CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

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Project Number

33959

Project Title

Testing the Efficiency of Wingtip Devices on Aircraft Wings

Abstract

Objectives/Goals

My goal was to check if wingtip devices improve the flight performance of an aircraft and which wingtip device (90 degree winglet, 45 degree winglet, and wingtip fence) will result in the highest efficiency in terms of the greatest amount of lift and the least amount of drag. My hypothesis was that the wing with wingtip fences would be the most efficient, and then by decreasing order: 90 degree winglet, 45 degree winglet and then the wing with no winglets.

Methods/Materials

In my study, I built four wings which were all exactly the same. The only difference between the wings was the winglet found at the end of the wing (90 degree winglet, wingtip fence, 45 degree winglet and one without winglet). I built a wind tunnel. Each wing was tested five times using 2 force sensors to measure the lift and drag forces.

Results

Lift- The wing with the wingtip fences came in 1st place and the wing with 90 degree winglets came in 2nd exactly according to my hypothesis. However, the 45 degree winglets came in 4th after the one without winglets. When I considered that the span of the wing is small and the 45 degree winglets take 1/3 of the span, I figured out that this wing has a smaller horizontal surface for creating lift and that is why it had the least lift. This effect will disappear if the span was larger with the same size winglet.

Drag- The results were opposite to my hypothesis: 1st the wing with no winglets, then the 45 degree winglets, then the 90 degree winglets and last was the wingtip fences. However, when accounting that the parasitic drag is proportional to the frontal surface area, and calculating the drag force/in2, the wing with 90 degree winglets came in 1st, then the wingtip fences, then the 45 degree winglets and the wing with no winglets came last, which directly matches my hypothesis.

Conclusions/Discussion

I can conclude that the wingtip fence is the best design to reach the greatest lift. The 90 degree winglet came in 2nd. As for drag, when you take the frontal surface area of each wing into account, then the wing with 90 degree winglets is the best design if you want the least amount of drag and the wingtip fence design had results very close to it. Therefore the best design if you want to increase the lift and decrease the drag of an aircraft is either the wingtip fence or the 90 winglets. My study proved that my hypothesis was correct in that the wingtip fences are the most efficient.

Summary Statement

My project tests whether wingtip devices improve the flight performance of an aircraft and which wingtip device results in the highest efficiency while maintaining all other aspects of the aircraft the same.

Help Received

Father helped build wind tunnel.