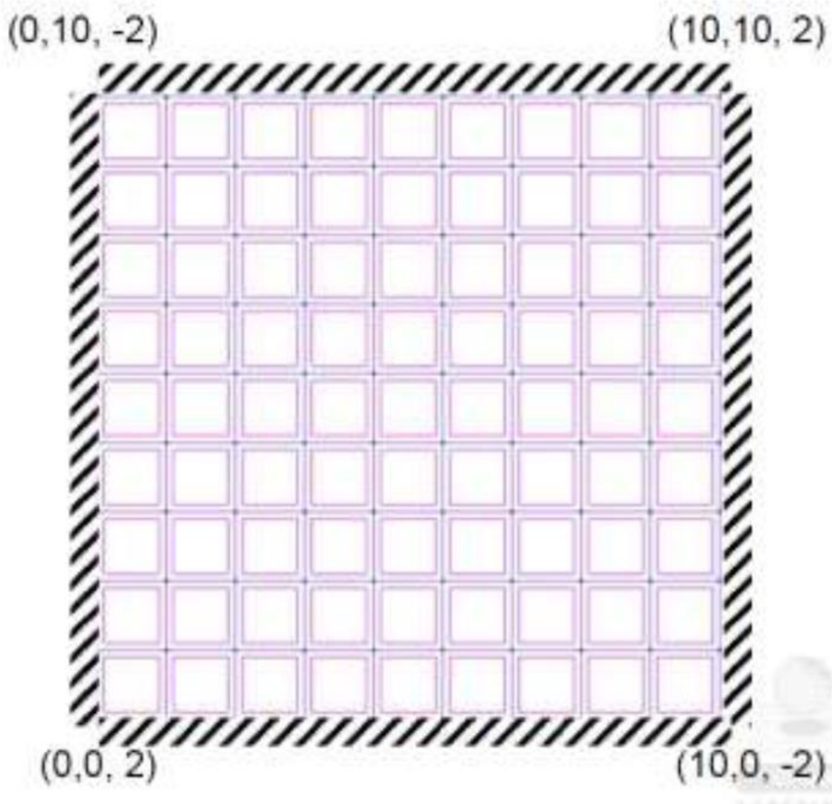

Fig.1 Hyperbolic shell

[Answer]

To simulate the shell, the input file has been written by GID problem 'MAT-fem_shell'. Then, we use the program of Matlab 'Shell_T_RM_v1.1' from the 'MAT-fem' website to solve it and check the results by GID as the post-processing. The variables are in the following:

$$E = 3e10\ Pa, \qquad v = 0.2, \qquad \rho g = 2.5e4 \frac{N}{m^3}, \qquad t = 0.1m,$$

We build the Geometry in GID.

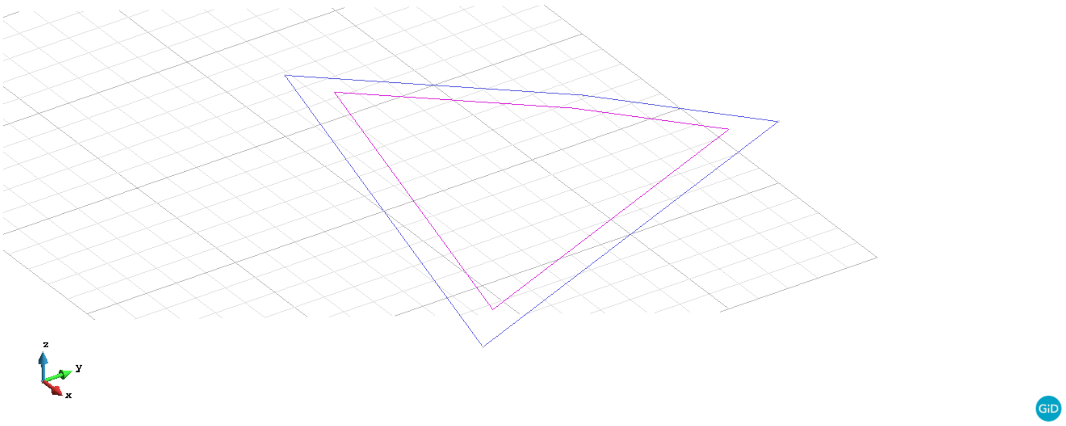

Fig.2 Geometry

Applying all clamped boundary condition, we fix all the edges:

