Effects of Gurney Flap Height on Low Reynolds Number Airfoil Performance

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Low-speed aerodynamic stalls remain a critical limitation for general aviation (GA) aircraft and unmanned aerial vehicles (UAVs) operating at low Reynolds numbers. Although the Clark-Y airfoil is widely used on these aircraft for its stable, predictable behavior, its maximum lift capability is limited at low speeds. This study experimentally determined the optimal Gurney flap height (0-4% chord) to maximize lift coefficient (Cl), lift-to-drag ratio (Cl/Cd), and stall margin at Reynolds numbers near 1x10^5. A Clark-Y model with interchangeable trailing-edge Gurney flaps was tested in subsonic wind tunnels across angles of attack from 0 degrees through post-stall. Differential pressure measurements were converted to lift coefficients, and ten trials were conducted for each configuration to ensure repeatability. A two-way ANOVA (Gurney height and angle of attack) was used to evaluate statistical significance, with a p-value <0.005. Computational fluid dynamics (CFD) simulations were conducted to support flow visualization and interpret pressure distribution trends. Results showed that lift increased with flap height up to approximately 3% chord. Configurations within this area produced the highest lift-to-drag ratio and delayed stall compared to the baseline airfoil. Although the 4% configuration generated the greatest Clmax, it introduced disproportionate drag penalties, reducing overall efficiency. Statistical analysis confirmed a significant effect of Gurney height on aerodynamic performance ($p<0.005$). These findings identify an optimal Gurney flap range for low-speed Clark-Y applications and demonstrate that small geometric modifications can substantially improve stall resistance and aerodynamic efficiency in small-aircraft platforms.

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