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Companion Guide: “Building Fly Baby”

Article 2: Wing Assembly

EAA SPORT AVIATION February 1963, Pages 6-9

Version 1.4

**By Ron Wanttaja
and the Fly Baby Community**

This Companion Guide is written to accompany the second of Pete Bowers' Fly Baby construction articles in EAA SPORT AVIATION magazine. The first article involved construction of key wing components. This article covers the actual assembly of these components into the wings themselves.

You will need to download these articles from the EAA Archives to actually build the wings. This Companion Guide merely supplies additional background information and some helpful hints on the actual construction. A full Table of Contents is included on the next page.



There are two kinds of figure references in this Companion Guide. If the reference is "Figure 4-1" (with a hyphen), it's a figure in the original EAA articles. Figures without a hyphen are contained in this document and should closely follow the text which refers to them.

For specific assistance in building the components described, see the [Workmanship](#) and [Hardware](#) articles on the PB100 Web Page.

Many thanks to Matt Wise, Jim Katz, Jim Hann, and the others of the Fly Baby community for providing some great pictures to illustrate the points in this Guide.

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1 OVERVIEW

In Part 1 of the “Building Fly Baby” series, major components of the wings were constructed.

What was built, in fact...was a set of Fly Baby wing kits! At this stage, the components from part 1 will be assembled into a pair of wings. There are other bits that have to be made and attached, of course.

Figure 1 summarizes the process. The components built in Part 1 are assembled, then the additional items and structure are added to produce a completed wing.

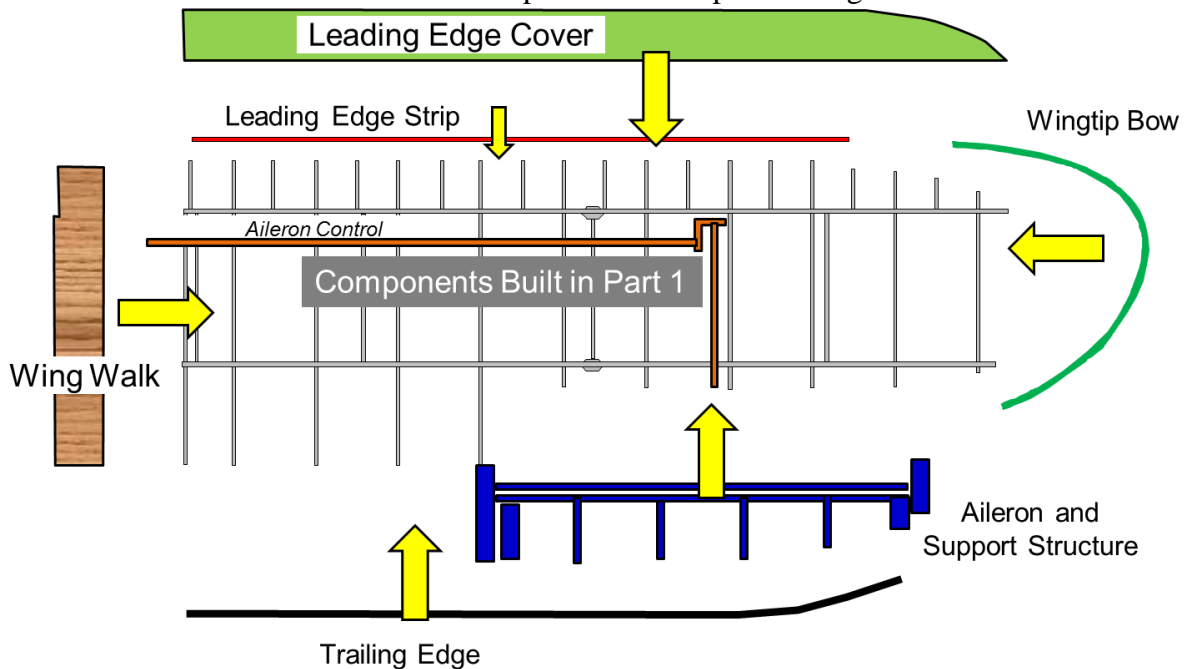


Figure 1: Fly Baby Wing Assembly

While the wing can be completed before the fuselage, for the best fit, certain finishing tasks should be left until the fuselage is available.

1.1 Workmanship

This is the first major construction activity that involves assembly of major components. This would be a good time to review the [Basic Workmanship](#) rules for building Fly Babies. Key notes:

- Do not varnish any areas which will subsequently be glued
- Varnish any closed areas (under the leading edge cover, inside the aileron support boxes) before they are completely closed up.
- Drill holes in wood directly to size, using a brad-point drill bit
- Varnish all bolt holes
- Varnish all areas where metal parts will be in contact with the wood
- All metal components should be painted or otherwise protected.

2 ERRATA

Please note the errata previously described in the first Companion guide.

2.1 Figure 4-27

Well...at least it was corrected prior to printing the articles in the magazine.

When Pete's draftsman drew the view of the aileron bellcrank, they had the bellcrank turned the wrong way. Rather than re-draw the whole diagram, Pete just added a prominent note about the error. Figure 2 shows the drawing corrected.

