

TOWLINE GLIDERS, HOW THEY WORK BEST SORT OF

Towline gliders have been around as long as kites. I would suspect that the first towline glider was a kite that the string broke on. Wilbur and Orville Wright first flew their experimental aircraft as towline gliders. At once the fascination of watching that kite float downwind led to some real invention in the minds of early aviation pioneers. Today, now that we sort of understand how airplanes work, the concept of having a pure gliding airplane, and testing it's flight characteristics and performance would follow.

One could imagine that there must be a means of getting the glider up in the air to do all of this and many things come to mind. Launching it off a high place like a cliff, or perhaps off a tall building are suitable means, as is towing it behind a piloted airplane. But, this is a very lonely way to fly. Full sized man carrying sailplanes, or gliders are usually towed up with a piloted airplane and released, or are towed up with a long cable operated from an engine powered winch. When you get to model airplanes, powered winches, extensible cable towlines (surgical tubing "high-starts"), and fixed length towlines are used. For Free Flight flying, the fixed length towline is the best choice because it since duration is the goal, one can fix the competition free flight towline glider's parameters to airplane size (wing area), it's weight, and the towline length. This is very straightforward and puts all the competitors on the same "plane" (no pun intended) to test their abilities in design, building, and flying.

The rules for competitive towline gliders have changed very little over the years. What has changed is the concept and innovation of the glider designs. The very first gliders were large "floaters" with all surfaces fixed. Eventually, the rules sorted into two classes: A-1 (small) and A-2 (big).

On early gliders with all flying surfaces fixed it made sense to have the rudders straight. And, if the rudder was straight during the towing of the glider it would be easier to tow in a straight line. However, if you did that, then the glider would fly in a straight line until it landed, causing a potentially long retrieval chase. Then, fliers used a rudder that had a fixed

turn built into it. This led to some difficulty in towing the glider up to the top of the line and the towline attach point was usually on the opposite side of the fuselage to counteract the plane's tendency to turn and fall off the line. Sometime later, somebody figured out that if the rudder could be made to flip over to a turn position, then the gliding portion of the flight would be in a circle and offer greater pleasure. Devices were invented that caused this "automatic rudder" to be used.

Flying this type of glider then allowed the competitive flyer to tow very fast and get the plane to a higher launch. This scheme evolved an airplane that had strong wings of a reasonable aspect ratio (wing span vs. Wing width or chord) that would resist the high forces of the launch. What this also required was the flyer waited on the ground and determined the best time to launch by observing local atmospheric conditions of wind, warmth, etc. What he was trying to do was launch into a thermal, or mass of rising warm air. This would greatly increase his chances of getting a long duration flight; what was needed to get in the winners circle. This could tie up someone's time too. You had a flyer, a launch person to hold the glider at the other end of the towline, and the person timing the flight.

Competitive duration timing starts when the towline comes off the glider. On a traditional straight tow type launch this happened very quickly, unless there was enough breeze to support the glider on the line. And it was an educated guess when thermal conditions were present so the whole thing was a lot of luck. It wasn't long until the concept of a "captive tow hook" came along which allowed the flyer to "fly" his airplane at the top of the line in the air and glide for a while until favorable air conditions were present aloft. This increased the chances of releasing the glider into a thermal too. And it allowed changes in the design configuration of the glider to not have to be as beefy to withstand the launch forces. Higher aspect ratio gliders led to higher performance gliders, and so on.

Since a towline glider is a glider that is launched using a long line or cord, towing a glider is a lot like flying a kite. When you have the string attached to far forward on the kite, it

“wags” on the line going right to left repeatedly, sometimes violently, and when the string is tied too far aft, the kite spins uncontrollably. That is why tails are usually used. But, if the string is tied onto the kite about the center of gravity (CG) or slightly ahead of it, the kite can be made to tow in a straight line. How you check this is hang the kite from the string and it should hang with a slight tail heavy attitude.

Similarly, for a typical towline glider, the proper CG location is usually about 50-55% aft of the leading edge. The hook location required for stable towing is such that the tow-ring on the line pulls about ½” forward of the CG. To check this location, hang the plane upside down from the tow-hook and the plane hangs slightly tail heavy. ½” forward is usually a good place to start but the best location is unique to the particular plane configuration you are flying and may need to be adjusted during test. Fortunately, this is easy to do if you have designed in adjustment capability on the tow-hook. However, most current designs have this feature whether a straight towing hook or the circle-tow hook. The simple straight tow hook is basically an “L” shaped wire mounted under the airplane. I have seen simple “L” screw in curtain hooks to bent 1/16” wire hooks held in by screws. They should be mounted to something very hard on the underside of the plane to keep from tearing out. The mounting positions can be plywood or hardwood.

For AMA or FAI competition, the rules say the tow line length is to be a maximum of 50 meters. This is about 164 feet. On the end of the line is a metal ring suitable for attaching onto a tow-hook. This ring is usually about ½” to ¾” in diameter.

Releasing the line is easy. For straight tow type ships, as long as tension is maintained on the line it will stay on the hook. The rules require a flag or other pennant on the top of the towline so the person timing the flight can see when the line has come off the hook and can start his watch. A simple flag of about 12” square will suffice. You want to mount it at least 6” below the tow ring to keep it from getting tangled in the tow line or snagged on the hook. This flag also serves to provide the proper drag that when there is slack in the line,

the tow ring will fall off the hook. On captive and circle tow hook designs, additional tension needs to be applied to the towline for the release mechanism to work, usually by “whipping” the airplane on the line to get the increased tension. Needless to say, this puts additional bending load on the wings

The tow setup is having the rudder pulled straight, usually restrained up against a stop by a line from the rudder to an attach point. When the line is released, the hook falls off and a secondary line attached to the tow ring, pulls a pin, or something equivalent, and releases the rudder restraint line and then allows the rudder to rotate over to the glide position, usually another stop.

The rudder set-up is quite simple. The rudder pivots about its hinge line and has a lever arm attached to it, usually on the “turn” side of the rudder. A rubber band or spring attached at one end to this lever arm with the other end attached to the fuselage pulls on the arm and pulls the rudder over. An adjustable stop keeps it from going too far. The correct amount of turn offset is determined by gliding the airplane and adjusting the stop until it is gliding in about 100 foot diameter circles. There is a lever arm attached to the rudder on the opposite side that has a line (auto rudder line) connected to it that goes to the front of the airplane. This line is one that pulls the rudder to a “straight” position for towing.

The forward end of the auto rudder line usually has a small diameter metal ring (like a glow-plug washer) on it that can be restrained by a pin (the one from the secondary line from the towline). A small diameter tube, mounted to or into the fuselage, is the receptacle for the pin when being towed. The pin inserts through the metal ring on the rudder line and then into the tube. At this point it is necessary to say that the auto rudder line needs some way to allow it to be stretched and maintain tension on it. For this, a spring or rubber band can be used in line with the auto rudder line. Now, when the towline is released, it pulls the pin and actuates the auto-rudder to flip to the “turn” side for flight.