CSMD HW 3

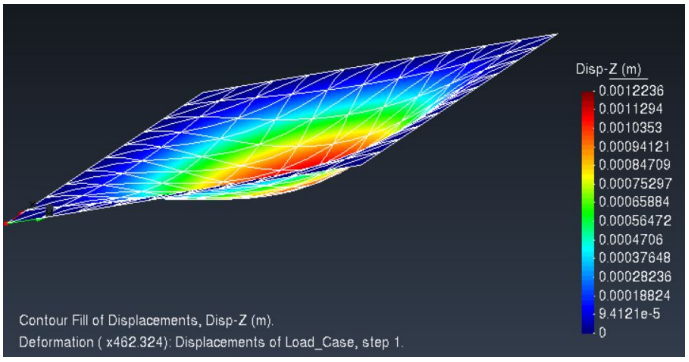
Garcia Albela, Cristina
Youssef, Aly
Hanna, John

1 Problem 1

A clamped quadratic plate, subjected to a uniform load, is being studied. The analysis is being carried out using 3 different element types: triangular DKT, triangular RM and quadratic CLLL. The obtained deflection is to be compared with the analytical solution calculated as:

$$u_z = \frac{12(1-\nu^2)\alpha q L^4}{Et^3}$$

where $\alpha = 0.0012567$, q is the uniform load, E is the Young's modulus, ν is Poisson's ratio, t is the thickness, L is the side length for a square plate.

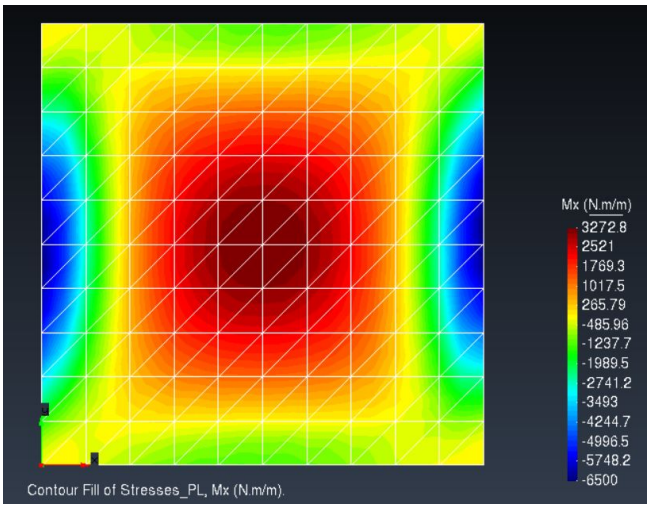


deformation using RM elements

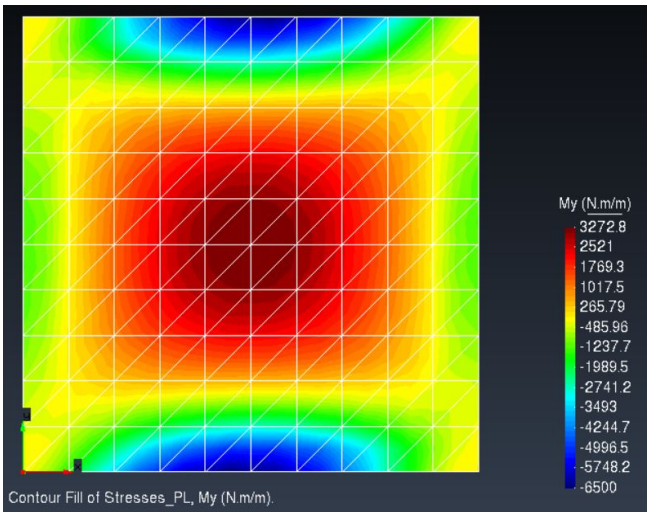
As shown in the above figure, the displacement is zero at the clamped edges and is maximum at the center of the plate as expected.

	DKT	RM	CLLL	Analytical
DOF	441	441	441	
u_z	-0.001249834	-0.001223569	-0.001254849	-0.00123539
error(%)	1.169	0.9565	1.575	

Displacements are being compared using the 3 different element types. RM elements provides the best result since it uses quadratic approximation. However, the 3 elements gave acceptable results.

