Escola Tècnica Superior d'Enginyers de Camins, Canals i Ports de Barcelona

UNIVERSITAT POLITÈCNICA DE CATALUNYA

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Materia: Computational Structural Mechanics and Dynamics

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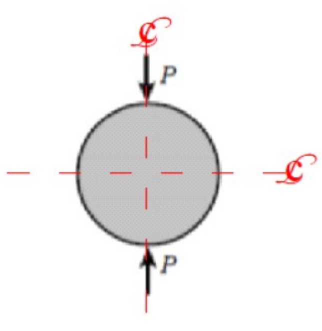
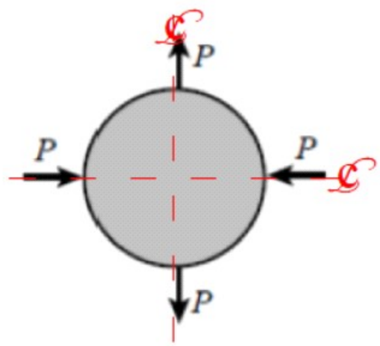
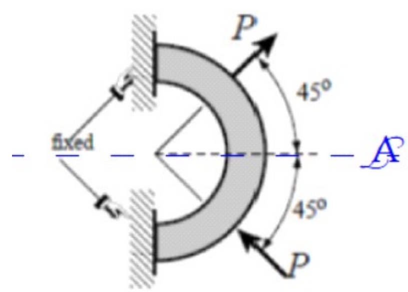
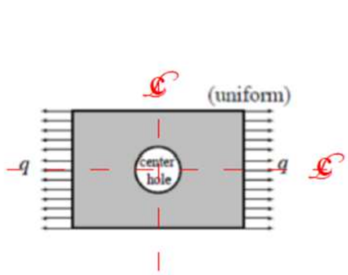
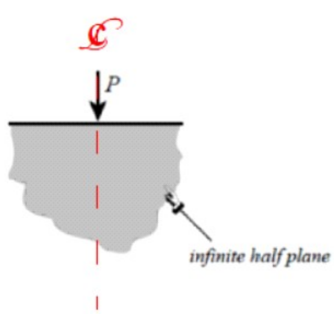
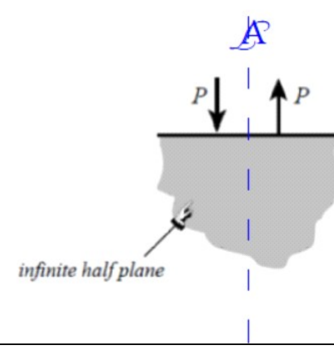
Descripción: Deber 2

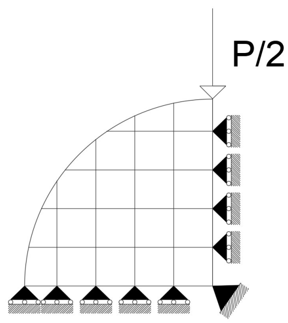
1. Identify the symmetry and antisymmetry lines in the two-dimensional problems illustrated in the figure. They are:

(a) a circular disk under two diametrically opposite point forces (the famous “Brazilian test” for concrete)
(b) the same disk under two diametrically opposite force pairs
(c) a clamped semiannulus under a force pair oriented as shown
(d) a stretched rectangular plate with a central circular hole.
(e) and (f) are half-planes under concentrated loads.

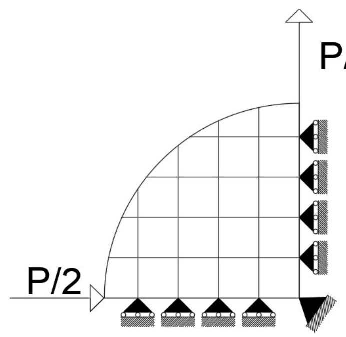
		
(a)	(b)	(c)
		
(d)	(e)	(f)

Lineas color rojo: simetría
Lineas color azul: antisimetria

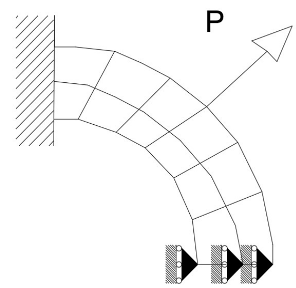
2. Having identified those symmetry/antisymmetry lines, state whether it is possible to cut the complete structure to one half or one quarter before laying out a finite element mesh. Then draw a coarse FE mesh indicating, with rollers or fixed supports, which kind of displacement BCs you would specify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



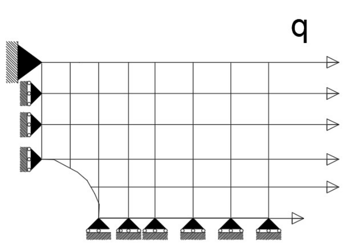
(a)



(b)



(c)



(d)

1. The plate structure shown in the figure is loaded and deforms in the plane of the paper. The applied load at D and the supports at I and N extend over a fairly narrow area. List what you think are the likely “trouble spots” that would require a locally finer finite element mesh to capture high stress gradients. Identify those spots by its letter and a reason.

