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Design and Construction of Twin-Boom Tail RC Aircraft

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Abstract

This paper includes the design, construction and flight test of twin-boom tail RC aircraft. Study and emphasize on RC twin boom, U tail construction with the selection of pusher type thrust and high wing for the best stability gaining accordance with the need of well clearance, good handling qualities of camera for aerial photographing

Keywords: twin-boom RC aircraft; design of twin-boom aircraft; design and construction of twin-boom tail RC aircraft

1. Introduction

A radio-controlled aircraft (RC aircraft) is a small flying machine that is controlled remotely by an operator on the ground using a hand-held radio transmitter. Building RC aircrafts has been growing worldwide with the advent of more efficient motor and lighter and more powerful batteries and less expansive radio systems.

2. Design

Design consideration represents design sizing, choosing propulsion system and electronic components and other basis aeronautical engineering related calculations such as the whole structure calculation, stability (static and dynamic) analysis and aircraft loading calculation, performance calculation. Eventually, the performance data from calculations are used to check whether it is relevant with the specified data for a success flight prior to actual flight test in the field. Many assumption, if necessary have to be made in accordance with specified limits for each calculation of each consideration.

2.1. Design Sizing

Table 1. Design specification

Sr.no	Description	Specification	Unit
1.	Weight	6	lb
2.	Wing area	4.0986	ft2
3.	Aspect ratio	9	
4.	Wing span	6.0735	ft
5.	Taper ratio	7.1982	
6.	Wing Root chord	8.9978	in
7.	Wing Tip chord	8.1313	in
8.	Fuselage diameter	6.3584	in
9.	Fuselage length	21.1948	in
10.	Airplane length	41.523	in
11.	Horizontal tail span	19.7	in
12.	Elevator chord length	2.1	in

Fig.1. Design of BOREAS XI

2.2. Electrical component Specification

A motor is the heart of an aircraft, it provides the required energy for flying. The power system converts the chemical or electrical energy into mechanical energy which will transformed into the lift and thrust force required. The speed of the airplane flies, the payload it can carry and type of manoeuvre it can do all depends directly or indirectly to the type of power system used.

Fig. 2. Motor (left) and propeller (right)

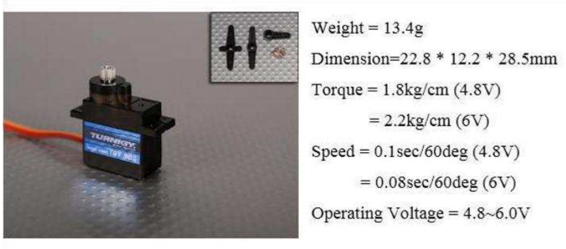

Fig. 3. Servo

Fig. 4. ESC

Fig. 5. Battery

2.3. Load Distribution of Wing

Actual air load along the span-wise and chord-wise load distribution are calculated to use the structural calculation.

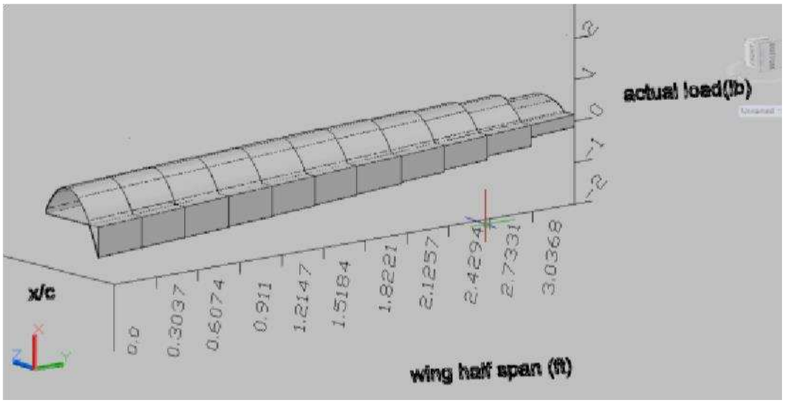

Fig. 6. Span-wise and chord-wise actual load distribution along the half-span

2.4. Structural Calculation of Wing

With the application of the actual point loads over the wing which has obtained from the span-wise and chord-wise distribution calculation above, will go for obtaining some structural information .Since BOREAS XI is twin boom, U tail plane, the loads are most applying on the wings .So need to calculate structure only wing and assume half span which is fixed on the fuselage at the root chord.

Maximum bending stress along the wing half span is 1.1113lb/in^2.

