OPEN ACCESS

International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-4, November 2019

Design and Analysis of Double Bobble Cross Section Fuselage Micro-Class Aircraft

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***Abstract*: The applications of micro-class aircraft is increasing day by day and all industrial community which depending on mobility and surveillance are accepting this type of aircrafts. The main objective of this work is to design and fabricate an aircraft that is capable to carry the highest payload fraction possible with lowest empty weight fraction which all industries required today. Bobble Cross Section Fuselage Micro-Class Aircraft carriers more pay load with maximum lift, minimum airplane weight and drag.**

Key words: UAV, Micro-Class Aircraft, Double Bobble Fuselage

I. INTRODUCTION

Now a day's unmanned air vehicles (UAV) usage is increasing due to its low cost and maneuverability. The applications of UAVs are increasing and spreading to all the fields. Micro-class aircraft (MCA) are small kind of unmanned air vehicles which are used for surveillance, armed attacking, search and rescue operations, and transportation, etc. Because of its relatively small size they are suitable for military surveillance applications and the probability of being intercept by the radar is low. Now a day's lot of research is going on design and fabrication of UAVs [1-3]. Composite materials are using to fabricate aircraft wings [4] to increase the strength to weight ratio of aircraft which is the need of the day. Optimization of wings is playing an important role to minimize the aerodynamic effects [5]. This steady mainly concentrates on cross section of fuselage which is the area not concentrated by much of researchers. The present steady focuses on design and development of double bobble cross section fuselage and increasing pay load with maximum lift, minimum airplane weight and drag.

II. METHODOLOGY

The main objective of the study is to design an aircraft which can achieve highest payload fraction possible with lowest empty weight fraction. The aircraft is designed to complete its mission profile as shown in the Figure 1.

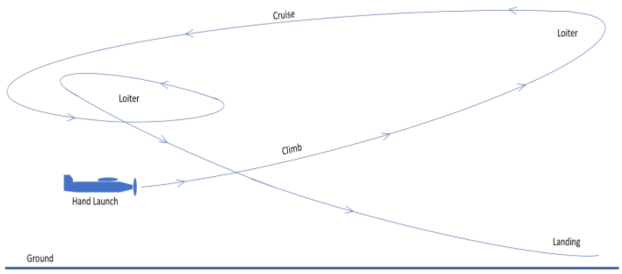

Figure 1: Mission Profile

A. Airfoil Selection

The selection of an airfoil plays a major role in designing an aircraft as it has to satisfy the Design requirements like cruise and stall characteristics.[1] After doing lot of research and thoroughly and investigating the available airfoil database, we have selected SELIG-S1223 a high lift low Reynolds number airfoil as shown in figure3 and the characteristics of Selig-S1223 Airfoil are given in table1.

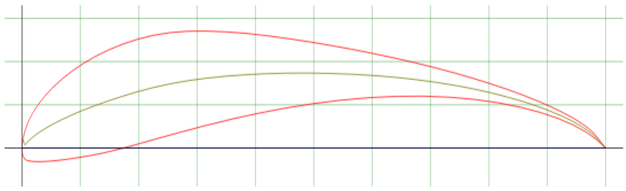

Figure 2: Selig-S1223 Airfoil

Table 1: Characteristic of Selig-S1223 airfoil

Airfoil Type	Reynold's Number	C_{LMax}	C_l/C_{Dmax}	Stall Angle
Camber	100,000	2.0814	54.5	10.75°

B. Wing Area & Wing Loading Calculations

After the airfoil selection, the next step is selection of wing configuration. Wing surface area should be maximum, so that it can able to carry maximum payload fraction possible, here we have selected the rectangular wing configuration with no sweep for our MCA and also calculated its wing span.[4] The dimensions of wing is given in Table2.

$$L = \frac{1}{2}\rho V_{stall}{}^{2} S C_L$$

Where, S = Projected area of the wing (m^2).

C_{Lmax} = Maximum Coefficient of Lift.

V_{stall} = Stall Velocity (10m/s).

Manuscript published on November 30, 2019.

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Table 2: Wing Dimensions

Wing Type	Surface Area (m^2)	Lift Coefficient	Wing Span (m)	Aspect Ratio	Chord (m)	MCA (m)
Rectangular Wing	0.2414	2.0814	1.3	7	0.186	0.046

According to the wing area the total lifting area is 4.265m^2(1.3m) and wing loading can be calculated for various segments using the ratio of takeoff weight and wing area, as an initial wing loading as shown Figure 3.

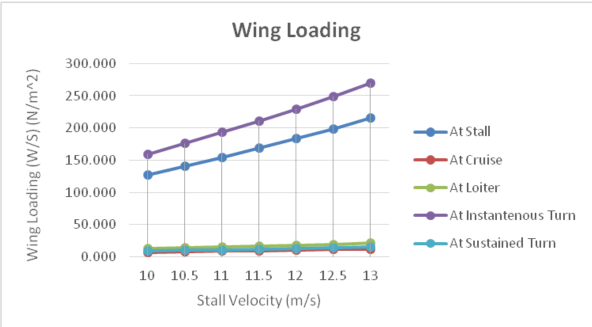

Figure3.Wing Loading Performance Graph

C. Fuselage Design

Fuselage was designed in such a way that it can implement all the instruments and payload as well as to support all the components such as wing, engines etc. our main objective is to carry the maximum payload possible so we have decided to implement a double bubble fuselage configuration which is capable to carry the maximum payload.[2] [3]

Fuselage is optimized to obtain appropriate static margin and center of gravity for aircraft stability and control.

