

**Master on Numerical
Methods in Engineering**

Computational Structural Mechanics and
Dynamics

Assignment 8

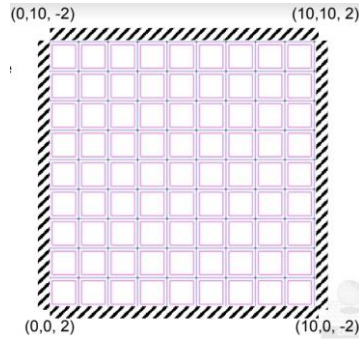
Shell theory

- Reissner-Mindlin Theory

Use of Matlab and GiD software

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Analyse the following concrete hyperbolic shell under self-weight.
Explain the behaviour of all the stresses presented.
 $t=0.1$



Pre-processing:

- In order to ease the process, geometry is defined in GiD software. Straight lines are defined by default. Resulting NURB surface is converted into a hyperbolic shape by using *Geometry* → *edit* → *Edit nurbs* → *surface*

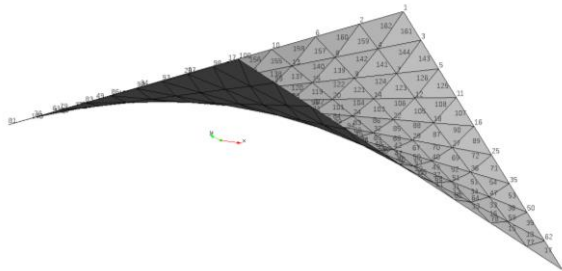


Figure 1. Nurb surface geometry used to solve the problem

- Mesh is defined as 3-noded triangle¹ elements. Nodes are distributed as follow (Fig.2).

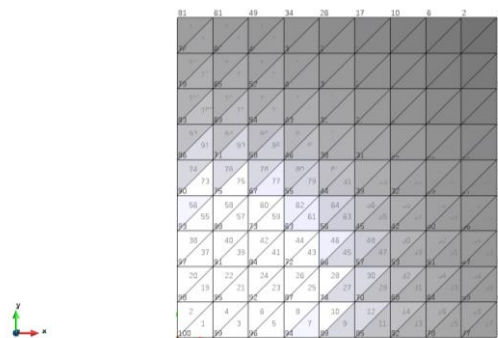


Figure 2. Mesh definition

¹ 4-noded quadrilateral elements: in order to compute this element, code must be edited from three to four Gauss points.

Relevant data for the problem description is as follow:

```

%
% Material Properties
%
young = 2.1 ;%concrete
poiss = 0.3 ;
thick = 0.1;
denss = 1 ;
%
% Coordinates
%
global coordinates
coordinates = [
10.00000000 , 10.00000000 , 2.00000000 ;
8.88888889 , 10.00000000 , 1.55555556 ;
10.00000000 , 8.88888889 , 1.55555556 ;
8.88888889 , 8.88888853 , 1.20987643 ;
10.00000000 , 7.77777778 , 1.11111111 ;
...
% Fixed Nodes for all the boundary nodes
%
fixdesp = [
1 , 1 , 0.0000 ;
1 , 2 , 0.0000 ;
1 , 3 , 0.0000 ;
1 , 4 , 0.0000 ;
1 , 5 , 0.0000 ;
2 , 1 , 0.0000 ;
2 , 2 , 0.0000 ;
2 , 3 , 0.0000 ;
2 , 4 , 0.0000 ;
...

```

Post-processing – Stresses analysis

First, defined local coordinates will be reviewed. They are as assigned during pre-processing so results are expected to be correct (Figure 3). Stresses are plotted in local coordinate system.

