Fuselage aerodynamic prediction methods

Fabrizio Nicolosi,[1] Pierluigi Della Vecchia,[2] Danilo Ciliberti,[3] Vincenzo Cusati and Lorenzo Attanasio.
University of Naples "Federico II", Naples, 80125, Italy

A CFD-based method to predict longitudinal and lateral-directional aerodynamic coefficients of an aircraft fuselage has been developed. A reliable aerodynamic characteristic estimation is crucial in order to carry out a well-designed aircraft. About 30% of an aircraft zero lift drag source is attained to the fuselage. Fuselage longitudinal instability is impacting on wing and horizontal tail design, whereas aircraft directional stability characteristics are strictly related to the fuselage aerodynamics. This paper proposes methods to estimate fuselage aerodynamic drag, pitching, and yawing moment coefficients. Given the fuselage geometry, simple user friendly charts allow to evaluate its aerodynamic characteristics. The method is here explained and numerical test cases are shown on several fuselage geometries. Finally, a comparison with typical semi-empirical methods is presented.

Nomenclature

b	=	wing span
c	=	fuselage cabin
C_D	=	drag coefficient
C_M	=	pitching moment coefficient
C_{M0}	=	zero α pitching moment coefficient
$C_{M\alpha}$	=	pitching moment coefficient derivative
d_f	=	fuselage maximum diameter
f, fus	=	fuselage
fp	=	flat plate
FR	=	fineness ratio
K	=	aerodynamic interference factor
L	=	fuselage lengths
mac	=	mean aerodynamic chord
n	=	fuselage nose
S_{front}	=	fuselage frontal area
S_{wet}	=	wetted area
S_{w}	=	wing area
t	=	fuselage tailcone
α	=	angle of attack
θ	=	tailcone upsweep angle
ψ	=	windshield angle

I. Introduction

THIS paper presents new preliminary design methodologies to estimate the aerodynamic coefficients of transport aircraft fuselage. Methods have been developed by numerical aerodynamic analyses performed with STAR-CCM+® (Ref. 1) and they have been focused on the estimation of aerodynamic drag, pitching moment, and yawing moment coefficients. Similar numerical approach to develop a methodology to be applied in preliminary design phase has been already carried out by the authors, which have deeply investigated the aerodynamics of the vertical

[1] Associate Professor, Dept. of Industrial Engineering, Via Claudio, 21, 80125, Naples, Italy, fabrizio.nicolosi@unina.it, AIAA Member.
[2] PostDoc, Dept. of Industrial Engineering, Via Claudio, 21, 80125, Naples, Italy, pierluigi.dellavecchia@unina.it, AIAA Member.
[3] PhD Student, Dept. of Industrial Engineering, Via Claudio, 21, 80125, Naples, Italy, danilo.ciliberti@unina.it, AIAA Member.