Assignment 7, Computational Structural Mechanics and Dynamics

Simen Lieng, Universitat Politecnica de Catalunya 23/03/2020

Problem 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.

Given that we already had some meshes provdided for us, I used the 4x4 Mesh (Clamp-UL-2.flavia.msh). The results I got from the calculation in Matlab is shown in both tables and graphs:

Reissner Mindlin Element					
Thickness	t = 0,001	t = 0,01	t = 0,04	t = 0,1	t = 0,4
Displacement	1.0174*10^4	0.1017*10^4	0.0509*10^4	0.0101*10^4	0.0024*10^4
Rotation	3.0937*10^3	0.3094*10^3	0.1546*10^3	0.0307*10^3	0.0069*10^3
Moment	0.000	0.0001	0.0006	0.0143	0.2076

MZC Element					
Thickness	t = 0,001	t = 0,01	t = 0,04	t = 0,1	t = 0,4
Displacement	1.4077*10^{10}	0.0014*10^{10}	0.0002*10^{10}	0.0000*10^{10}	0.0000*10^{10}
Rotation	4.1742*10^9	0.0042*10^9	0.0005*10^9	0.0000*10^9	0.0000*10^9
Moment	3.1693	3.1693	3.1693	3.1693	3.1693

The results are very hard to assess these values, and therefore I chose to plot the three different values for each element:

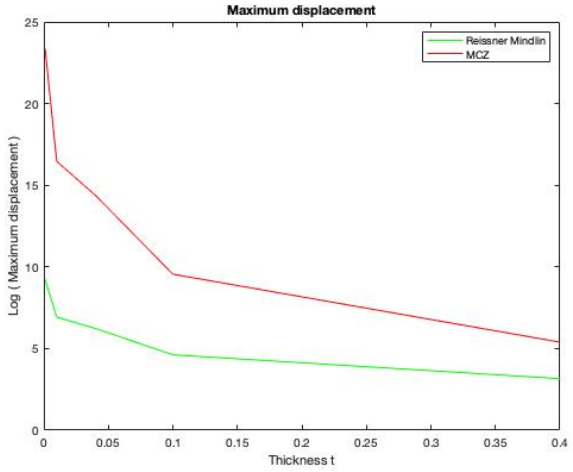

Figure 1: Logaritmic plot of the displacement based on the thickness of the element.

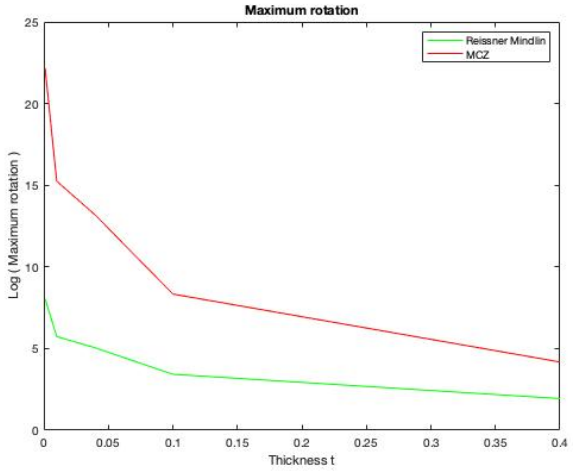

Figure 2: Logaritmic plot of the rotation based on the thickness of the element.

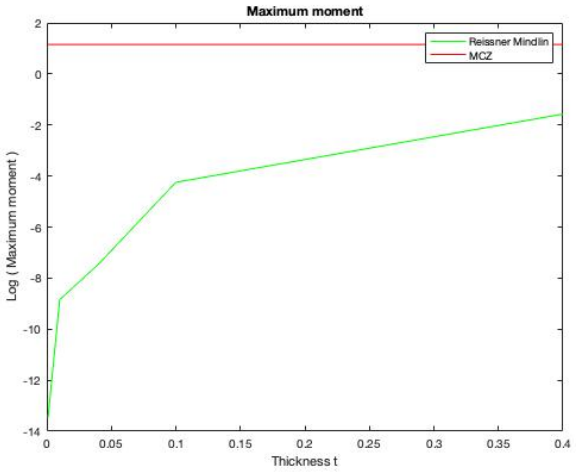

Figure 3: Logaritmic plot of the moment based on the thickness of the element.

