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Numerical Studies on 2D and 3D Boundary Layer Blockage and External Flow Choking at Wing in Ground Effect

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Abstract : In this paper using a validated double precision, density-based implicit standard k-ε model, the detailed 2D and 3D numerical studies have been carried out to examine the external flow choking at wing-in-ground (WIG) effect craft. The CFD code is calibrated using the exact solution based on the Sanal flow choking condition for adiabatic flows. We observed that at the identical WIG effect conditions the numerically predicted 2D boundary layer blockage is significantly higher than the 3D case and as a result, the airfoil exhibited an early external flow choking than the corresponding wing, which is corroborated with the exact solution. We concluded that, in lieu of the conventional 2D numerical simulation, it is invariably beneficial to go for a realistic 3D simulation of the wing in ground effect, which is analogous and would have the aspects of a real-time parametric flow. We inferred that under the identical flying conditions the chances of external flow choking at WIG effect is higher for conventional aircraft than an aircraft facilitating a divergent channel effect at the bottom surface of the fuselage as proposed herein. We concluded that the fuselage and wings integrated geometry optimization can improve the overall aerodynamic performance of WIG craft. This study is a pointer to the designers and/or pilots for perceiving the zone of danger a priori due to the anticipated external flow choking at WIG effect craft for safe flying at the close proximity of the terrain and the dynamic surface of the marine.

Keywords : boundary layer blockage, chord dominated ground effect, external flow choking, WIG effect
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