Computational Structural Mechanics and Dynamics

Masters in Numerical Methods

Assignment 2

FEM Modelling

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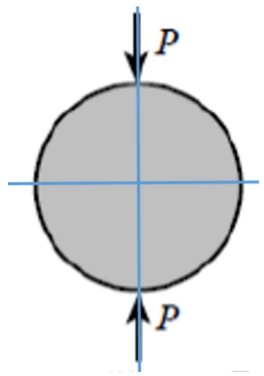
1 Question 2.1

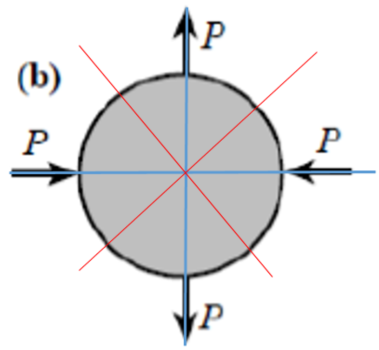
1.1 Part A

Identify the symmetry and antisymmetry lines in the two-dimensional problems illustrated in the figure:

The blue color represents a symmetry line and the red color represents the anti-symmetry line

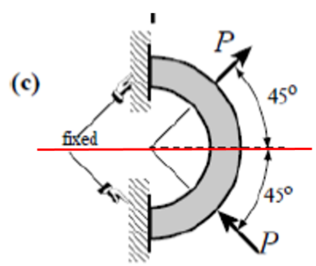


(a) Q1

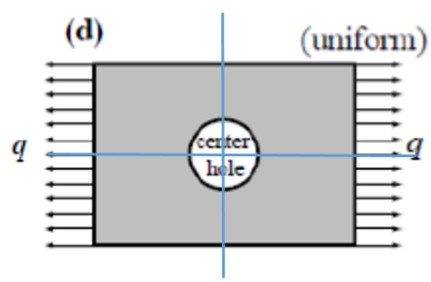


(b) Q2

Figure 1



(a) Q3



(b) Q4

Figure 2

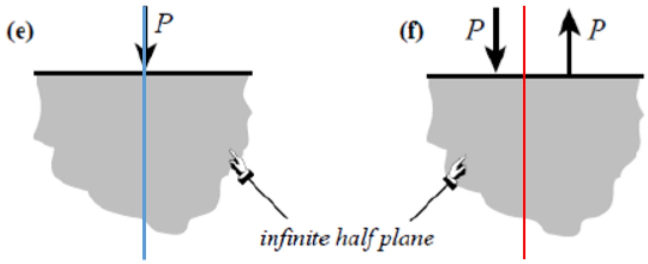
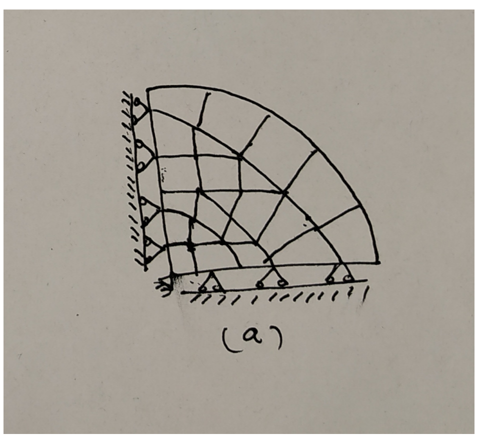


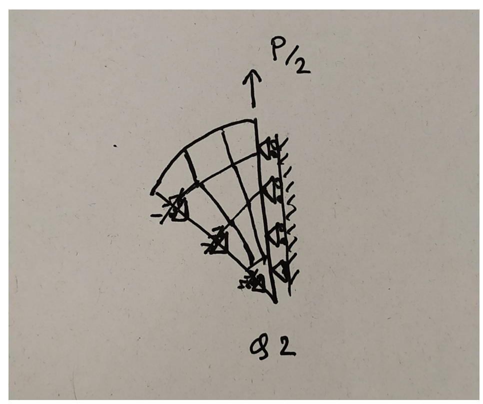
Figure 3: Q5 and Q6

1.2 Part B

Having identified those symmetry/antisymmetry lines, state whether it is possible to cut the complete structure to one half or one quarter before laying out a finite element mesh. Then draw a coarse FE mesh indicating, with rollers or fixed supports, which kind of displacement BCs you would specify on the symmetry or antisymmetry lines

