IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 01- 05

Effect of High-Lift Devices on Aircraft Wing

Gaurav B. Mungekar[1], Swapnil N. More[1], Samadhan V. Niwate[1],
Prof. Sagar Dharmdhikari[1]
[1](Department Mechanical Engineering, Bharati Vidyapeeth College of Engineering, India)

Abstract : *In aircraft design, a high-lift device is a component on an aircraft's wing that increases the amount of lift produced by the wing. Wind tunnel test is a common method for wing analysis, but the problem with wind tunnel tests is that they are expensive and time consuming. A simple designed wing geometry was analyzed and modified by adding different high-life devices, further analysis was carried out on the modified wing for a comparative study. For this purpose, a virtual wind tunnel model was created and CFD analysis was carried out at various angle of attacks for each wing geometry separately. The lift and drag forces and coefficients of each wing were determined and the comparative study of these showed how minute changes to the wing improves its overall flow characteristics.*

Keywords –*Angle of attack, CFD analysis, Flaps, Lift, Simulation*

I. Introduction

The wings of any airplane have a profile which is curved at the top and flat at the bottom. This is because the air has to move faster over the top than at the bottom of the airplane wing in order to create a difference in pressure that will lead to the creation of an upward force. The airfoil, also known as the cross-section of the airplane wing, provides the necessary lift to the wings. However, they also generate drag, which reduces the speed of the airplane. Thus, the design of the airfoil plays an important role in deciding the type and limitations of an airplane. For e.g. airplanes with thick airfoils are not suited for long duration and high speed flights as they generate more drag, whereas thin airfoils are suited for both high speed and long duration flight. For any airplane to fly, one must lift the weight of the airplane itself, the fuel, the passengers, and the cargo. The wings generate most of the lift to hold the plane in the air. To generate lift, the airplane must be pushed through the air. The air resists the motion in the form of aerodynamic drag. So here various modifications like square slot, gurney flap, boundary layer fence, notch leading edge were designed and analyzed to increase the lift and to reduce the power consumption.

II. Methodology

This is the overview of methodology adopted for solving the problem.

1. Problem identification
2. Pre-processing
3. Boundary conditions and Solve
4. Post-processing

1.1 Problem Statement:

Vision of this paper is to increase the aerodynamic efficiency of aircraft in terms of its flow characteristics at the upmost level. Flow characteristics are lift, drag, lift to drag ratio.

Now-days increase in a drag is the major issue aircraft can have, it decreases the lift to drag ratio which results in poor performance of aircraft. It delays the TAKE-OFF and LANDING of aircraft and it also enables aircraft to travel more distance before TAKE-OFF. Since drag slows down airplanes and makes them less efficient (requiring more fuel), one aims to design planes that reduce drag. Minimizing the amount of drag acting on aircraft often involves modifying the wing and/or fuselage shapes.
So, to sort out this issue optimization of aircraft wing using different geometries is carried out.

2.2 Pre-Processing:

NACA website provides the excel coordinate file according to preferred chord length. After running this coordinate file in CATIA one can easily get the 2D coordinates which can be transferred easily to 3D wing using spline, pad operations. For modification purpose,CATIA V5 get used. ANSYS FLUENT software is used for CFD simulation of aircraft wing because it has powerful modeling and meshing capabilities, and this software is more familiar comparative to other.

