Assignment 2

Nadim Saridar

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Assignment 2.1

1)

Identify the symmetry and antisymmetry lines for the following two-dimensional problems:

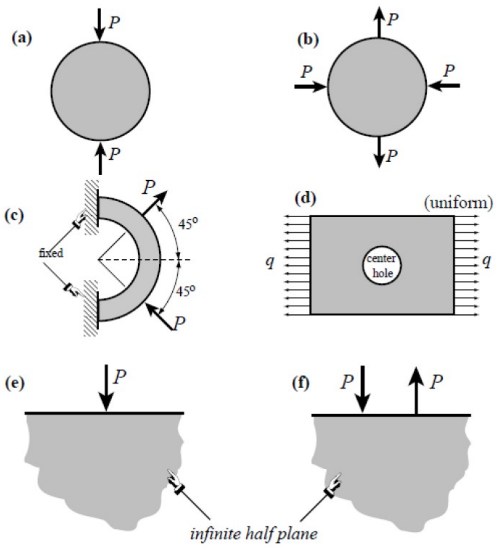

Figure 1: Problems for assignment 2.1

a) The disc has two symmetry lines: horizontal and vertical symmetry lines passing through the center.

b) The disc has two symmetry lines: horizontal and vertical symmetry lines. It also has two antisymmetry lines: the first line which is 45°with the horizontal, and the other line perpendicular to the first one. All of these four lines pass through the center.

c) The semiannulus has one antisymmetry line which is a horizontal line passing through the middle of the figure.

d) The rectangular plate has two symmetry lines: horizontal and vertical symmetry lines passing through the center of the center hole.

e The half plane has a symmetry line which is a vertical line passing through the force P.

f The half plane has an antisymmetry line which is a vertical line passing through the midpoint between the two forces.

2)

All the geometries with two symmetric lines can be cut to one quarter, while the ones with one symmetric or antisymmetric line can be cut to one half.

a) cut into one quarter
b) cut into one quarter
c) cut into one half horizontally
d) cut into one quarter
e) cut into one half vertically at force P
f) cut into one half vertically between the two forces

The resulting meshes for the cut geometries are shown below:

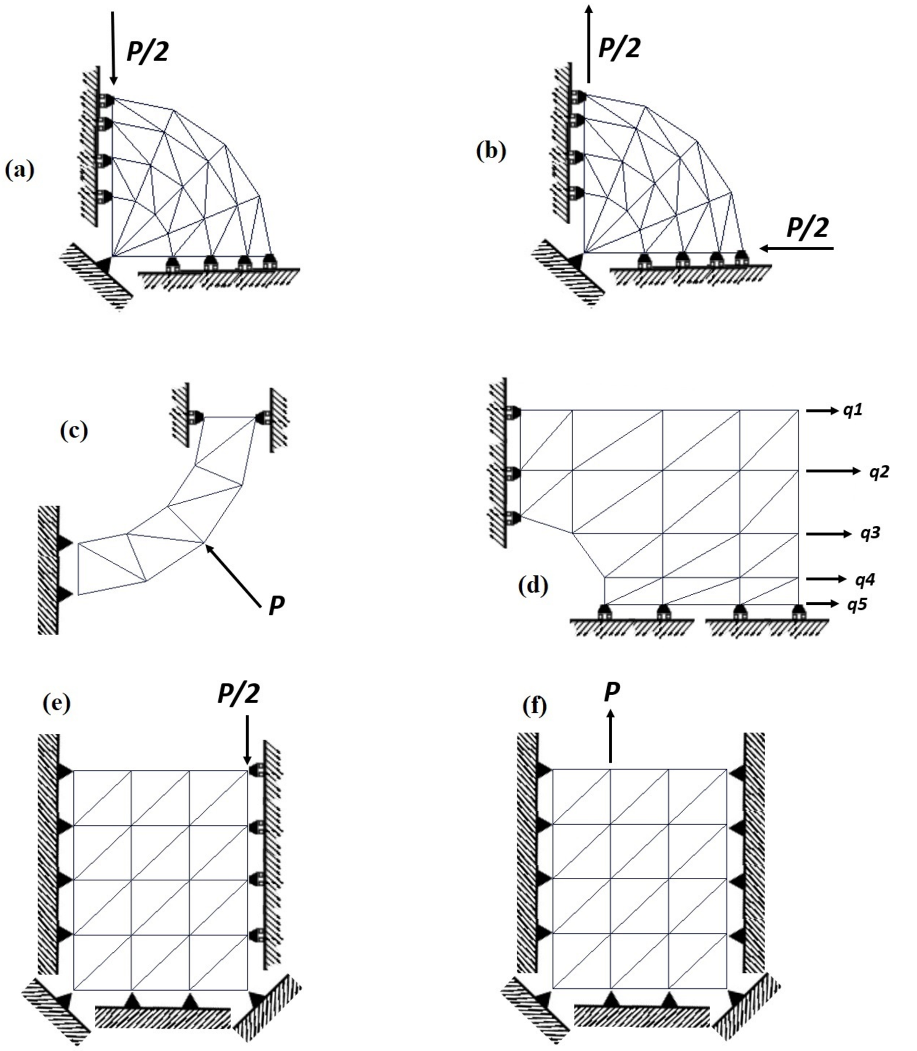

Figure 2: Resulting meshes with boundary conditions

Note that in figure 2(d), the each force depends on the size of the mesh and the uniform force q.

Assignment 2.2

Verification deals with fixing the errors in the mathematical model and equations to check if the equations are being solved properly. Validation deals with comparing the mathematical results with the experimental results, therefore if the right equations are chosen. Therefore verification focuses on the math of the problem, and validation focuses on the physics of the problem.

Assignment 2.3

The bar is approximated by one finite bar element with different cross-sectional areas at each node. To find the consistent node forces for each node, the following formula from the slides is used:

$$f = \int_0^1 q(x) \begin{bmatrix} \zeta - 1 \\ \zeta \end{bmatrix} l d\zeta$$

replacing $x = \zeta l$ and A by its value in the equation of $q(x)$, the force for each node are following:

$$f_i = \int_0^1 \rho(A_i(1-\zeta) + A_j\zeta)\omega^2(\zeta - 1)\zeta l^2 d\zeta$$

$$f_i = \rho\omega^2 l^2 \int_0^1 \zeta^3(A_j - A_i) + \zeta^2(2A_i - A_j) - A_i\zeta d\zeta$$

$$f_i = -\frac{\rho\omega^2 l^2 \left(A_i + A_j\right)}{12}$$

$$f_j = \frac{\rho\omega^2 l^2 \left(A_i + 3A_j\right)}{12}$$

For a prismatic bar ($A_i = A_j = A$):

$$f_i = -\frac{\rho\omega^2 l^2 A}{6}$$

$$f_j = \frac{\rho\omega^2 l^2 A}{3}$$

It is noticeable that the force at the tip majorly increases for a minor increase in the area of the tip.