VIVA-TECH IJRI
ANNUAL RESEARCH JOURNAL
VIVA-TECH INTERNATIONAL JOURNAL FOR RESEARCH AND INNOVATION
ANNUAL RESEARCH JOURNAL
ISSN(ONLINE): 2581-7280

Design and Fabrication of Blended Wing Body

Rahul Posture[1], Shreyash Paradkar[2], Omkar Pawar[3], Omkar Padwal[4]
[1](Mechanical Department, VIVA Institute of Technology/ Mumbai University, India)
[2](Mechanical Department, VIVA Institute of Technology/ Mumbai University, India)
[3](Mechanical Department, VIVA Institute of Technology/ Mumbai University, India)
[4](Mechanical Department, VIVA Institute of Technology/ Mumbai University, India)

Abstract : *Aircrafts are the widely used vehicle for rapid and long distance transportation. Although it is time consuming, the conventional design of aircraft doesn't gives much space inside the aircraft and also consumes more power because of its aerodynamic structure. Hence it is necessary to develop a new composite structural design which overcomes these barriers. Blended Wing Body (BWB) is one of the solution of these problems. The BWB configuration is a new concept in a aircraft design which provides greater internal volume, aerodynamics and structural efficiency & noise reduction. The design approach of BWB is to maximize overall efficiency by integrating the propulsion system, wings and the body into a single lifting surface. BWB is a unibody air craft where the fuselage, wing and tail gets merged to form a single entity. The fuselage section of BWB is flattened and has slightly airfoil shaped structure which exceeds the overall lift generation of aircraft. The objective of this paper is to study aerodynamic study of Blended Wing Body. The project deals with the designing, analysing and fabricating of UAV(Unmanned Aerial Vehicle) type electrically powered BWB aircraft system, and also selecting appropriate propulsion system and other electric components.*

Keywords –*Aerodynamic and structural efficiency, Blended Wing Body, Unmanned aerial vehicle*

I. INTRODUCTION

In the future, the world is going to face the issue of lack of fuel. Hence scientists started to work on fuel-efficient vehicle systems. In a aviation field scientists are come up with the idea of Blended Wing Body Aircraft. Since the thrust to weight ratio of Blended Wing Body is more than the conventional type of aircraft, it requires lesser amount of energy and it burns less amount of fuel. The main objective of our project is designing and fabricating the Blended Wing Body aircraft which is very fuel-efficient.

The conventional aircraft system gives very less amount of space for passengers and cargo inside the fuselage. This is one of the main problem which we face during transportation. Because of the less amount of space, it's very hard to transport goods which are large in size. Hence, it is our aim to design a aircraft system which gives more space to the passenger during transportation.

In the modern era, air pollution and noise pollution are two of the major problems for environment and mankind. The conventional aircraft system is emits more gas and makes more noise which is hazardous for environment. Hence, building a aircraft system which burns less amount of fuel and generates less amount of noise is also our aim.

1. Project Background

The concept of airplane was firstly introduced by Wright brothers in early 1903. But the Nicolas Woyevodsky is the first person who bought the idea of Blended Wing Body Aircraft in 1920. He tested first flight in 1924, but unfortunately pilots gets some major injury and project gets cancelled. Then again this idea was proposed in 1940 for miles M26 airliner project and the miles M30 ‘x-mina’ research prototype was built to investigate it. The McDonnell XP-67 prototype interceptor also get tested in 1944 but this time also the expectations are not matched as per requirement. After that many aircraft companies come with their projects and research on BWB still in progress to fulfill the requirements.

1.1 Boeing Blended Wing Body Program

In 2001, Boeing has collaborated with NASA and Air Force Research Laboratory for the joint program which is based on Blended Wing Body aircraft. The main objective of this joint program is to develop a aircraft vehicle is more fuel-efficient and also reduce the noise and gas emission. They are working on optimization in designing of Boeing X-48B aircraft. On July 2007, they had tested a 12ft model of BWB aircraft at NASA Dryder Flight Research Centre (DFRC). The result of flight test is actually very good and it also shows that the flight control system of the BWB was feasible.

