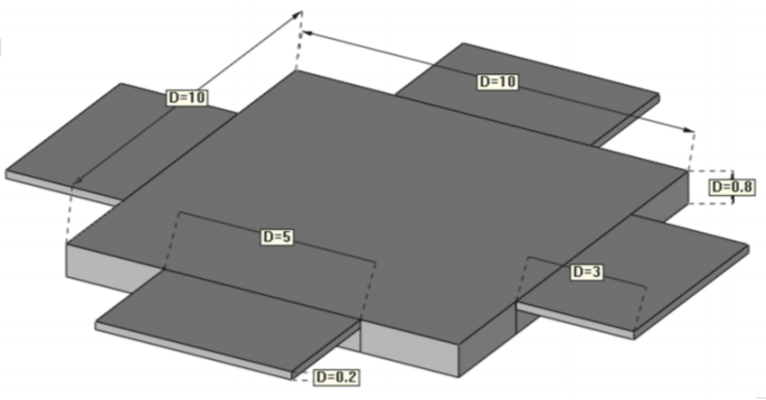
Assignment Plates

a) What kind of strategy will you use for solving the following problems?

a.1



Theory: We consider object as a 2D plate structure.
Given that fins t/L are around 0,05<0,10 and Main plate t/l is 0,008>0,10, Kirchhoff MCZ could be implemented, or BFS, which requires less elements to obtain same error seems to fit quite well.

***Elements**:* Seems more appropriate to implement quadrilateral non-arbitrary elements given the geometry of the objects, in order to keep simplicity. Depending on ulterior forces applied, finer meshes could be considered near the joints between fins and main plate. Also symmetries seems to fit, again, depending on forces applied.

Integration rule: 2D product-type Gauss integration rules could be p=1 (1x1 G.P), p=2 (2x2 G.P), p=3 (3x3 G.P.) or P=4 (4x4 G.P.) depending on Shape functions. The latter ones should be compatible, e.g. linear on main plates and fins.

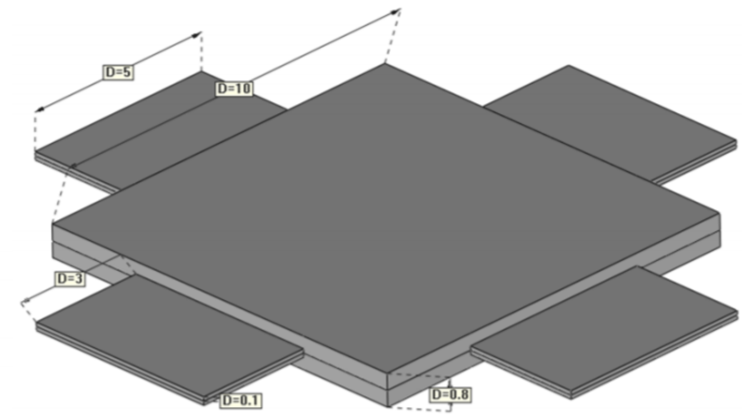
For MCZ plane element *w* varies as a cubic polynomial, $(...+.\alpha_7x^3+\alpha_{10}y^3+\alpha_{11}xy^3+\alpha_{12}xy^3)$ and with natural coordinates has a highest *degree of 4*. This requires for the stiffness matrix an integration with two points (QUADRATIC), per axis, so 4 for Gauss points.

Boundary conditions:
Geometry invites us to think most probable outcome would be either an force applied over the main plate body (distributed or not) , with fixed pins edges, or just a middle point support at the middle of the main plate with forces applied in fin edges, for example.

In the first case, a point support in the center node (w=0, θ_x and θ_y free), and in the second one edge could be clamped ((w= θ_x= θ_y =0 or simple supported (only θ_x or θ_y equal 0, depending on which fin).

In this case we could assume that θ on edge of fin is the same as on the joint, acting as a hing, and thus diminishing DoF.

a.2



This geometry still does maintain approximately same scale, though fins are thinner. Maintaining MCZ could be an option.

Elements and integration rules follow same rules, but boundary conditions might be considered different. In this case seems not plausible to consider θ the same on edge and joint of the fin.

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

On displacements, we do test patch with *Clamp_UL_1,* **without external "*denss*" force.**

The "w" vertical displacement is 0 given that boundary nodes are 0, and so it behaves as a rigid body in this particular case.