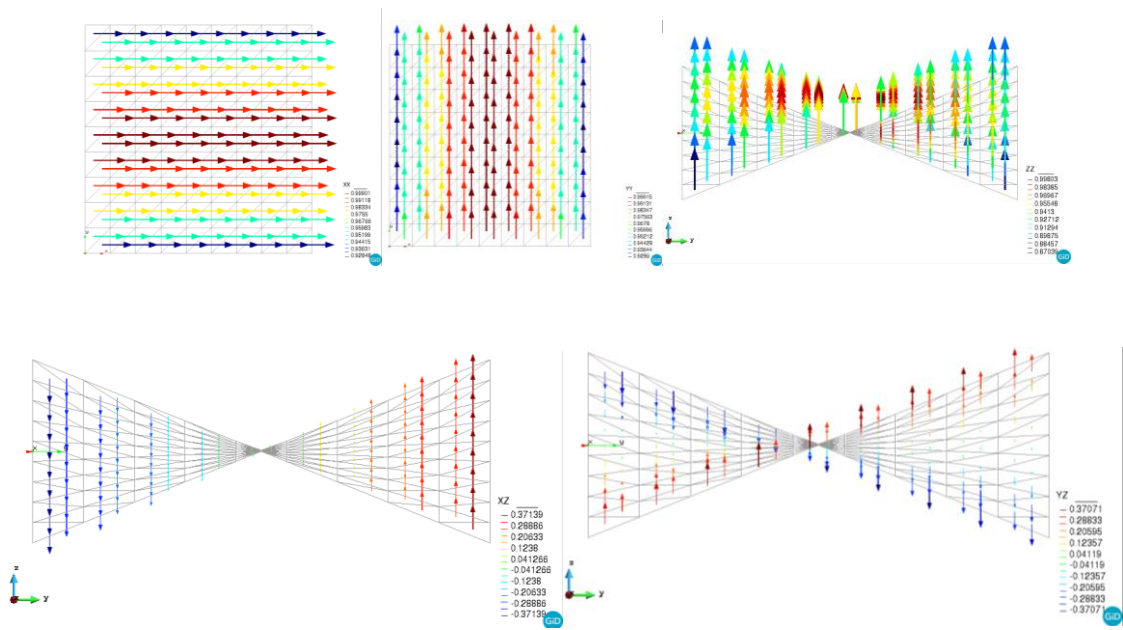


Figure 3. Vector's direction for XX, YY, ZZ, XZ and YZ

Membrane stresses

They are the axial stresses in the shell. Values from T_x and T_y remain close zero while in the area near nodes with $z=-2$ values are negative and for $z=2$ values are positive. However, magnitude stresses are similar for both axes. It has an axisymmetric behaviour (Figure 1).

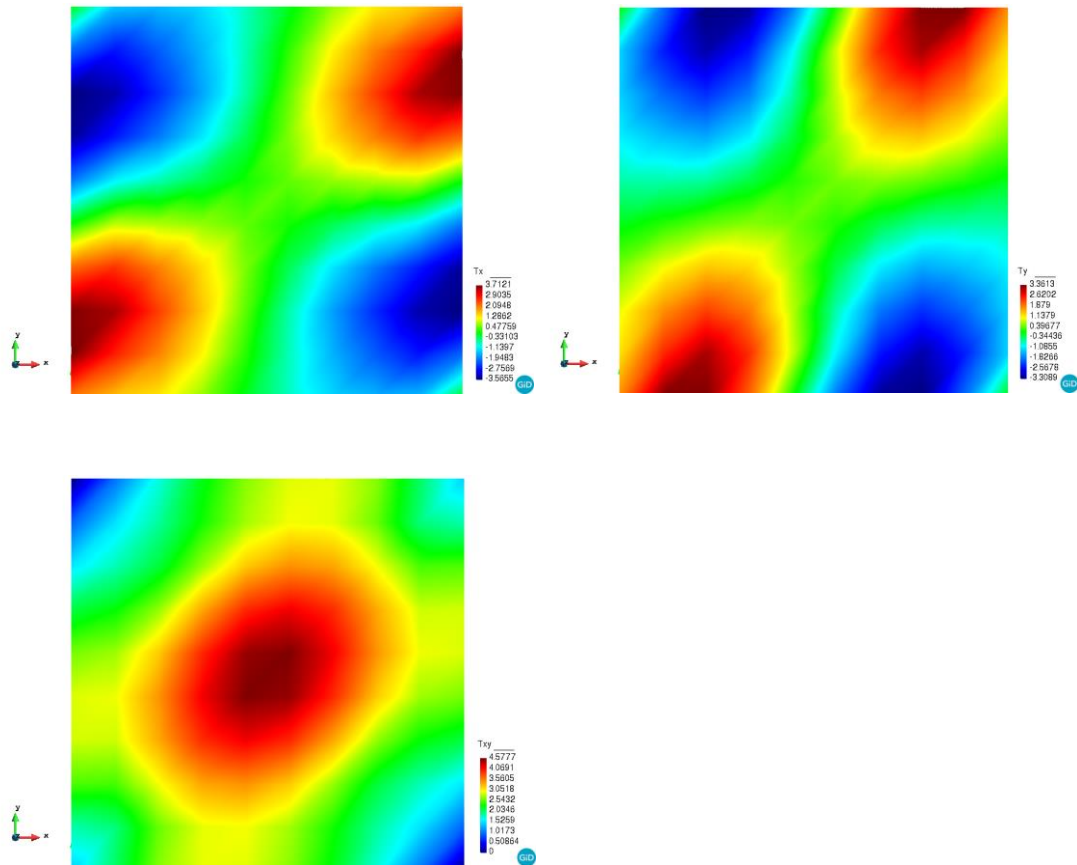


Figure 1. Membrane stresses T_x , T_y , T_{xy} . Contour lines plot

Bending stresses

Figure 2 represents momentum caused by the stresses orthogonal to the surface shell. In general, these stresses are low or zero in the central shell area for X and Y axes.

If drawing the diagonal from node 1 to node 100, M_{xy} , negative values are in both sides. It might be for the geometrical distribution as well as the self-weight effect plus the geometrical definition of the shell. In this case, clamped effects are especially noticeable on the 4 fixed sides.