2.2.1 Modelling:

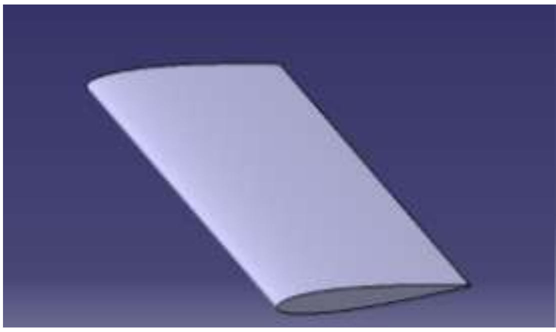


Fig. 1 Simple wing

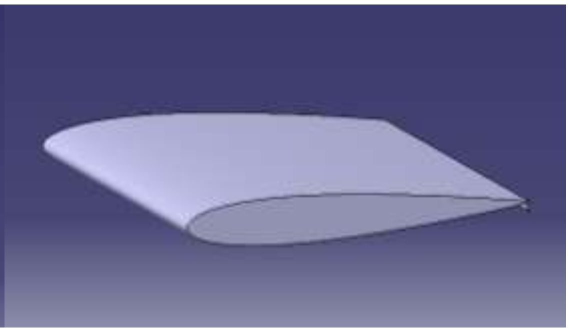


Fig. 2 Wing with gurney flap

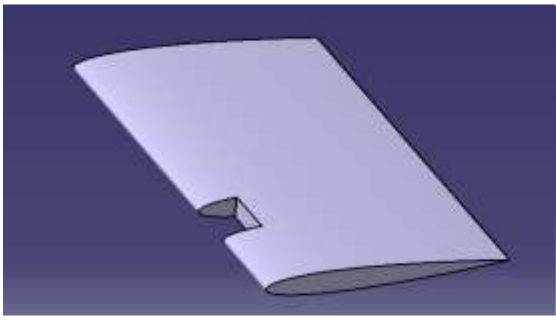


Fig. 3 wing with square slot

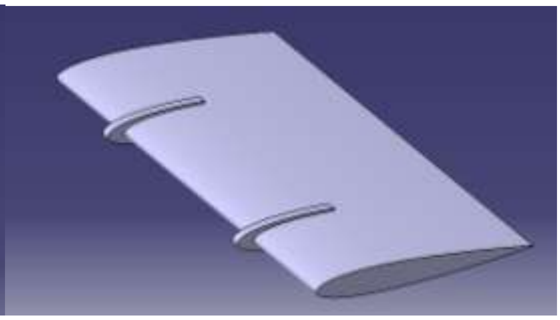


Fig. 4 wing with boundary layer fence

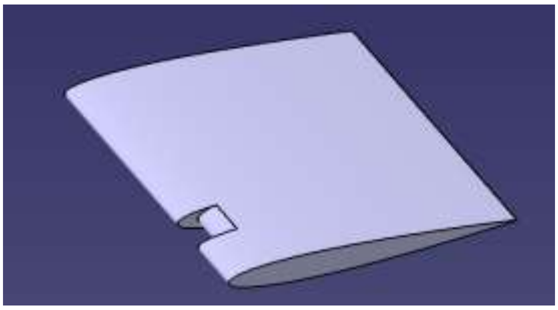


Fig. 5 wing with notch leading edge

2.2.2 Meshing:

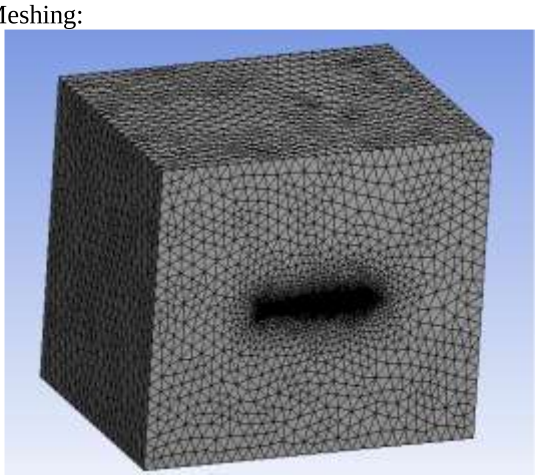


Fig. 6 meshing in simple wing (full view)

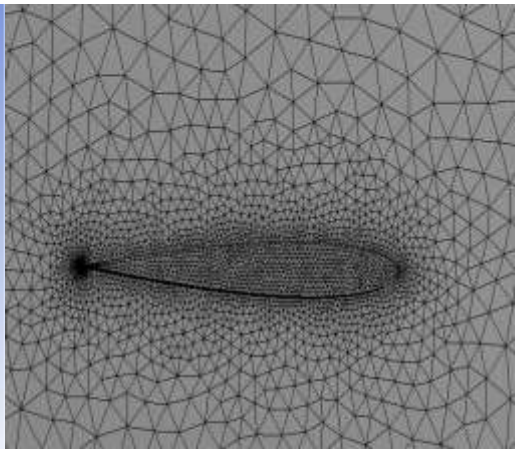


Fig. 7 meshing in simple wing (closer view)

2.3 **Boundary Conditions:**

TABLE 1: Setup Parameters

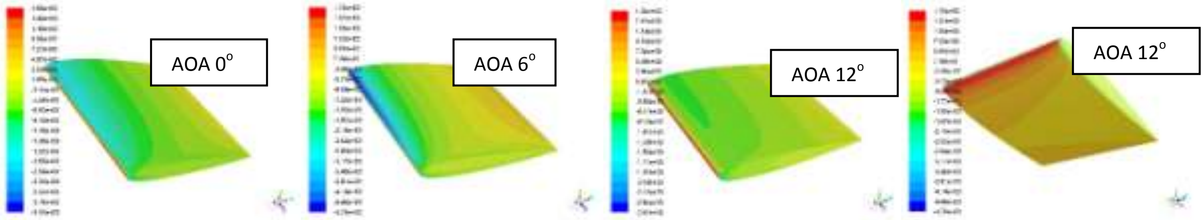
Parameter	Value
Model	k-epsilon Realizable
Material	Air
Density	1.225 kg/m^3
Viscosity	1.7894 x 10^{-5} kg/m-sec
Inlet Velocity	200 m/s
Operating Pressure	101325 Pascal
Solution Scheme	Coupled
Solution Initialization	Hybrid

