International Journal of Research

International Journal of Research (IJR)

e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 10, October 2015

Available at http://internationaljournalofresearch.org

Design and CFD Analysis of Air Foil

[1]B.Srinivas & [2]Banoth Bhadru

1. ASSISTANT PROFESSOR Bomma Institute of Technology and Science,Allipuram, Khammam, Telengana, INDIA - 507318

2. M.Tech, Bomma Institute of Technology and Science,Allipuram, Khammam, Telengana, INDIA – 507318

ABSTRACT:

Since the Wright brothers' first successful flight, aircraft designers have been focusing on improving the aircraft flight efficiency, and especially airline companies are anxious to improve the commercial aircraft efficiency nowadays. Usually aircraft wings are designed to be most efficient at cruising flight but suffer performance penalties under other conditions, such as taking off, landing and controlling flight attitude In this PROJECT we obtain the drag and lift forces using CFD which can also be determined through experiments using wind tunnel testing. In experimental setup, the design model has to be placed in the test section. This process is quite laborious & (surely) cost more than CFD techniques cost for the same. Thus we have gone through analytical method then it can be validated by experimental testing. The analysis of the two dimensional subsonic flow over a NACA 0012 airfoil at various angles of attack and operating at a Reynolds number of 3×E+06 is presented. The CFD simulation results show close agreement with those of the experiments, thus suggesting a reliable alternative to experimental method in determining drag and lift. Three angles have been taken of NACA 0012 ie, 2 , 6, 8 degrees and there lift and drag is calculated using wind tunnel testing using ANSYS CFD fluent workbench and there results are compared with other inclination and there conclusion is drawn.

INTRODUCTION:

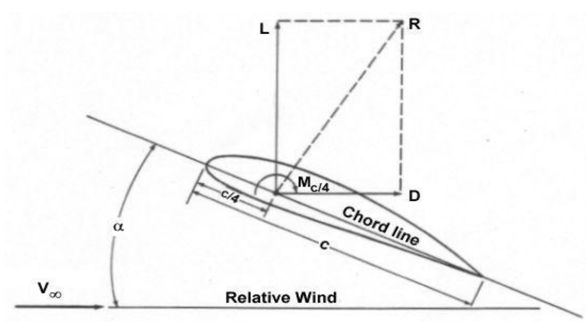
The application of potential-flow theory together with boundary-layer theory to airfoil design and analysis was accomplished many years ago. Since then, potential-flow and boundary layer theories have been steadily improved. With the advent of computers, these theories have been used increasingly to complement wind-tunnel tests. Today, computing costs are so low that a complete potential-flow and boundary-layer analysis of an airfoil costs considerably less than one percent of the equivalent wind-tunnel test. Accordingly, the tendency today is toward more and more commonly applicable computer codes. Multi-objective genetic were used to aerodynamically optimize a high-altitude long-endurance aircraft in order to improve its geometry and increase its performance. A conceptual design was created to satisfy a high altitude long-endurance flight mission. However, to tackle the common problem high-altitude aircrafts have of generating a high CL with low speeds, the airfoil selected for the conceptual design was optimized to maximize its lift capacity at the cruise altitude. The optimization produced an airfoil that maximizes the required aerodynamic performance for high-altitude flight. This aerodynamic performance improvement eventually leads to the reduction of necessary wing area, which leads to weight and cost reductions which are significant for high-altitude unmanned aircrafts. Since the Wright brothers' first successful flight, aircraft designers have been focusing on improving the aircraft flight efficiency, and especially airline companies are anxious to improve the commercial aircraft efficiency nowadays. Usually aircraft wings are designed to be most efficient at cruising flight but suffer performance penalties under other conditions, such as taking off, landing and controlling flight attitude. Inspired by the bald eagle which can change its own flap configuration to fit different flight conditions and control the rolling, pitching and yawing performance many researchers have investigated different ways to change the flight efficiency in different environments. Many research works have been published on smart wing and morphing aircraft technique in recent years. The design of multi-element high-lift systems for aircraft has become increasingly important. Where early attention was mostly focused on maximum lift requirements to satisfy the high cruise wing loading needs of jet transport aircraft while retaining acceptable takeoff and landing distances, more recently the attention has turned to reducing the complexity and weight of the high-lift systems for given maximum lift levels. Multi-element high-lift systems have a significant impact on the cost of a typical jet transport because