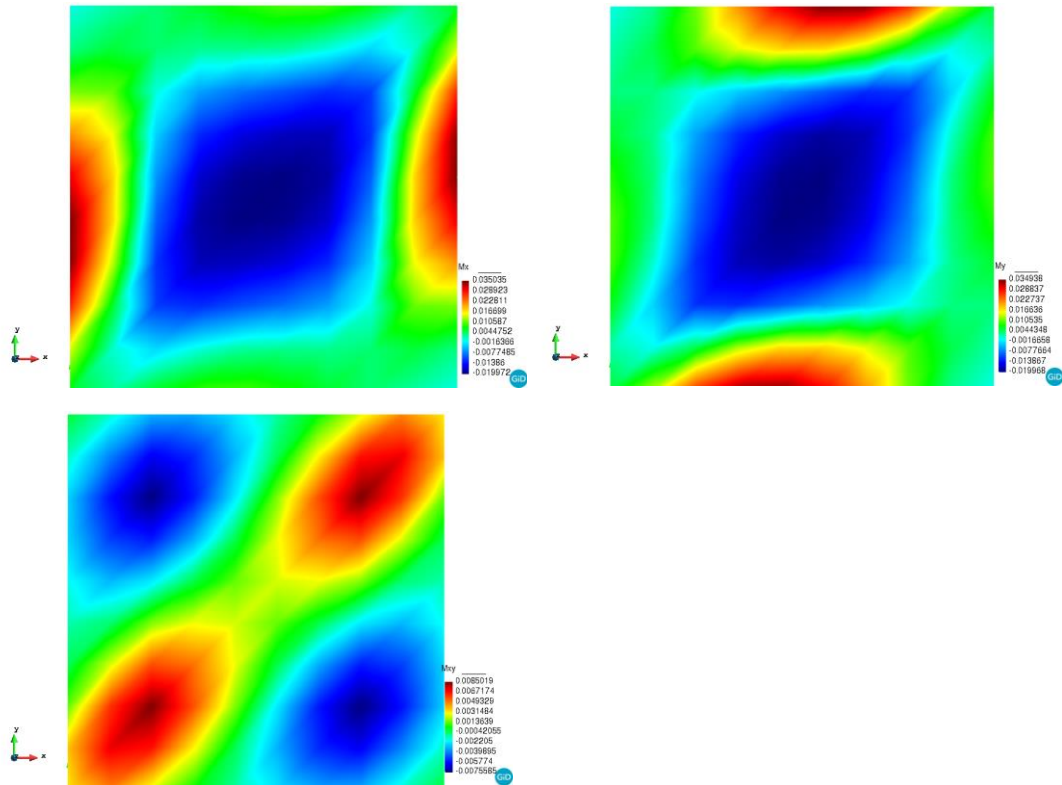


Figure 2. Momentum stresses M_x , M_y , M_{xy} . Contour lines plot

Shear stresses

They are the orthogonal to the other two that were already mentioned. It is interesting to notice that significant values only occur in an area where the positive value of the axis where the results are studied are the highest for both, x and y axes. The lowest value is in the opposite side. Shear stresses in the remaining area seems to be neglected.

Values must be defined this way due to clamping effects.

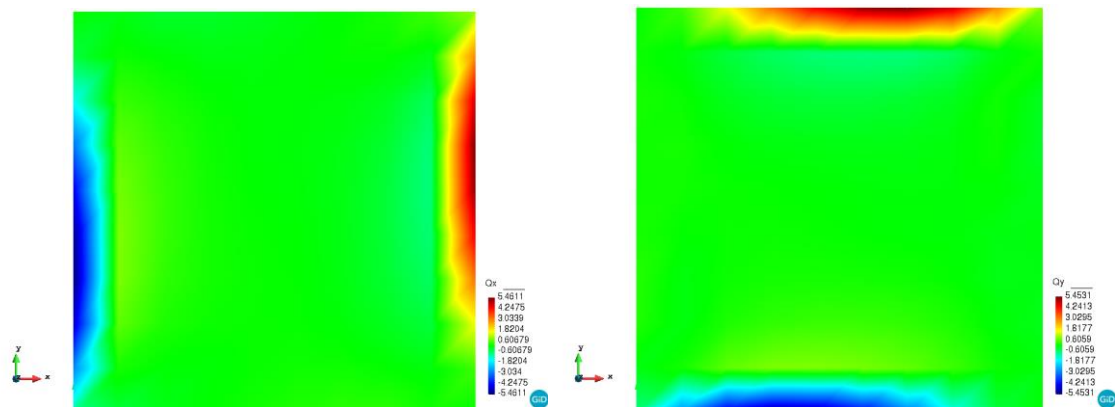


Figure 3. Shear stresses Q_x , Q_y . Contour lines plot