# TECHNICAL AEROMODELING

## TOWING TECHNIQUES

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It seems surprising that most fliers of sailplanes, be these model or full-scale, are not more familiar with some of the advanced towing techniques available today, especially since getting up higher is as important as coming down slower. In this article we will consider the essential principles of "ground-towing" (as distinct from airborne tows) wherein the aircraft is "kited" to altitude before release, and will review some of the interesting new techniques such as twin tow-hooks and the "rolling-bobbin" bridle.

**Best Towing Attitude**

The function of the towline is to impart the most altitude to a combination of aircraft and cable being pulled. In more general scientific terms, we wish to "maximise the energy height of the aircraft," which simply means that the sum of the potential energy (due to altitude) and kinetic energy (due to excess forward speed) should be as great as possible.

Consider the forces acting on the glider under tow as depicted in Figure 1. Without taking too much space for a thorough explanation (it's better to discuss this with your cronies, anyway) it may be shown that the glider's attitude will adjust itself until the line-of-action of the towline passes very near the aircraft center of gravity. The only way to cause the tow-force to act in front of the CG is by extreme up elevator movement, which is not possible with a model sailplane, of course. Hence a forward hook on the fuselage gives a shallow angle between the fuselage centerline and towline, while an aft hook gives a steep towline angle when dealing with model aircraft.

The towline is pulling the aircraft downwards as well as forwards, and this is resisted by the lift and drag developed on the glider. It can be seen with some reflection, using Figure 1 as a guide, that the forward hook (through the action of low towline angle) cannot develop large lift forces on the wing, while an aft hook, giving a higher angle of attack consequently loads the wing to its maximum amount.

By now you may wonder, "why all this need for maximum lift?" Here is why: It may be demonstrated both mathematically and in practice that the most efficient tow (that is one using the least reeled-in line, or the minimum running distance) is achieved by "kiting" the glider up while it is as close as possible to its stalling angle of attack. The fundamental reason, for those who care, is that for every foot-pound of energy imparted to the system by the towline, the least distance is used when the forces are at their maximum, i.e., just short of stalling. These principles have been beautifully applied to winch towing by Norman Lipstein in the July-August 1954 issue of SOARING.

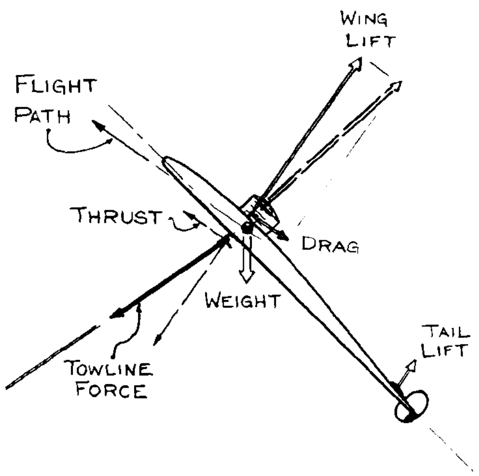


**Fig. 1**

*Forces acting on a model sailplane during tow.*

In summary, then, we see that large lift forces are desirable for the best tow, and that the corresponding high angle of attack is obtained without need for elevator movement by an aft towhook location.

**Stability and Trim Problems**

Before going on to exploit these principles for efficient towing, another important aspect must be considered: aircraft stability and trim during tow. While full-scale gliders can be controlled through gusty air models cannot, so any aircraft disturbances due to gusts should not be aggravated by the towline's presence or a crash will surely follow.

The essential picture is this: stability depends primarily on the moments (or torques) exerted about the aircraft CG by the wings, tail and towline. Consequently, if the towline were mounted exactly on the CG, it could exert no moments thereon and thus its presence could not affect the basic stability of the glider. Now all model aircraft must be inherently stable in free flight in order to fly at all, so a CG towhook would provide a STABLE tow with any normal model sailplane.

*Trim* during tow is a problem for model sailplanes because they are normally set to fly in small, thermal-seeking circles by an offset rudder. Some means of counteracting this tendency to turn must be provided while on the line in order to achieve a straight tow.

**Towline Sag**

Due to the combined action of its weight and drag the towline will sag between the line from glider to tow-er, which results in a steep angle between towline and glider long before the maximum altitude is reached. The remedy is threefold: use more line tension (i.e., a high lift tow). use a light towline (nylon is ideal). and use a low drag towline (smooth nomofilament lines are best). Some European experts have used fine steel wire for towing Nordic class gliders, but have switched to nylon because of the inconvenience, and danger of long metallic lines.

**Single Towhooks**

Single towhooks, when correctly placed and used, provide a simple and reliable arrangement. It has already been pointed out that the hook should be as close to the CG as practical. However in order to counteract the circular trim one of two techniques must be employed: *Offset towhook*—by trial and error the hook is moved off-center towards the center of the natural turn. This is most effective with tow-hooks and shallow tows. *Auto-rudder*—a linkage, lever, or towline extension is used to move the rudder to a straight flight setting