(i) they are time consuming to design and test,
(ii) their flows, geometry and actuation and support systems are complex,
(iii) they are heavy,
(iv) have a high part count, and
(v) Are maintenance intensive. According to Rudolph , an aircraft's high-lift system accounts for somewhere between 6% and 11% (potentially higher for more complex configurations) of the production cost of a typical jet transport. Another example on the importance of high-lift systems for a generic large twin engine transport is presented by Meredith:

1. An increase in maximum lift coefficient of 1.0% translates into an increase in payload of 22 passengers or 4400 lb for a fixed approach speed on landing.
2. An improvement in lift-to-drag ratio of 1.0% during takeoff translates into an increase in payload of 14 passengers or 2800 lb for a given range.
3. A shift of DCL ¼ 0:10 of the lift curve in the linear range results in a 11 reduction in attitude for a given glide slope angle. This allows a reduction in required landing gear height of 14 in. for a given tail strike attitude angle and a decrease in OEW of 1400 lb.

2. Angle of Attack

If you stretch your arm out through the window of car that is moving at a good speed, you can feel your arm pushed backward. If you hold your arm straight with your hand parallel to the road, and change the angle slightly, you can suddenly feel that it is drown upwards. The hand and arm work like the wing of an airplane and with the right angle (of attack) you can feel a strong lift force. AOA is the angle between the oncoming air or relative wind and a reference line on the airplane or wing. Sometimes the reference line is a line connecting the leading edge and trailing edge at some average point on a wing. Most commercial jet airplanes use the fuselage center line or longitudinal axis as the reference line. It makes no difference what the difference line is as long as it used as consistently. As the nose of the wing turns up, AOA increases, and lift increases During take-off an airplane builds up to a certain speed and then the pilot “rotates” the plane that is, the pilot manipulates the controls so that the nose of the plane comes up and, at some AOA, the wings generate enough lift to take the plane into the air. Since an airplane wing is fixed to the fuselage, the whole plane has to rotate to increase the wing's angle of attack. Front wings on racecars are fabricated so the angle of attack is easily adjustable to vary the amount of down force needed to balance the car for the driver.



is essentially a statement that the drag force on any object is proportional to the density of the fluid and proportional to the square of the relative speed between the object and the fluid. In fluid dynamics the *cd* is a dimensionless quantity that is used to quantify the drag or resistance of an object in a fluid environment such as air or water. It is used in the drag equation where a lower drag coefficient indicates the object will have less aerodynamic or drag. The drag coefficients always associated with a particular surface area. The drag coefficient of any object comprises the effects of the two basic contributors to fluid dynamics drag: skin friction and from drag. The drag coefficient of a lifting airfoil or hydrofoil also includes the effects of lift induced drag. The drag coefficient of a complete structure such as an aircraft also includes the effects of interference drag. The overall drag coefficient defined in the usual manner is The reference area depends on what type of drag coefficient is being measured. For automobiles and many other objects, the reference area is the projected frontal area of the vehicle. This may

Coefficient of Drag and Coefficient of Lift

The drag equation,

$$F_d = \frac{1}{2}\rho v^2 c_d A$$

so co efficient of drag is given by the,

$$c_d = \frac{2F_d}{\rho v^2 A}$$

not necessarily be the cross sectional area of the vehicle, depending on where the cross section is taken and for an airfoil the surface area is a plane form area. The lift equation,

$$L = \frac{1}{2}\rho v^2 A C_L$$

so coefficient of lift is given by the,

$$C_L = \frac{L}{\frac{1}{2}\rho v^2 S} = \frac{2L}{\rho v^2 S} = \frac{L}{qS}$$

A fluid flowing past the surface of a body exerts a force on it. Lift is the component of this force that is perpendicular to the oncoming flow direction. It contrasts with the drag force, which is the component of the surface force parallel to the flow direction. If the fluid is air, the force is called an aerodynamic force.

