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"REVIEW PAPER ON AIRFOIL BASIC INTRODUCTION"

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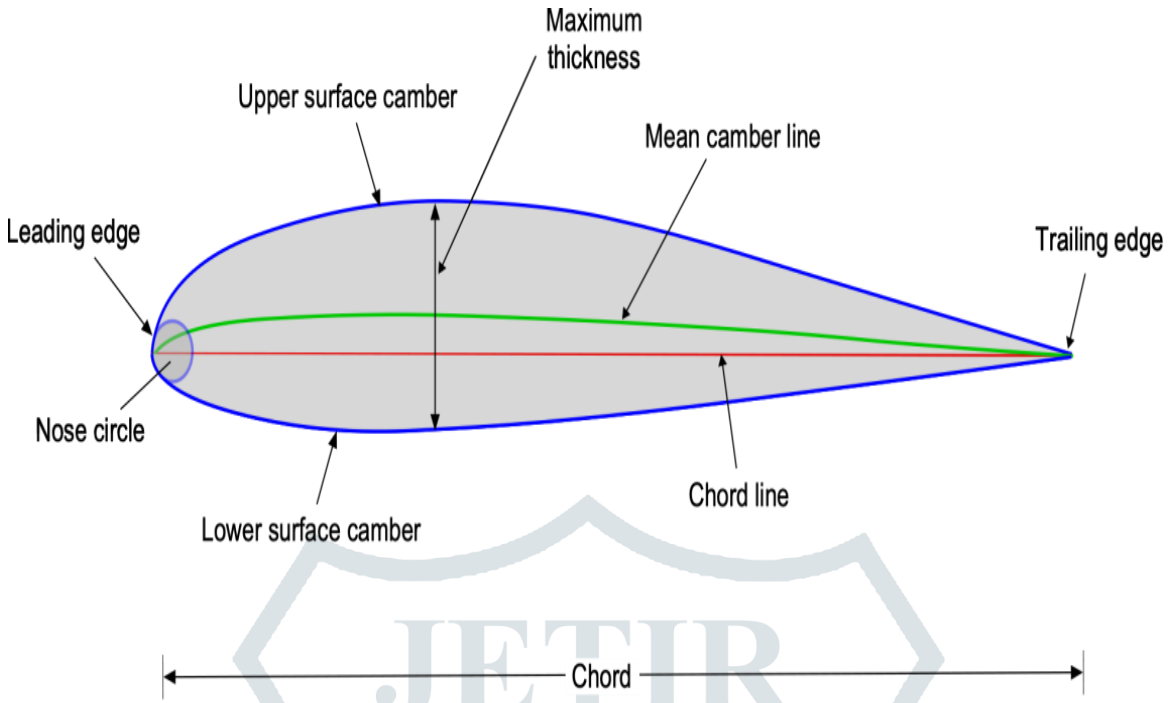
Abstract:

This report thoroughly analyses a newly developed airfoil design aimed at improving aerodynamic efficiency and reducing drag. The proposed airfoil features a distinctive combination of curvature and camber, which has been refined using computational fluid dynamics (CFD) simulations and wind tunnel experiments. The results demonstrate significant improvements in lift-to-drag ratio, stall angle, and overall performance across various Reynolds numbers and angles of attack. This new airfoil design shows promise for enhancing fuel efficiency, reducing emissions, and increasing stability in aerospace and wind energy applications. The research contributes to the ongoing efforts to develop optimisedairfoil shapes, advancing the limits of aerodynamic performance and sustainability.

Introduction to Airfoil:

Airfoils are a critical component in various aerospace and wind energy applications, and their design plays a vital role in determining the overall performance and efficiency of aircraft, wind turbines, and other devices. The aerodynamic characteristics of airfoils, including lift and drag, are highly dependent on their geometric shape, and even small modifications can significantly impact their performance.

Airfoil Terminology:



An aerofoil consists of various cross-sectional shapes. Different types of aerofoils are used for the construction of aircraft wings. To differentiate between different aerofoil shapes, an aerofoil's properties are defined and specific terminologies are used. Aerofoil Terminology. An Aerofoil is being designed with a shape that has the capability of producing lift with relatively high efficiency as it passes through the air. An aerofoil can have many cross-sectional shapes.

