Universitat Politecnica de Catalunya CIMNE
Master in Computational Mechanics

# Computational Structural Mechanics & Dynamics

# Assignment 7

## Plates

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# Part a :

Analyze the shear blocking effect on the Reissner Mindlin element and compare with the MZC element. For the Simple Support Uniform Load square plate.

Use the 5x5 Mesh.

E= 10.92
v= 0,3
Q = 1.0

t = 0,001

t = 0,010

t = 0,020

t = 0,100

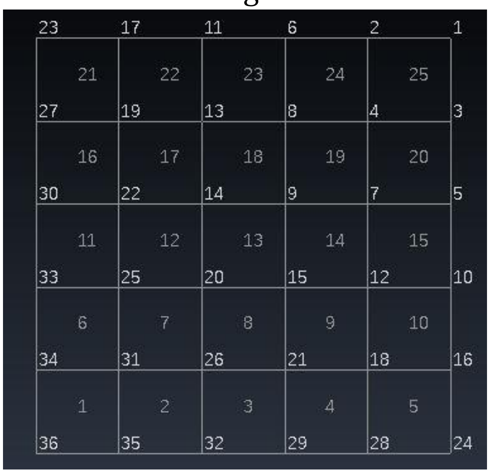
t = 0,400

Discuses the results observed.

## Solution:

The goal of this assignment is to compare RM and MZC elements for simply supported uniform load square plate. We are using a 5x5 mesh for the purpose. Different thicknesses for the plate elements are being analysed here.
The geometry of the plate has to be created in GiD by loading the 'MAT-FEM Plates' problemtype. Keeping the material properties of the plate constant, and varying the thicknesses given, an input file for MATLAB program of RM plate element and MZC plate element has to be generated. Then, this generated file is used in the RM and MZC MATLAB codes downloaded from MAT-FEM website. After running this code, it generates a result file which can be viewed for the displacement, moment and force results.
The boundary conditions imposed on the plate were 'fixed displacement in vertical direction, and allowing rotations in both directions' on the edges of the plate. A uniform load of value 1 unit was applied over the plate.

Shown below is the picture of the 5x5 mesh generated for analysing the plate.




Mesh generated for the plate element

The maximum values obtained for displacement and moments for both the RM and MZC element by varying the thickness values for different cases have been tabulated below. For plotting purposes absolute values of results have been taken.

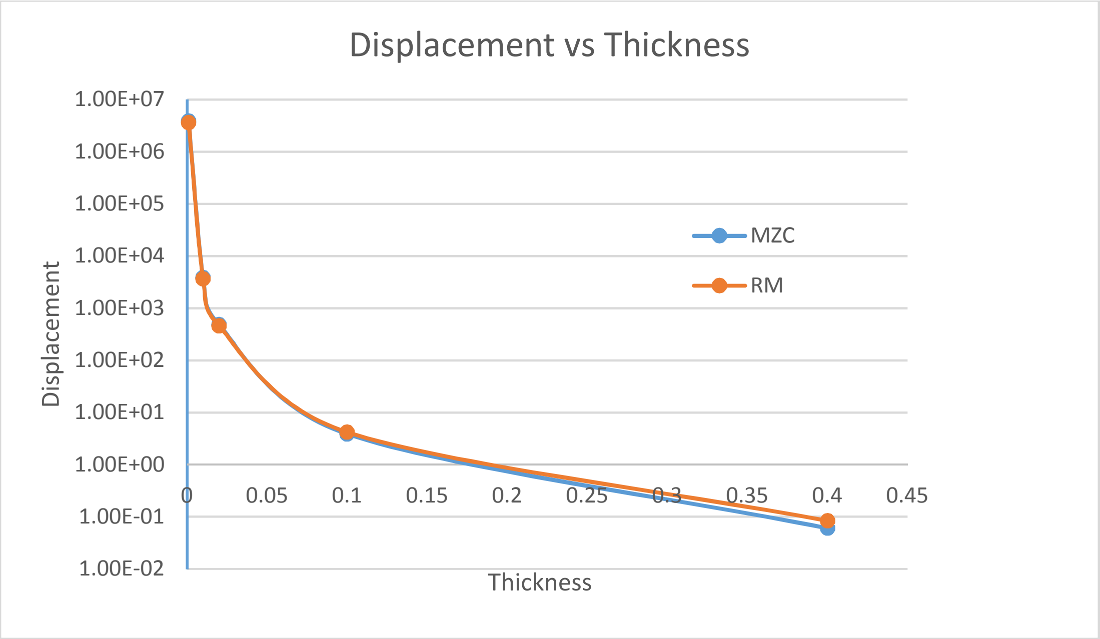
| Displacement | | |
|---|---|---|
| t | MZC | RM |
| 0.001 | 3.86E+06 | 3.64E+06 |
| 0.01 | 3.86E+03 | 3.65E+03 |
| 0.02 | 4.83E+02 | 4.59E+02 |
| 0.1 | 3.86E+00 | 4.18E+00 |
| 0.4 | 6.03E-02 | 8.38E-02 |

Results for Max. Displacement for MZC and RM Element

| Moment | | |
|---|---|---|
| t | MZC | RM |
| 0.001 | 4.74E-02 | 4.42E-02 |
| 0.01 | 4.74E-02 | 4.43E-02 |
| 0.02 | 4.74E-02 | 4.45E-02 |
| 0.1 | 4.74E-02 | 4.88E-02 |
| 0.4 | 4.74E-02 | 5.40E-02 |

