OPTIMIZATION IN WING DESIGN OF FIGHTER AND PASSENGER AIRCRAFT

BHAVANA MADHEKAR[1], M. SATYANARAYANA GUPTA[2]

[1] *PG Student, Department of Aeronautical, MLR Institute of Technology, Telangana, India*
[2] *Assistant Professor, Department of Aeronautical, MLR Institute of Technology, Telangana, India*

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Abstract: ***A wing is an appendage with a surface that produces lift for flight. A wing has a streamlined cross-sectional shape producing lift to drag ratio. The wing considered is the trapezoidal wing for fighter aircraft and for passenger aircraft is rectangular wing.***

Software tools used for designing and analyzing the wing is CFD. Firstly we design the wing using gambit software and analyze the flow analysis using fluent. Gambit and fluent are CFD soft wares.

Key Words: *Airfoil, wing, Aircraft, Gambit, and Ansys.*

1. INTRODUCTION OF AIRFOIL

An airfoil is the perpendicular cross section of the wing. An airfoil-shaped body moved through a fluid produces an aerodynamic force. The component of this force perpendicular to the direction of motion is called lift. The component parallel to the direction of motion is called drag. Subsonic flight airfoils have a characteristic shape with a rounded leading edge, followed by a sharp trailing edge, often with asymmetric camber. Foils of similar function designed with water as the working fluid are called hydrofoils.

The lift on an airfoil is primarily the result of its angle of attack and shape. When oriented at a suitable angle, the airfoil deflects the oncoming air, resulting in a force on the airfoil in the direction opposite to the deflection. This force is known as aerodynamic force and can be resolved into two components: Lift and drag.

1.1 Airfoil Design or Airfoil Selection

The primary function of the wing is to generate lift force. This will be generated by a special wing cross section called airfoil. Wing is a three dimensional component, while the airfoil is two dimensional section. Because of the airfoil section, two other outputs of the airfoil, and consequently the wing, are drag and pitching moment. The wing may have a constant or a non-constant cross-section across the wing.

There are two ways to determine the wing airfoil section:

1. Airfoil design
2. Airfoil selection

1.2 Airfoil Selection Criteria

Selecting an airfoil is a part of the overall wing design. Selection of an airfoil for a wing begins with the clear statement of the flight requirements. For instance, a subsonic flight design requirements are very much different from a supersonic flight design objectives. On the other hand, flight in the transonic region requires a special airfoil that meets mach divergence requirements. The designer must also consider other requirements such as airworthiness, structural, manufacturability, and cost requirements.

2. Aerodynamics of wing

The design and analysis of the wings of aircraft is one of the principal applications of the science of aerodynamics, which is a branch of fluid mechanics. However, except for simple geometries these equations are notoriously difficult to solve. For a wing to produce "lift", it must be oriented at a suitable angle of attack relative to the flow of air past the wing. When this occurs the wing deflects the airflow downwards, "turning" the air as it passes the wing. Since the wing exerts a force on the air to change its direction, the air must exert a force on the wing, equal in size but opposite in direction. This force manifests itself as differing air pressures at different points on the surface of the wing.

2.1 Design parameters of wing

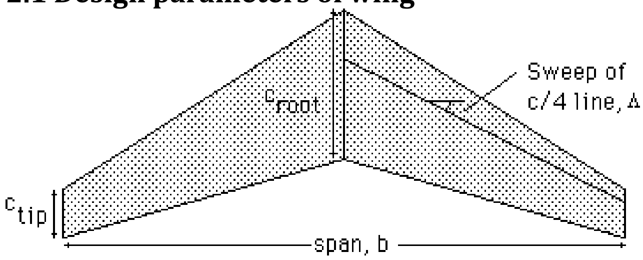

Fig -1 Full length wing with design parameters

Selecting the wing span is one of the most basic decisions to made in the design of a wing. The span is sometimes constrained by contest rules, hanger size, or ground facilities but when it is not we might decide to use the largest span consistent with structural dynamic constraints (flutter). However, as the span is increased, the wing structural weight also increases and at some point the weight increase offsets the induced drag savings. This point is rarely reached, though, for several reasons.

