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SOME LAMINAR PROFILES FOR SAILPLANES

by Dr. F. X. Wortmann

(Editor's note: The original paper was presented at the 1963 OSTIV Congress at Junin, Argentina, and was published in German in the "OSTIV Section" of the Nov., 1963, issue of the Swiss Aero Revue. *This translation of the paper was done by SSA member Oswin Niehuss and approved by Dr. Wortmann prior to its publication here.)*

Summary

Test results of a group of four laminar profiles of various thickness ratios are reported. These laminar profiles are characterized by a wider laminar "bucket" (laminar flow region) than are achieved by the known NACA profiles, and have equal drag. Regarding the aerodynamic characteristics, this profile group fits the requirements of soaring flight in an almost optimum way. The polars of this group are matched in a manner such that an aerodynamically uniform, and at the same time "well-mannered," wing can be designed using this profile group. In addition, test results of two profiles with simple variable camber flaps are reported, which are especially designed for the requirements of soaring flight. These profiles show approximately 20 to 25% less drag than the profiles of the mentioned profile group and have a similar polar form.

Introduction

In a previous analysis of the influence of section polars on cross-country flights (see reference 1), it has been shown that section polars which exhibit a very wide laminar region, or "bucket," are most suitable for sailplanes. This conclusion is independent of the basic design of the sailplane. These section polars are the best solution, not only for conventional types, but also for sailplanes which are designed for high cruising speeds. The development of section profiles for sailplanes, therefore, can be limited to only one type of polar. How this polar type with moderate drag but very wide laminar region can be realized in practice using results received from the laminar wind tunnel of the Institute of Aero and Gasdynamik at the Institute of Technology at Stuttgart, is the subject of the report. (A more detailed report, which was financed by the "Deutsche Forschungsgemeinschaft," will be published soon.)

Remarks on the Design of Section Profiles With Wide Laminar Region (Wide "Bucket")

In previous reports (ref. 3 and 4) the author has shown that the drag of laminar section profiles can be reduced considerably in the region of the turbulent boundary layer by employing a concave velocity distribution, if one controls carefully the location of the point of transition (from laminar to turbulent flow) with the aid of so-called "Instabilisierungsstrecken" (surface length where the boundary layer becomes increasingly unstable). The application of this instability length to sailplane airfoils is most important and also practical because of the relatively small Reynolds numbers of soaring flight. Because the drag of laminar profiles within the laminar region is always somehow dependent on the width of the "Bucket," one can dispense with the possibility of drag reduction and instead widen the region of laminar flow (widen the "bucket"). Of course, one will closely watch, while selecting the velocity distribution during the development process, that the effective Reynolds numbers at the lower boundary of the bucket are two to three times greater than those near the upper boundary.

Concentrating on as wide as possible laminar region (Bucket) during the development process has two natural consequences, 1, it is hardly possible to achieve a greater maximum lift than that of the NACA laminar profiles, and 2, the average aft location of the transi-

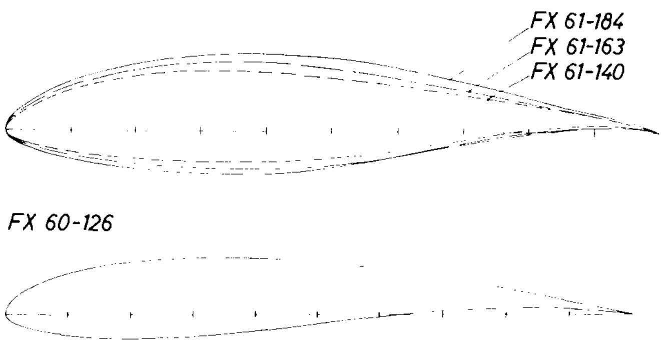

Fig. 1. The four laminar airfoils described in this paper which feature wide laminar flow buckets in their polar curves.

About the Author

Dr. Wortmann is associated with the Institute for Aero- and Gas Dynamics of the Technischen Hochschule in Stuttgart, West Germany. He was the person primarily responsible for the development of the low-turbulence wind tunnel at Stuttgart which was used for the low Reynolds number testing of the sailplane airfoils discussed in this paper. He is the only one known to be working in this field and is performing most valuable data for the furtherance of sailplane design. After reviewing the American translation of this paper, Bruce Carmichael, noted U. S. sailplane aerodynamicist, commented that he thinks this is the best work ever done on sailplane airfoils and that all new sailplanes should use these sections due to their obvious superiority.

Dr. Wortmann has submitted numerous technical papers for recent OSTIV Congresses and has supplied *Soaring* magazine with some of his work. His "Concerning an Improvement of the NACA 63-618 Airfoil," used on the Ka-6 sailplane, appeared in the May, 1962, issue.