UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Computational Structural Mechanics and Dynamics

Master's Degree in Numerical Methods in Engineering

Assignment 7: Plates

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a) Analyse 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 description of the problem is:

E= 10.92
ν= 0,3
Q = 1.0

The plate has a longitude of 1 m for each side and it is required to do calculate for different thickness: t=0.001, t=0.010, t=0.020, t=0.100, t=0.400. It has been introduced simple support in each side. The representation of the plate and its mesh of 5x5 in Gid is shown in figure 1.

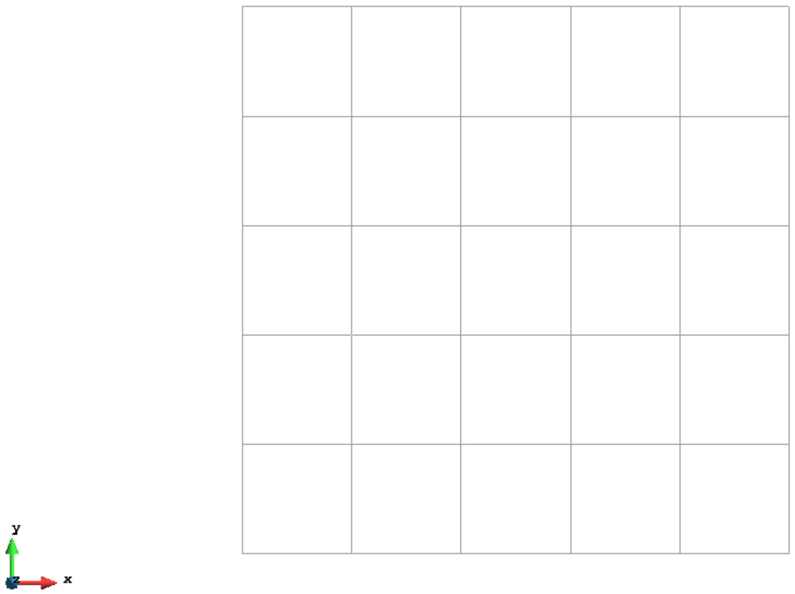

Figure 1. Geometry of the plate and its mesh

As it is done in the study for beams, it is downloaded two different programs for Matlab provided by MatFem and the interface for Gid software. In the interface of Gid, it is introduced the properties given and created the geometry of the plate and its mesh for the solution. Thanks to the modelling of the plate did in Gid, it is extracted an input (with extension .m) for the program of Matlab to work out the different parameters to differentiate between Reissner Mindlin and MZC to analyse the shear blocking effect. Finally, it is exported the solution from the Matlab problem to the Gid interface to visualize the results.

In order to study both elements, it is studied the displacement produced in the plates with both methods as it is shown in figure 2.

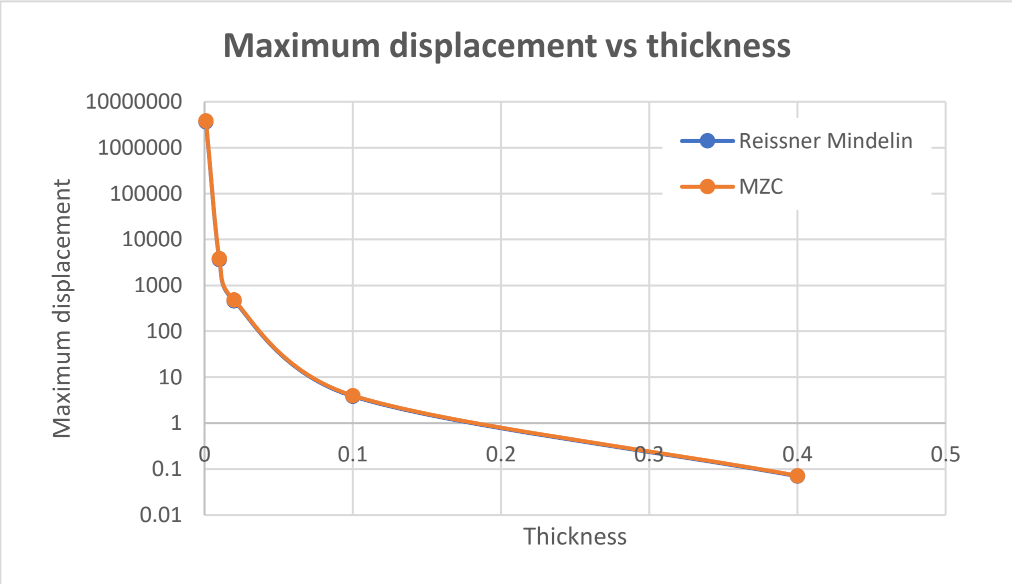

Figure 2. Maximum displacement vs thickness for each element

As it is not possible to appreciate the difference between the two elements, it is shown in figure 3 the difference (in %) for the displacements calculated between both methods, obtaining in Reissner Mindelin element lower displacements.