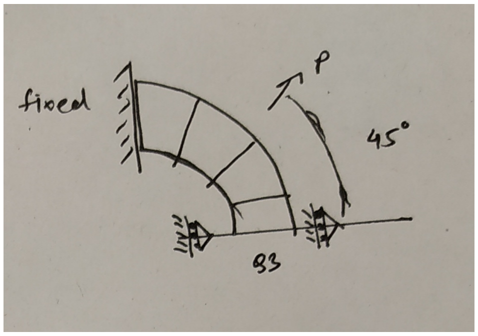


(a) Q1

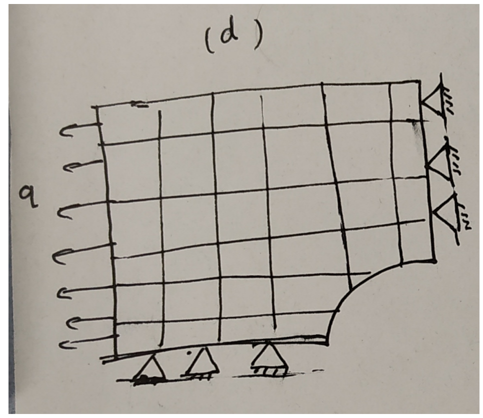


(b) Q2

Figure 4

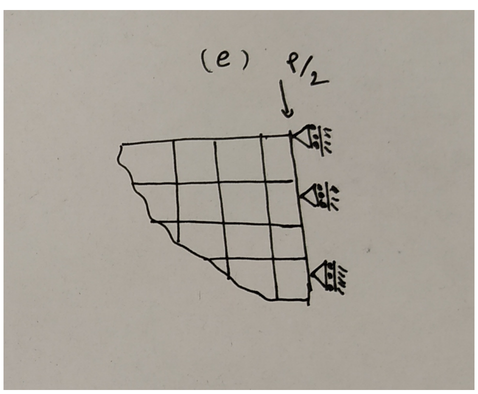


(a) Q3

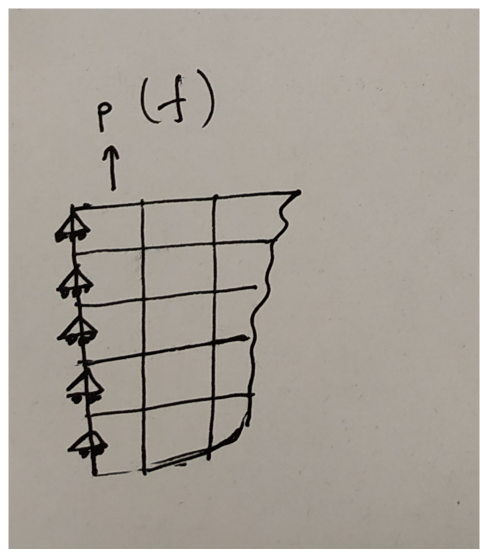


(b) Q4

Figure 5



(a) Q5



(b) Q6

Figure 6

2 Question 2.2

2.1 Validation

It is a process of determining that the mathematical model leads to the solution with sufficient reliability. It is a test that the model truly represents the problem at hand.

2.2 Verification

Verification is process of determining that the computational model and the code execution give us an accurate solution. That is the difference between the expected solution and the obtained solution is as small as possible.

3 Question 2.3

The area is related as follows A = $A_i(1-\xi) + A_j\xi$, and the centrifugal axial force is given by q(x) = $\rho A\omega^2 x$. Making a simple transformation from ξ to x we get that $x = x_i + l\xi$ and dx = $ld\xi$

The unknown variables are expressed as a function of ξ

$$\mathbf{N} = \begin{bmatrix} 1-\xi \\ \xi \end{bmatrix} \tag{1}$$

$$F^e = \int \rho A(\xi)\mathbf{N}\omega^2 x dx \tag{2}$$

changing the variable from x to ξ we obtain

$$F^e = \int_0^1 \rho\omega^2(A_i(1-\xi) + A_j\xi) \begin{bmatrix} 1-\xi \\ \xi \end{bmatrix} (l\xi)ld\xi \tag{3}$$

$$F^e = \rho\omega^2 l^2 \int_0^1 A_i \begin{bmatrix} (1-\xi)^2\xi \\ \xi^2-\xi^3 \end{bmatrix} + A_j \begin{bmatrix} \xi^2-\xi^3 \\ \xi^3 \end{bmatrix} d\xi \tag{4}$$

$$F^e = \rho\omega^2 l^2 (A_i \begin{bmatrix} \frac{1}{12} \\ \frac{1}{12} \end{bmatrix} + A_j \begin{bmatrix} \frac{1}{12} \\ \frac{1}{4} \end{bmatrix}) \tag{5}$$

and if $A_i = A_j = A$ for a prismatic bar,

$$F^e = \rho\omega^2 l^2 A \begin{bmatrix} 1/6 \\ 1/3 \end{bmatrix} \tag{6}$$