Commuter aircraft aerodynamic characteristics through wind tunnel tests

Fabrizio Nicolosi, Salvatore Corcione and Pierluigi Della Vecchia
Department of Industrial Engineering, University of Naples Federico II, Naples, Italy

Abstract

Purpose – This paper aims to deal with the experimental estimation of both longitudinal- and lateral-directional aerodynamic characteristics of a new twin-engine, 11-seat commuter aircraft.

Design/methodology/approach – Wind tunnel tests have been conducted on a 1:8.75 scaled model. A modular model (fuselage, wing, nacelle, winglet and tail planes) has been built to analyze both complete aircraft aerodynamic characteristics and mutual effects among components. The model has been also equipped with trailing edge flaps, elevator and rudder control surfaces.

Findings – Longitudinal tests have shown the goodness of the aircraft design in terms of aircraft stability, control and trim capabilities at typical clean, take-off and landing conditions. The effects of fuselage, nacelles and winglets on lift, pitching moment and drag coefficients have been investigated. Lateral-directional stability and control characteristics of the complete aircraft and several aircraft component combinations have been tested to estimate the aircraft components' interactions.

Research limitations/implications – The experimental tests have been performed at a Reynolds number of about 0.6e6, whereas the free-flight Reynolds number range should be between 4.5e6 and 9.5e6. Thus, all the measured data suffer from the Reynolds number scaling effect.

Practical implications – The study provides useful aerodynamic database for P2012 Traveller commuter aircraft.

Originality/value – The paper deals with the experimental investigation of a new general aviation 11-seat commuter aircraft being brought to market by Tecnam Aircraft Industries and it brings some material on applied industrial design in the open literature.

Keywords Commuter aircraft, Longitudinal and lateral-directional stability and control, Wind tunnel tests

Paper type Research paper

Nomenclature

Symbols

$\bar{c}$ = wing mean aerodynamic chord (m)
AR_W = wing aspect ratio
b_h = horizontal tail span (m)
b_v = vertical tail span (m)
b_w = wing span (m)
C.G. = aircraft centre of gravity
cC_l/mgc = wing span loading referred to the wing mean geometric chord (mgc)
C_D = three-dimensional (3D) drag coefficient
C_{Do} = 3D drag coefficient under zero-lift conditions
C_L = 3D aircraft lift coefficient
$C_{L\alpha}$ = aircraft lift curve slope (deg^{-1})
C_M = 3D aircraft pitching moment coefficient
$C_{M\alpha}$ = aircraft pitching moment coefficient derivative with respect to the angle of incidence (deg^{-1})
C_N = aircraft yawing moment coefficient
$C_{N\beta}$ = aircraft yawing moment coefficient derivative with respect to the sideslip angle (deg^{-1})
$C_{N\beta,v}$ = vertical tail yawing moment coefficient derivative with respect to the sideslip angle
$C_{N\delta r}$ = aircraft yawing moment coefficient derivative with respect to the rudder deflection (deg^{-1})
C_{roll} = aircraft rolling moment coefficient
$C_{roll\beta}$ = aircraft rolling moment coefficient derivative with respect to the sideslip angle (deg^{-1})
e = Oswald factor
$d\varepsilon/d\alpha$ = wing downwash angle derivative with respect to the aircraft angle of attack
i_{to} = horizontal tail incidence angle (deg)
l_F = fuselage length (m)
N_0 = aircraft neutral point as percentage of $\bar{c}$
S_h = horizontal tail surface (m^2)
S_v = vertical tail surface (m^2)
V_{EF} = aircraft engine failure speed
V_{MC} = minimum control speed (m/s)
V_{STO} = aircraft stall speed under take-off conditions (m/s)
w_F = maximum fuselage width (m)

The current issue and full text archive of this journal is available on Emerald Insight at: **www.emeraldinsight.com/1748-8842.htm**

Aircraft Engineering and Aerospace Technology: An International Journal
88/4 (2016) 523–534

[ISSN 1748-8842]
[DOI 10.1108/AEAT-01-2015-0008]

The authors wish to thank the Design Office of Tecnam Aircraft Industries (Costruzioni Aeronautiche Tecnam) for the technical collaboration with the DII. The authors want also to express gratitude to Prof L. Pascale (former Professor at the same Department and now President of Tecnam) for many useful suggestions and interesting considerations in the analysis of obtained experimental results.

Received 12 January 2015
Revised 8 April 2015
Accepted 8 April 2015