

ASSIGNMENT 7: PLATES

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1 PROBLEM 1

a) Think first and answer later. What kind of strategy (theory, elements, integration rule, boundary conditions, etc.) will you use for solving the following problems:

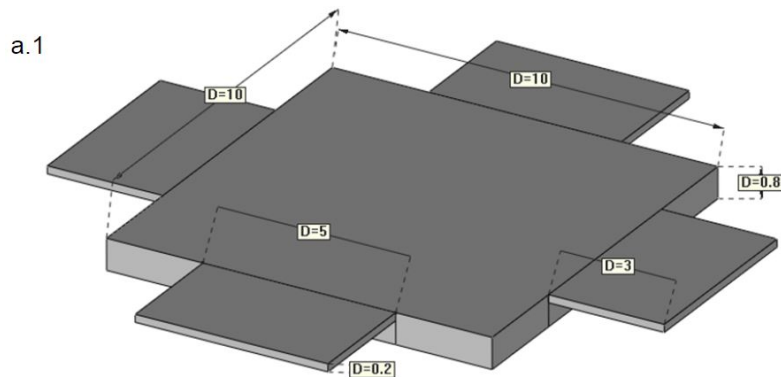


Figure 1: Problem a1.

Equivalence thickness of the external plates and the midplane of the central thicker plate coincides with the outsider plates as compares figure 2.

- Theory: Reissner-Midlin
- Elements: For nodes quadrilateral
- Integration rule: Reduced integration
- Boundary conditions: The geometry has double symmetry, but depends also on the loading conditions.

In the second case, all the midplanes of the plates coincides.

- Theory: Reissner-Midlin
- Elements: For nodes quadrilateral



Figure 2: Cross section (a) Actual section. (b) Idealization.

- Integration rule: Reduced integration
- Boundary conditions: The geometry has double symmetry, but depends also on the loading conditions.

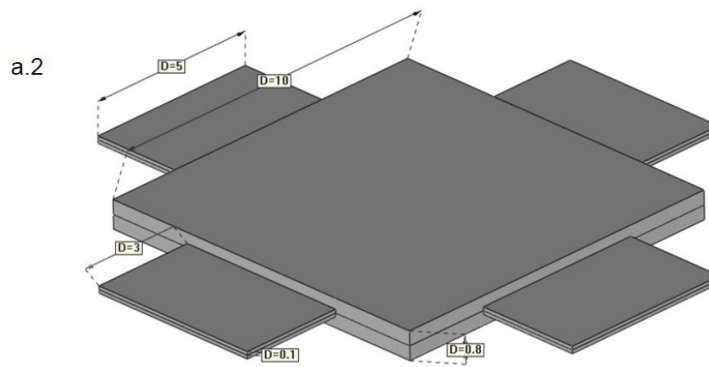


Figure 3: Problem a2.

2 PROBLEM 2

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

We develop a patch test for a plate with dimensions 2x2m. The discretization considers two types of MCZ elements. The two meshes uses four rectangular elements and non-rectangular elements as shown figures 4a and 4b, respectively.

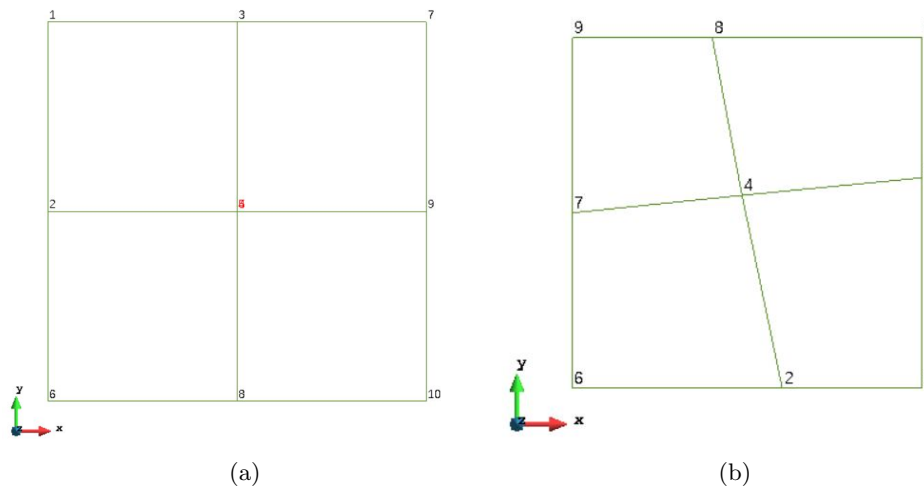


Figure 4: Mesh (a) Rectangular elements. (b) Non-rectangular elements.

The patch test consist in prescribing the the vertical displacements on the boundary nodes. Then the results in the interior node is compare with the expected vertical displacement.

First we apply a first order polynomial with the form

$$w(x, y) = c - ax - by$$

Replacing the values of $a = b = c = 0.1$ results:

$$w(x, y) = 0.1 - 0.1x - 0.1y$$

The table 1 shows the prescribed values of the vertical displacement and the expected value in the interior node. For the rectangular elements the output coincides with the expected vertical displacement -0.1 and for the non-rectangular elements the expected value is higher than the obtained one. Figure 5 present the vertical displacement distribution on the plate.