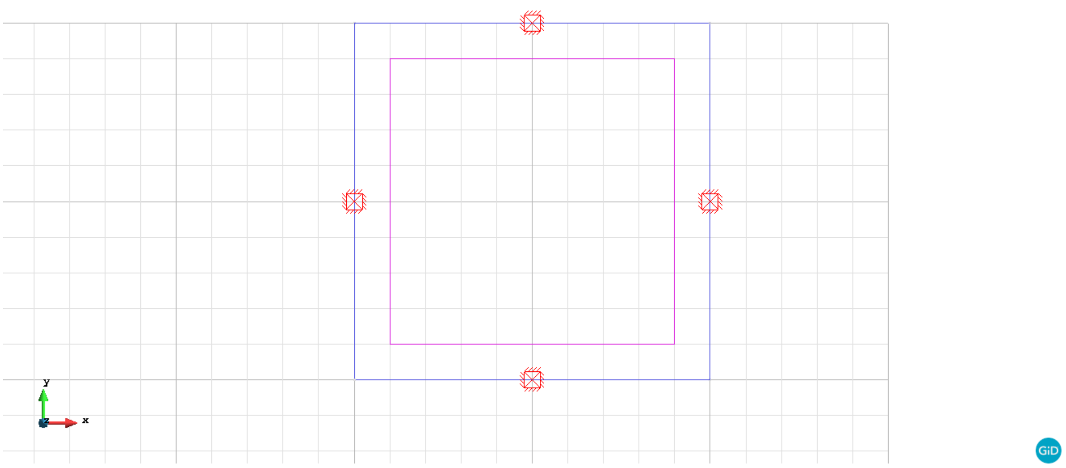

Fig.3 Boundary Condition

We applying 10×10 mesh on the shell, 121 nodes, 200 1st order triangle elements on the mesh.

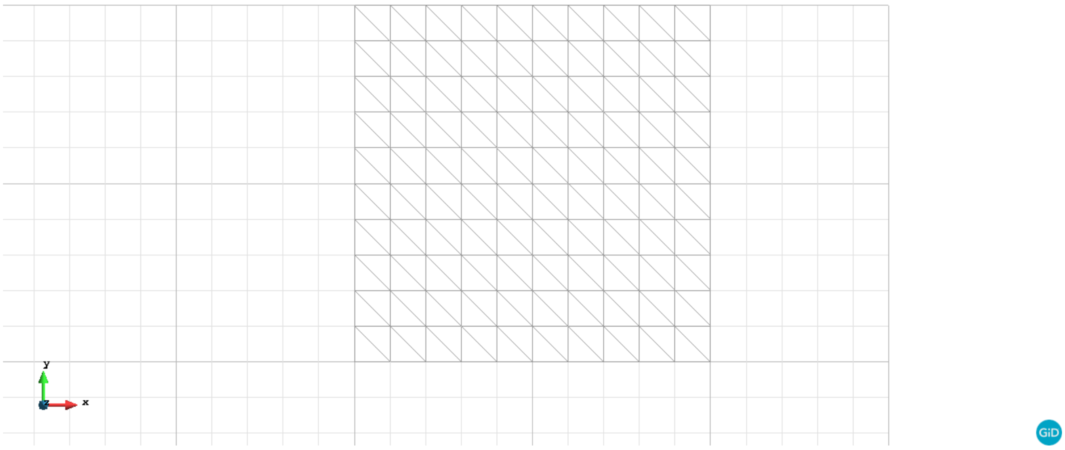

Fig.4 Mesh

We analysis the result from Displacement, Membrane stress, Moment and Shear stress.
First, we investigate the displacement:

