29th Congress of the International Council of the Aeronautical Sciences
St. Petersburg, Russia; September 7-12, 2014

DEVELOPMENT OF NEW PRELIMINARY DESIGN METHODOLOGIES FOR REGIONAL TURBOPROP AIRCRAFT BY CFD ANALYSES

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Keywords: *Aircraft Design, Aerodynamics, CFD, Regional Turboprop*

Abstract

Since 2011 the aerodynamic research group of the Dept. of Industrial Engineering of the University of Naples "Federico II" makes use of the University's computing grid infrastructure SCoPE to perform parallel computing simulations with the commercial CAE package Star-CCM+. This infrastructure allows Navier-Stokes calculations on complete aircraft configurations in a relative short amount of time. Therefore, the software and the above mentioned infrastructure allow the parametric analysis of several configurations that are extremely useful to the correct estimation of aerodynamic interference among aircraft components and to highlight some useful trends that could indicate how a specific aerodynamic characteristic (i.e. the drag of a component, the wing downwash or the directional stability contribution of the vertical tail) is linked to aircraft geometrical parameters. Thus, with the choice of a specific set of test-cases it is possible to make a deep investigation on some aerodynamic features and, from the analyses of results, it is possible to extract and develop ad-hoc semi-empirical methodologies that could be used in preliminary design activities.

In this paper, two investigations are presented: the aerodynamic interference among aircraft components in sideslip and the aerodynamic characteristics of a fuselage, focusing on typical large turbopropeller aircraft category.

Nomenclature

A	aspect ratio
b	wing span
D	diameter
L	length
N	yawing moment
r	fuselage radius
S	planform area
Y	sideforce
z	vertical position of component
α	angle of attack
β	angle of sideslip
δ	angle of deflection of control surface
λ	taper ratio
Λ	sweep angle
ψ	windshield angle
θ	upsweep angle

Aerodynamic coefficients

C_D	drag coefficient
C_{M0}	pitching moment coefficient at $\alpha = 0$
$C_{M\alpha}$	pitch stability derivative
C_N	yawing moment coefficient

Capital letters

V	vertical tailplane
BV	vertical tail-fuselage combination
WBV	wing-fuselage-vertical tail comb.
WBVH	complete aircraft

Subscripts

f	fuselage
ftc or t	fuselage tailcone
h	horizontal tailplane
n	fuselage nose
r	rudder
v	vertical tailplane
w	wing