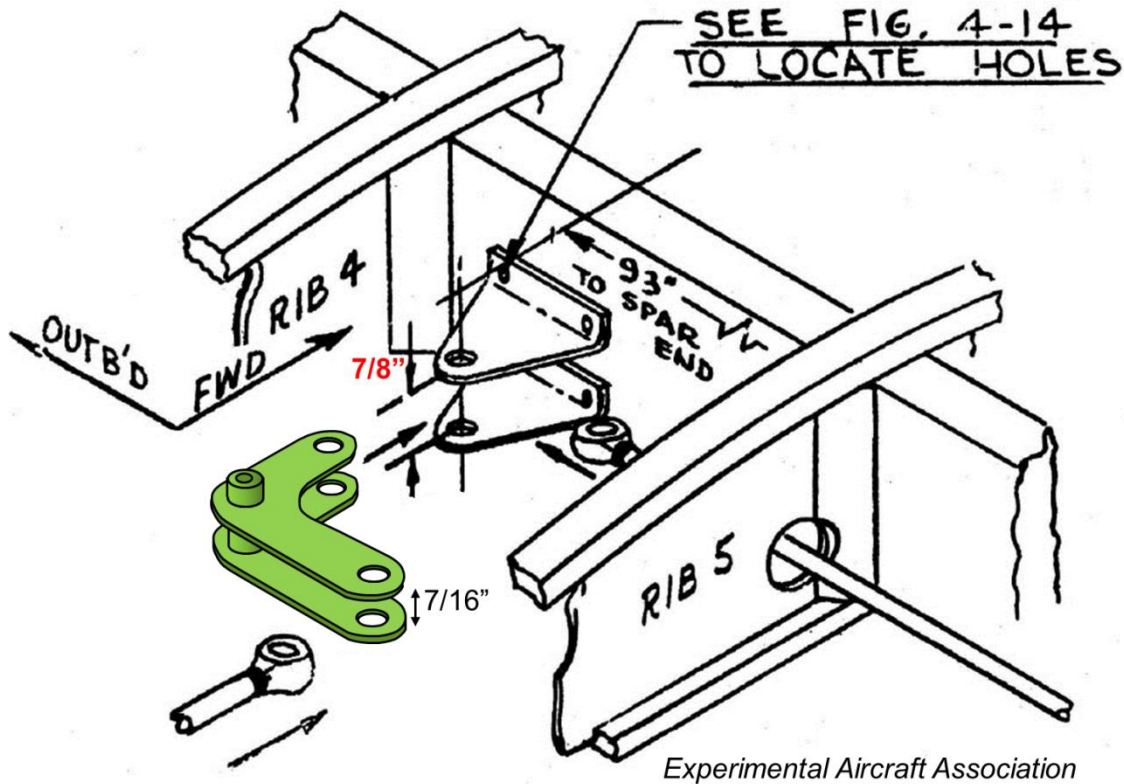


Figure 2: Figure 4-27 Corrected

Note, also, the dimension in red labeled $7/8''$ in the figure. Pete shows $7/16''$ here, which is the separation of the plates in the bellcrank, NOT the gap in the mounting plates bolted to the spar.

This wouldn't have been a problem, since Pete specifies the bolt pattern for the brackets in Figure 4-14. But this might take care of some confusion....

2.2 Figure 4-28

Pete made two changes to Figure 4-28 in the plans. The distance from the aft face of the front spar to the center of the pivot hole for the aileron swing arm is now one inch, rather than $1\frac{1}{2}$ inches. And as the figure below illustrates, he now wants the short bit of tubing welded to the BOTTOM of the aileron pushrod, not to the top.

place, bending the outboard ends to follow the decreased depth toward the tip. Add spacers at rib and aileron horn backup block per Fig. 4-30, then varnish entire

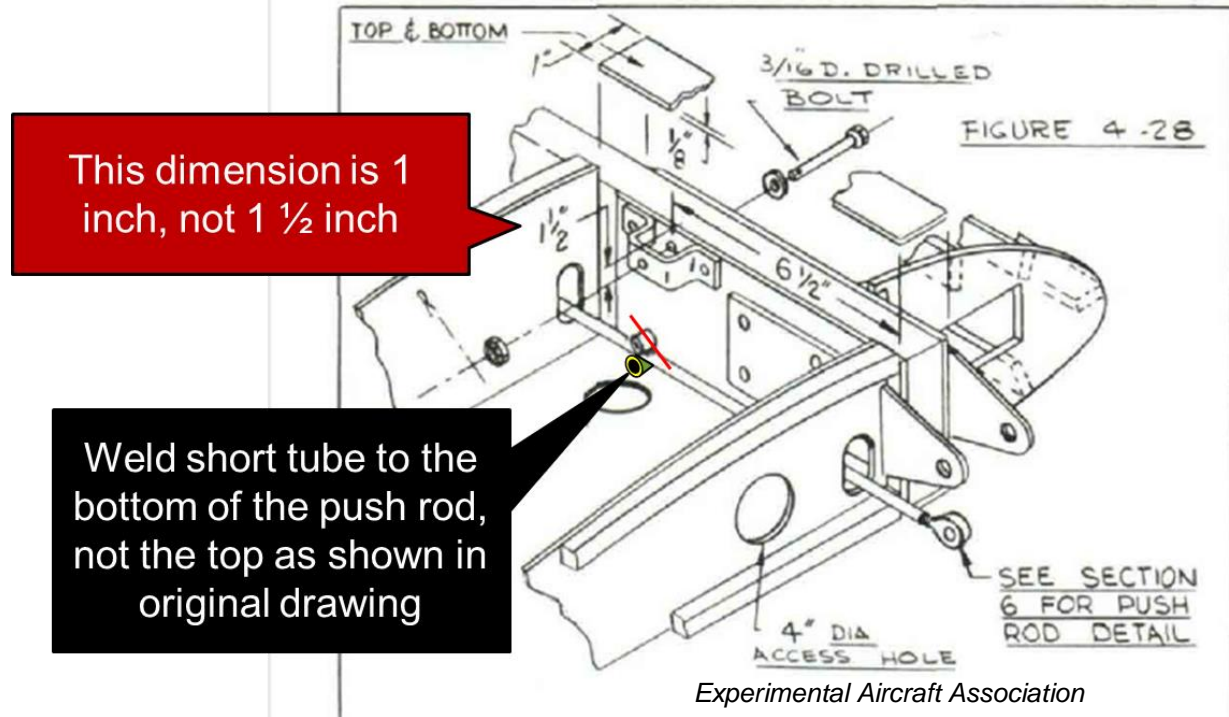


Figure 3: Aileron Linkage Changes in Figure 4-28

Figure 4 provides a side view of the aileron linkages, which hopefully will be a bit clearer.