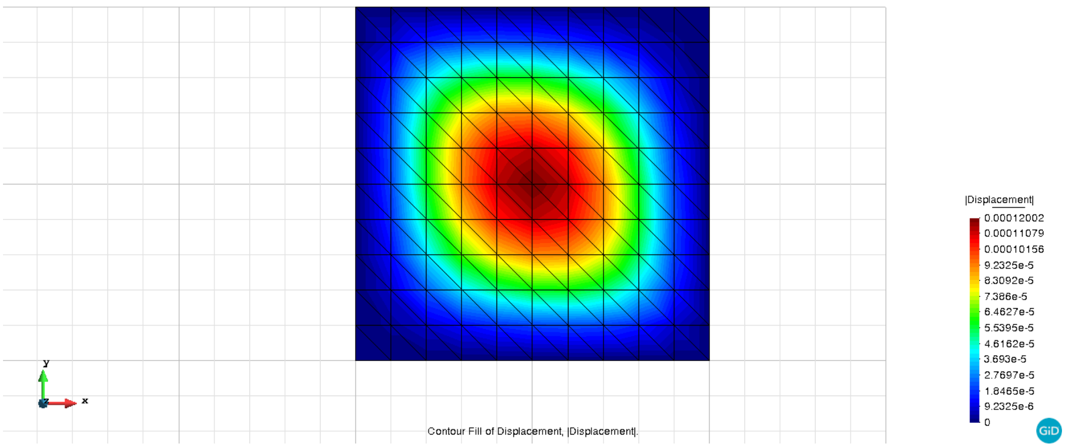

Fig.5 Displacement

As expected, the displacement is larger in the central of this structure. They are mainly in the z-direction.

