DRAG REDUCTION IN SAILPLANES

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More than any other aircraft the sailplane relies on a low resistance to airflow. To reduce drag is nearly as difficult as saving money, and often involves great effort. This is especially true in sailplanes, where the drag must remain small at both high and low speeds. Furthermore, an effective reduction of drag cannot be achieved by just one single measure, such as the use of suitable laminar profiles. If the results are to show any clear improvement over the levels currently being achieved many small improvements, involving much troublesome detail work, must be made. It might therefore be useful to set out the simpler possibilities of drag reduction which may, especially in the second half of this article, be of interest to sailplane pilots.

GENERAL REVIEW

Before one discusses drag reduction it is well to have an idea of the magnitude of the contributions of separate areas to the overall drag. In this manner it is possible to establish the influence of a particular improvement on the overall performance. Figures 1 and 2 give such an example for a sailplane such as the K-6, Figure 1 as a speed polar, and Figure 2 in the form of a lift-drag polar. Both Figures give information as to the effect of drag change in a given lift or speed range. Unfortunately they are only valid for straight flight, not for circling flight.

The influence of these two flight conditions in combination shows up primarily in the cross-country speed, which therefore is the proper criterion for the optimum design of a sailplane. Another useful criterion may be the longest distance which can be achieved over the whole day in prescribed weather conditons.

But we are not considering the problems of design here and drag reduction will only be taken in the restructed sense of designing for low drag in each separate detail. However, a pointer here will not be out of place.

In the case of a drag reduction of ΔC_d 1 $\times$ 10^{-3} in the high-speed range, for example, with a C_L value of 0.2-0.5, the cross-country speed increases by around 4%, and this practically regardless of thermal conditions. An equal drag saving in the low-speed range, with a C_L value of 1.1-1.3, reduces the rate of sink by around 2.5 cm/s.

The effect on the cross-country speed is strongly dependent on the rate of climb. With an average climb of V_{cb}, which is approx. = to 0.5 m/s the percentage gain is about 4% on the cross-country speed. With V_{cb} approx. = to 1 it is reduced to 2.2%, and with V_{cb} approx. = to 2 m/s to 0.5%. This means that a saving of drag in the high-speed range (this refers to cross-country speed in better thermal conditions) is two to eight times as valuable as in slow flight.

WING PLANFORM AND TWIST

In Figures 1 and 2 the induced drag is shown for a wing with aspect ratio A = 17 with elliptical lift distribution. As is known, this distribution will be obtained at all angles of attack only with elliptical planforms. For practical reasons, however, one avoids the elliptical planform and chooses instead tapered, double-tapered or rectangular-tapered (rectangular inner wing with tapered tip) planforms.

The aerodynamic advantages and disadvantages of such planforms will be mentioned briefly in this article, but two questions come to the fore:

By how much does the induced drag increase as against the ideal case of an elliptical lift distribution?

How do the different wing forms perform in slow flight?

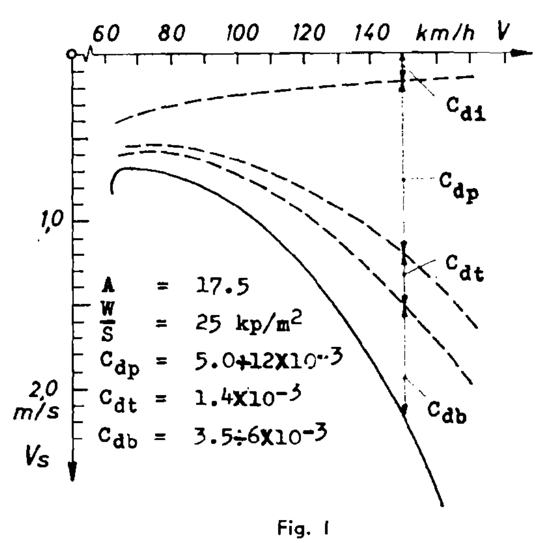

Fig. 1

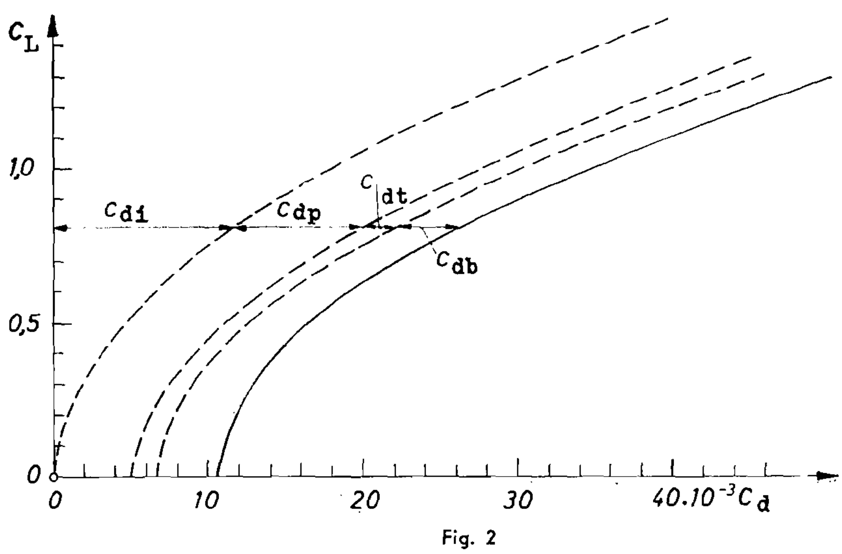

Fig. 2