Computational Structural Mechanics and Dynamics

Masters in Numerical Methods

Assignment 6

Plates Theory

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1 Assignnment 7.1

1.1 Task

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

The constants are $E = 10.92\ \nu = 0.3$, $Q = 1.0$. The thickness varies as $0.001, 0.01, 0.02, 0.1 and 0.4$.

1.2 Solution

A 5x5 mesh is made from a simple square plate of length 5 in GiD. Using the plates MATFEM problem type a matlab input file was generated for the Matlab solvers of the Reissner Mindlin and the MZC type. The boundary conditions are that all the nodes at the boundary were given zero displacements in the Z direction, they were allowed to rotate freely. As for the loads, a uniform unitary load was applied to all elements. All quantities are considered dimensionless since this is a comparative test.

The displacements for both these type of elements are summarized in the table below:

thickness	MZC	Reissner Mindlin	% change
0.001	1.55E+09	1.46E+09	6.02E+00
0.01	1.55E+06	1.46E+06	6.01E+00
0.02	1.94E+05	1.83E+05	5.97E+00
0.1	1.55E+03	1.48E+03	4.94E+00
0.4	24.2665	26.01	8.22E+00

Table 1: Displacements and Percentage change in two methods

The results are plotted on a log-log graph

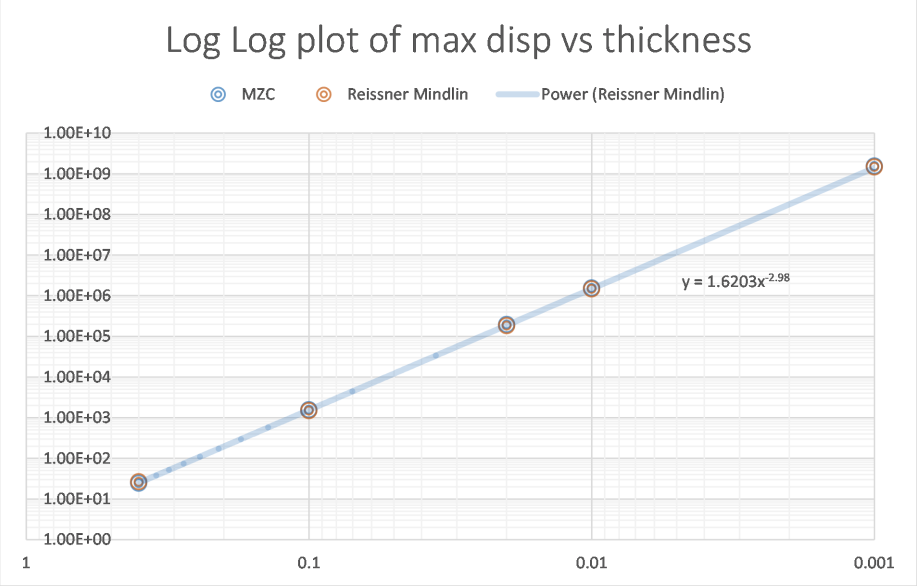

Figure 1: Displacement vs thickness

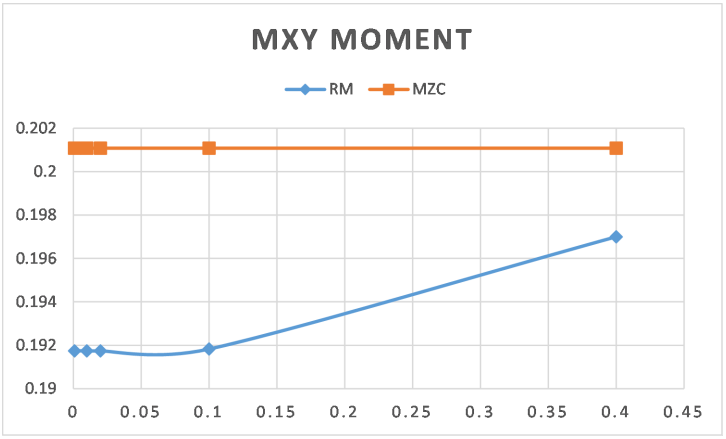

Figure 2: Mxy Moment

1.3 Conclusions

- If we look at the analytical expression, the displacement depends on the inertia of the cross section of the structure so as we decrease the the order of thickness by 1 the displacements should increase by 1000 times. We can see that in the MZC model as we go from 0.1 to 0.01 to 0.001 the displacement exactly increase by a factor of 10^3. This does not happen in Reissner Mindlin model because of the shear blocking
- Due to the shear blocking the displacements obtained in with the RM model are slightly lesser than MZC model for every case except when the thickness is 0.4. The percentage difference is less than 10 percent in all the cases.
- From the moment plot we can see that the the values are similar to each other at high thickness such as $t = 0.4$.

2 Patch test for MZC

2.1 Task

Define and verify a patch test mesh for the MZC element.

2.2 Solution

To perform this test we discretize a square domain in 4 elements and 9 nodes the outer nodes are set to zero displacements and the inner node is free. The coordinates of the nodes are given below.

X	Y
0	1
0.5	1
0	0.5
0.5	0.5
0	0
1	1
0.5	0
1	0.5
1	0

Table 2: Coordinates of Patch test input mesh

In the MZC method the elements are linearly interpolated, the displacement can we written as $d = ax + by$. Thus the expected displacement for the free node 4 (0.5,0.5) would be 0.01. After running the simulation the obtained value is 0.0100045. Thus we can say that the patch test is verified.