Second, we investigate the membrane stresses

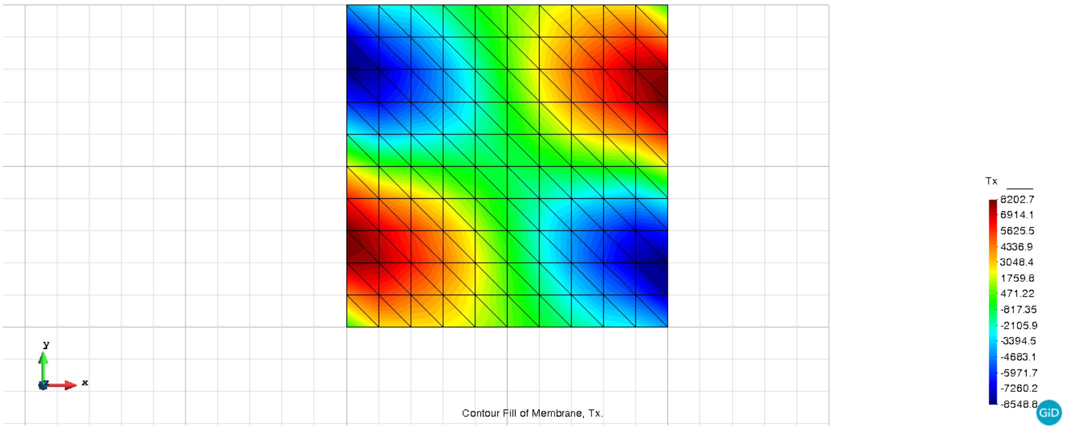

Fig.6 Tx

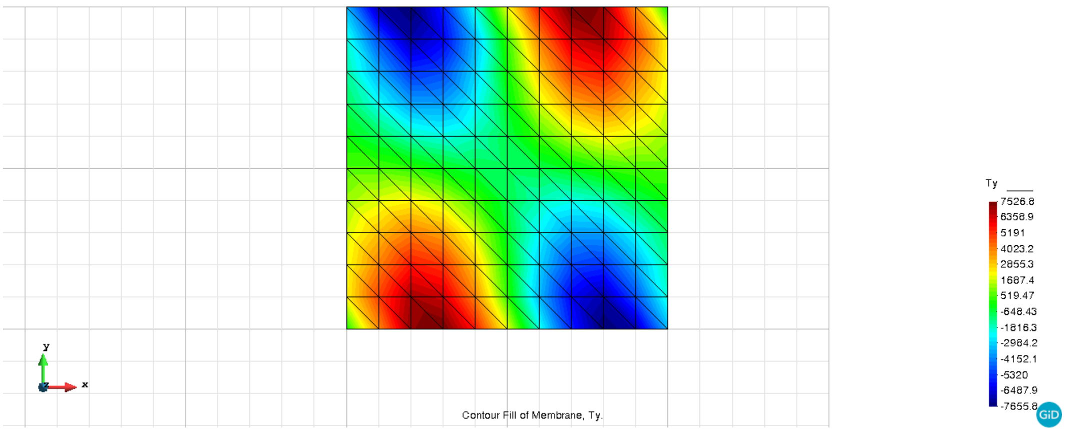

Fig.7 Ty

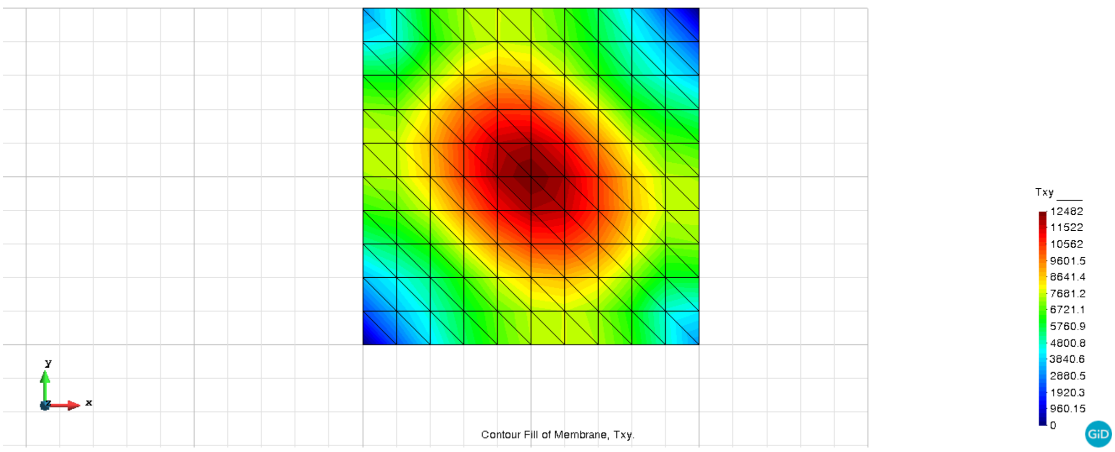

Fig.8 Txy

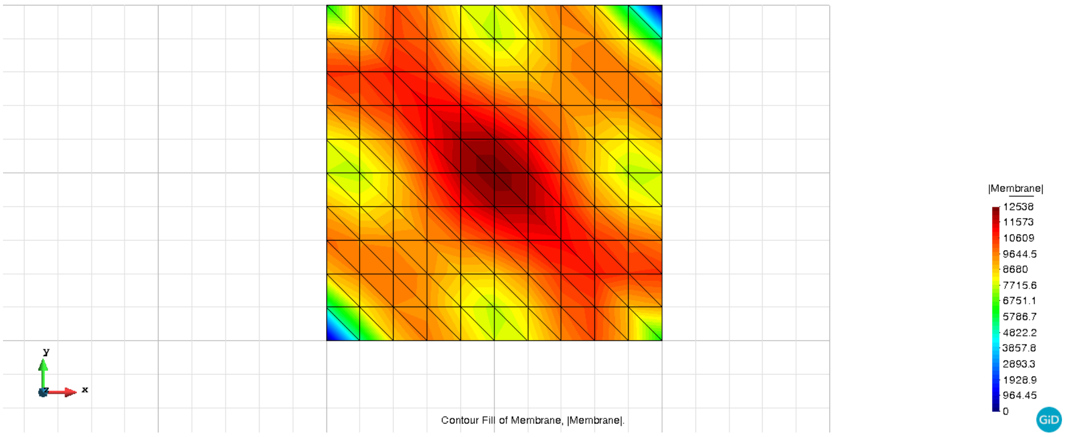

Fig.9 Norm of Membrane stress

The membrane stress Tx and Ty are concentrated on the boundary of the domain and preserve anti-symmetry along the diagonal. Meanwhile, Txy is concentrated on the central of the domain. On engineering, we focus on the norm of Membrane because it is related to the material safety and material choice.