Table 1: Displacement field of first order polynomial

Mesh 1				Mesh 2			
x	y	w	Output	x	y	w	Output
0	0	0.1	-	0	0	0.1	-
1	0	0	-	1.2	0	-0.02	-
2	0	-0.1	-	2	0	-0.1	-
2	1	-0.2	-	2	1.2	-0.22	-
2	2	-0.3	-	2	2	-0.3	-
1	2	-0.2	-	0.8	2	-0.18	-
0	2	-0.1	-	0	2	-0.1	-
0	1	0	-	0	1	0	-
1	1	-0.1	-0.1	0.9701	1.1	-0.107	-0.1045

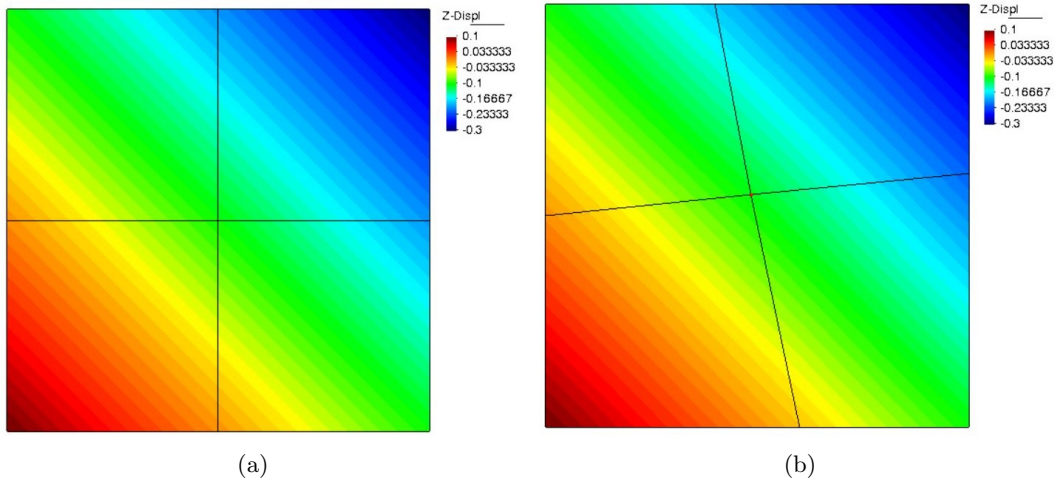


Figure 5: Vertical displacements.

Table 2: Displacement field of second order polynomial

Mesh 1				Mesh 2			
x	y	w	Output	x	y	w	Output
0	0	0	-	0	0	0	-
1	0	0.05	-	1.2	0	0.072	-
2	0	0.2	-	2	0	0.2	-
2	1	1.25	-	2	1.2	1.472	-
2	2	2.4	-	2	2	2.4	-
1	2	1.25	-	0.8	2	1.032	-
0	2	0.2	-	0	2	0.2	-
0	1	0.05	-	0	1	0.05	-
1	1	0.6	0.64	0.9701	1.1	0.6411	0.6448

Another patch test was developed with a second order polynomial of the vertical displacements.

$$w(x, y) = \frac{1}{2}(ax^2 + by^2 + cxy)$$

Replacing the values of $a = b = c = 0.1$ results:

$$w(x, y) = 0.05x^2 + 0.05y^2 + 0.05xy$$

Table 2 presents the values of w at boundary nodes and at the interior node. The expected value is smaller than the resulted value. The expected value at $x = 1$ and $y = 1$ is 0.6 while with rectangular elements we obtained a value of 0.64. With non-rectangular elements occurs the same at point $x = 0.97y = 1.1$ the expected value is 0.641 and the output is 0.644.

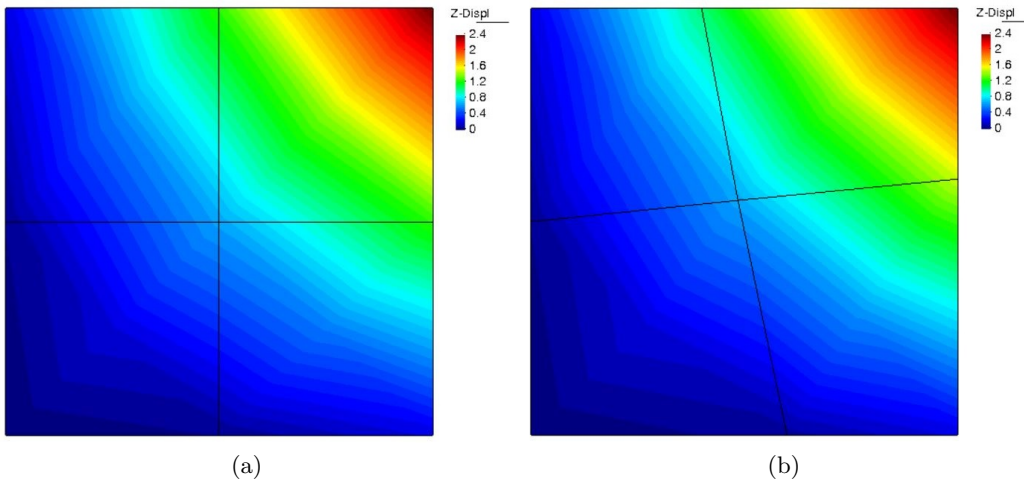


Figure 6: Vertical displacements.