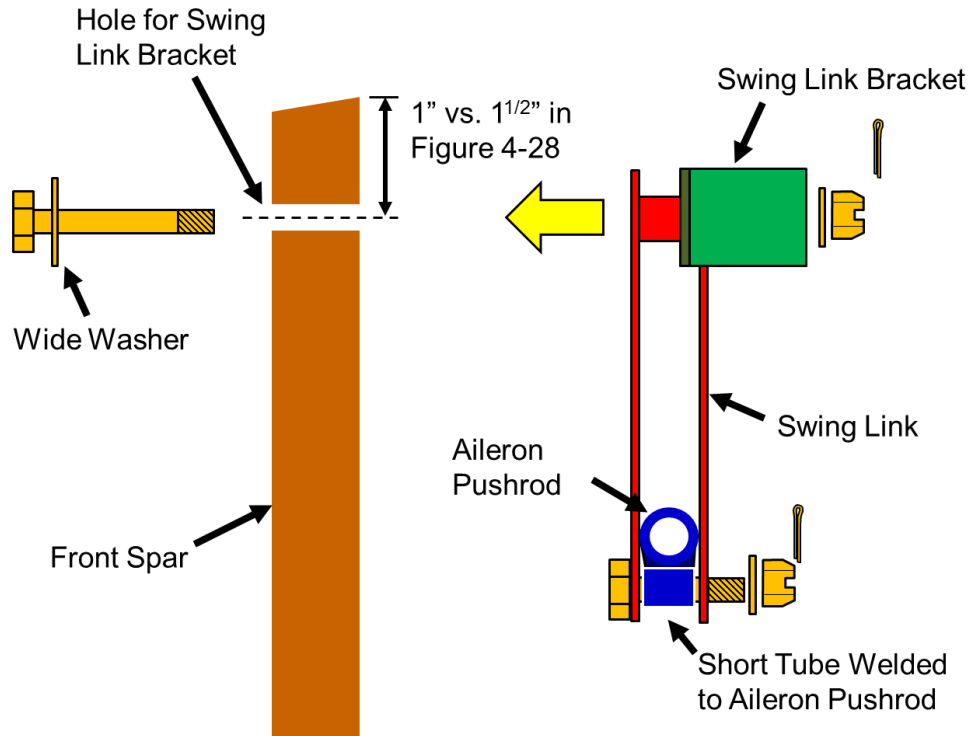


Figure 4: Figure 4-28 Clarified

One point several builders have made is that the position of the swing link assembly required shimming to allow the aileron pushrod to run without scraping against the holes in the ribs. In this case, you'd install the shims between the bracket and the spar. The shims would be pieces of plywood the size of the bracket with three holes drilled in them to match the holes in the spar. Figure 5 shows an example.



Figure 5: Shim for Aileron Link

2.3 Aileron Bellcrank

This is actually corrected on the diagram itself, but: For Figure 4-27 on Page 8, see the note near the aileron bellcrank that says “This arm should point inboard.”

2.4 Aileron Pushrod Holes in Ribs

Oddly, Pete doesn't mention these in either the EAA articles or the plans themselves. But as can be seen in Figure 3 above, the aileron pushrod is installed aft of the front spar, and ribs 5 through 11 need to have holes to pass the pushrod through.

Without an “Official” dimension from Pete, I'm hesitant to specify location or sizes of these holes. However, we know the Compression Rib centers are two inches above the bottom of the spars (that would be two inches above the bottom CAPSTRIP on the ribs, or $2\frac{1}{8}$ " above the rib web itself).

Figure 6 shows the approximate area of the pushrod holes in the ribs. As Figure 4-28 (recreated in Figure 3 above) depicts, though, the holes in the nearest ribs to the wing root might need more height. This is due to the fact that the pushrod actually will rise and fall slightly as the stick is moved left and right.