1.2 The Hyperion Project

In today's era, within the aerospace community, many global companies had collaborated with each other for a complex global joint which is known as Hyperion Project, is grows rapidly, in this project all the collaborated companies tries to overcome the challenges together. It helps to keep standardization in models of BWB aircraft and it also helps to increase the speed of researching on optimization of BWB aircraft.

II. CONSTRAINTS AND REQUIREMENTS

As we are developing new technologies, everyone wants effective and faster moving plane. For this we found that electric motor or engine can be used. The main task is selection of motor. To give power we can use battery as a source, so we select cell battery for our aircraft as our first constraint. After that the main part of any aircraft is Airfoil. For stability, the airfoil plays a vital role in aircraft. For our plane we select airfoil which is essential for BWB. The efficiency, stability and performance of aircraft depend upon the airfoil and motor.

In Design of BWB, selection of airfoil is one of the difficult task. In BWB, we require large space for payload and since we does not have fuselage we have to select airfoils, which have thickness to cord ratio near by 17 to 18. These airfoils are not similar, which have seen in todays commercial aircraft i.e. supercritical airfoils. For center part we required large leading-edge radii. And for the wing we can use the conventional airfoil for lifting purpose and for the middle body we have to use the reflexed air foil to provide pitch trim, lifting and compensating for the lack of tail. These both are simply meshed for single body BWB.

For the centre part we have to select airfoil which has more area in leading part. This space will act as a fuselage which will used for carrying cargo. So this type of airfoil fulfills the both requirement, one is fuselage and other is large load carrying space. For generating more lift, the wing airfoils is very important. While generating more lift we also have to consider drag coming on plane when landing is taking place. So we have to choose airfoil which gives us more lift during take-off purpose and also minimum drag during landing of plane.

The motor also plays vital role in RC plane. We want motor which can produce sufficient thrust during flight.

III. METHODOLOGY

1.Process of Designing

It includes all the necessary virtual analysis, calculation and selection process which we have to do before starting manufacturing of physical model. All kinds of parameters of aircraft and all the necessary components are selected in this process. A well optimized design will help to better performance. It is most important Process in the methodology. This process is mainly consist three stages these are follows.

1.1 Material Selection

In every product, material performance a key role in its success. For any aircraft system light weight material is required for making a light weight aircraft. Because the light weight of aircraft helps for the better and efficient performance. Also the shape of BWB aircraft is very complex, hence the machinability of material should be good.

As we know the wood is light weight material and it is also very easy to machine. Hence we are going to use two different types of wood for better design.

i. Balsa wood (density 170-220 kg/m^3)- It is light weight material.
ii. Bass wood (density 400-450 kg/m^3) –It will provide strength.

1.2 Airfoil selection

In the design of aircraft, the airfoil selection plays a vital role. The generated lift and induced drag both are dependent on the airfoil we have selected for the wing and stabilizers. In conventional aircraft, the airfoils used are supercritical airfoil but in BWB we require more than that the supercritical airfoil

In the fuselage section, we are going to use the airfoil N-22. Since it has good amount of thickness which gives more amount space inside the fuselage. The coefficient of lift of N-22 is0.6461. Hence, it will also contribute in overall lift of aircraft.

In the wing section, we are going to use S1223 airfoil. The coefficient of lift of S1223 is 1.1665 which is very high. Hence it will help to give high amount of lift to aircraft