2.4 Post-processing

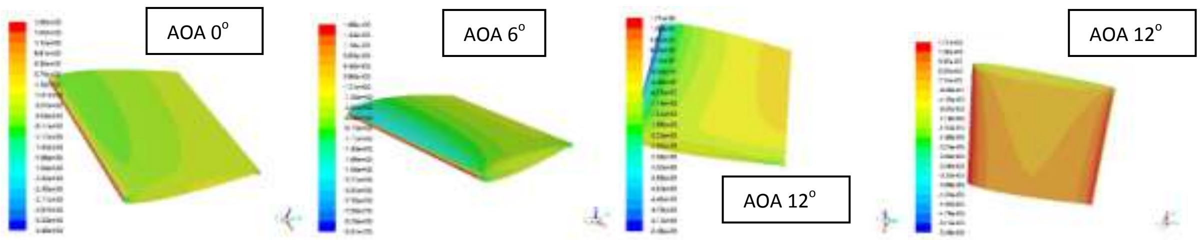
It includes calculation of lift and drag forces and their coefficients after successful convergence of iterations,
Simulation and pressure, temperature, turbulence contours.

2.4.1 Pressure contours

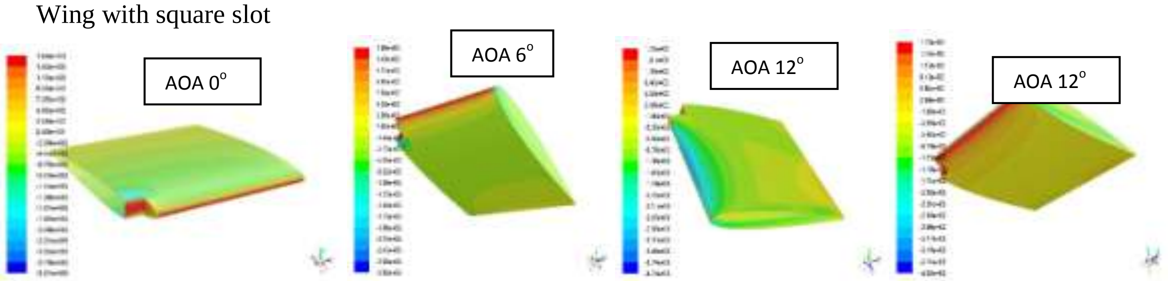
Simple wing



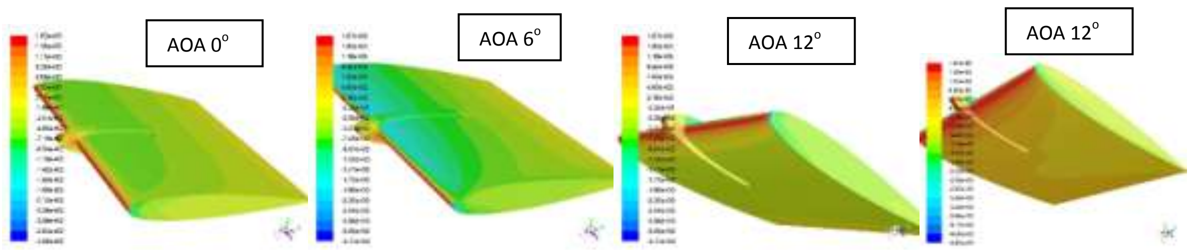
Wing with gurney flap



Wing with square slot



Wing with boundary layer fence



Wing with notch leading edge

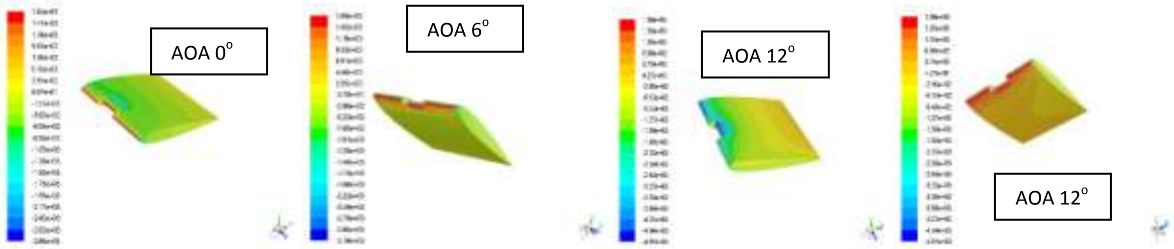


Fig 8. contours of static pressure of different geometries at different aoa's 0 °,6 °,12 °