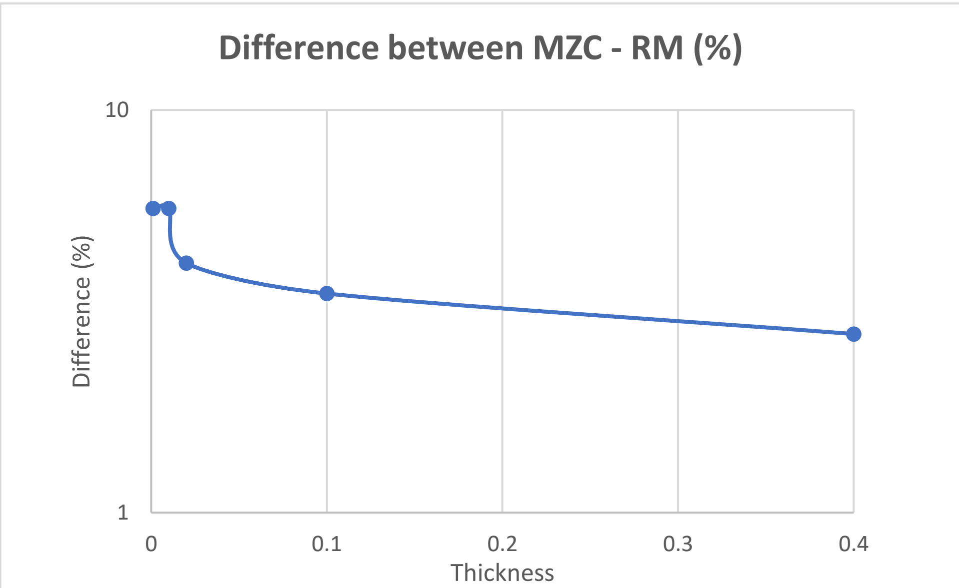

Figure 3. Difference, in %, between MZC and Reissner Mindelin elements

In figure 2, it is possible to observe that for both methods, increasing the thickness, the maximum displacement of the plate is decreasing, as it was expected.

Moreover, it is possible to appreciate that the displacements for MZC are always bigger than for Reissner Mindelin. This is because the shear locking effect which produces this difference. However, it is seen that for bigger thickness, this difference between elements decreases. This shear locking effect provokes that the plate seems stiffer, therefore, there are lower displacements from the ones it actually corresponds.

It is concluded that for thin plates, MZC elements behave better for obtaining results more approximated to the real ones. When the thickness increases, it reduces the effect that provokes the shear locking for Reissner Mindelin solutions.

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

The patch test is based in imposing at the boundary of a patch of element a displacement field which can be exactly reproduced by the shape functions.

The patch test is satisfied if the displacements and strains within the patch coincide with the exact values deduced from the prescribed displacement field.

The MZC element satisfies the patch test for rectangular shapes. It is not fulfilled for arbitrary quadrilateral shapes, therefore, the MZC is not reliable in these cases.

Then, it is analysed a case with the same geometry and properties of the previous exercise, but for this case thickness of t=0.01. The mesh is the same as in figure 1. To do the patch test, it is imposed the Dirichlet conditions of displacement of -0.2 for all the patch boundaries. It is also imposed a 0 rotation (both x and y) for these boundaries. The patch boundary will behave as a rigid body if the patch test is right.

Interior element	Displacement	X-Rotation	Y-Rotation
Node 1	-2.00E-01	0	0
Node 2	-2.00E-01	1.06E-07	1.06E-07
Node 3	-2.00E-01	-1.06E-07	-1.06E-07
Node 4	-2.00E-01	9.41E-08	-9.41E-08

Table 1. Results for the patch in test in an interior element of the mesh

As it is possible to appreciate, the body acts as a rigid body, reproducing the same displacement and rotations (almost 9) for the inner nodes equal to the boundaries.

It is concluded that the patch test has been implemented correctly.