

The Investigation of the Possibility of Increasing the L/D Ratio of Record Sailplanes with the Help of a Sailplane Model.

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Wing laminarization is one of the ways of increasing the L/D ratio of sailplanes. The L/D ratio can be increased by 1.5 times with the help of non-turbulent flow in the wing boundary layer. The effective way of wing laminarization is the suction of a definite quantity of air from the boundary layer through permeable skin which can result in a decrease of profile drag of 25 to 45%.

In a number of countries the study of air suction from the boundary layer has been conducted on piloted aircraft. Beside the study of suction effect, the structure and technology of wing laminar flow control system has been worked out.

Though the results achieved in decreasing wing friction drag were satisfactory on some aircrafts (in USA airplanes F-94, X-21, in Great Britain MA-4 «Vampire», in Holland Fokker S-12) this system has some specific disadvantages:

1. Since the installation of a boundary layer control system involves changes in wing construction, the wing strength is clearly affected. Such must undergo a complete strength testing programme. As a result the period of testing is prolonged.
2. Almost no changes are possible in the construction of a manufactured wing with boundary layer control system during the period of experimental flights.
3. Experimental wings with the boundary layer suction system are rather expensive according to the published data.

But there is a method without these disadvantages. It is the method of studying the effect of boundary layer suction, and the improvement of the structure and the technology of developing the wing laminar flow control system with the help of a radio-controlled model sailplane. We could transfer with enough accuracy the data obtained to the real sailplane if we selected linear parameters of the model and the velocity of flight in such a way that the study could be conducted within the required range of Reynolds numbers.

The radio-controlled sailplane model that was built at Kharkov Aviation Institute is a metal monoplane of a classical

scheme with high wings. The model is launched from a guide with the help of a solid propellant rocket engine. After launching the engine separates and the model performs a gliding flight with the speed of $V = 40$ m/sec. Having reached minimum safe height of $H = 100$ m, the parachute system operates and the model lands using a soft landing system. The recovery system guarantees a soft landing if any difficulty occurs in flight.

The wing profile of the radio-controlled model is NACA 65₃-618.

The preliminary-study of a part-span model of the profile in the wind tunnel showed that the control of boundary layer with the help of air suction through spanwise slots may give:

1. Laminarization of flow up to 80% chord.
2. The decrease of profile drag C_{x_0} of 41%.
3. The L/D ratio of the profile increases from $K = 83$ to $K = 129$.

The air flow during suction was negligible and power cost was small.

Boundary layer suction on the radio-controlled model of KAI is conducted on the measuring glassfiber wing panels, the area of which is 40% of the total wing area of the model.

The boundary layer control system includes:

1. Slots of 0,2 mm width, cut in at intervals along the span of the panels.
2. Underslot channels.
3. Throttling holes with diameter of 2 mm.
4. Air collector.
5. Air extracting channels.
6. Venturi tubes to find the airflow through each slot.
7. Iris diaphragms for airflow control in slots.
8. Receiver.
9. Suction unit with electric drive.
10. Exhaust branch pipe.

The suction panels are provided with vent systems which permits the measurement of pressure along the profile chord on the upper and lower surfaces of the panels under the slots and in the Venturi tubes. The panels also have a hung sliding traversing gear, with the

help of which we determine the spread of the laminar flow area in the boundary layer of the profile and the spread of the boundary layer transition area.

On the brackets, directly behind the panels we attach a device that allows us to measure pressure in the wing wake in order to determine its profile drag C_{x_0} . The data received from the above mentioned sensors are converted into electrical signals and together with the signals of the velocity transducers, slip angle and angle of attack are transmitted into an airborne loop oscillograph and are registered on the tape. In order to determine the effect of atmospheric turbulence on the effect of the air suction out of the wing boundary layer a ball with a diameter of 150 mm is fixed on the brackets of the model.

The adjustment of wing boundary layer control system is done before the flight. The wing of the KAI model structurally is divided into five detachable sections, two of which are made of glassfibre and three of duralumin. Such a structure permits easy change of glassfibre measuring sections with different structural and technological solutions of the boundary layer control system during the flight testing.

Here are given the reasons why glassfibre was used for measuring sections:

1. The possibility to get the panel contour within the accuracy of a hundredth part of a millimeter while forming it on a matrix.
2. The possibility to get wing surface of high smoothness with approximate roughness of 0,5 microns.
3. The possibility to get identical wing surfaces while forming them in consecutive order on one matrix.
4. High skin stiffness of the measuring panels with low weight by using three-ply skin structure with polyurethane as a filler.
5. High corrosion resistance of glassfibre.

The radio-controlled KAI glider model had a number of experimental flights. The results showed a decrease of wing profile drag of 35% with low power costs for air suction from the boundary layer. The effect of applying suction makes it possible to increase the L/D ratio of a record glider, e.g. A-15, by reducing wing profile drag from $K = 40$ to $K = 47$ taking into account power costs.

These test results, as well as the solutions of structural and technological problems for manufacturing the wing of the model sailplane with boundary layer control system, could be applied to the design of sailplanes with high L/D ratio.