D. Double Bubble Fuselage

The "Double-Bubble" fuselage configuration is a non-round fuselage. This design took inspiration from biomimicry i.e. by joining of two soap bubbles separated by a single membrane. In our design consists of two standard fuselages side by side and fusing them together? This innovation helps us in achieve more cabin space and to accommodate maximum payload possible. The Cross-section View of Double-Bubble Fuselage is shown in figure4 and Fuselage Volume Comparison is shown in figure5

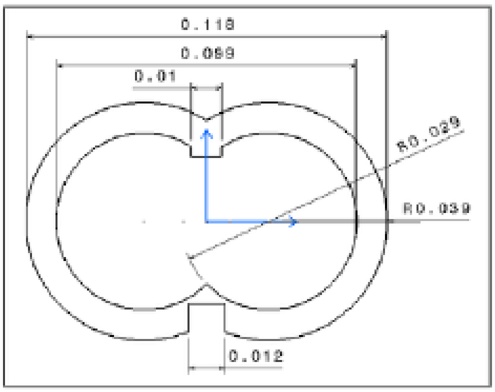

Figure 4: Cross-section View of Double-Bubble Fuselage

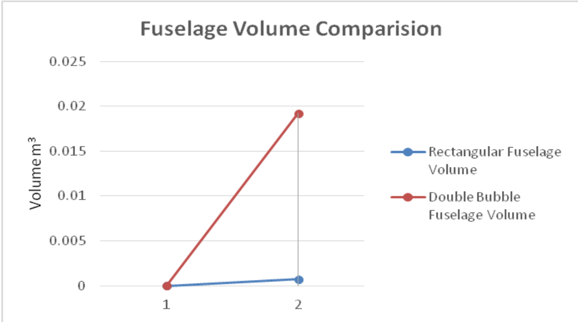

Figure 5: Fuselage Volume Comparison

E. Fuselage Sizing

Length of fuselage is about 60-75% of wing span after performing the iteration we have selected the 70% of wing span i.e. we have got the length of fuselage as 0.91 m as shown in Table3 and fuselage specifications are mansion in Table 3.

Table 3: Fuselage Sizing

$\frac{L_f}{b_W}$	Wing Span (m)	Length of Fuselage (m)
0.7	1.3	0.91

Table 4: Fuselage Specifications

Parameters	Solution	
Fuselage body	Tail Boom	
Cross-section geometry	Double-Bubble	
FRL	0.39m	
L_f in % of wing span(b_w)	0.7	
Frontal cross-section area		
Fuselage structure	Semi-Monocoque Structure	
Interior	W	99.1 mm
	H	58 mm
Exterior	W	119.1 mm
	H	78 mm

III. COMPUTATIONAL ANALYSIS

CFD analysis of the designed aircraft was performed using ANSYS 18.1 software. From this analysis we have make the necessary changes for our model to make it more efficient in aspects of aerodynamics and structural design. The CFD analysis over the Selig S1223 airfoil is done using Autodesk CFD. Initial conditions like velocity; angle and domain size is defined.

IV. RESULT AND DISCUSSION

The static pressure of airfoil and the velocity of the airfoil are as shown in the given figure6 and 7. The figure 6 and 7 shows the velocity is less at bottom of the airfoil and velocity is high at the top of the airfoil.

Retrieval Number: D9133118419/2019©BEIESP
DOI:10.35940/ijrte.D9133.118419
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

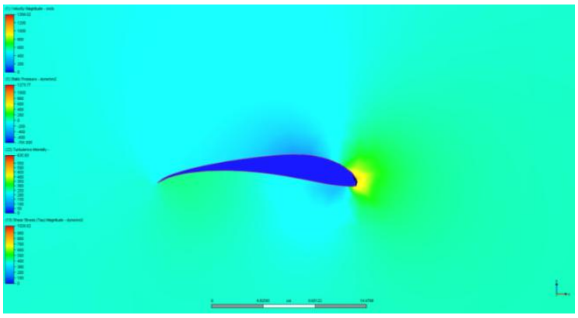

Figure6: Static Pressure of Selig-1223 Airfoil

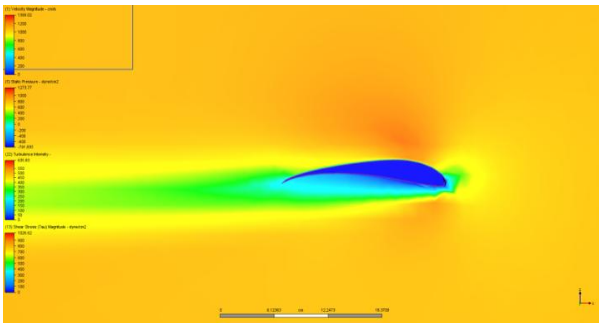

Figure7: Velocity over Selig-1223 airfoil

V. CONCLUSION

The double bubble fuselage is designed and analyzed to carry the more pay load. The velocity is less at bottom of the airfoil and velocity is high at the top of the airfoil.

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Dr. MSN Guptha is specialized in the field of Design and Production engineering from JNTU Ananthapur. He has 33 International Journal Publications, 13 of which are scopus indexed and 20 are peer reviewed journals, 08 international conference publications, 07 National Conference publication. He was the convener for various faculty development programs and conducted /organized short term training programs for both students and faculty. He is also a faculty coordinator and mentor at SAE Southern Section. He has 17 years of experience in academics. He is the chairman for Board of Studies, MLRIT and member of Boards of Studies fortwo UGC Autonomous Engineering Colleges. Currently, he is serving as the Head of the Department, Aeronautical Engineering, MLRIT

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