The wing area, like the span, is chosen based on a wide variety of considerations including:

1. Cruise drag
2. Stalling speed / field length requirements
3. Wing structural weight
4. Fuel volume

Wing sweep is chosen almost exclusively for its desirable effect on transonic wave drag. (Sometimes for other reasons such as a c.g. problem or to move winglets back for greater directional stability.)

3. GAMBIT

GAMBIT allows you to construct and mesh models by means of its graphical user interface(GUI), which is designed to be mouse-driven. The GAMBIT GUI consists of eight components, each of which serves a separate purpose with respect to the creating and meshing of a model.

3.1 FLUENT

FLUENT is a computational fluid dynamics (CFD) software package to simulate fluid flow problems. It uses the finite-volume method to solve the governing equations for a fluid. It provides the capability to use different physical models such as incompressible or compressible, in viscid or viscous, laminar or preprocessor bundled with FLUENT.

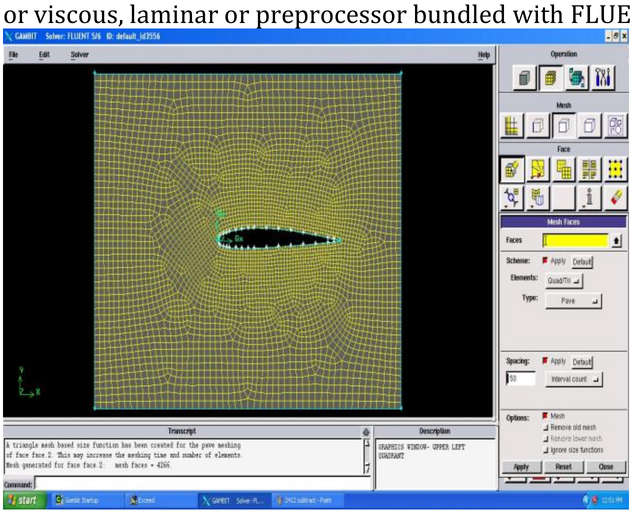

Fig -2: NACA2412- Airfoil meshing

The wing mesh must be setup for processing. First, the solver needs to be selected. To do this select Define → Models → Solver. Depending on the version of Fluent, the screen that appears should be similar to that shown in Figure.

Select coupled or density based (depending on the version). Be sure that the steady, 3D, and implicit options are selected. Leave all other settings at their default values, and select 'OK'.

Mach number contours: The mach numbers on wing at different positions, so we have maximum Mach number at middle part of the wing and less at trailing and leading edge areas .by this figure we known that more Mach number and less pressure at middle part of the wing. because pressure and velocity are inversely proportional to each other.

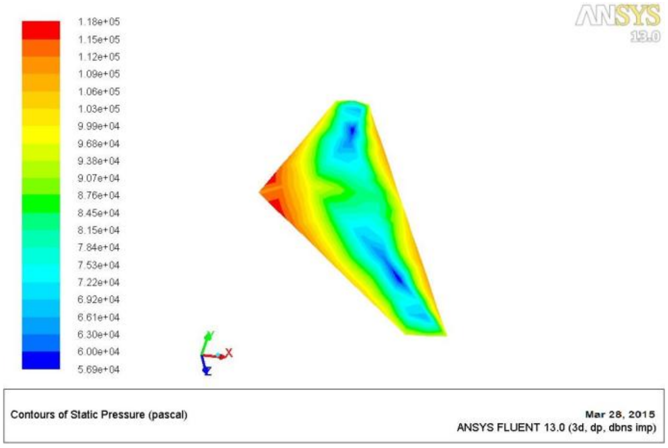

Fig -3 Contours of static pressure

4. CONCLUSIONS

The design of wing done by GAMBIT software and the flow analysis of wing was done in fluent software's. The results are plotted in the report. From the results we can get idea about the performance of wing and cl, cd values are compared. From the values we know that by twisting the angle of tip airfoil we will get better cl,cd values. when compared with wing which is not twisted. The total report of this project gives us theoretical as well as technical knowledge of wings used for fighter aircraft and passenger aircraft.

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