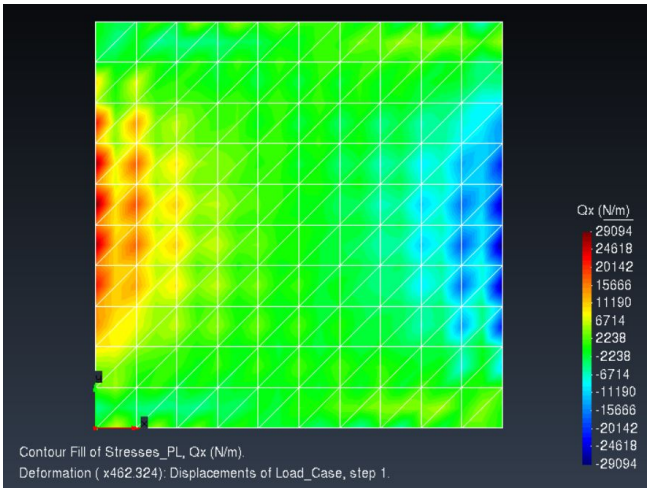


Mx for RM elements

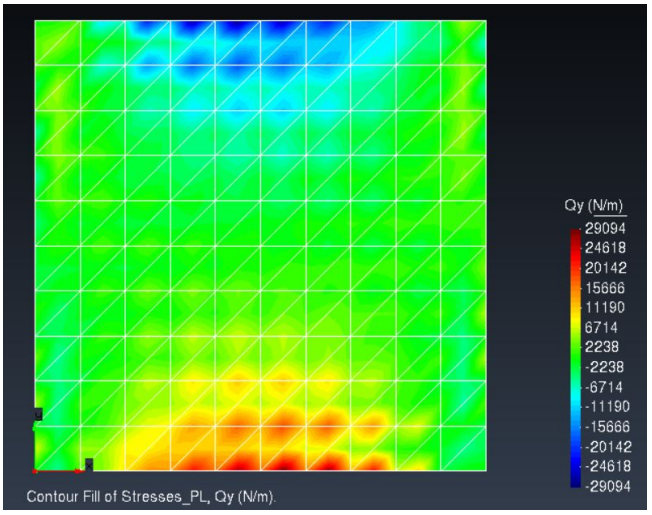


My for RM elements

For both directions due to bending moments, maximum positive stress moment is obtained at the center of the plate. Then, the maximum negative stress moment occurs at the mid point of the side normal to the axis.



Qx for RM elements

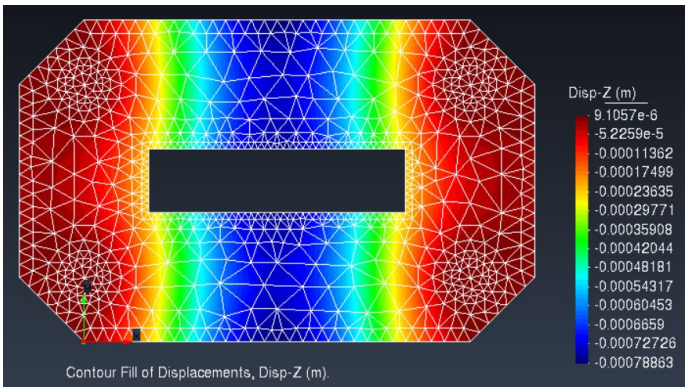


Qy for RM elements

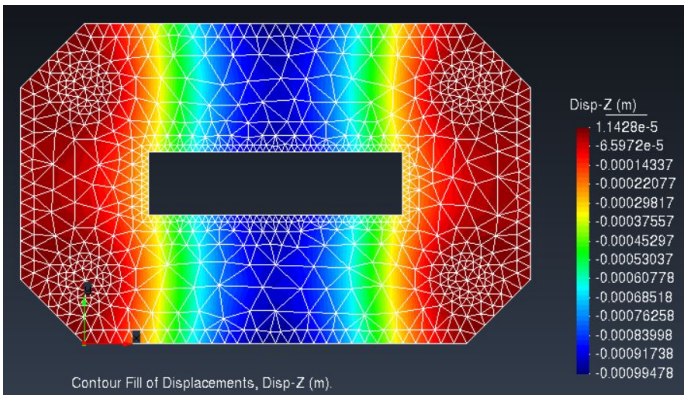
Shear stress are showed in the above figures. Due to the uniform load, it takes value zero at the mid plate and maximums occurs at the fixes sides perpendicular to the studied axis.

