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A Simple Analytical Model to Describe the Impact of Wing on the Flowfield over the Tail in Subsonic Flow

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Abstract

A new approach is presented based on Response Surface Method to estimate the tail normal force in the immediate vicinity of a low aspect ratio swept wing by a simple analytical model in subsonic flow regime. Apart from the inevitable role of the tail in aircraft static stability, the force on the tail is needed for structural design process and also to select the proper actuator mechanism to deflect it in both on-design and off-design flight conditions. Several wind tunnel tests have been performed to obtain a physical insight into the impact of wing on the tail flow filed and to identify the independent factors responsible for this interaction. In these experiments, various wing palnforms were placed closely upstream of a tail. Many combinations of body angle of attack and tail deflections have been examined and the tail flow field was studied for each wing by measuring the tail pressure distribution on its either sides. The response surface was constructed using these experimental results and several comparisons were made between the experimental data and those predicted by the proposed model. Remarkable agreement was achieved for the total angles below the one corresponding to vortex burst and flow separation on the tail surface. For any cases, far out of the ranges considered in this paper, the model needs to be corrected to account for the flow phenomena associated with the new ranges of the variables.

Keywords: Vortex, Wing Planform, Interference, Vortex Shedding, Response Surface Method

Nomenclature

α	Body angle of attack	$AR=b^2/S$	Planform Aspect Ratio
δ	Tail deflection angle	Λ	Leading edge sweep angle.
b	Planform semi-span	c_N	The tail normal fore coefficient
S	Planform Area	c_p	Pressure coefficient on the tail.