COMPARATIVE ANALYSIS ON WINGLETS FITTED ON AIRCRAFT MODEL

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ABSTRACT

An aircraft model was fabricated that can fit into wind tunnel size of 3x4x6 feet available at MIT, Chennai. The model was tested with winglet cant angles 0, 30 and 60 degrees. The object of the experiment was to study the effect of winglets and comparative analysis of cant angle varied winglets using the subsonic wind tunnel. An automated turntable was used to facilitate the measurement of data at different test section velocity and angle of attacks. The data analysis indicate winglet establish substantial improvement in wing efficiency by reduction of induced drag. The winglets fitted on the model were tested at 0, 30 and 60 degrees. The wind tunnel testing speeds were at 8m/s, 16m/s and 24m/s. The wind tunnel data analysis indicates the 30 degree winglet has provided comparatively superior performance.

Key words: wind tunnel, winglet, subsonic, aircraft model.

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1. INTRODUCTION

Induced drag in a subsonic aircraft is caused due to vertex generation at the wing tips at port and starboard. This is an unavoidable phenomenon in an aircraft as the wings are three dimensional. The wing tip vortex caused by the pressure difference between upper and lower wing has strong vortex strength to induce additional drag in the aircraft. This affects aircraft performance as it reduces the range and climb. The trailing vortices are formed at the wing tips alters the pressure distribution over the wing and the effective angle of attack is reduced.
2. AIRCRAFT MODEL

Aircraft model (Fig 1) of suitable size was chosen for the study so that the model fits into the low speed wind tunnel test section of size 3ftx4ftx6ft available in the Department of Aerospace Engineering, Madras Institute of Technology, and India. The blockage ratio of the model with reference to wind tunnel test section was estimated and less than 5%. The surface finish is smooth and friction drag is not considered as the surface area is small.

![Aircraft model](image1)

**Figure 1** Aircraft model

The model is mounted (Fig 2) in the wind tunnel and the adaptor is first fixed to the front part of the strain gage balance. It is ensured that it is fixed rigidly so that no error occurs during the experiment. The model is tightened to the adaptor with the base in a position so that the balance does not shake or touch the edge whenever the angle of attack is changed.

![Aircraft model mounted in test section of wind tunnel](image2)

**Figure 2** Aircraft model mounted in test section of wind tunnel

3. VARIATION OF FREE STREAM VELOCITY

For 0° yaw at constant speed of 8 m/s for various pitch angles (-8° to +20° with steps of 4°) the model is tested using model mounting mechanism and the aerodynamic coefficients ($C_L$, $C_D$) are determined using empirical relations.
Comparative Analysis on Winglets Fitted on Aircraft Model

**Figure 3** Coef of lift Vs angle of attack for 8 m/s at cant angles 0, 30 and 60 deg

The graph shown in Fig 3 the coefficient of lift for 30 cant angle is more predominant compared to other two cant angle 0 and 60 degrees at 8 m/s.

**Figure 4** Coef of lift curve at 16 m/s at 0, 30 and 60 cant angles

The graph shown in Fig 4 for 16 m/s for 30 cant the coef of lift is higher compared to other cant angles. At less than 0 deg angle of attack the lift is moderate for 30 cant angle.

**Figure 5** Coef of lift curve for 24 m/s for 0, 30 and 60 cant angles
The graph shown in Fig 5 the coef of lift for 30 cant angle is higher compared to 0 and 60 cant angles at 24 m/s

The coef of lift curves for cant angle 0,30 and 60 degrees estimated experimentally at speeds 8m/s,16m/s and 24 m/s are compared. The model with winglet 30 cant angles clearly establishes the best performance at tested speeds 8m/s, 16m/s and 24m/s.

4. CONCLUSIONS
The aerodynamic coefficients $C_L$ and $C_D$ were estimated for the model with winglet. The testing was done for pitch angle from -8 degree to +20 degree on 0 degree, 30 degree and 60 degree cant angles at 8 m/s, 16m/s and 24 m/s. The conclusions are at 8 m/s 30 cant angle has significant coef of lift followed by 60 cant angle at 16m/s and 24 m/s 30 degree cant angle shown marginal coef lift improvement compared to other two cant angles at 16 m/s and 24 m/s the coef of drag is minimum for 30 degree cant angle. Conclusion drawn from the above cases the 30 degree cant angle is better performing winglet angle. It is observed the stall characteristics at higher speed 16 m/s and 24 m/s are better compared to 8 m/s.

REFERENCES


