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COMMUTER AIRCRAFT AERODYNAMIC DESIGN: WIND-TUNNEL TESTS AND CFD ANALYSIS

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Abstract

The paper presents wind-tunnel tests and CFD numerical aerodynamic analysis of Tecnam P2012 Traveller aircraft. An extensive wind tunnel tests campaign of several different modular aircraft configurations analyzed has been performed on a scaled model in order to experimentally estimate both longitudinal and lateral-directional stability, control derivatives, and to improve the aircraft aerodynamic performances. Simultaneously numerical investigations through a CFD software has been performed, both at wind-tunnel tests Reynolds number (Re=0.6millions) and at free flight Reynolds number of the full scale aircraft (Re=4 or 9 millions). Finally results are compared showing a good agreement in the lift and pitching moment coefficient both with and without control surfaces or flap deflections, and an underestimation of drag coefficient in the CFD numerical analysis. Horizontal tail positions are also tested in wind-tunnel and compared to CFD analysis highlighting how an accurate design leads to improvement both in stability and control. Results will be very useful in the final design of the aircraft and to perform dynamic simulations.

Nomenclature

AR aspect ratio
ADAG Aircraft Design and AeroflightDynamics Group
b wing span
b_H horizontal tail span
b_V vertical tail span
$\bar{c}$ mean aerodynamic chord
DII Department of Industrial Engineering
h_F fusealge height
l_F fusealge length
λ taper ratio
S wing surface
S_H horizontal tail surface
S_V vertical tail surface
w_F fusealge span

Aerodynamic coefficients
C_D drag coefficient
C_L lift coefficient
C_{L0} alpha zero lift coefficient
$C_{L\alpha}$ lift coefficient derivative
C_{roll} rolling moment coefficient
$C_{roll\beta}$ rolling moment derivative
C_{M0} pitching moment coefficient at $\alpha = 0$
$C_{M\alpha}$ pitch stability derivative
C_N yawing moment coefficient
$C_{N\beta}$ yawing moment derivative
$C_{Y\beta}$ sideforce derivative

Capital letters
B body or fuselage
V vertical tailplane
WWB wing winglet body
WWBN wing winglet body nacelle
WWBNHV wing winglet body nacelle + horizontal and vertical tail

1 Introduction

The Tecnam P2012 Traveller is a twin engine eleven seats aircraft designed by Prof. Luigi Pascale at Tecnam Aircraft Industries. The aerodynamic design of the aircraft has also been