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Generalized Vortex Lattice Method for Predicting Characteristics of Wings with Flap and Aileron Deflection

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Abstract : A generalized vortex lattice method for complex lifting surfaces with flap and aileron deflection is formulated. The method is not restricted by the linearized theory assumption and accounts for all standard geometric lifting surface parameters: camber, taper, sweep, washout, dihedral, in addition to flap and aileron deflection. Thickness is not accounted for since the physical lifting body is replaced by a lattice of panels located on the mean camber surface. This panel lattice setup and the treatment of different wake geometries is what distinguish the present work form the overwhelming majority of previous solutions based on the vortex lattice method. A MATLAB code implementing the proposed formulation is developed and validated by comparing our results to existing experimental and numerical ones and good agreement is demonstrated. It is then used to study the accuracy of the widely used classical vortex-lattice method. It is shown that the classical approach gives good agreement in the clean configuration but is off by as much as 30% when a flap or aileron deflection of 30° is imposed. This discrepancy is mainly due the linearized theory assumption associated with the conventional method. A comparison of the effect of four different wake geometries on the values of aerodynamic coefficients was also carried out and it is found that the choice of the wake shape had very little effect on the results.

Keywords : aileron deflection, camber-surface-bound vortices, classical VLM, generalized VLM, flap deflection
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