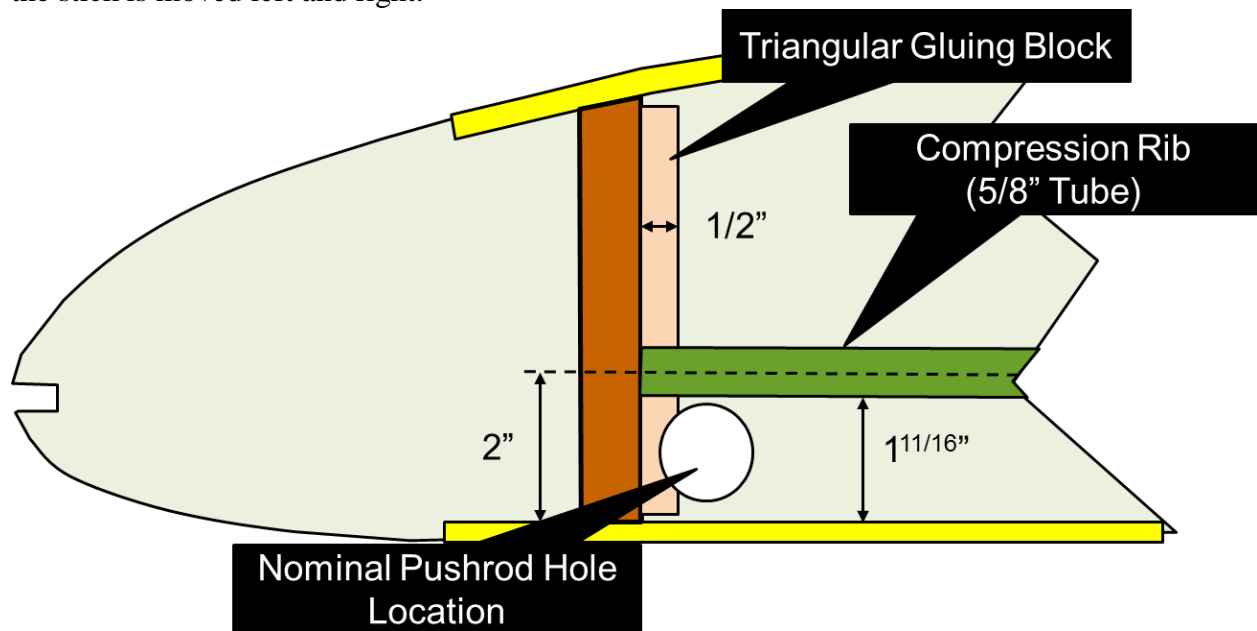


Figure 6: Hole For Pushrod in Ribs 5-11 (Nominal)

Figure 6 shows the hole actually crossing into the area of the triangular gluing block at the intersection of the rib and the spar. This is a reflection of the way the hole is depicted in Figure 4-27 on Page 8 of article two. The Figure shows the corner block slightly carved away by the aileron pushrod hole in Rib 5.

Figure 7 shows how Matt Wise implemented the holes in his ribs.

It'd be easiest to cut these holes while the ribs were being constructed, but I wouldn't blame folks for waiting until the ribs were actually on the wing. Considering how close the hole is to the front spar, though, a fairly flat-topped hand drill will be needed.

On the PLUS side, these holes are not critical to the strength of the rib.

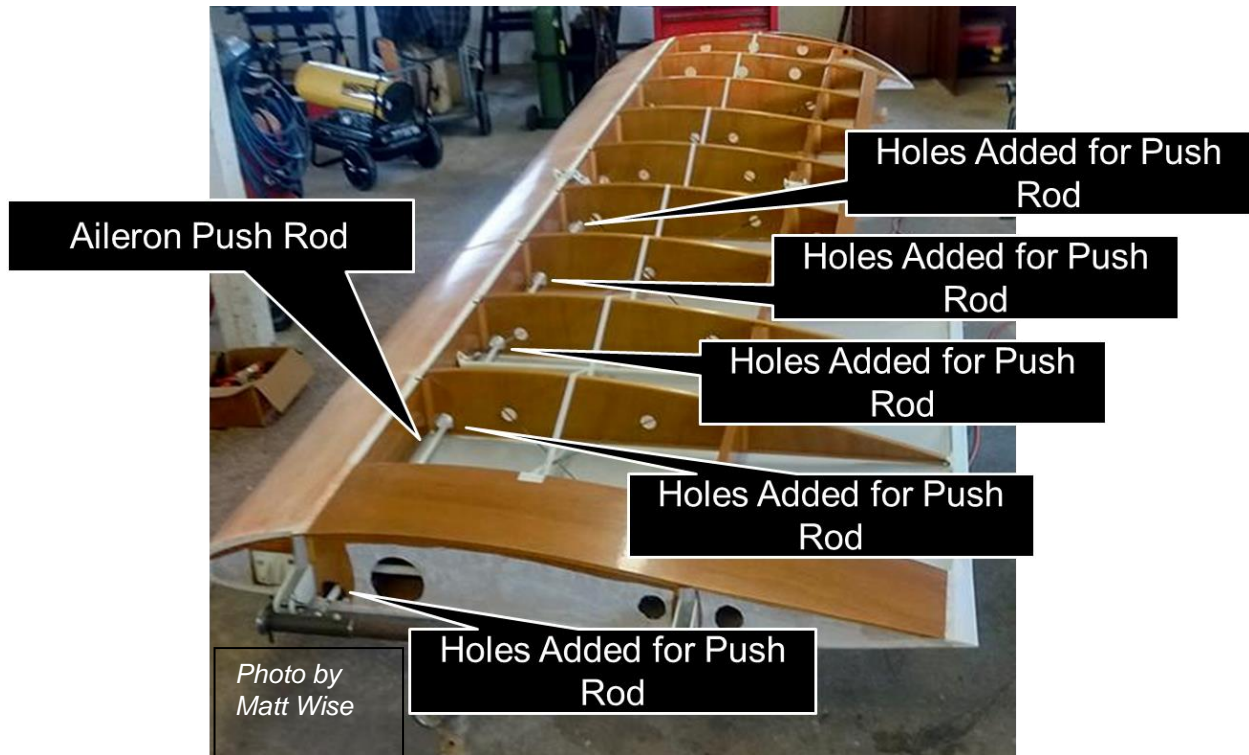


Figure 7: Wing Structure Showing Holes for Aileron Pushrods

2.5 Spar Root Fittings

This was included in the Guide for Article 1, but let’s repeat it, here: The two plates bolted to the butt of the spars for attaching the wing to the fuselage are illustrated in Figure 4-3 on page 23. However, Pete changed the dimensions of these plates. The actual dimensions are shown in Article 11, “Corrections,” dated January 1964. Basically, it’s a finer taper...the plates start tapering right at the last bolt hole rather than waiting until the plate is clear of the spar butt.