2 Problem 2

The structural behaviour of a steel plate supported by 4 columns,limiting the motion in the z-direction, is going to be analyzed using triangular DKT elements. Uniform load is applied on all the surface. The mesh is refined near the supports as well as around the center hole, a critical zone, in order to obtain better results. The effect of self weight is studied too by doing analysis with and without it.

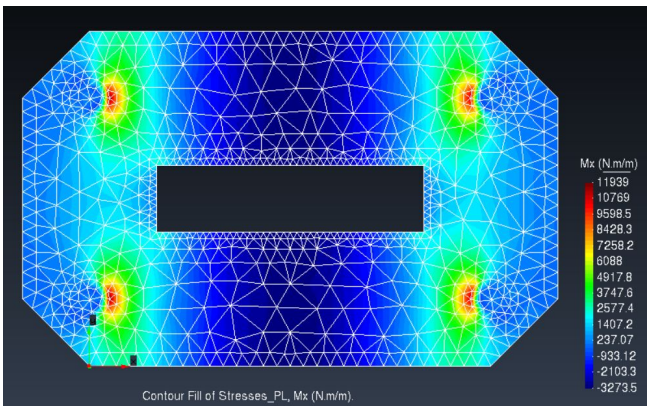


Displacement without self weight

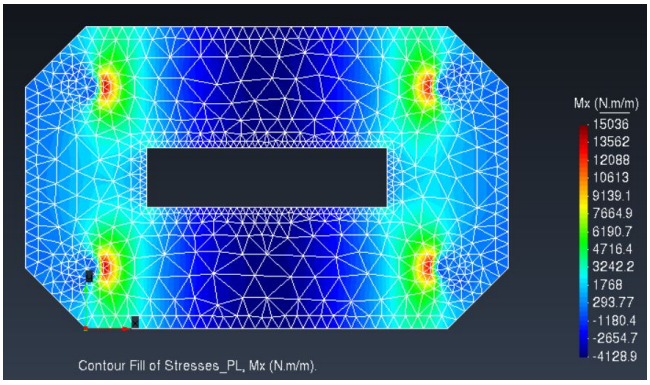


Displacement with self weight

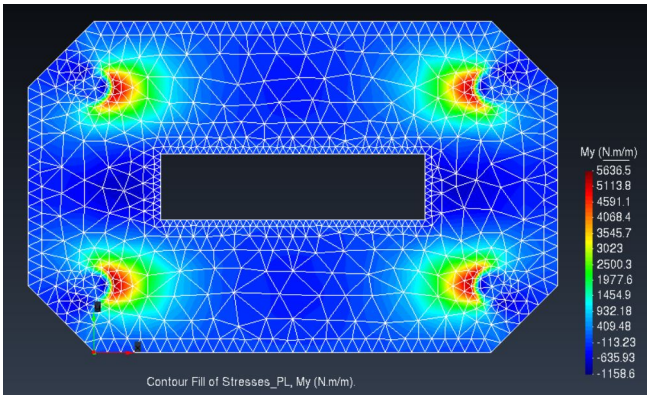
Due to the geometry of the plate, longer dimension in the x-direction, it could be expected that the maximum deflection would occur at the middle plate along the x-axis. This effect would be more pronounced due to the presence of the rectangular whole in the middle of the pate. This reduction in material would result in a decrease in the decrease of the plate's resistance to deformation at the mid-plate. The distribution of the displacement is the same for both cases of considering self weight or not. The only difference is that the magnitude of deflection is higher when self weight is considered. Small positive displacements are obtained at the ends due to the reaction done by the supports.