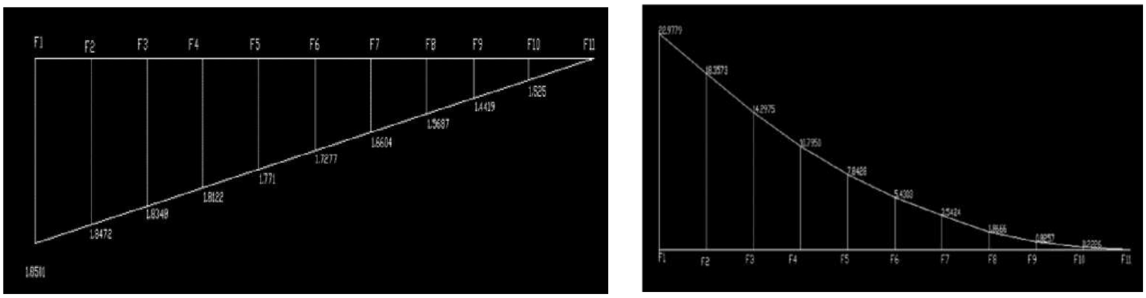

Fig. 7. Shear force (left) and bending moment (right) along the wing half span

2.5. Stability and Control

An airplane in flight is constantly subjected to forces that disturb it from its normal horizontal flight path. Rising columns of hot air down drafts gusty winds etc., make the air bumpy and the airplane is thrown off its course. How the airplane reacts to such a disturbance from its flight attitude depends on its stability characteristics. Stability is tendency of an airplane to remain in straight, level, upright flight and to return to this altitude, if displaced without corrective action by the pilot.

