ABSTRACT

This thesis presents a comprehensive experimental investigation of the aerodynamic characteristics of various delta wings, with a primary focus on the flow field around a double delta wing under subsonic flow conditions. The study aims to enhance the understanding of the complex aerodynamic phenomena associated with double delta wings, particularly in the subsonic regime, by utilizing both experimental and numerical approaches.

The double delta wing configuration, known for its two distinct leading-edge sweeps, offers unique aerodynamic advantages, including enhanced lift, delayed stall, and improved maneuverability. These characteristics make it an ideal design for high-speed and high-performance aircraft. The research explores these benefits by employing various experimental techniques, including wind tunnel testing, oil flow visualization, balance measurement, surface pressure distribution measurements, and velocity profile assessments using a three-hole pressure probe.

The experimental investigations were conducted in a subsonic open circuit wind tunnel at the Fluid Mechanics and Machinery Laboratory, Department of Power Engineering, Jadavpur University, Kolkata, India. The double delta wing model, designed and fabricated in-house, was tested under various angles of attack to capture a comprehensive dataset. The wind tunnel tests were complemented by high-fidelity numerical simulations using Computational Fluid Dynamics (CFD) to validate and extend the experimental findings. The flow visualization techniques revealed detailed insights into the vortex formation and interaction patterns over the double delta wing. The oil flow visualization technique provided qualitative data on the surface flow streamlines and vortex structure, while the surface pressure measurements quantified the pressure distribution across the wing surface, which is critical for understanding lift and drag characteristics. The velocity profile measurements using the three-hole pressure probe further detailed the flow field over the wing, highlighting the complex interaction of vortices and the resulting aerodynamic forces. The study identified several key aerodynamic phenomena, including the formation of strong leading-edge vortices that enhance lift and delay stall, particularly at high angles of attack. The pressure distribution data showed significant variations corresponding to different flow regimes, contributing to a deeper understanding of the aerodynamic efficiency of the double delta wing. The velocity measurements corroborated the experimental observations, providing a detailed map of the flow field and supporting the numerical simulation results.

In addition to the experimental work, extensive numerical simulations were performed to model the airflow around the double delta wing. These simulations used advanced turbulence models and grid configurations to ensure an accurate representation of the flow physics. The numerical results closely matched the experimental data, validating the computational approach and providing further insights into the unsteady flow characteristics and vortex dynamics. The findings of this thesis contribute significantly to the field of aerodynamics, particularly in understanding the flow behavior around complex wing configurations like the double delta wing. The combined experimental and numerical approach provides a robust framework for analyzing and optimizing such wing designs, with implications for improving the performance of high-speed and high-maneuverability aircraft. Future work recommended includes extending the experimental investigations to different flow regimes, such as transonic and supersonic, and exploring the impact of different wing geometries and configurations. Additionally, further refinement of the numerical models to capture more detailed unsteady flow phenomena would enhance the predictive capabilities for advanced aerodynamic designs.

In conclusion, this thesis provides a thorough investigation of the aerodynamics of double delta wings, offering valuable insights into their performance characteristics and contributing to the broader knowledge base in aerospace engineering. The integration of experimental and numerical methods presents a comprehensive approach to studying and optimizing advanced wing configurations for modern aircraft applications.

Keywords: **Aerodynamics, Double Delta Wing, Delta Wing, Oil Flow Visualization, Vortex Lift**

GRAPHICAL ABSTRACT