EXERCISES

3.1. A plate 10 mm thick is subjected to bending moments $\mathbf{M_x}$ equal to 5 Nm/mm and $\mathbf{M_y}$ equal to 2 Nm/mm. Calculate the maximum normal stresses in the plate.

Ans. σ_{max} = 300 MPa

3.2. A thin, elastic square plate of side **a,** and thickness **h**, is simply supported on all four sides and is subjected to a uniformly distributed load $\mathbf{q_0}$. The Young modulus, **E**, and the Poisson's ratio, ν, are known. Using the first three terms of the displacements series expansion, calculate the maximum deflection of the plate.

Ans. $w_{max} = 0.04866 \cdot (1 - \nu^2) \cdot q_0 \cdot a^4/(E \cdot t^3)$

3.3. Consider a circular plate of radius **a**, and thickness **h**, with clamped edge, and loaded by a distributed uniform compressive load $\mathbf{p_0}$

Calculate:

1. The bending moments distributions
2. The maximum transversal displacement of the plate

Data

Plate radius, **a = 3.5 m**; plate thickness, **h = 0.12 m**; Young Modulus, **E = 210** GPa, Poisson ratio, ν **= 0.3**; distributed load, $\mathbf{p_0}$ **= 0.1 MPa**

Ans. w_{max} = - 7.06 mm

3.4. Repeat the exercise 3.3 considering the plate has a simply supported edge.

Ans. w_{max} = - 28.77 mm

Authors: Enrique Barbero Pozuelo, Carlos Santiuste Romero, José Fernández Sáez,

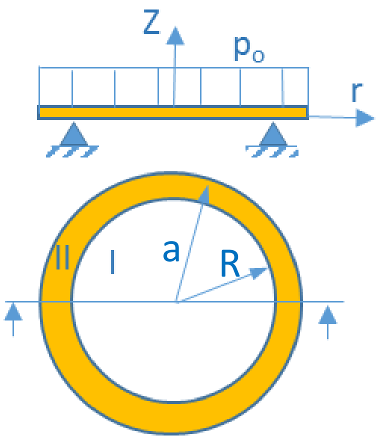
3.5. Consider a circular plate of radius **a**, and thickness **h**, simply supported on an annular interior ring of radius **R**, and loaded by a uniform load $\mathbf{p_0}$, as shown in the figure.

Calculate:

1. The bending moments distributions
2. The transversal displacement at the centre of the plate

Data

Plate radius, **a = 4.5 m**; plate thickness, **h = 2 cm**; supporting ring radius, **R = 3.5m**
Young Modulus, **E = 210000** MPa, Poisson ratio, ν **= 0.3** .
Distributed load, $\mathbf{p_0 = 1000\ N/m^2}$



Ans. w(r = 0) = -19.7 mm

3.6. Consider a spherical tank of radius **a**, and the wall thickness **h**, supported by and annular ring as showed in the figure. The tank is filled with kerosene.

Calculate:

1. Internal forces in the shell at the section given by $\phi = \pi/3$,
2. The horizontal displacement, δ at the section given by $\phi = \pi/3$
3. The meridian rotation, γ at the supported section **(**$\phi = \phi_s$)

Data

a = 20 m; **t = 10 mm**; annular ring radius, **R = 16 m;** Young Modulus, **E = 210 GPa**; Poisson ratio, ν **= 0.3;** Density of kerosene: $\mathbf{800\ kg/m^3}$

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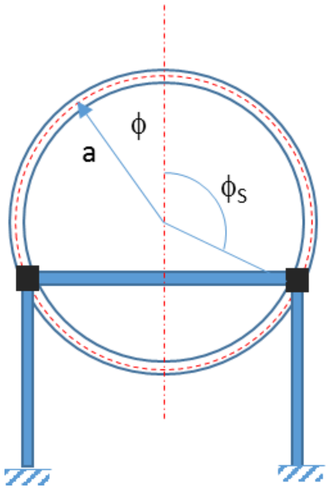
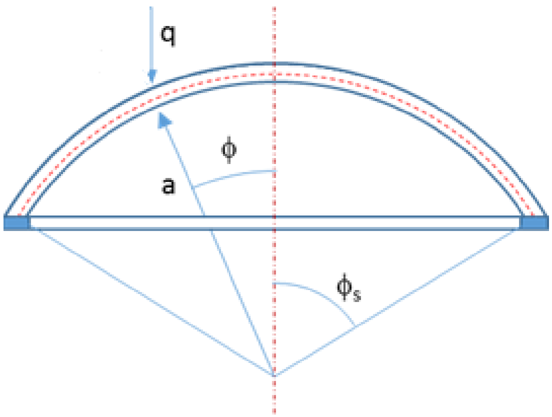


Ans.
$N_\phi(\pi/3)$ = 280.4 kN/m
$N_\theta(\pi/3)$ = 981.3 kN/m
$\delta(\pi/3)$ = 7.9 mm
$\gamma\ (\phi_s) = -1.20\cdot10^{-3}$ rad

3.7. The roof of an airport terminal building can be modelled as a semi-spherical shell supported by an annular ring as sowed in the figure. The total load on the roof shell is taken as q = 3.5 kPa constant over its surface area.
At the supported section, **(**$\phi = \phi_s$), calculate:

1. Internal forces in the shell
2. The horizontal displacement, δ
3. The meridian rotation, γ

Data
a = 40 m; **t = 20 mm**; **ϕ_s = 60º;** Young Modulus, **E = 27 GPa**, Poisson ratio, **ν = 0.20**



$N_\phi(\pi/3)$ = -93.3 kN/m
$N_\theta(\pi/3)$ = 23.3 kN/m
$\delta(\pi/3)$ = 2.7 mm
$\gamma\ (\pi/3) = -4.94\cdot10^{-4}$ rad

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