NOTHING NEW to build this month—just some corrections to make. I apologize for getting behind, but a “hot” project at my place of employment, plus the need to make a couple of mockups to find out about some errors in the drawings and work up fixes hasn’t left any time for finishing succeeding installments. All of the drawings are now finished, but the typing is still to be done.

Experimental Aircraft Association

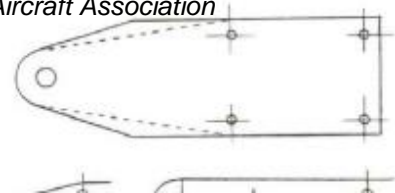


Figure 8: Revised Wing-Root Fitting (From Sport Aviation, January 1964)

The same diagram shows some other shapes of the spar fitting. Ignore those; they’re for correcting Fuselage problems that we’ll address in Part 3.

3 SAFETY ISSUES

Relevant safety issues were addressed in the Guide for the first article. Since the internal brace wires are being installed at this state, the issue regarding the wire size is repeated here.

3.1 Internal Bracing Wire Size

In 1982, EAA of Canada released a [safety bulletin](#) recommending that the internal bracing cables of the Fly Baby be upgraded to 5/32." Their analysis showed some of the internal bracing, at extreme corners of the flight envelope, might exceed the 2000 lb cable/1600 pound turnbuckle ratings of the standard bracing system:

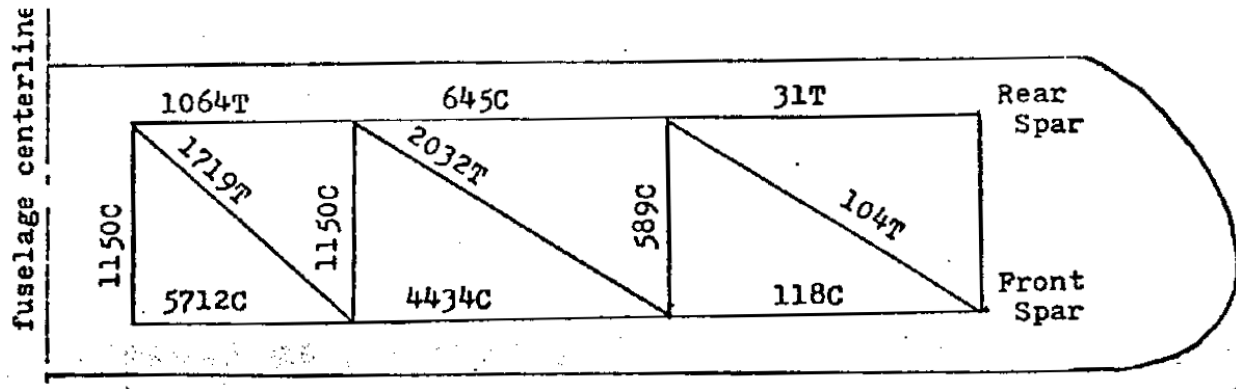


Figure 9: EAA Canada Loading Diagram

There is some controversy over this, with some believing that the methodology used to determine this loading was flawed. In any case, there has not yet been any accidents or known incidents relating to the internal cable bracing size. In addition, the original Fly Baby flew for ~20 years with SMALLER bracing cables...3/32" inch.

However, the cost for this upgrade is pretty minor. You'll need the next-size larger turnbuckle (rated as 2200 pounds), but they don't cost that much more.

4 CONSTRUCTION DETAILS

Before starting, read the [Errata](#) section and the [Alternate Approaches](#).

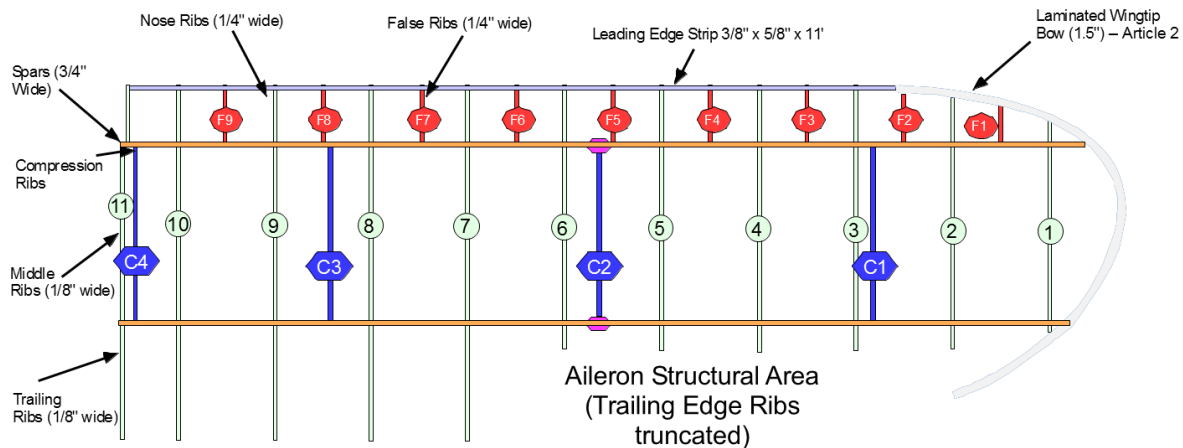


Figure 10: Wing Components in Article 1

4.1 Drilling the Spar

First step will be to drill the holes in the spar to accommodate the compression struts, aileron hardware, and the spar plates on the roots.

The wing spars are drilled before the wing-wire anchor pads are glued into place, for reasons that will become apparent.

Note that these are, practically, the most important holes you'll drill. You've done a lot of work to get your very expensive spars to this point, so you want to drill the holes both in the proper location as well as being exactly perpendicular

This means using a drill press. There are guides available for hand drills, but small drill presses are pretty cheap.

