COVER PHOTO EXPLAINED

in a Timely Article

by Alexander Satin

This month's cover shows a Russian two-place training sailplane in flight. The interesting features of this ship are the two wheel undercarriage and sharply swept forward wing, which is rather common with the Soviet two-seater motorless craft. This type of wing permits locating pilot and passenger well ahead of the leading edge, insuring excellent visibility for both.

The aerodynamic features of this type of design are well covered in the article below, authored by Alexander Satin, who was formerly associated with Briegleb Aircraft Corp. and is now on the engineering staff of Consolidated Aircraft Corp.

In the design of two-seater tandem sailplanes, the visibility for the rear man requires special consideration. In the conventional design, the two men are separated by the main spar of the wing, and the longitudinal stability and balance of the plane do not require particular attention. Lately, however, due to the increased demand for better visibility for the rear pilot, some designs, such as those of the Bowlus Company and a group of Consolidated engineers, utilize an arrangement where both seats are placed ahead of the main spar of the wing. This brings with it an increase of the over-all length of the ship and vertical tail area, which can be partially counter-balanced by sweeping the wing forward. In this respect, the location of the center of gravity of the ship in relation to the aerodynamic center or the center of pressure of the wing is of great importance, being the most significant parameter affecting longitudinal stability. The question of the effect upon the stability of a small fore- or aft-shift in the center of gravity location arises. Generally the shifts in question are so small that their effect in changing the tail length is negligible. In other words, the tail moment is practically unaffected by a c.g. shift. It can be said that in most cases a movement of the c.g. aft will decrease the stability by an amount equal to the fraction of the chord length moved. At the same time, moving the c.g. forward usually increases the stability by a corresponding amount. The reason for the importance of longitudinal c.g. position in connection with stability problems is therefore clear. It can be said that for an airplane having only a wing, of the "flying wing" type, the c.g. must be ahead of the aerodynamic center if it is to be stable.

To avoid excessive tail load, the location of the c.g. should be at approximately 24% M.A.C. Otherwise, it will be very hard to nose the ship up into a stall; and again, landing will be complicated by the impossibility of flaring up to a near-stall. For sailplanes, however, some degree of nose heaviness is desirable to achieve the necessary longitudinal stability.

Unfortunately, little data exists on the characteristics of wings having a sweep forward. The longitudinal stability seems to be satisfied in the case of a two-seater tandem sailplane if the leading edge of the wing has a sweep forward of two or three degrees, assuming a chord ratio of 2.6:1 and an aspect ratio of 15. Available data seems to indicate that a small sweep forward is beneficial to stalling characteristics.

The most outstanding result for wings of different taper and sweep back is the difference in the nature of the stall according to whether the wing is tapered by sweeping the leading edge back or the trailing edge forward. With the swept-back leading edge and straight trailing edge a taper of 2.5:1 results in stalling starting near the tip.

With a straight leading edge and a swept-forward trailing edge a much sharper taper may be used before tip stalling occurs. With the swept-forward trailing edge the component of the flow along this edge towards the center apparently acts as a kind of boundary layer control, removing air from the tip region and transferring it to the center, thus tending to keep the tips unstalled and stalling the center first.