2.5.1. Static Stability

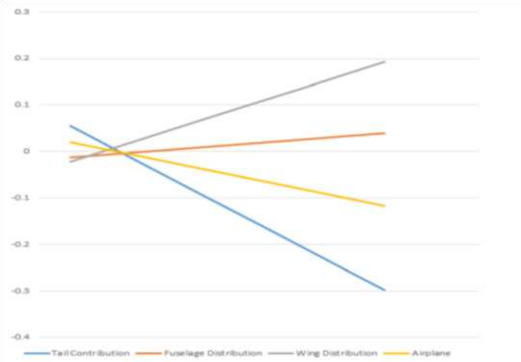

Fig. 8. Aircraft component contribution to stability

2.5.2. Dynamic Stability

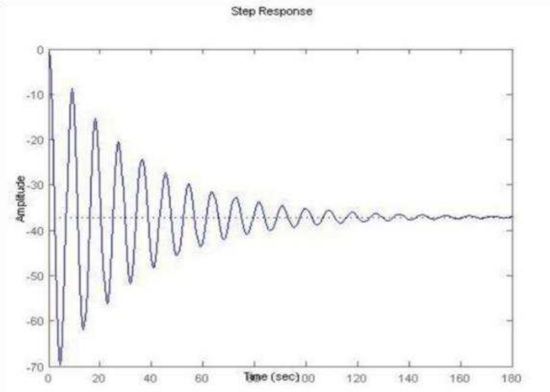

Fig. 9. Step response of velocity output

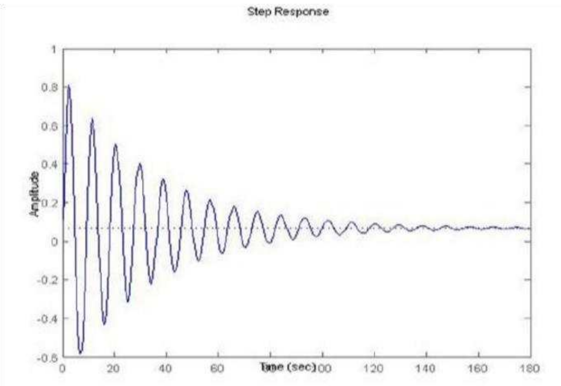

Fig. 10. Step response of pitch angle output

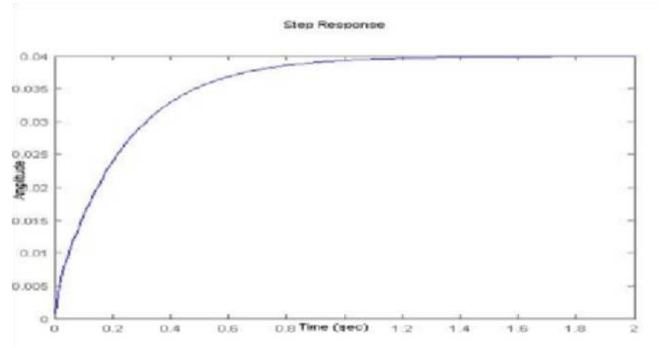

Fig. 11. Step response of angle of attack output

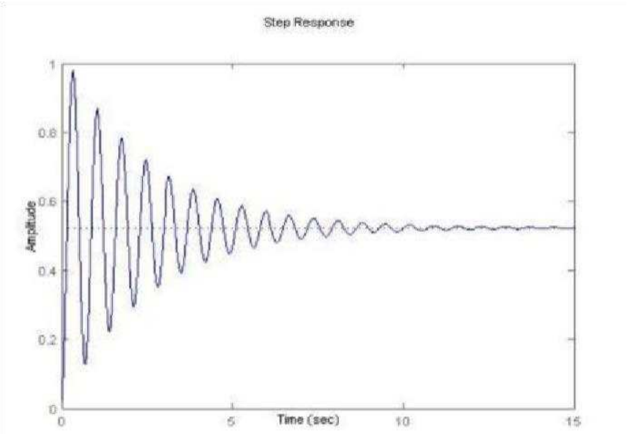

Fig. 12. Step response of sideslip angle output

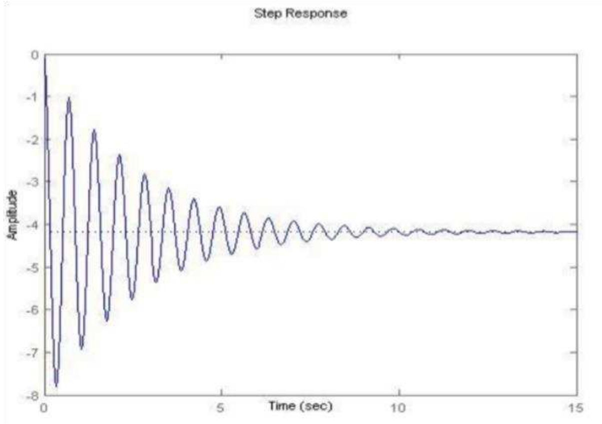

Fig. 13. Step response of yawing rate output

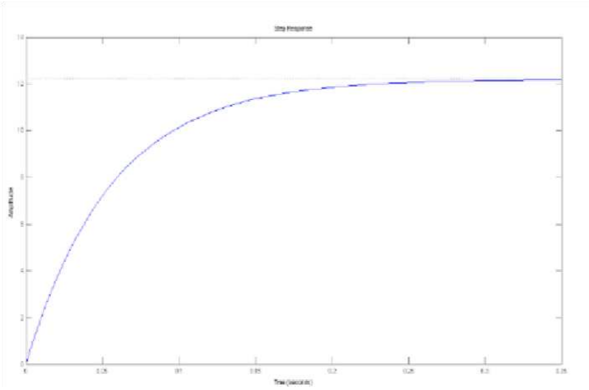

Fig. 14. Step response of rolling rate output

According to data obtained from dynamics and static stability calculation (Fig. 8 to 14), aircraft is statically and dynamically stable.

2.6. Performance

Performance is one of the important role in aviation. So me obvious questions were asked a given design. What is the maximum speed of the airplane? How fast can it climb to a given altitude? How far can it fly on a given tank in fuel? How long can it stay in the air? Answer to these questions constitutes the study of airplane performance.

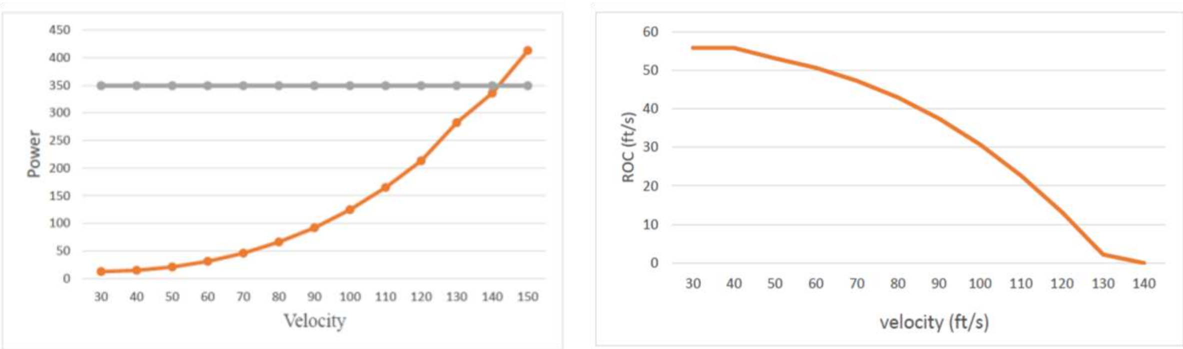

Fig. 15. Maximum velocity calculation (left) and rate of climb and velocity (right)

Table 2. Range and Endurance

Sr no.	Description	specification
1.	Range	40.11miles
2.	Endurance	51.56min

3. Construction and Flight Test

Fig. 16. Airfoil Cutting

Fig. 17. Combination of Wing and Twin-boom

Fig. 18. Ground Test

Fig. 19. Flight Test

4. Conclusions

As conclusion, this twin-boom aircraft is the low speed flight vehicle. Its flight time. During flight test, the wind speed was so heavy and so we found some difficulties in flight test. Due to an advantages of aircraft design that is large span of wing which produces a lot of lift that compensate the disturbance cross wind. So, the flight is stable and smooth from take-off to landing. Although the wind speed is so heavy in flight test, the aircraft retained to its original flight path because of wing stability. But this aircraft is a little heavy (nearly 8 lb), so it is not compatible for aerobatic flight. Eventually, flight test is successful although still need some weakness. The pilot recommended for its good stability and manuverability.

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