Aerospace Engineering Thesis Defense

Revisiting aerodynamic modifications to a thin transonic wing and Küchemann's critical pressure co-efficient rule

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Abstract

Modern transonic aircraft have been designed and refined over the ages for better performance. Aerodynamic refinements typically optimize a number of performance parameters: lift-to-drag ratio (L/D), zero-lift drag coefficient, Cp distribution, design Critical Mach number and design lift coefficient. This thesis explores the effects of aerodynamic refinements to a baseline thin transonic wing, namely, modifications to the leading-edge radius, camber, droop and thickness to determine their effectiveness to optimize the aerodynamic performance of the wing. Prior works has shown that these modifications can be helpful to improve the performance of a wing. We utilize panel methods and computational fluid dynamics (CFD) to show that these modifications do not necessarily help in improving the aerodynamic performance. This work also presents data to show the appropriate use of Küchemann's critical pressure co-efficient equation in a 3D flow field over a thin transonic wing integrated to a nominal fuselage. The final work of the thesis aims to provide clear definitions of the terms involved in the classical Küchemann's equation and how the design modifications depend on the correct interpretation of the Küchemann's equation. It also studies effect of winglet on design performance and throws some light on the inconsistency in the simple sweep theory.

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