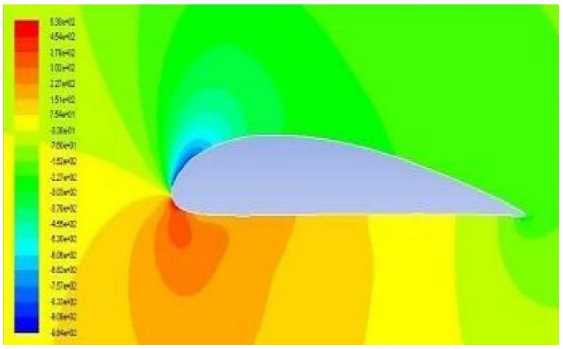

Fig. 1 Contours of static pressure of N-22 airfoil

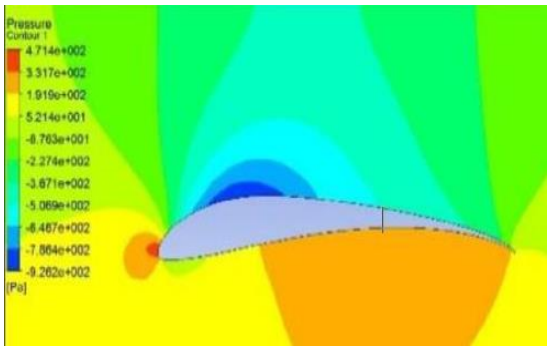

Fig. 2 Contours of static pressure of S-1223 airfoil

1.3 Overall configuration of air craft

Blended Wing Body aircraft is a unibody aircraft in which the fuselage, empennage and wing gets merged to reduce the drag and increase overall lift. The aircraft has wing span of 1.6 m and it's length is around 0.8 m. The middle 40 cm part of span consists the fuselage section. The rest of wing has a chord around 40-35 cm. The two rudder are situated at the both end of air crafts

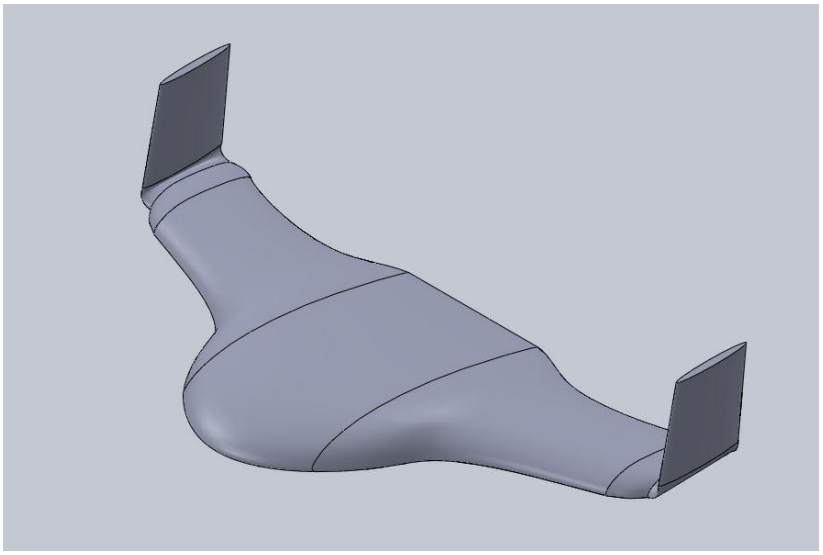

Fig. 3 CAD Model of Blended Wing Body

1.4 Lift calculation

By Theoretical Method,
The formulae of lift is given as

$$L = ½ \times \rho \times v^2 \times C_l \times A$$

Where, L = Lift generated by aircraft
ρ = density of air
v = velocity of aircraft
C_l = coefficient of lift
A = surface area

Lift generated by wing

$$L_w = ½ \times 1.225 \times (8)^2 \times 0.615 \times 1.1665$$
$$= 28.12 \text{ N}$$

Lift generated by fuselage

$$L_f = ½ \times 1.225 \times (8)^2 \times 0.3 \times 0.6461$$
$$= 7.6 \text{ N}$$