To be fair it is not easy to assess these plot either, given that the values for both elements are completely different. This is probably due to some error in the implementing of the uniform

load, or something similar. Therefore it is really hard to discuss and compare the result based on the effect of shear blocking, but I would like to explain what would usually happen.

So the main difference in my results are that the moment is bigger for the MZC element, and would therefore provide bigger displacement and rotations. This is true, but the Reissner Mindlin Element is also stiffer because it takes into account the shear stiffness. When the thickness of the plate is very little, the shear stiffness will be dominant for this element. The Reissner Mindlin Element experiences shear locking, and it results in a stiffer element at lower thickness. This is not the case for MZC elements, because the shear stiffness is not included in the total stiffness matrix.

Problem b

- Define and verify a patch test mesh for the MCZ element.

For this part, I only persued the weak form of the patch test, which includes regular rectangular elements (no distortion). For this, a 2x2 mesh was made in GiD with h = b = 5m. The tickness, t = 0,001m.

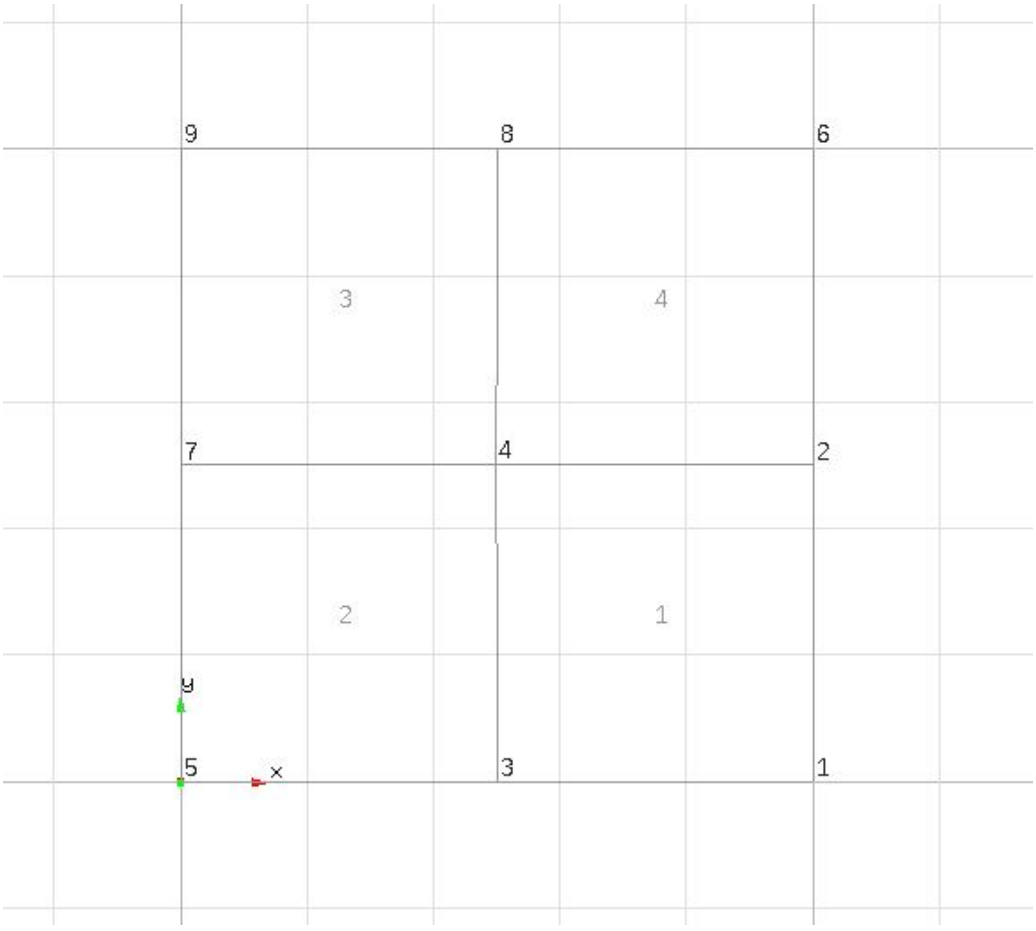

Figure 4: 2x2 mesh displayed in GiD.

So for this exercise I will introduce two displacement patterns, and if it results in a reasonable solution. The displacement patterns will be introduced by stating displacement in the boundary nodes, and evaluate the result given in the middle node 4. The fist displacement pattern is given by $w = 0$, and it should result in a constant displacement along the whole mesh. This can be seen in the figure below.