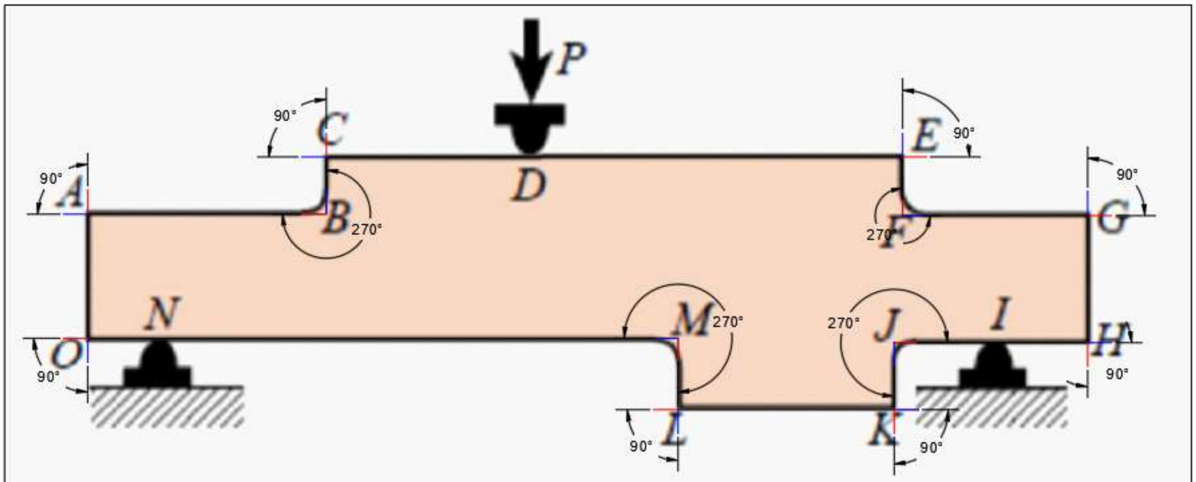


Figure 2.2.- Inplane bent plate

Los puntos I, N, y D por ser zonas próximas a cargas puntuales, y reacciones.

Los puntos B ,F, M y J por esquina entrante, en que se toma la consideración si el ángulo es mayor a 180 es considerada como esquina entrante, este ángulo será medido entre las normales exteriores, en sentido antihorario entre la primera línea y la segunda, considerando la primera en sentido antihorario de la estructura.

2.3 A tapered bar element of length l and areas Ai and Aj with A interpolated as:

$$A = Ai(1 - \xi) + Aj\xi$$

and constant density ρ rotates on a plane at uniform angular velocity ω (rad/sec) about node i. Taking axis x along the rotating bar with origin at node i , the centrifugal axial force is $q(x)=\rho A\omega^2 x$ along the length in which x is the longitudinal coordinate $x=x^e$.
Find the consistent node forces as functions of ρ, Ai, Aj, ω and l, and specialize the result to the prismatic bar A = Ai = Aj

Formulas:

$$\mathbf{f}^e = \int_{x_1}^{x_2} q \begin{bmatrix} 1-\zeta \\ \zeta \end{bmatrix} dx = \int_0^1 q \begin{bmatrix} 1-\zeta \\ \zeta \end{bmatrix} \ell \, d\zeta.$$

Vector de fuerzas nodales

$$\zeta = \frac{x - x_1}{\ell} = \frac{\bar{x}}{\ell}$$

Coordenada natural

Caso barra cono truncado

$$A := Ai \cdot (1 - \xi) + Aj \cdot \xi$$

$$x := \xi \cdot L$$

$$q(x) := \rho \cdot A \cdot \omega^2 \cdot x \rightarrow -\rho \cdot \omega^2 \cdot x \cdot [Ai \cdot (\xi - 1) - Aj \cdot \xi]$$

$$\mathbf{f} := \int_0^1 q(x) \cdot \begin{pmatrix} 1 - \xi \\ \xi \end{pmatrix} \cdot L \, d\xi \rightarrow \begin{bmatrix} \dfrac{L^2 \cdot \rho \cdot \omega^2 \cdot (Ai + Aj)}{12} \\ \dfrac{L^2 \cdot \rho \cdot \omega^2 \cdot (Ai + 3 \cdot Aj)}{12} \end{bmatrix}$$

Caso barra prismatica

$$q(x) := \rho \cdot A \cdot \omega^2 \cdot x$$

$$x := \xi \cdot L$$

$$q(x) \rightarrow A \cdot L \cdot \xi \cdot \rho \cdot \omega^2$$

$$\mathbf{f} := \int_0^1 q(x) \cdot \begin{pmatrix} 1 - \xi \\ \xi \end{pmatrix} \cdot L \, d\xi \rightarrow \begin{pmatrix} \dfrac{A \cdot L^2 \cdot \rho \cdot \omega^2}{6} \\ \dfrac{A \cdot L^2 \cdot \rho \cdot \omega^2}{3} \end{pmatrix}$$