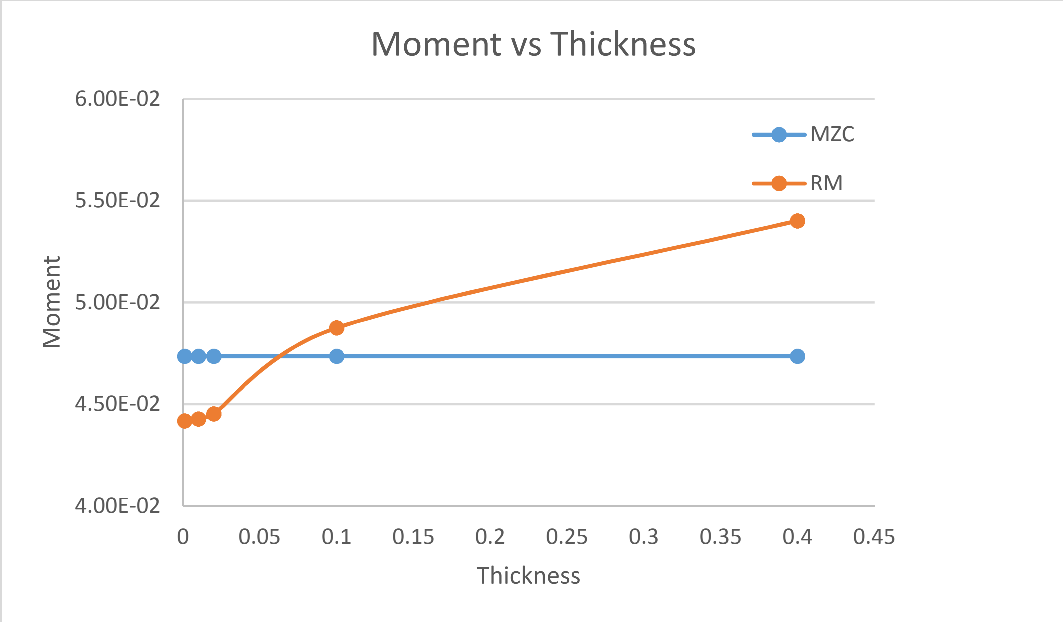
Results for Max. Moment for MZC and RM Element

Shown below are the log plots of maximum displacement and moments against different thickness values. These graphs represent the comparison of RM and MZC plate elements.




Comparison of graphical results for MZC and RM elements with respect to max. displacement

The displacement of both the elements shows a lower value with increase of thickness. At lower thickness values, both the elements exhibit almost the same behaviour with negligible difference in the max. displacements, but as the thickness increases the difference starts to become more prominent. The RM element shows lower displacement values as compared to the MZC element because of shear blocking effect at lower thicknesses.




Comparison of graphical results for MZC and RM elements with respect to max. moment

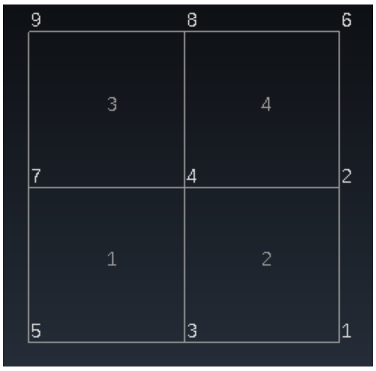
As seen from the moment graph comparison, the MZC element shows constant values for all thickness while there is a notable change in behaviour of the RM element which shows very less values for moments at small thickness, but these values tend to increase with the increase in thickness. The MZC element though gives a more stable solution for moments for varying thicknesses.

# Part b:

Define and verify a Patch Test for a MCZ Element and discuss the results observed.

## Solution:

The patch test aims basically to verify whether the Finite Element solution goes hand-in-hand with the exact solution. In this test, the nodes at the boundary of the patch are prescribed with some known displacement field, and the results obrained by the nodes inside the patch are observed. The results typically are the displacements. The element passes the patch test if the displacement values of the inner nodes are similar to the prescribed displacement at the boundary nodes of the patch. Thus, in short, displacing the patch as a rigid body.
In the scope of this assignment, a patch test has been applied to a MZC element. The patch used for analysis is shown below:



Mesh generated for the plate element

The boundary nodes of this patch have been prescribed by a unit vertical displacement in Z-direction while the rotations have been restrained. All the material properties and forces are kept same as the earlier part of this assignment with thickness 0.1. Thus, in order to satisfy the patch test, here the middle node should show displacement as '1' which will be similar to the prescribed displacement field at the boundary. Shown below are the prescribed conditions and coordinates for different nodes.

| Node | Location of Node | Coordinates x | Coordinates y | Prescribed Displacement |
|---|---|---|---|---|
| 1 | Boundary | 1 | 0 | 1 |
| 2 | Boundary | 1 | 0.5 | 1 |
| 3 | Boundary | 0.5 | 0 | 1 |
| 4 | Inner | 0.5 | 0.5 | - |
| 5 | Boundary | 0 | 0 | 1 |
| 6 | Boundary | 1 | 1 | 1 |
| 7 | Boundary | 0 | 0.5 | 1 |
| 8 | Boundary | 0.5 | 1 | 1 |
| 9 | Boundary | 0 | 1 | 1 |

Prescribed BC for different nodes

After generating the geometry of the patch in GiD, the Matlab file is obtained and it is given to the MZC plate Finite Element code which generates a result file in MATLAB. This file is post-processed by using GiD and the displacement results are obtained. The patch therefore passes the patch test as the results prescribed initially have been obtained after the analysis. The results for the middle node are shown below:

| Node | Z - Displacement | X - Rotation | Y - Rotation |
|---|---|---|---|
| 4 | 1 | 1.5268400E-14 | 2.6353000E-15 |

Results for node 4

Thus, it can be seen that result displacement in Z direction is equal to the prescribed displacement field and since the rotation values have a very high negative 10 power, it is approximately 0. Hence, the patch test has been successful.