

## Tapered Wings

### *Paul:*

My concerns for the highly tapered wing is the build difficulty and stall characteristics. Remotely piloted aircraft can be difficult to control if the wing isn't built true i.e. free of warps and surface flaws. Building a straight warp free tapered wing requires jigs or fixtures to hold the ribs in alignment. If the wing is warped or has some other minor inconsistency from one side to the other it effects the stall characteristics. Highly tapered wings are very efficient but the wing tips stall before the root. An inconsistency in construction can create drag that induces yaw causing one wing to drop first. Most of the time the resulting stall quickly progresses into a spin. Because there is no feel or feed back when flying RC it is difficult at best to know if you are approaching a stall. With full scale piloted flight it is necessary to maintain coordination of the rudder and aileron control to prevent one wing from dropping. This can be very difficult to do without yaw instrumentation like a skid/slip indicator. Airfoil design also has a great effect on how the wing recovers from the stall. The wrong airfoil on a highly tapered wing will exacerbate the stall/spin.

My point is that I understand wanting to design an efficient wing with great roll characteristics based on theory and analysis but there must be a compromise simply because these are remotely piloted aircraft. The only aircraft from the designs teams that I can remember that got it right was the Darth Kiwi.

I have attached a documents on tapered wing construction. The round leading edge and constant spars is not a problem.

### *Brandon:*

I generally find that wings that have a tapered leading edge but a straight trailing edge do not exhibit 'scary' stall characteristics. In fact, many precision aerobatic airplanes that feature stability through precise maneuvers are built this way. So from a flying perspective, I think they'll be fine. From a construction standpoint, they are only slightly more complicated and require unique sequential ribs but with a laser cutter, that should be no problem. However, it is important to avoid twist in the wings or unintended washout which requires more attention as the chord gets smaller.

A rounded leading edge is still recommended and can be glued to the front of each rib on the angle of the taper. The spar should be straight across the wing which should not be a problem. The ailerons likely will not require any shaping to fit and should be uniform in size throughout their span. Shaped ailerons should be avoided, if possible.

## **Mounting Servos (Particularly for Ailerons)**

*Paul:*

I would prefer that servos are mounted externally on the wing. If a group wants to mount internally they need to provide access for removal and adjustment. If the servo is mounted through a rib it is difficult to get a screwdriver to the screws, especially the servo out put arm. Every year we see a case where we need to access the servo and cant do it at the field which delays flying. The easiest way to mount servos is with the top of the servo and drive arm outside. Span two ribs with two spruce rails that are 1/8" x 1/2" x the span. The space between the rails is the length of the servo. You can also do this with a rectangular 1/8 lite-ply plate spanning the ribs with a cut out for the servo. If they think their ribs are to far apart to span then they can add an extra rib at the servo location. I am pretty sure that there are a couple of photographs in the handout I provided that may help you a little in addition to the picture attached. The servos must be mounted into hardwood! The same goes for the fuselage. Servos can be mounted internally on two rails or a plate that spans the fuselage sides. If the servos are mounted externally it only requires a rectangular cut out for the servo and a small piece of plywood or spruce laminated behind where the servo screws go.

*Brandon:*

-Make sure the servos are screwed into plywood. If you have to place a plywood doubler on a piece of balsa, that's no problem. Having servos securely mounted is half the battle.

-Make sure the servos can be accessed and the control arm can be removed/adjusted without having to damage the model. Access hatches and leaving servos exposed are good tactics for this. Having to cut covering or wood to adjust the servo arm is no good and odds are VERY good we'll have to adjust them.

-Make sure the servo and the surface can move through their entire travel without binding and that the geometry is sound. The horn should be at a 90 degree angle to the servo body when the surface is in its neutral position.

## Appendix A: Building Tapered Wings

Construction of tapered wings requires a jig or fixture to hold the wing ribs at the proper height and alignment. You must secure the fixture to a flat surface. There are two methods that produce good results.