Overall Lift

$$L = L_w + L_f$$
$$= 28.12 + 7.6$$
$$= 35.72 \text{ N}$$

By Graphical Method,

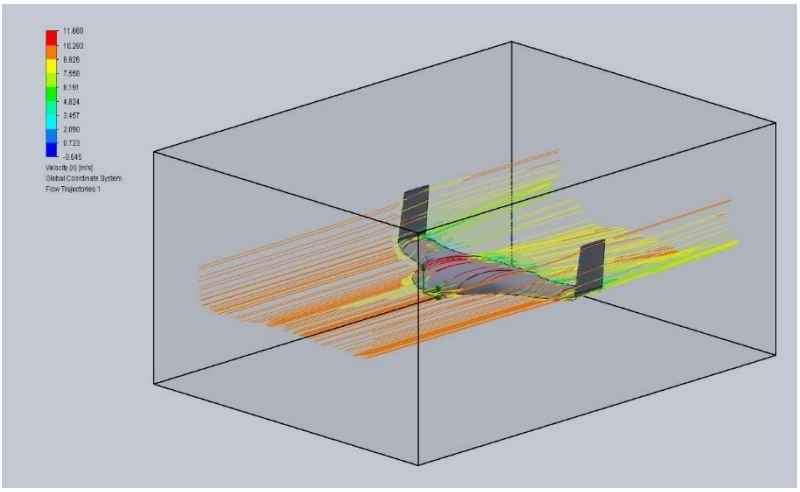

Fig. 4 CFD Analysis of CAD Model of BWB Aircraft

For finding the lift of the aircraft we perform the CFD analysis on CAD model of BWB aircraft by using SOLIDWORKS Software. The result shows that the this aircraft configuration gives lift 26.37 N.

2. Process of Manufacturing

The whole physical model of Blended Wing Body aircraft is made in this process. In this process, we have to perform different kinds of operations and manufacturing process. The process of manufacturing mainly consist the two steps these are follows.

2.1 Manufacturing the different parts

All the required parts are manufactured in this step. First, all parts are generated on CAD modelling software SOLIDWORKS. And then verify it with the virtual assembly and after the final checking, Lesser Cutting Machine is used to cut the required parts of aircraft such as airfoil on balsa wood sheet and basswood sheet. It includes all operational parts of aircraft such as airfoils, spars, etc.

2.2 Fabricating the BWB Aircraft

The different parts of aircraft which we obtain after lesser cutting are joined together with adhesive to fabricate the BWB aircraft. This process requires high accuracy to joint them properly at exact position and perfect orientation. We have to use adhesive efficiently because it performs major role in weight of aircraft. It can increase use weight of aircraft.

IV. CONCLUSION

We Conclude that the BWB which made with the above consideration will have an efficient design than the conventional aircraft design. The design of our plane is efficient to some extent for RC plane. It will give some new designs in Blended Wing Body aircraft than that present design. This aircraft has high volume capacity in fuselage. So, it is capable of carrying some extra amount of payload than that of the conventional aircraft. During this project, we enhanced our technical and software skills by using different types of tools and softwares.

REFERENCES

Journal Papers:

[1] Edwin Ordoukhanian, Azad M. Madani, "*Blended Wing Body Architecting and Design: Current Status and Future Prospects," Science direct,2016.*

[2] Wensheng Zhu, Xiongqing Yu, Yu Wong, "*Layout Optimization for Blended Wing Body Aircraft Structure," International Journal of Aeronautical and Space Sciences, May 2019.*

[3] Odeh Dababneha, Timoleon KIpouros, "*A review of Aircraft Wing Mass Estimation Methods," Aerospace Science and technology, Vol 72, January 2018.*

[4] G. D. Goh, "*Additive manufacturing in Unmanned Aerial Vehicle: Challenges and Potential, "Science, March 2014.*

[5] RH Liebeck, " *Design of blended wing body subsonic transport," Journal of aircraft, 2012.*

[6] Mark Voskuijl, Gianfranco La Rocca, Frank Dircken, "*Controllability of Blended Wing Body Aircraft," 26th International Congress of the Aeronautical Science, 2008.*

[7] LI Peifeng, Zang Binqian, Chen Yingchun, Yuan changsheng, Lin Yu, " *Aerodynamic Design Methodology for Blended Wing Body Transport," Chinese Journal of Aeronautics, October 2011.*

[8] D. S. Lee, L. F. Gonzalez, "*Multy-objective/multidisciplinary design optimisation of blended wing body UAV via advanced evolutionary algorithms," 45th AIAA Aerospace Science Meeting and Exhibit, January 2007.*

Books:

[9] John D. Anderson, *Aircraft Performance and Design*.

[10] Mohammad H. Sadraey, *Aircraft Design.*