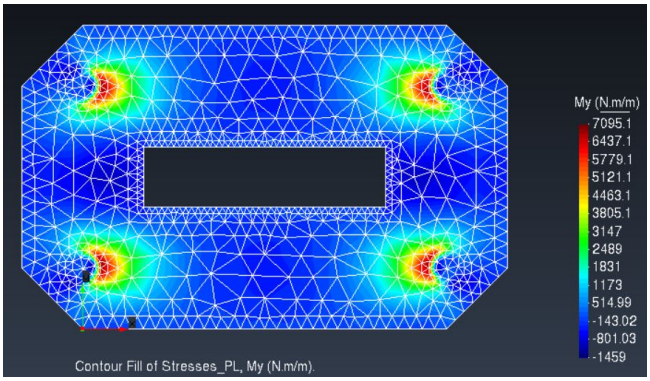
Mx without self weight



Mx with self weight



My without self weight

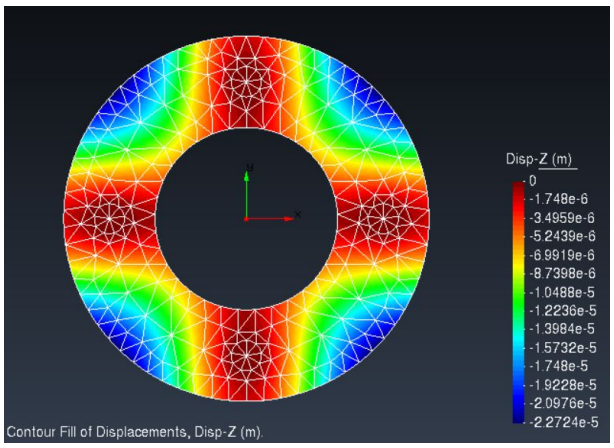


My with self weight

As for the stress moments, the behaviour for the two cases is almost the same apart from the magnitudes, that are higher when self weight is considered. Maximum negative values for Mx occur at the mid-plate as this is the region of maximum deflection. Maximum positive values for Mx and My occurs near the supports, because of the reaction forces. There effect is extenuated due to stress concentration as the reaction is not evenly distributes. These maximum positive values are directed towards the mid-plate due to the bending experienced by the plate.

3 Problem 3

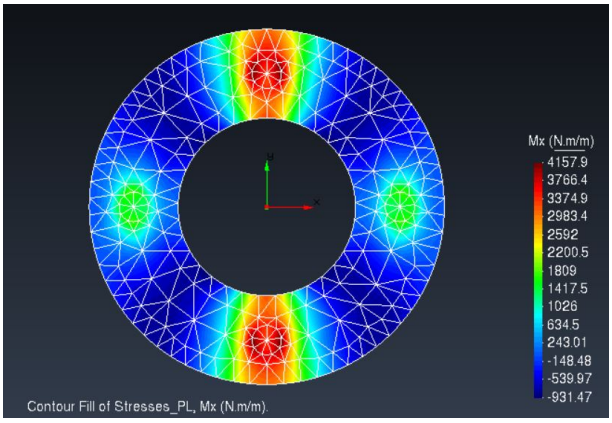
The structural behaviour of a reinforced concrete plate supported by 4 columns,limiting the motion in the z-direction, is going to be analyzed using triangular RM elements. Uniform load is applied on all the surface and self weight is being considered. Due to the limited number of nodes, refinment is barely done near the supports.



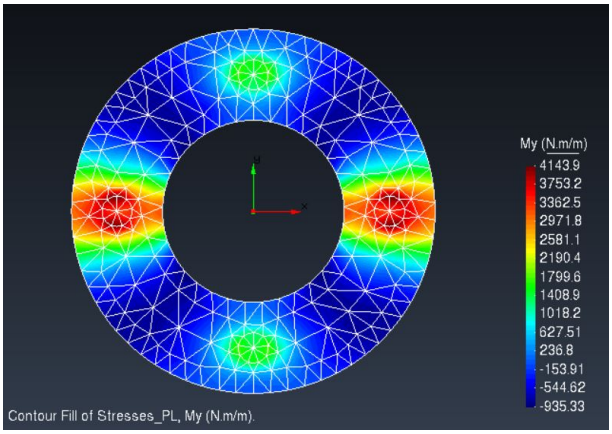
z-displacement

It could be seen that the the geometry of the plate and how it is supported exhibits symmetry about the x and y

axis.Thus, the obtained distribution of the displacement is symmetric about the x and y axis. The maximum displacement is obtained at the furthest points from the supports.



Mx



My

Again, due to the symmetric nature of the problem in hand the maximum values for the moment stress occurs at the middle of the plate perpendicular to the axis depending on the direction being considered. Stresses also occur at the supports due to the reaction exerted by them on the plate.