Wind tunnel testing of a generic regional turboprop aircraft modular model and development of improved design guidelines

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This article presents results of a wide experimental aerodynamic test campaign, regarding the longitudinal and lateral-directional stability, performed in the low-speed wind-tunnel of the University of Naples "Federico II", on a generic modular model of a modern regional turboprop aircraft. The modular model has been designed to arrange more than 200 possible different configurations with the modification of the aircraft main geometrical characteristics, such as wing-fuselage relative position, vertical tail size, and horizontal tail position. All tests, both longitudinal and lateral-directional, were addressed to the derivation of improved semi-empirical formulations or surrogate models for the estimation of aerodynamic characteristics and derivatives for the regional turboprop aircraft category (similar to the ATR and Bombardier Q-Series) in preliminary design phase. Longitudinal tests were addressed to the measurement of aircraft lift, downwash, and horizontal tailplane contribution to longitudinal stability. Directional tests were instead focused on the correct estimation of vertical tail and fuselage contributions to directional stability for different vertical tail planforms, horizontal tail arrangements, and fuselage after-body shapes. The combined effects of wing and horizontal tail positions on aircraft lateral stability have also been investigated. All the obtained results are likely to be extremely useful for a future application in the preliminary design phase, since the derived charts may give indications for accurate sizing and position of both horizontal and vertical stabilizers.

I. Nomenclature

A_v	=	vertical tail aspect ratio
B	=	body (fuselage)
BVH	=	body – vertical tail – horizontal tail configuration
c	=	chord
C_{D0}	=	parasite drag coefficient
$C_{L\alpha}$	=	lift curve slope
$C_{M\alpha}$	=	pitching moment coefficient derivative
$C_{N\beta}$	=	yawing moment coefficient derivative
C_R	=	rolling moment coefficient
dC_M/dC_L	=	longitudinal stability derivative
$d\varepsilon/d\alpha$	=	downwash derivative
H	=	horizontal tail
l_H	=	distance between wing and horizontal tail aerodynamic centers
q	=	dynamic pressure
Re	=	Reynolds number
S	=	planform area
V	=	vertical tail
x	=	longitudinal station

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