Then, we investigate the moment.

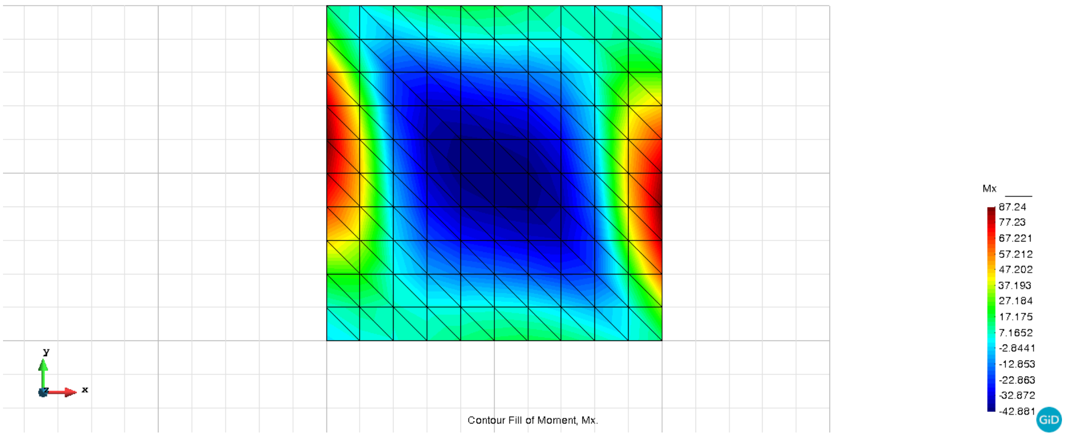

Fig.10 Mx

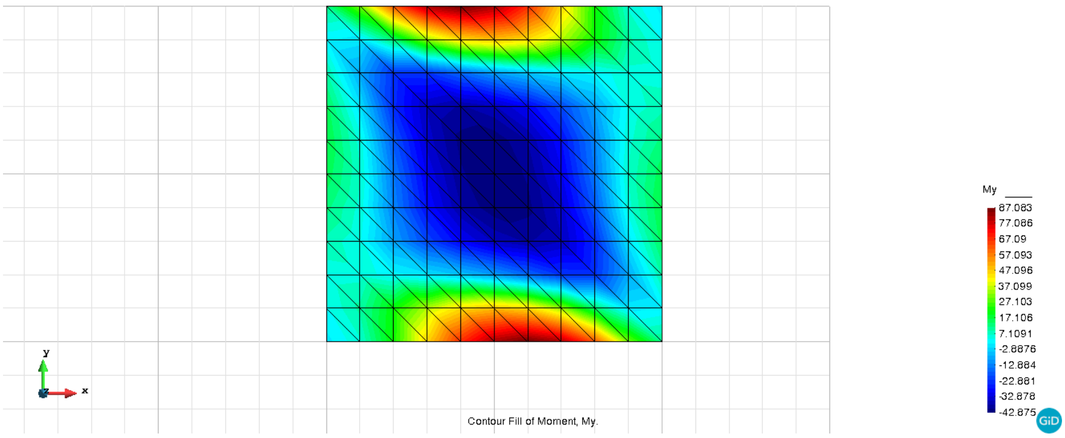

Fig.11 My

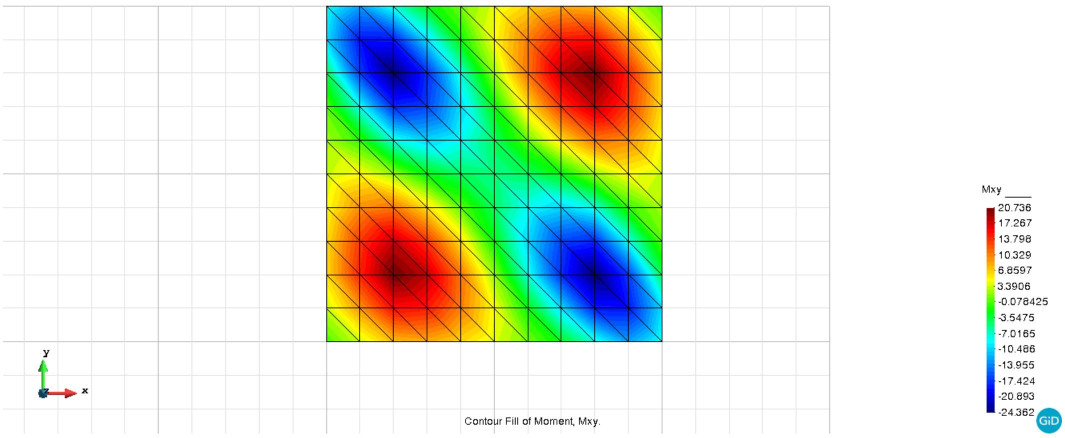

Fig.12 Mxy

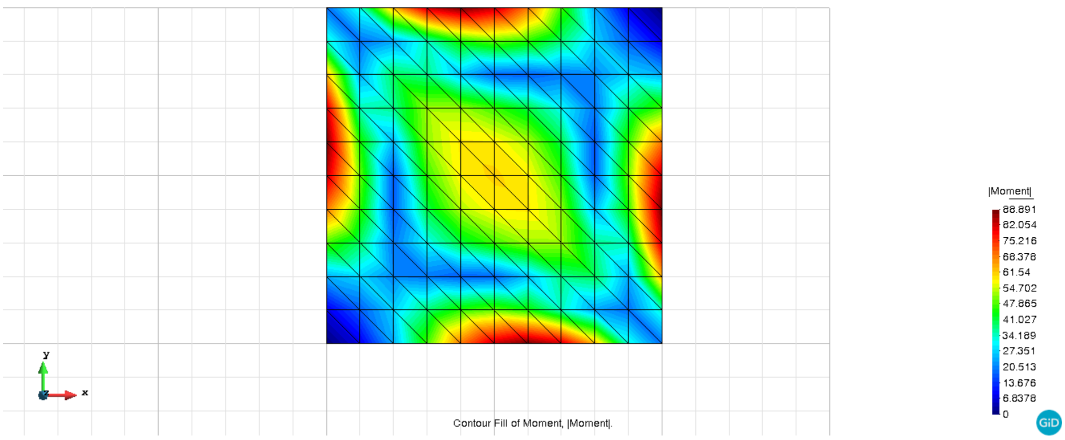

Fig.13 Norm of moment

Mx and My show the same behavior which are concentrated on the edges of the geometry since the edges are clamped. Meanwhile, the Mxy and norm of moment show symmetry in the result.

Finally, we investigate the shear stress.