Lift Coefficient:

The lift coefficient is a relationship between the lift generated by a lifting body to fluid density, fluid velocity, and the associated reference area, this is a dimensionless coefficient. Mathematical Representation is as follows:

$$C_L = \frac{L}{q_s} = \frac{L}{\frac{1}{2}p.u.u.s} = \frac{2L}{p.u.u.s}$$

Where,

C_L : lift coefficient

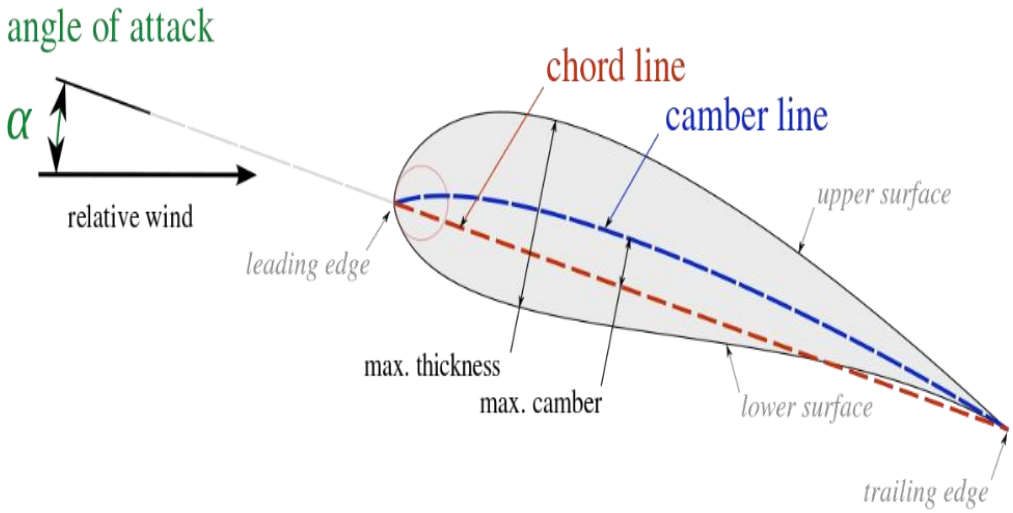
L: lift force

S: relevant surface

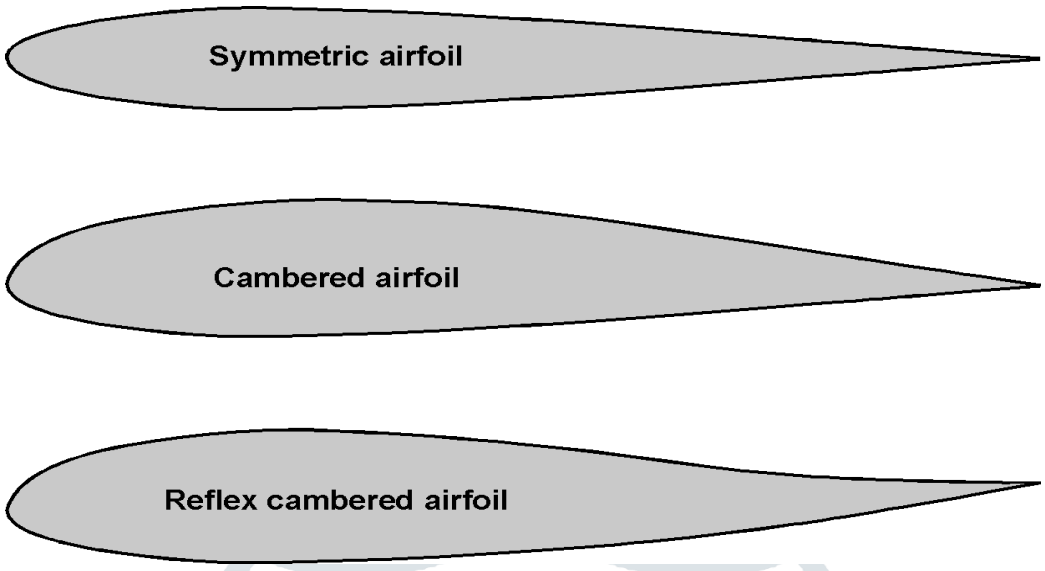
q: fluid dynamic pressure

ρ: fluid density

μ : flow speed



Types of Aerofoils:



Symmetric airfoil: A symmetrical airfoil has the same curvature on their top and bottom surfaces, providing an aerodynamic shape with lower drag then an oval tube as show in fig above.

