Name(s)

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Project Number

S0398

Project Title

A Novel Approach to Capture Wingtip Vortices

Abstract

Objectives/Goals

1.) To design a method to "print" vortices, on physical permanent medium, like the Richter Scale recording earthquake activities, could facilitate comparison and historical analysis on the nature of the wingtip vortices.

2.) To incorporate winglet lengths and angles into the computation of induced drag and vortices, in order to save time and cost as currently the designs of winglets for various aircraft were trials and errors, build then test.

Methods/Materials

With help and reference to NASA website, I designed and built a Baals wind tunnel test rig. I also crafted 5 different winglet lengths, each had 5 different winglet angles. And there was one straight wing with no winglets as benchmark reference. All test wings were of the same weight, wing area, and airfoil shape. For each wing I mounted on the platform, I recorded the lift and drag generated in equal duration and charted the vortices at fixed distance. In other words, I had recorded a total of 390 data; 3 readings from each of the 5 trials for each of the 26 test wing.

I also derived formulas to predict the effect of winglets and vortices so as to better plan for efficient and safe operation of aircraft.

Results

Lift, drag and vortices generated did not change with respect to the various winglet lengths or angles but change with my proposed "virtual span;" the effective wingspan of wings with winglets derived from the Cosine Law based on the Lifting Line Theory. I also derived formulas to compute Induced Drag by wings with winglets, Induced Deflection Angle, and Radius of Induced Wingtip Vortices.

I knew my results were accurate because my test data agreed with my analysis mathematically. Also, the vortex sizes recorded varied reasonably with the readings of lift and drag generated. Hence, this experiment I designed and the formulas I derived were validated.

Conclusions/Discussion

1.) True measure of winglet efficiency should be by increased Lift-to-Drag Ratio, not by Lift, Drag, or Vortices' sizes alone.

2.) Length and angle of winglets could be factored into the calculation of the Induced Drag by my proposed "virtual span." 3.) Wingtip Vortices could be "printed" and that the paint coverage reflected the size of the vortices.

Summary Statement

To measure wingtip vortices graphically, and to design winglets mathematically.

Help Received

NASA Glenn Research Center Website - the Beginner's Guide to Aeronautics. My dad helped shopping for materials, supervising construction, and trouble-shooting of the test set-up.