The drill press has an adjustable table to bring the work in close proximity to the drill bit before starting. This table can usually be adjusted to drill at an angle. Obviously, that's not wanted when drilling wing spars. So the adjustable table in the press must be checked to ensure it's in exactly perpendicular to the drill bit. Use a reference such as a combination square, and check to BOTH sides of the drill bit.

You'll notice that the table has a large hole in it. Obviously, it's to keep the user from drilling into the metal for every hole.

However, when a drill bit exits wood, it tends to chew up the fibers at the exit point. When drilling, put a piece of wood under the item in work. Having the "good" wood in contact with this sacrificial block will minimize the splintering.

The table height is adjustable. Prior to starting to drill, set the table so that the drill bit is just clear of the wood to be drilled. The drill press bit control is spring loaded; one rotates the handles to lower the bit, but it springs back up when released. The higher the bit is at the start, the more the handles have to be rotated before the drilling begins.

These points are illustrated in Figure 11.

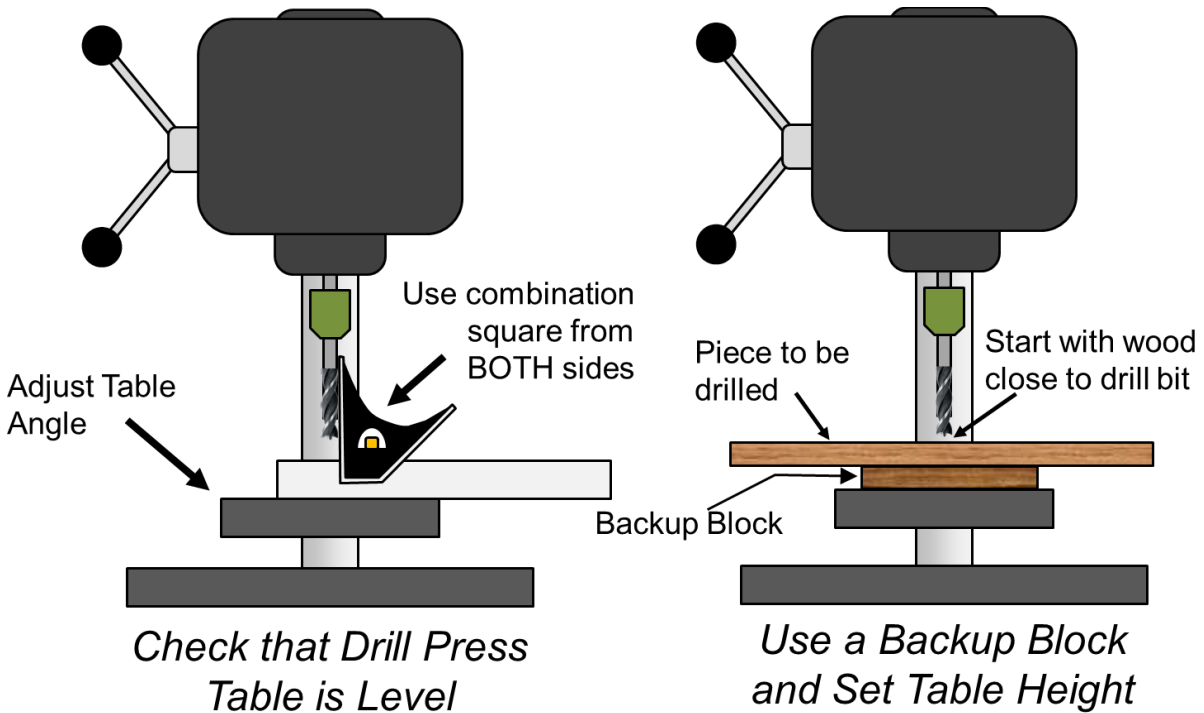


Figure 11: Drill press setup

While the table works for keeping most wood pieces in the proper attitude for drilling, the weight of long pieces can drag down so the piece isn't level. The long pieces have to be supported so they don't have a slant in them. Figure 12 shows the issue. The spar has to be held level during the drilling process. This could be done using supports, like the figure, or just get a helper. When you drill, make sure the spar is firmly level on the table and underlying block.

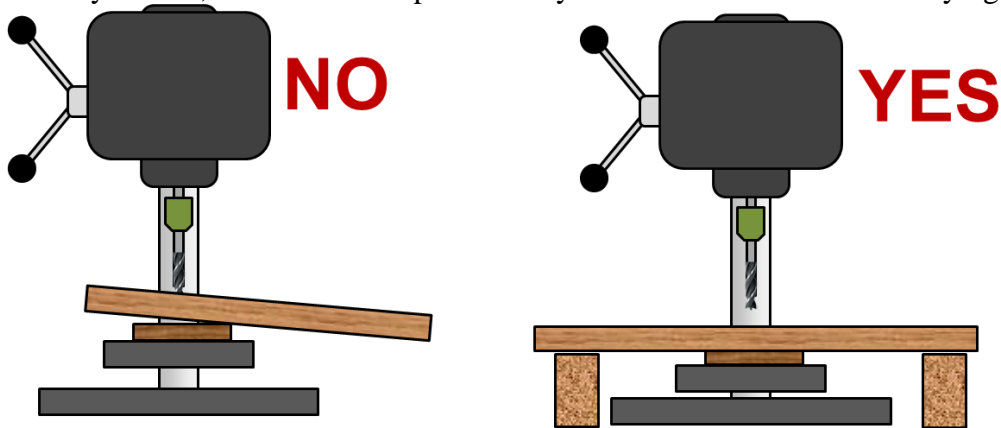


Figure 12: Wing spar support during drilling

4.1.1 Spar-Drilling Philosophy

The ultimate goal of drilling the spars is to be able to assemble the Compression Ribs to the spar with a straight, strong structure resulting.