Non-symmetric airfoil & Cambered airfoil: A Non-symmetric airfoil has different upper and lower surfaces shuch that the cord line happens to be placed above with large curvature, their cord line chamber line are different. As show in fig above.

Reflex cambered airfoil: An airfoil where the camber line curve back up near the trailing edge is call a reflex cambered airfoil.

Representation of Forces and Moments:

usually treated as a set of two two-dimensional geometric features; the airfoil (x-z plane as shown in Figure 8-2)

and planform (x-y plane, see Section 9.4, Planform Selection). It was shown by dimensional analysis (i.e. via the

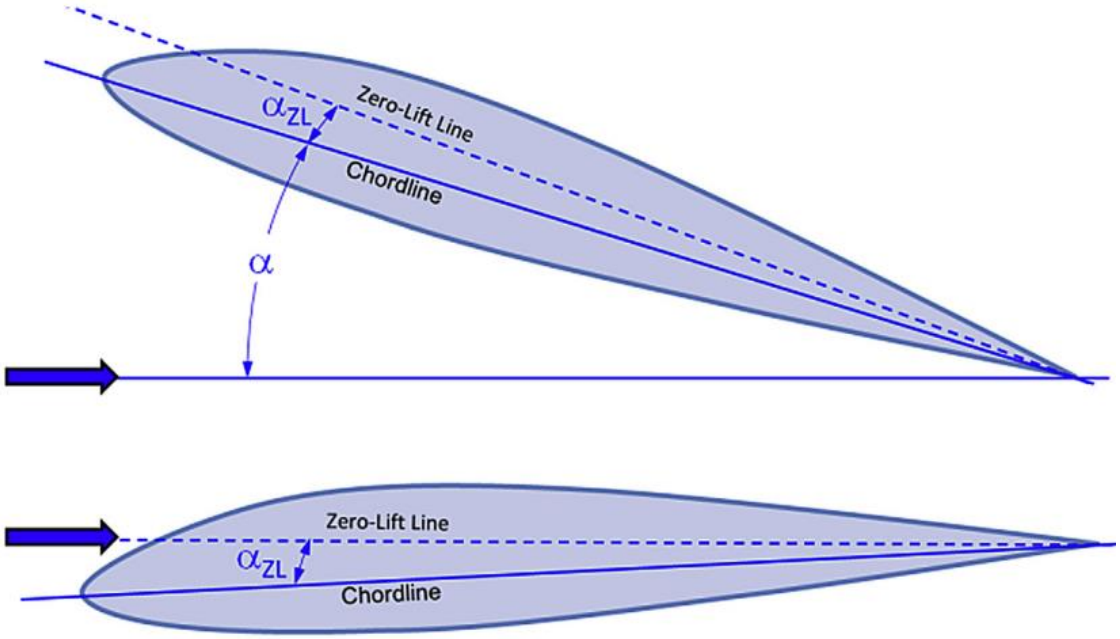
Buckingham's P theorem) that the equation describing

this resultant force, r, is given by:

$$r = \frac{1}{2}\rho V^2 \cdot S \cdot C_r$$

Angle-of-attack at Zero Lift:

Remember this information: The "zero-lift angle of attack" is the angle at which the airfoil produces no lift. This is important when considering wing washout and when converting the two-dimensional lift curve to three dimensions. The change can be approximated by rotating the lift curve around this point toward a shallower slope. (Refer to Section 9.3.5 for more on wing twist and washout, and Section 9.5.5 for transforming the lift curve from 2D to 3D.)



Conclusion:

In this study, we have successfully designed, simulated, and experimentally validated a new airfoil geometry that shows improved aerodynamic performance. The results demonstrate a significant

reduction in drag and a substantial increase in lift, leading to an enhanced lift-to-drag ratio. The unique curvature and camber distribution of the airfoil contribute to its superior performance, making it a promising candidate for various applications in aerospace and wind energy.

The findings of this research contribute to the advancement of airfoil design, highlighting the potential for optimized geometries to improve fuel efficiency, reduce emissions, and enhance stability. Future work can build upon this research by exploring additional optimization techniques, investigating the airfoil's performance in various flow conditions, and integrating the design into practical applications.

The conclusion summarizes the main findings, highlights their significance, and provides a direction for future research. Let me know if you'd like any changes!

References:

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