III. Result And Discussion

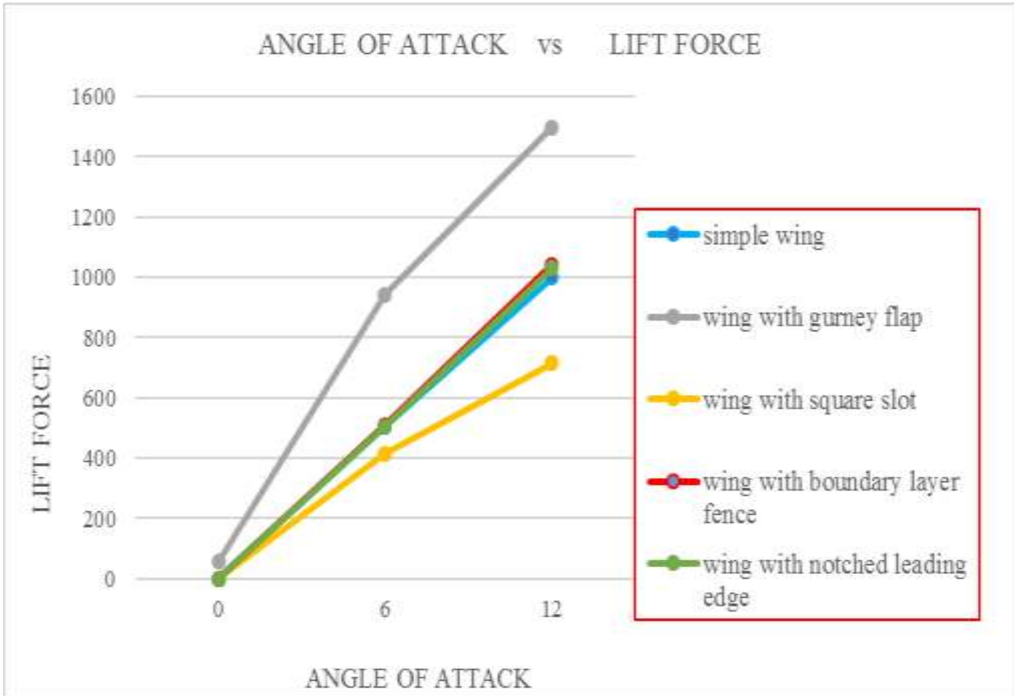


Fig 9. Simulated results

Above graph is all about angle of attack(AOA) vs lift force for different types of wings such as simple wing, wing with gurney flap, wing with square slot, wing with boundary layer fence, wing with notched leading edge. Variation in lift values with respect to different AOA is shown by different colors i.e. blue (simple wing), grey (wing with gurney flap), yellow (wing with square slot), red (wing with boundary layer fence), green (wing with notched leading edge).

From the plot, it is clear that wing with gurney flap(grey) produces maximum lift at 0^0 AOA and also increases with maximum lift as AOA changes from 0^0-6^0-12^0. Wing with square slot(yellow) produces minimum lift compared to other wings as AOA changes from 0^0-6^0-12^0. Simple wing(blue) has moderate amount of lift increment compared with gurney flap and square slot. Wing with boundary layer fence(red) and wing with notched leading edge (green) produces slight more lift force as compared with simple wing(blue).

IV. Conclusions

1. Adding flap increases both lift and drag but increment in lift is much higher as compared to drag.
2. Gurney flap shows highest lift among all the geometries from AOA 0 to 12

Acknowledgements

We are highly indebted to our college for guidance as well as for providing necessary information regarding the project & also for support in completing the project.

References

[1] Shreyas Krishnamurthy, Suraj Jayashankar, Sharath V. Rao, Rochen Krishna T S, Shankargoud Nyamannavar, "CFD Analysis Of An RC Aircraft Wing", International Journal of Mechanical And Production Engineering, Volume- 2, Issue-9, Sept.-2014

[2] Shivasharanayya Hiremath, Anandkumar.S.Malipatil, "CFD Simulations of Aircraft Body with Different Angle of Attack and Velocity", International Journal of Innovative Research in Science,Engineering and Technology, Vol. 3, Issue 10, October 2014

[3] E. Livya, G. Anitha, P. Valli, "Aerodynamic Analysis of Dimple Effect on Aircraft Wing", International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering Vol:9, No:2, 2015.

[4] Rubiat Mustak, MD. Nizam Uddin, Mohammad Mashud, "Effect of Different Shaped Dimples On Airfoils", International Conference on Mechanical Engineering and Renewable Energy 2015 (ICMERE2015), 26 – 29 November, 2015, Chittagong, Bangladesh

[5] Karansingh Dangi, Miss Neha Mathur, "CFD Analysis of an Aircraft delta wing", International Research Journal of Engineering and Technology (IRJET), volume:03, Issue:12, Dec 2016