Comment on "Thickness and Camber Effects in Slender Wing Theory"

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IN the paper by Plotkin,[1] first-order corrections to slender wing theory[2] were developed due to spanwise thickness and camber distributions. The velocity potential $\phi(x, y, z)$ calculated in the paper[1] actually corresponds to the flow having zero normal velocity at the body contour and a vertical velocity at infinity proportional to the angle of attack [$\phi_z(x, y, |z| \to \infty) = U\alpha$]. The mentioned velocity potential ϕ is not the perturbation velocity potential of the inner flow, $\phi'(x, y, z)$, having a vertical velocity $-\alpha U$ at the body contour and zero velocity at infinity.[3] Therefore, the lift obtained by an integration of the pressure jump over the wing surface, calculated using ϕ, should have been calculated using ϕ' in Plotkin's Eqs. (20–22), the difference in the lift value being

$$\rho U^2 S_b \alpha \tag{1}$$

where S_b is the area of the final section, which is zero for wings without thickness but should be retained in the case considered in Plotkin's paper.

Particularly, for the elliptical cross-sectional wing solved in Plotkin's paper,[1] this new term cancels out the perturbation term $\frac{1}{2}\pi A\alpha\varepsilon$ calculated in the paper, which is, finally,

$$C_L = \tfrac{1}{2}\pi A\alpha \tag{2}$$

Up to the considered approximation, there is no contribution of the thickness of a wing with the considered shape to the lift.

For the elliptical section wing, Eq. (2) can also be obtained using the Joukowsky conformal transform to map the ellipse into a circle. It is not necessary, for this particular case, to use the expansion in Plotkin's paper[1] Eq. (4). Therefore, it can be stated that for slender wings with elliptical sections, there is no contribution to the lift due to its thickness.

References

[1] Plotkin, A., "Thickness and Camber Effects in Slender Wing Theory," *AIAA Journal*, Vol. 21, No. 12, 1983, pp. 1755–1757.

[2] Jones, R. T., "Properties of Low-Aspect-Ratio Pointed Wings at Speeds Below and Above the Speed of Sound," NACA Rept. 835, 1946.

[3] Ashley, H., and Landahl, M., *Aerodynamics of Wings and Bodies*, Addison Wesley, Reading, MA, 1965, Chap. 6.

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