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AN INVESTIGATION ON VERTICAL TAILPLANE DESIGN

Fabrizio Nicolosi
Dep. of Aerospace Engineering
University of Naples Federico II
Via Claudio, 21
80125 Napoli - Italy
fabrnico@unina.it

Pierluigi Della Vecchia
Dep. of Aerospace Engineering
University of Naples Federico II
Via Claudio, 21
80125 Napoli - Italy
pierluigi.dellavecchia@unina.it

Danilo Ciliberti
Dep. of Aerospace Engineering
University of Naples Federico II
Via Claudio, 21
80125 Napoli - Italy
dancili@gmail.com

Abstract. The paper presents a deep investigation on the methodologies to design a vertical tailplane. Nowadays the most used methodologies in preliminary design to estimate the contribution of vertical tailplane on aircraft directional stability and control are: the classical method proposed by USAF DATCOM (also presented in several aeronautics textbooks) and the method presented in ESDU reports. Both methodologies derive from NACA world war II reports of the first half of the ’900, based on obsolete geometries, and give quite different results for certain configurations, e. g. in the case of horizontal stabilizer mounted in fuselage. As shown in literature, the main effects on the side force coefficient of the vertical tail are due to the interactions among the aircraft components: the fuselage acts like a cylinder increasing the local sideslip angle, the wing position and aspect ratio have an influence on the airflow near the tail zone and the horizontal tail, depending on position and size, can act as an endplate increasing the side force. In order to better highlight these effects, a different approach using the RANS equations has been adopted. Several CFD calculations have been performed on some test cases (used as experimental database) described in NACA reports and used in the past to obtain the semi-empirical methodology reported in USAF DATCOM, to verify the compliance of CFD results with available experimental data. The CFD calculations (performed through the use of a parallel supercomputing platform) have shown a good agreement between numerical and experimental data. Subsequently the abovementioned effects have been deeply investigated on a new set of propeller transport aircraft configurations. The different configurations that have been prepared differs for wing aspect ratio, wing-fuselage relative position (high-wing/low-wing), vertical tailplane aspect ratio (vertical tail span versus fuselage radius) and horizontal tailplane position respect to the vertical tailplane (in particular investigation the effect of fin-mounted T configuration, typical of regional turboprop transport aircraft). For all configurations the computational mesh has been carefully analyzed and prepared. All the CFD analyses will be useful to obtain new curves to predict the above-mentioned effects and to have a more accurate estimation of vertical tailplane contribution to aircraft directional stability and control.

Keywords. Vertical tailplane aerodynamics, directional stability, aircraft preliminary design