An improved method for transport aircraft for high lift aerodynamic prediction

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ABSTRACT

The aim of this work is the development of a methodology to predict lift characteristics for transport aircraft in the whole flight envelope, useful in the preliminary aircraft design stage. The purpose is an attempt to improve the classical methodologies for wing load distribution and lift prediction, considering the airfoils aerodynamic characteristics until stall and post stall conditions during the process, and modifying 2D characteristics in case of high lift devices to take into account 3D effects introduced by the devices themselves. The method is a modification of Nasa Blackwell procedure, capable to predict wing stall aerodynamic characteristics for both clean and flapped configuration. As far the high lift devices effect is concerned, the improved method works substituting clean airfoil aerodynamic characteristics with the flapped aerodynamics ones, and introducing a correction to evaluate the 3D effects induced by high lift devices geometrical discontinuities. The results of the developed method have been compared with CFD and experimental data showing good agreement, making available a fast and reliable method, useful in preliminary aircraft design.

KEYWORDS: *Aircraft design, high lift aerodynamic, transport aircraft, span lift coefficient distribution,* extended lifting-line theory*.*

NOMENCLATURE

α – Angle of attack
α_{0L} – Zero lift angle of attack
AR – Aspect ratio
b – Span
C_l – Local 2D lift coefficient
C_L – 3D lift coefficient
$C_{L,max}$ – Maximum lift coefficient
C_{L0} – Lift coefficient at zero angle of attack
c_k – Kink chord
c_r – Root chord
c_t – Tip chord
Λ_{LE} – Sweep at leading edge
η – Non-dimensional station along semi-span
η_{in} – Flap/Slat inner station
η_{out} – Flap/Slat outer station
h – Altitude
M – Mach number
MAC – Mean aerodynamic chord
Re – Reynolds number
S – Surface
Y – Dimensional station along semi-span