We can repeat test within x-axis and y-axis.

if *fixdesp* is defined with nodes 1,3,5 with w=1 and nodes 6,8,9 with w=4, we should await for a linear displacement on the 3 middle points. Of course is required to "free" both 2,7 nodes, given that node 4 was already free by default.

Furthermore, is it also required to fix a same reviative for w along x-axis in both fixes boundaries, being the difference of displacements divided by the length of a side of the patch (two elements). This is 3/10=0,3.

For x-axis

```
fixdesp  = [1, 1,  1.0;1, 2,  0.3;1, 3,  0.0; 3, 1,  1.0;3, 2,  0.3;3, 3,  0;5, 1,  1.0;5, 2,  0.3;5, 3,  0;6, 1,  4.0 6, 2,0.3;
   6, 3,  0; 8, 1,  4.0;8, 2,  0.3; 8, 3,  0;9, 1,  4.0;9, 2,  0.3;9, 3,  0];

Result "Displacements" "Load Analysis"  1  Vector OnNodes
ComponentNames "X-Displ", "Y-Displ", "Z-Displ"

    1 0.0 0.0        00001
```

```
    2 0.0 0.0  2.50000e+00
    3 0.0 0.0       00001
    4 0.0 0.0  2.50000e+00
    5 0.0 0.0       00001
    6 0.0 0.0       00004
    7 0.0 0.0  2.50000e+00
    8 0.0 0.0       00004
    9 0.0 0.0       00004

Result "Rotation" "Load Analysis"  1  Vector OnNodes
ComponentNames "X-der", "Y-der", "Z-der"
Values
    1  3.00000e-01       00000 0.0
    2  3.00000e-01  1.58725e-16 0.0
    3  3.00000e-01       00000 0.0
    4  3.00000e-01  3.25167e-17 0.0
    5  3.00000e-01       00000 0.0
    6  3.00000e-01       00000 0.0
    7  3.00000e-01  4.10735e-17 0.0
    8  3.00000e-01       00000 0.0
    9  3.00000e-01       00000 0.0
```

Nodes 2,4,7 response as expected, delivering a 2,5 displacement and a dw/dx of 0,3.

For y-axis

Analogously, if we consider displacement w=1 for boundary defined by nodes 1,2,6 and w=4 for boundary composed by nodes 5,7,9, a displacement for nodes 3,4,8 should be expected to be 2,5, following linear displacement and unfixing nodes 3 and 8.

It is also required to fix a dw/dy, which again is difference of displacements divided by the length of a side of the patch, 3/10=0,3. Notice that it is taken into account the y-axis direction direction regarding increase/decrease of deflection, so in this case displacement derivatives are settled with negative values.

```
fixdesp  = [ 1, 1,  1;  1, 2,  0;  1, 3,  -0.3;  2, 1,  1;  2, 2,  0;  2, 3,  -0.3;    5, 1,  4;  5, 2,  0;  5, 3,  -0.3;  6, 1,  1;  6, 2,  0;  6, 3,  3;
7, 1,  4;  7, 2,  0;  7, 3,  -0.3;  9, 1,  4;  9, 2,  0;   9, 3,  -0.3];

Result "Displacements" "Load Analysis"  1  Vector OnNodes
ComponentNames "X-Displ", "Y-Displ", "Z-Displ"

    1 0.0 0.0       00001
    2 0.0 0.0       00001
    3 0.0 0.0  2.50000e+00
    4 0.0 0.0  2.50000e+00
    5 0.0 0.0       00004
    6 0.0 0.0       00001
    7 0.0 0.0       00004
    8 0.0 0.0  2.50000e+00
    9 0.0 0.0       00004

Result "Rotation" "Load Analysis"  1  Vector OnNodes
ComponentNames "X-der", "Y-der", "Z-der"

    1       00000 -3.00000e-01 0.0
    2       00000 -3.00000e-01 0.0
    3  9.25436e-17 -3.00000e-01 0.0
    4  -1.04170e-16 -3.00000e-01 0.0
    5       00000 -3.00000e-01 0.0
```

6 00000 -3.00000e-01 0.0
7 00000 -3.00000e-01 0.0
8 -3.03286e-16 **-3.00000e-01 0.0**
9 00000 -3.00000e-01 0.0

Expected values are obtain thus approving patch test for this concrete quadrilateral non-arbitrary mesh.