International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 10, October 2015
Available at http://internationaljournalofresearch.org

3.Designing an Airfoil

The design of an airfoil usually starts with the definition of the desired or required characteristics. These can be a certain range of lift coefficients, Reynolds- or Mach numbers, where the airfoil should perform best, stall characteristics, moment coefficient, thickness, low drag, high lift, cavitation (for hydrofoils), insensitivity with regard to dust and dirt, easy to build (flat bottom) or any combination of such requirements. When these requirements have been written down, the next step would be to look around, what's available. If there is an airfoil available, which perfectly fits the desired conditions, why create a new one? Often there is no existing airfoil, which fulfills all requirements, or the designer believes, that he can design something new with improved performance. Starting from this point, each designer has his own way and his preferred tools to proceed

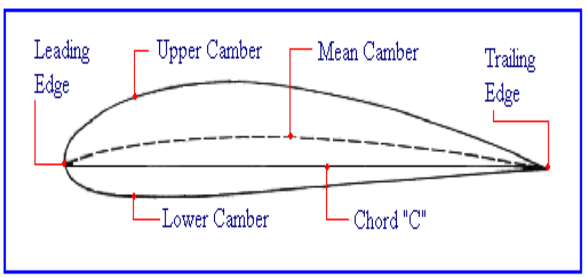
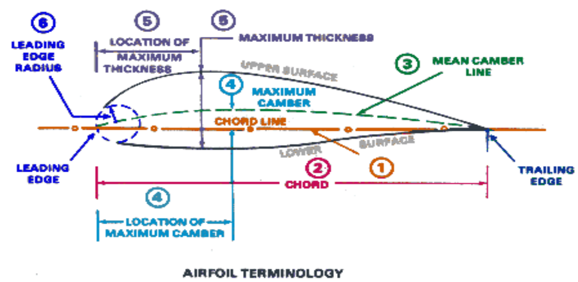
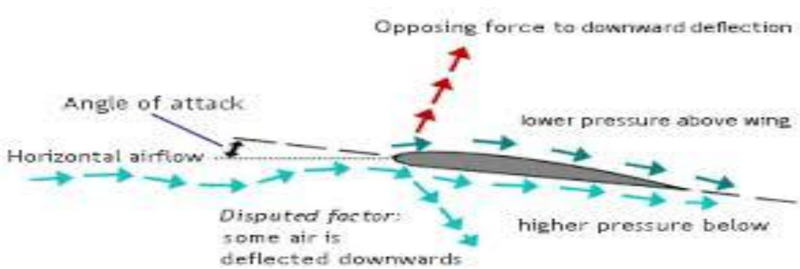


Figure 3-1 Cross section of an airfoil





The **leading edge** is the point at the front of the airfoil that has maximum curvature. The **trailing edge** is defined similarly as the point of maximum curvature at the rear of the airfoil. The **chord line** is a straight line connecting the leading and trailing edges of the airfoil. The *chord length*, or simply **chord** is the length of the chord line and is the characteristic dimension of the airfoil section.

CONCLUSION

Based on the CFD analysis of the flow over NACA 0012 air foil we can conclude that at the two degree of AOA there is no lift force generated and if we want to increase amount of lift force and value of lift co efficient then we have to increase the value of AOA. By doing that obviously amount of drag force and value of drag coefficient also increased but the amount of increment in drag force and drag coefficient is quite lower compare to lift force. We conclude that by inclination of 6 degree there is a great lift difference and by our results six degree has greater lift values when compared to 2 and 8 degrees

References

[1] The Element Of Aerofoil and Airscrew theory By H. Glauert

[2] Developing Wind PowerProjects : Theory and Practice By Tore Wizelius

[3] Flight Theory And Aerodynamics : A Practical guide for Operational safety By Charles E. Dole, James E. Lewis

[4]G.V.Parkinson and G.D.watt "Some new applications of linearized airfoil theory" (1983)

[5] Ghias, R., Mittal, R., and Lund, T., "A Non-Body Conformal Grid Method for Simulation of Compressible Flows with Complex Immersed Boundaries," AIAA **Paper 2004-0080, 2004**

[6] Alex Sullivan Cleveland, F. A., "Aerodynamic forces acting on an airfoil

[7] McGhee, Robert J.; and Beasley, William D.: Low-Speed Aerodynamic Characteristics of a 17-Percent-Thick Airfoil Section Designed for General Aviation Applications. NASA TN D-7428, 1973.

[8] Whitcomb, Richard T.: Review of NASA Supercritical Airfoils. ICAS Paper No. 74-10, Aug. 1974

[9] McGhee, Robert J.; and Beasley, William D.: Effects of Thickness on the Aerodynamic Characteristics of an Initial Low-Speed Family of Airfoils for General Aviation Applications. NASA TM X-72843,1976

[10] McGhee, Robert J.; and Beasley, William D.: Low- Speed Wind-Tunnel Results for a Modified 13-Percent- Thick Airfoil. NASA TM X-74018, 1977