UE Fluids Problem 9 Solution S'08

a) $\boxed{L' = \rho V_\infty \Gamma = \rho V_\infty^2 \, 2b \left[A_1 \sin\theta + A_3 \sin 3\theta + A_5 \sin 5\theta \right]}$

where $\boxed{\theta(y) = \arccos\left(\frac{2y}{b}\right)}$

i) $A_1 = 0.040$, $A_3 = 0$, $A_5 = 0$, $b = 15$

ii) $A_1 = 0.0352$, $A_3 = -0.0055$, $A_5 = 0.0011$, $b = 16$

Plot L' vs y for i) and ii) cases (below)

b) $\boxed{\alpha_i = A_1 + 3A_3 \frac{\sin 3\theta}{\sin\theta} + 5A_5 \frac{\sin 5\theta}{\sin\theta}}$ → plot for i) and ii) (below)

c) $L = \frac{\pi}{4} \rho V_\infty^2 b^2 A_1$ → $\boxed{\begin{array}{l} i)\ L = 7.07 \\ ii)\ L = 7.07 \end{array}}$ same lift

$\delta = 3\left(\frac{A_3}{A_1}\right)^2 + 5\left(\frac{A_5}{A_1}\right)^2$ → i) $\delta = 0$, $e = 1$

$e = [1 + \delta]^{-1}$ ii) $\delta = 0.0782$, $e = 0.9275$ ← lower span eff.

$D_i = \pi b^2 \frac{1}{2} \rho V_\infty^2 A_1^2 [1 + \delta]$ → i) $D_i = 0.5655$

ii) $D_i = 0.5372$ ← lower D_i

d) Elliptical loading gives minium D_i only <u>for a fixed span</u>. Not the case here.