Thin Aerofoil in subsonic Flow

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- Question 1. The experimenters can obtain the value of $\tilde{C}_L$ for $M_2 = 0.4$ (Mach number) with the following formula

$$C_L = \frac{2}{\sqrt{1-M_\infty^2}} \int_0^1 \big[\tilde{p}(x,0-) - \tilde{p}(x,0+)\big]\, dx = \frac{2\tilde{C}_L}{\sqrt{1-M_\infty^2}},$$

  calculate $\tilde{C}_L$ and then using this expression, calculate C_L for Mach number $M_\infty = 0.55$.

- Question 2. Remember, the thin aerofoil theory loses it validity in a small vicinity of the leading edge. Additionally, calculating lift force by integrating the pressure difference between the lower and upper sides of aerofoil might lead to an error due to the fact that the leading edge of an aerofoil can produce a "suction force" that might contribute to the lift force. The lift force is defined as

$$\hat{L} = \int_0^L \Big[\cos{(\alpha-\theta_-)}\hat{p}_- - \cos{(\alpha-\theta_+)}\hat{p}_+\Big]\, d\hat{x},$$

  In the thin aerofoil theory, it is assumed that the angle of attack and camber are small therefore the term $(\alpha - \theta_-)$ must be small as well. Thus one could argue that the lift forced is reduced to

$$\hat{L} = \int_0^L \big[\hat{p}_- - \hat{p}_+\big]\, d\hat{x},$$

  In the vicinity of the leading edge we have two different behaviours one is rapid (inner region) and the other one is a slow (outer region). To show the behaviour of the flow near the leading edge we introduce the inner region where it produces an $O(\epsilon^2)$ contribution to the lift force.

Questions

The questions are found in Ruban (2015).

References

Ruban, A. I. (2015), 'Fluid dynamics. part 2, asymptotic problems of fluid dynamics'.

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