Aircraft directional stability prediction method by CFD

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

The aim of this paper is to present a new method to predict aircraft directional characteristics. The proposed approach is completely CFD based and it has been developed with more than 300 simulations of complete and partial aircraft configurations. The method accounts for mutual aerodynamic interference effects among components. First, the isolated vertical tailplane and fuselage yawing moment coefficients are calculated. Then, correction factors are applied to take into account for aircraft components (fuselage, wing, vertical and horizontal tailplanes). The corrected yawing moment coefficients represent the contributions of vertical tailplane and fuselage to aircraft directional stability, including the aerodynamic interference among all aircraft components. Finally, the method is tested and compared to typical semi-empirical approaches (USAF DATCOM, ESDU).

Nomenclature

A	=	aspect ratio
B	=	compressibility correction factor
b	=	span
$C_{L\alpha}$	=	three-dimensional lift curve slope
$C_{l\alpha}$	=	airfoil lift curve slope
$C_{N\beta}$	=	yawing moment coefficient due to sideslip
c	=	chord
D, d	=	fuselage diameter
F, f	=	fuselage
ftc	=	fuselage tailcone
H, h	=	horizontal tailplane
l_v	=	vertical tailplane yawing moment coefficient arm
K	=	aerodynamic interference factor
L	=	fuselage length
M	=	Mach number
r	=	fuselage radius
S	=	planform area
V, v	=	vertical tailplane
W, w	=	wing
z	=	vertical distance
α	=	angle of attack
β	=	angle of sideslip
Λ	=	sweep angle
λ	=	taper ratio

Note: a symbol written without subscript refers to wing, otherwise subscript indicates the component.
Example: A is the wing aspect ratio, whereas A_v is the vertical tailplane aspect ratio.

---

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