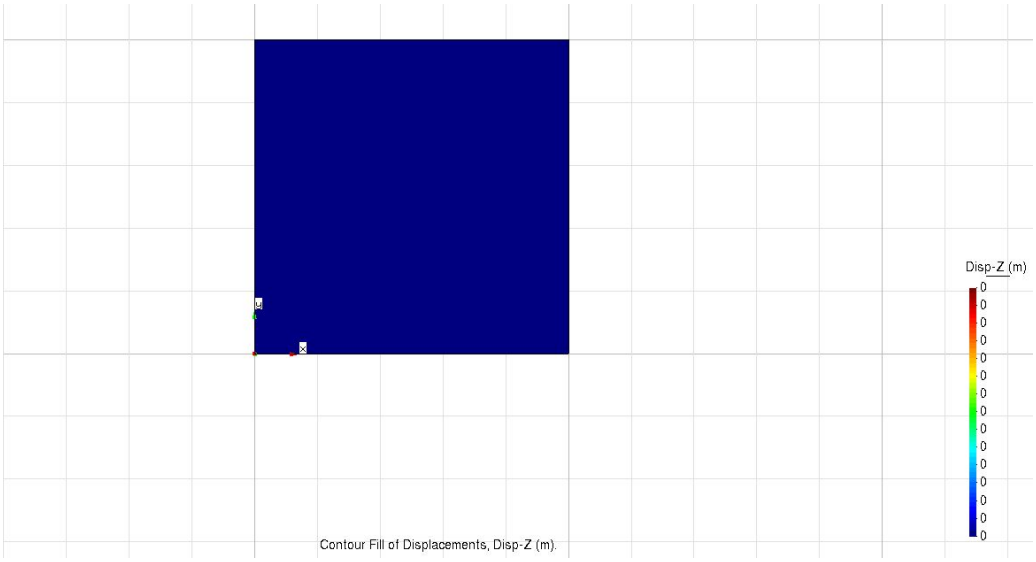

Figure 5: Constant solution for $w = 0$.

The second displacement pattern is given by $w = 4(x + y)$, where $x \epsilon [0, 5]$ and $y \epsilon [0, 5]$. So the given displacement for node 4 should be equal to 20m. The displacement displayed by GiD shows:

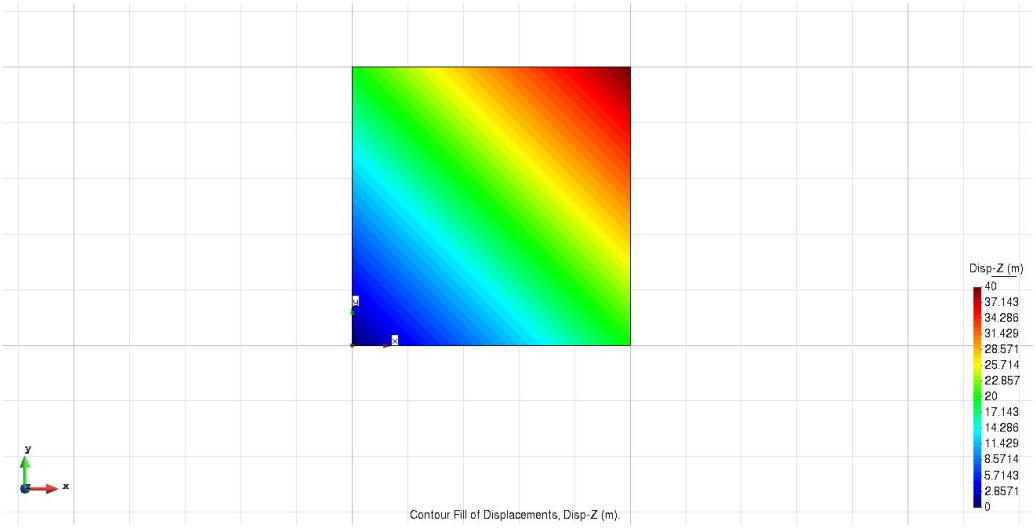

Figure 6: Linear solution for $w = 4(x + y)$.

The results show that the elements is able to reproduce the linearity from the displacement pattern, and will result in a value that is pretty much equal to 20m at node 4. This result is sufficient and means that the element passes the weak form of the patch test. Therefore will the element be able to converge to the exact solution with a refined mesh for a given problem. When checking if it passes the strong form, the elements in the mesh needs to be angular distorted.