There are two basic philosophies, depending on how accurately the Compression Ribs were built.

4.1.1.1 DEFAULT DRILLING PHILOSOPHY

In Article Two, Pete says to drill the holes with the front and rear spars clamped together. This assumes the builder has confidence in the accuracy of the Compression Rib construction.

The key thing with this process is to exactly align the front and rear spars prior to drilling. The bottom surfaces of the spars must be exactly aligned, as well as the butts of the spar (the ends that attach to the fuselage). Clamp them together, check that they're aligned, check them again, and drill the first hole. Push a spare bolt through the hole to help keep the alignment, then drill a second hole. Insert a bolt, etc, and repeat until all the holes are drilled. Figure 13 illustrates this process.

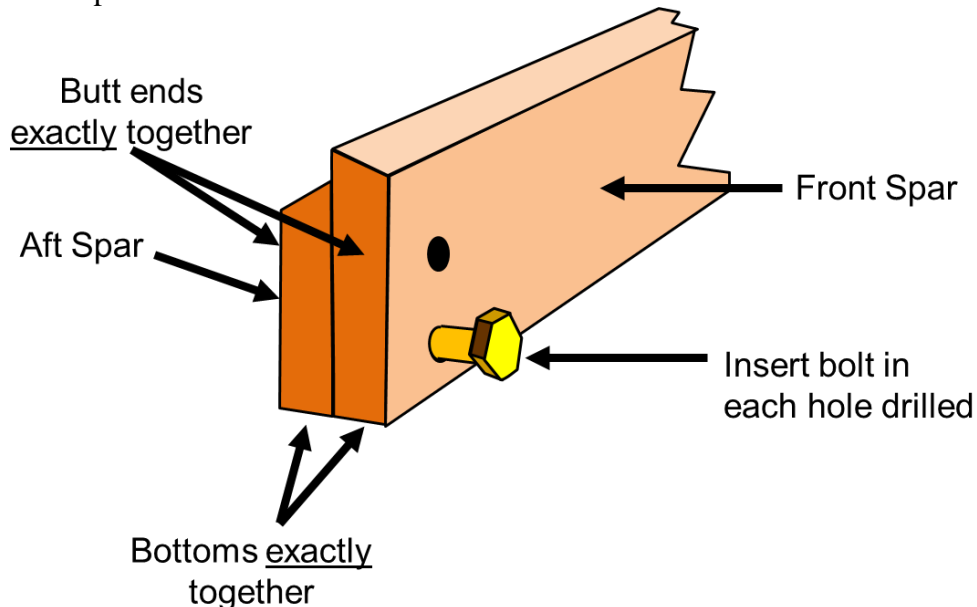


Figure 13: Drilling Spar Holes at the Same Time

The other way is to drill the front spar first, then lay it against the rear spar (carefully aligning it, etc.) and use it as a pattern to drill the aft spar. Again, drop a bolt in each hole as it's drilled to help maintain the alignment.

It should be noted that not all holes are drilled in both the front and aft spars. The front spar gets a few extra to install the aileron linkages.

4.1.1.2 ALTERNATE METHOD(S)

The above process works great if the bolt holes in the flanges on the end of the Compression Ribs are precisely drilled, either by hand or by a water jet/plasma/etc. process when they were cut out.

If you have some questions on how accurate the holes are, then drilling the holes with the two spars held together is not the best way to assemble the wing. Consider the sequence illustrated in Figure 14: Drill the holes in the front spars first, for all the Compression Ribs. Drill the holes for the spar plates at the root of the spar (the two rear holes in the spar plate are shared by Compression Rib C4). Then bolt the spar plates and Compression Rib C4 to the end of the front spar (over a temporary set 1/8" plywood reinforcements, as shown by the inset diagram on Figure 14).

