WINCH TOWING FUNDAMENTALS

By NORMAN J. LIPSTEIN

Introduction

Winch towing is a cooperative effort. The pilot, winch operator and tow line handling crew make up the towing team. As in every group activity, each member must have an understanding of his own job and how it fits into the over-all operation. This is especially true of the pilot and winch operator. They are separated by a long slender line often of such length that neither can see the other during the initial stages of the tow. The force transmitted by this line and the rate at which it is being reeled determines the angle of climb and flight speed of the glider. It is no wonder that a safe, performance tow requires the utmost of coordination between pilot and winch operator. Each must have an understanding of the limitations of the equipment on the other end of the line. Each must be responsive to the changing force and speed requirement as the tow progresses.

When we started winch towing in the Mohawk Soaring Club, the coordination between winch operator and pilot was limited by our understanding of the dynamics of the tow. Almost of necessity we were forced to sit down and "figure the thing out". What follows is an outgrowth of our experience and study over the last two years. We hope that this information can be of some help to you in improving the performance and safety of your own operations.

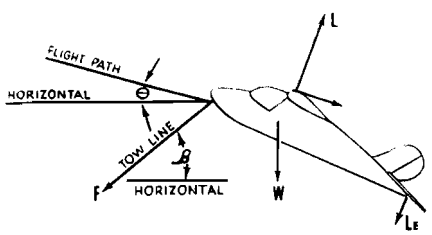
Analysis

We shall first consider the forces acting on the glider during any point in the tow.

L = Lift
D = Drag
W = Weight
F = Force (Wire)
Le = Stabilizer Force
θ = The angle between the horizontal and the flight path of glider
β = The angle between the horizontal and the line force of the wire

The glider is in steady flight during the tow so that the forces illustrated in the figure must be in equilibrium. This condition has been used to determine the stable flight path angle θ and the force F of the tow line. The results are presented in figures (1) and (2). In each of the figures the progress of the tow is identified by the tow line angle β. This angle is the direction of the tow line at the glider and can be approximated by the angle between the horizon and a straight line from glider to winch. The difference between the two is the sag in the line which varies from 3 to 6 degrees in a normal tow and, interchanging the two angles, will not effect interpretation of the results. As the glider gains altitude, the winch operator can readily identify β, and it is a convenient reference to judge the speed and torque required as the launch progresses.

The family of curves of figure (1) indicates the equilibrium flight path angle as a function of the glider loading in G's for any point in the tow.[1] Since the position in the tow is identified by an angle, the results can be applied equally well to a 5,000 ft. or 500 ft. tow. The curves indicate that maximum climbing altitude can be attained as the glider leaves the ground. The angle of climb decreases gradually as the launch progresses until the glider is literally being pulled towards the ground. As β increases and we approach the top of our tow, it requires an increasing load to maintain a positive climbing angle. Here is where the law of diminishing re-



turns takes over. After a β of 70° there is virtually no more altitude which can be gained and the pilot who foolishly persists in attempting to climb until practically over the winch is in danger of seriously overloading the glider. Actually, as shown in figure (4), 90% of the final altitude is reached at a β of 45° and, in practice, release is normally made at a β of 60°.