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SUMMARY OF THE INFLUENCE OF THE AIRFOIL POLAR ON THE PERFORMANCE OF SAILPLANES

by DR. F. X. WORTMANN *and* K. SCHWOERER

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During the design of laminar airfoils for sailplanes, several airfoil choices are available. One can design airfoils, for example, which obtain extreme low drag values within a small lift region, and, on the other hand, others exhibiting a wide laminar bucket associated with slightly greater drag. Fig. 1 shows three examples of measured polars of different laminar airfoils. It cannot be readily recognized which airfoil, or rather, which polar, is most suitable for sailplanes. It is possible that differently designed sailplanes require also different airfoil polars.

These questions can be answered theoretically if one calculates the circling and cruising flight independently, based on the measured polars and classical flying tactics, and uses the maximum cruising speed as the criterion in passing judgement on the airfoil polars.

Without considering here the details of the original paper, one can sum up that during circling flight under identical conditions, the sailplane having the polar A sinks about 0.7 to 1.0 ft./sec. faster than that with polar C. The difference between the sink rates of A and C during circling flight is almost independent of the turn radius, for turn radii between 150 and 300 ft.

The relation between optimum cruising speed and the experienced climb rate during circling flight does not show how different the climb rate may be for various sailplanes climbing under equal thermal strength. Because the difference of sink rate in circling flight is almost independent of the turn radius, for sailplanes with the different airfoils of Fig. 1, the optimum cruising speed can be obtained and compared directly by shifting the climb rate scale. Thus, the flight polar of a given sailplane with airfoil A, for example, is shown in Fig. 2. The plot goes through (climb rate) = (cruising speed) = 0. The cruising flight polar of the same sailplane with profile C shows that it intersects plot A at a thermal strength of 2.5 m./sec. (approx. 500 ft./min.). It runs below A for lower thermal strengths and above for higher thermal strengths. This means that a sailplane with airfoil C will cruise faster under weak thermal conditions and a sailplane with airfoil A will cruise faster under strong thermal conditions.

This reasoning, however, is incorrect. If one increased the wing loading of the sailplane with airfoil C, without changing the geometry, such that the sink rate during circling flight becomes as great as the sink rate of the sailplane with airfoil A, the cruising speed will be greater than in the case of airfoil A. This difference will increase with increasing thermal strength (see Fig. 9 of the original paper). Of course, it is more advantageous to increase wing loading by reducing

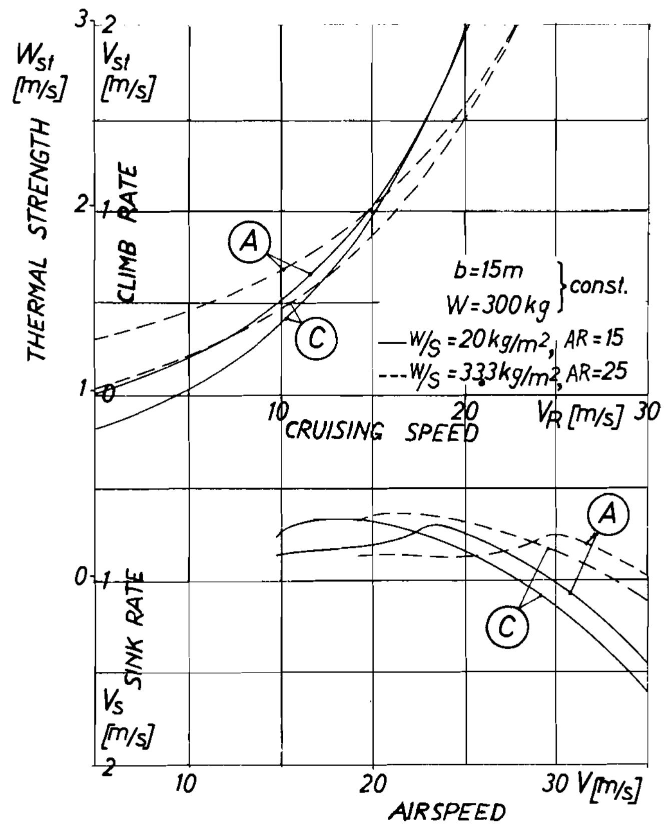

Fig. 2. A comparison between airfoils A and C of the effects on performance of increasing wing loading by reducing wing area, keeping span, b, and weight, W, constant, thereby increasing aspect ratio, AR.

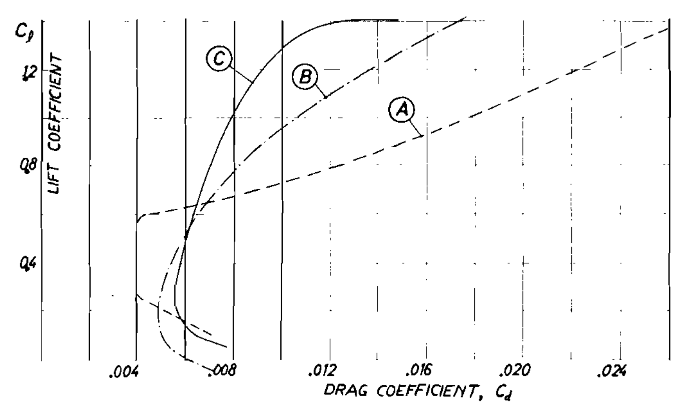

Fig. 1. Three examples of measured polars of different laminar airfoils.