Name(s)

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Project Number

J0113

Project Title

Wingin' It: Design and Construction of a Modular Model Aircraft for Wing Studies

Abstract

Objectives

Design and construct a modular control-line model aircraft to allow a range of wings to be easily swapped at the flying field to evaluate aerobatic performance.
The design would allow wings with different airfoil section thicknesses (13% to 26%, symmetric) and different planforms to be evaluated.

Methods

Using a full length carbon fiber tube spar for strength and a secondary stub spar for alignment, gave a strong, accurate and reproducible system. Wings were hotwire cut from insulating foam using airfoil templates printed from Profili software. Wings were flight tested to measure their lift and drag characteristics. Drag of the wings was measured by timing sets of level laps. For lift, photogrammetry was used to measure the angle of attack for level flight, and aerobatic loop radius.

Results

Reasonable agreement with basic drag theory was found when multiple sources of drag, including the control lines, were allowed for. Wing lift was first evaluated by measuring the angle of attack for level flight using graphic measurement of video recordings. Observed values for angle of attack ranged from 1.3 deg. for the 16% high aspect ratio wing (close to theory), to 4.3 deg. for the 26% rectangular planform. Lift was evaluated at high angles of attack by flying the plane through figure-8 maneuvers. From videos, composite images capturing the path of the model through the maneuvers were created using Microsoft ICE software. This allowed the loop radius to be determined and from these the centripetal acceleration and coefficient of lift (CL) were calculated. The model pulls more than 9g though figure-8 maneuvers. The measured CL values agreed well with the basic theory.

Conclusions

The design has proven to be very rugged, surviving more than 100 test flights, with three major and two moderate crashes. Flight performance was both good and consistent between test sessions, showing that wing alignment is accurate and reproducible. The small changes in level flight lap times (<0.2 sec/lap) highlighted the relatively small contribution of airfoil section drag to total drag for a small, low aspect ratio model of this type. The expected ability of thicker sections to turn tighter was confirmed, but the increased drag led to almost no difference in time for the figure-8 maneuvers. The only data which showed a significant difference for the high aspect ratio wing was angle of attack in level flight.

Summary Statement

I designed and built a modular control line model aircraft which allowed me to evaluate a range of wings for the best performance, measuring lift and drag for a range of both airfoil section thicknesses and wing planforms.

Help Received

My dad helped with the foam wing hot-wire cutting, pitman duties and poster graphics.