### 1. Wing jig rods (*Figure 1*)

Two parallel rods (1/4" steel music wire) are supported just beyond the root and tip ribs at a height that accommodates the thickest rib.

Each individual rib has two holes drilled on the centerline for the rods. The holes have to be designed in the proper locations fore and aft to create or control sweep.

Slide all of ribs over the rods then secure the rods to support blocks making sure that the blocks are identical in height and are level.

The ribs then have to be positioned either by measurement or the fixture can be secured over the plan view.

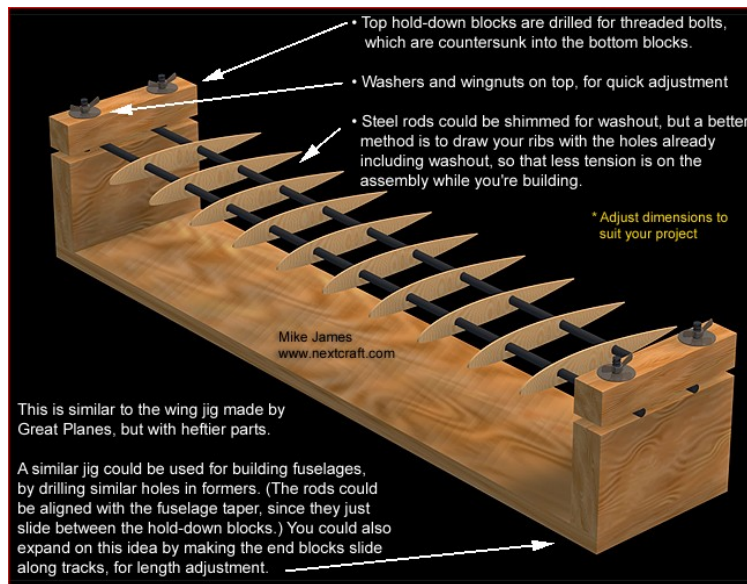


Figure 1 - Wing rod jig example

## Tabbed Ribs (*Figure 2*)

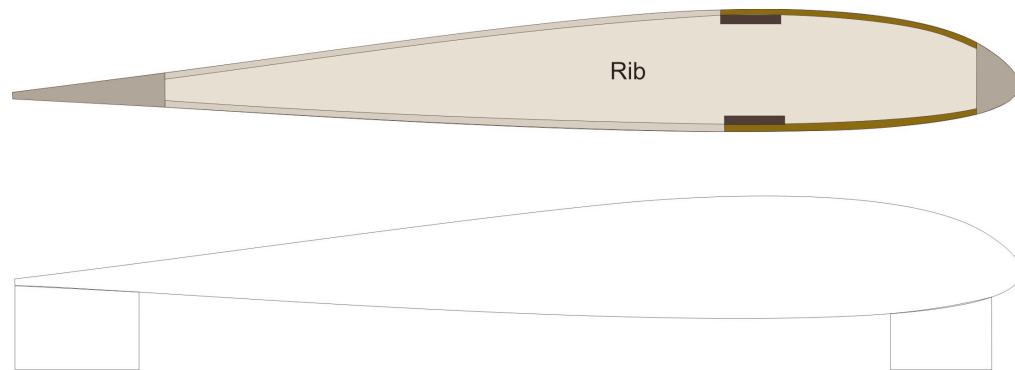
Jig tabs can be designed onto the ribs at the front and back that set their height and alignment

Each rib is pinned in place through the tab over the plan view taking care to make sure they are perpendicular to the building table.

Install the spars, leading edge and trailing edge.

Then install any wing sheeting on the surface that is facing up.

Flip the wing, cut away the jig tabs and install the remaining sheeting.



Each rib has tabs that set its height and keep it aligned. The tabs are removed after spars, leading edge and trailing edge are bonded.

**Figure 2 - Wing Rib with Tabs**

## Appendix B: Servo Mounting Pictures