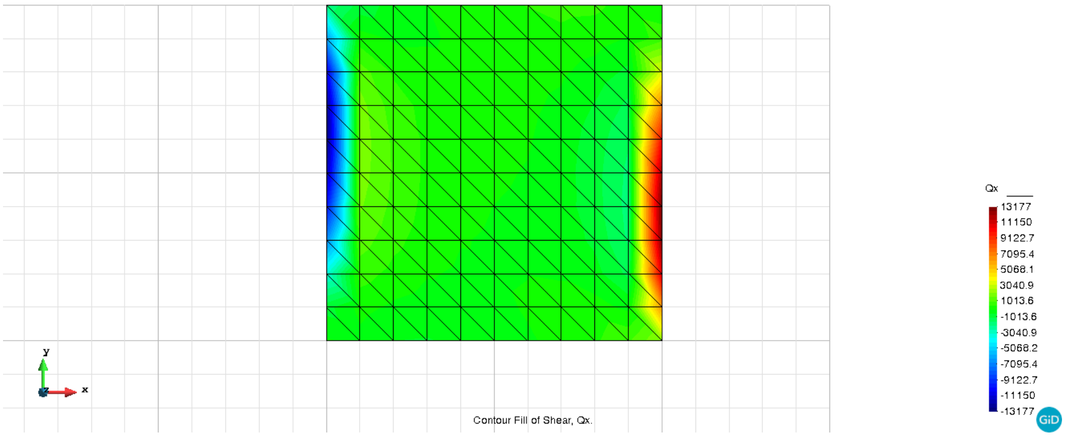

Fig.14 Shear stress-x

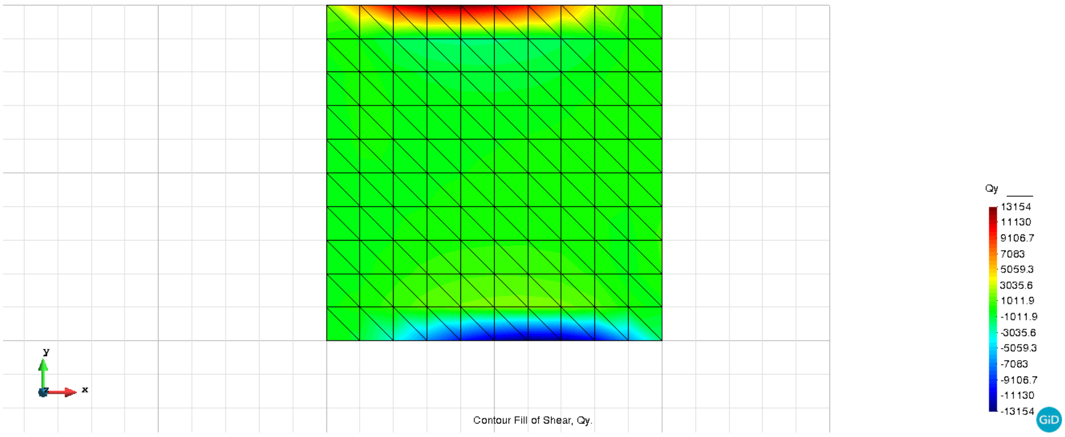

Fig.15 Shear stress-y

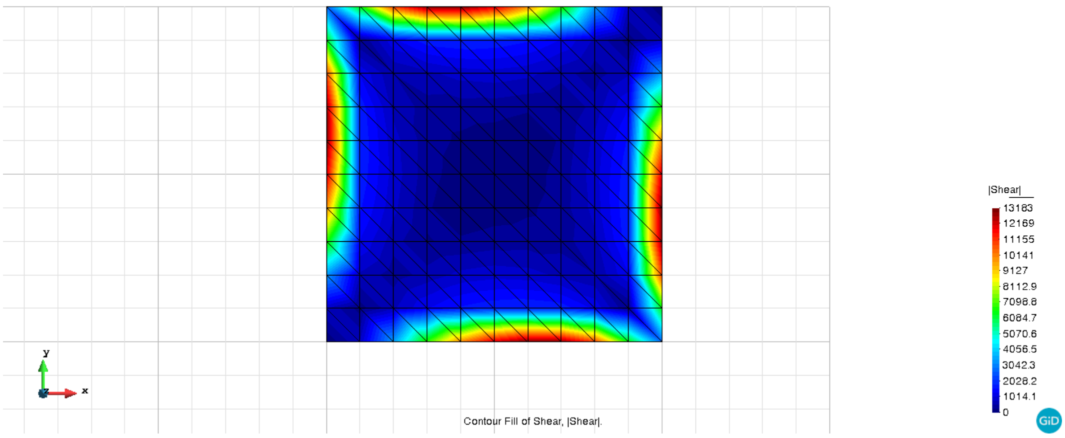

Fig.16 Norm of Shear stress

Again, the shear stress Qx and Qy are also concentrated around the boundary and present anti-symmetry. Since all the boundary's displacement are set to 0 while the boundary must support all the structure's self-weight, huge shear stress appears around the boundary.