CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
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Project Number
S0108

Project Title
Winging It: An Analysis of the Effects of Varying Aspect Ratios on a Toy Glider's Flight

Abstract

Objectives/Goals
The primary objective of this project was to analyze the effects of varying the aspect ratio of a rectangular wing while keeping the surface area constant. The secondary objective was to find the optimum aspect ratio for the toy glider. Aspect ratio (AR) is a measure of the slenderness of a wing. As the aspect ratio increases, the wing becomes more slender.

Methods/Materials
The fuselage of a small toy glider was selected as the platform for the experiment. The surface area of the original wing was then calculated. Nine rectangular wings (Wings 1-9) with the same surface area were constructed from balsa wood. The aspect ratios of the wings were: 2.5:1, 4.0:1, 4.7:1, 5.7:1 7.1:1, 9.0:1, 13.5:1, 22.9:1, and 27.1:1. Each glider was then launched from a table with 8 Newtons of force supplied from a rubber band. The location where the gliders hit the ground was marked and measured from the base of the table using a metric tape. This process was repeated 30 times for each of the nine rectangular wing designs.

Results
After 296 total trials, the average distances (cm) for wings with aspect ratios: 2.5:1, 4.0:1, 4.7:1, 5.7:1 7.1:1, 9.0:1, 13.5:1, 22.9:1, and 27.1:1 were 389cm, 458cm, 488cm, 481cm, 465cm, 454cm, 444cm, 426cm, and 415cm, respectively.

Conclusions/Discussion
Wing 3 produced the longest flights # an average distance of 483cm # and had an effective Lift/Drag (L/D) ratio of 6.68. The wing had an aspect ratio of 4.7:1. Wing surface area is the dominant variable related to producing the lift that is necessary to allow the glider to fly. The wing area was held constant in this experiment, thus causing the Lift of the L/D ratio to remain constant. Drag is therefore the independent variable in the L/D ratio and changed as the AR was varied. Total drag is the sum of induced (drag due to lift) and parasite drag (drag due to design). As the AR was increased, the induced drag decreased. However, the shrinking chord (wing width) caused an increase in parasite drag. There is a point where the total drag was at a minimum, or optimum drag. Wing 3 produced the optimum drag and, consequently, exhibited the highest L/D ratio and flew the farthest. An understanding of these concepts is essential in order to design aircraft with maximum efficiency and maximum L/D ratio. This is extremely applicable in glider and sailplane design.

Summary Statement
The student designed, constructed, and tested nine wings with the same surface area but different aspect ratios in order to analyze the effects of varying aspect ratios on a toy glider.

Help Received
The student's brother and mother marked the locations of where the glider hit the ground.