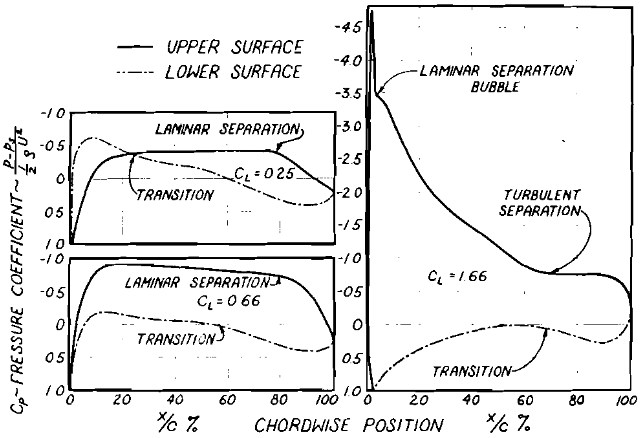

Fig. 6. Pressure distribution on Eppler airfoil.

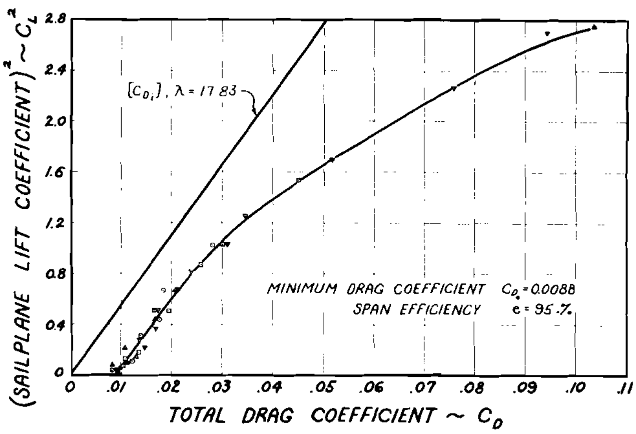

Fig. 7. Linearized drag polar for Phoenix.

layer on the Phoenix airfoils it is quite easy to appreciate the contribution these airfoils offer to modern soaring. However, boundary layer theory and practice now show that the rather minor failings of Eppler's airfoils can be corrected with suction boundary layer control. This may well be the next big step beyond the Phoenix.

Pressure distributions for the Phoenix airfoil are shown in fig. 6. At $C_L = 0.25$ one sees that the pressure gradient in the upper surface is favorable to nearly 80% chord. On the bottom, however, the pressure peak occurs at 8% chord.

For the case $C_L = 0.66$ the pressure gradient is adverse from 17% chord. The gradient is so mild, however, that the flow remains laminar to 80% chord. On the bottom surface the gradient is also much softer than in the previously discussed case. A large laminar extent can be expected from such a pressure distribution.

At $C_L = 1.66$, which is a very high lift coefficient, the gradient on top is so severely adverse that very little laminar flow can exist. In fact a laminar separation bubble is shown by the plateau in pressure distribution.

These pressure distributions merely reinforce the validity of the boundary layer development shown in fig 6. However, they can be used to obtain pitching moments for structural design purposes.

Aerodynamic Characteristics of Phoenix

The linearized drag polar, fig. 7, offers a means for evaluating the span efficiency factor of a sailplane by simply reading the slope of the linear portion. It also shows where pressure drag begins to grow due to turbulent separation occurring in some areas of the sailplane. Such a behavior is shown by the slope of the linearized polar falling off as it does in fig. 7 beyond $C_L = 1.0$. It is quite interesting to note that Phoenix develops a span efficiency of 95%. This is due to the excellent wing root intersection and to the airfoil behavior at high lift coefficients.

The minimum drag coefficient measured for Phoenix, 0.0088, is the lowest known to have been achieved on any aircraft. Although Tiny Mite had a value almost as low as Phoenix, Tiny Mite was limited in speed range because it did not possess the high lift which Phoenix displays.

In order to check the minimum drag coefficient the polar was linearized by plotting the product of the sinking speed by the weight and the forward velocity versus the forward velocity to the fourth power, fig. 8. The slope of this curve now determines the minimum drag coefficient. The value $C_{Do} = 0.0088$ is clearly in good agreement with the value found from the linearized drag polar.

As an ultimate display of fine aerodynamics one usually refers the total drag less induced drag to the total wetted area of the aircraft. In fig. 9 are shown such curves for the Phoenix and the RJ-5. The laminar and turbulent flat plate skin friction curves are included in order to show

Fig. 8. Linearized power curve for Phoenix.

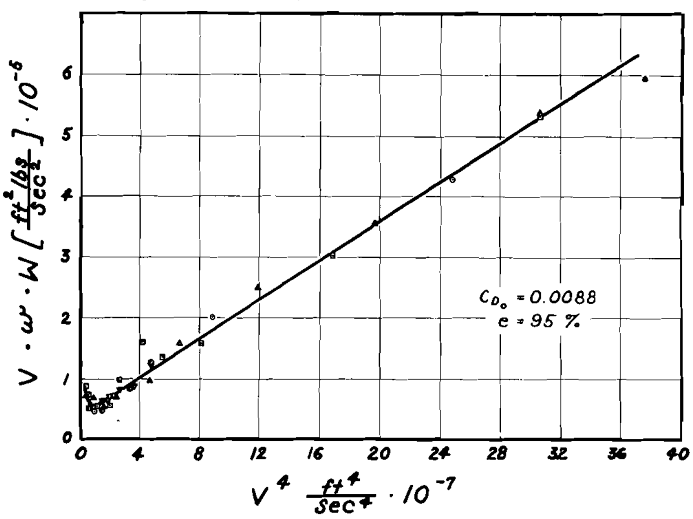

Fig. 9. Skin friction curves of Phoenix, RJ-5 and Tiny Mite.