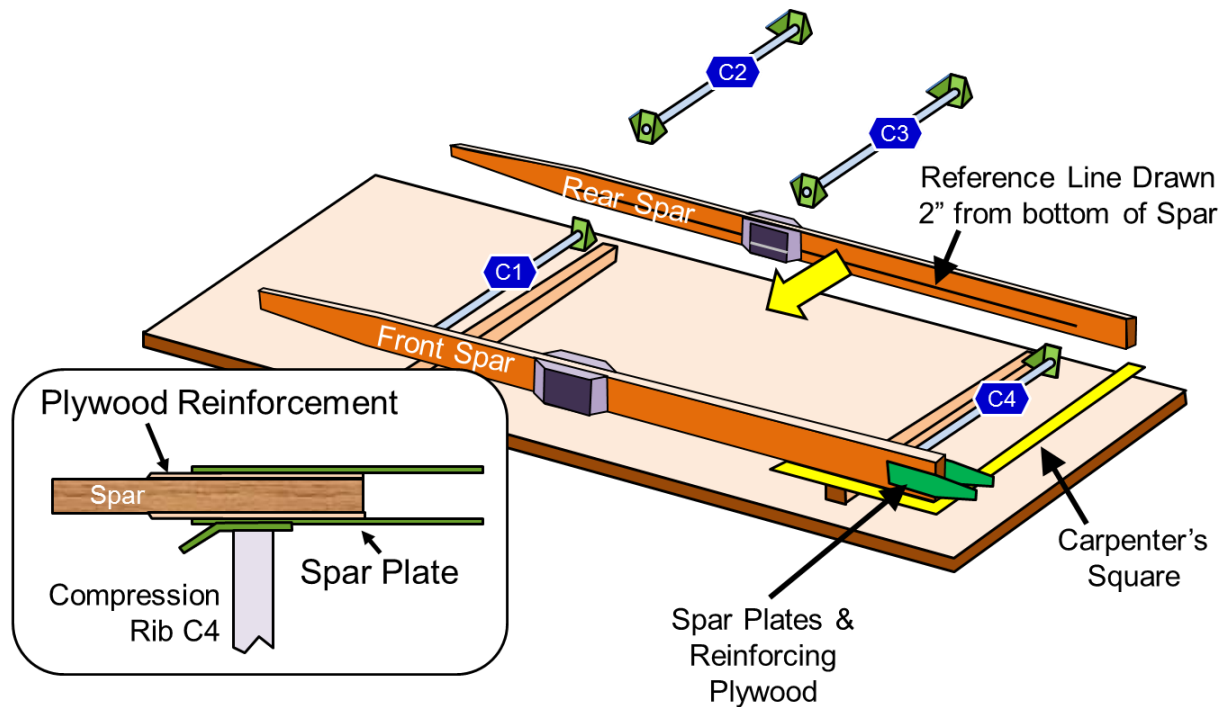


Figure 14: Alternate Spar-Drilling Sequence

Bring the rear spar into position. Use a carpenter's square to make sure the ends of the two spars are exactly even. Then use the bolt holes in the aft flange of Compression Rib C4 to mark the bolt holes on the aft spar. The center of the Compression Rib should fall on the reference line drawn two inches from the bottom of the spar, as described in Companion Guide #1.

Drill the bolt holes for aft Compression Rib flange, and bolt the rib to the spar.

Measure the distance between the spars at the root. It should be 26.25 inches between the spars themselves (not in the area of the spar plates or 1/8" reinforcing plywood). If it's less, no problem: you can add small shims of plywood under the Compression Rib flanges when things are permanently bolted. If it's too wide, you might try sanding down reinforcing plywood.

How much is too short...or too wide? It's a tough call. Fly Babies aren't precision machines, so I think a sixteenth of an inch one way or the other is probably tolerable. If the dimension is off, though, remember that when you're building the fuselage. The spar plates have to correspond with Bulkheads 3 and 5 in the fuselage, and the wrong dimensions at the wing root might call for some adjustment in the fuselage.

With Compression Rib C4 in place, install C1 to the front spar near the tip, hold it up to the rear spar with the Rib aligned with that 2" reference, then mark the holes for Compression Rib flange to bolt to the rear spar. Bolt C1 into place, then repeat for C2 and C3.

4.1.2 Sets of Holes to Drill

Let's go, step by step, through the holes needed for the spars.

4.1.2.1 HOLES TO DRILL NEAR WING ROOT

The holes that must be made in the wing root area are defined in two locations: Figure 4-6, in the Part 1 Article, and Figure 4-17 on page 7 in the Part 2 Article.

The holes for the spar plates are shown in Figure 4-6. These plates are used to attach the wings to the fuselage. The holes also are used to bolt Compression Rib 4 to the spars. These are 1/4" holes, to match the AN4 bolts used to hold the spar plates to the spar.

The holes in Figure 4-17 are used to support the aileron swing link, and **are only needed on the front spar**. They're also shown in Figure 4-28 on page 9. They're drilled to 3/16"

4.1.2.2 COMPRESSION RIBS C1-C3

If you followed the process in the first Companion Guide, you marked a 2" line above the bottom of both the front and aft spars. This marks the centerline for the Compression Ribs.

Oddly enough, Pete doesn't provide a discrete table showing the distance of the compression ribs from the root. However, one can use Figure 4-1 (the overall wing diagram in Article 1) to derive the spacing:

Compression Rib	Distance from Root (as measured on the bottom of the spar)	Distance of centerline from the bottom of the spar
C4	2.25" (Figure 4-6) – Part of the Spar Plates at the root	2"
C3	32.25" (#4 + 2'6")	2"
C2	74.25" (#3 + 3'6")	2"
C1	116.25" (#2 + 3'6")	2"

Compression ribs C1-C3 have the same basic footprint, with the about 1.75" apart (7/8" above, and 7/8" below the guide line that's 2 inches above the bottom of the spar). Compression Rib C4 (the one nearest the wing root) has a different spacing, to match the holes in the spar plates.

Both sets of holes for the Compression Ribs should be drilled to 1/4", to fit an AN4 bolt.

Compression Rib 2 is actually installed into the wing-wire anchor pads. Don't worry about that right now...it'll be clear in a bit.

Note that after the Compression Ribs are installed, the spars should be 26.25 inches apart. If your Compression Ribs are slightly undersized, use thin plywood shims to set the gap.

4.1.2.3 AILERON BELLCRANK MOUNT HOLES

Figure 4-15 shows another set of four holes between the outboard Compression Ribs, about 93 inches from the root. These are for mounting the aileron bellcranks, and should be drilled to 3/16" (AN3 bolt size).

4.1.2.4 BUSHINGS FOR THE SPAR HOLES?

If a component is expected to be removed during normal maintenance, and will be bolted to a wooden structure, it's better if the hole is drilled slightly oversize and a bushing installed. This will ensure that the bolts will not get locked into the wood by corrosion or wood swelling.

However, so far, none of these bolts should have to be removed during maintenance short of a major rebuild or repair.

4.1.3 Installing the Wing Anchor Pads

Before installing the Wing Wire Anchor Pads, make sure that you've got the right combination of pad thickness and Compression Rib length. If the Anchor Pads are 5/8" thick (per plans), Compression Rib #2 should be 25 inches long (from the OUTSIDE of the mounting plates. The spars are designed to be 26.25 inches apart... 25 inches, plus the twice 5/8" added by the two inside Anchor Pads. See Figure 15.

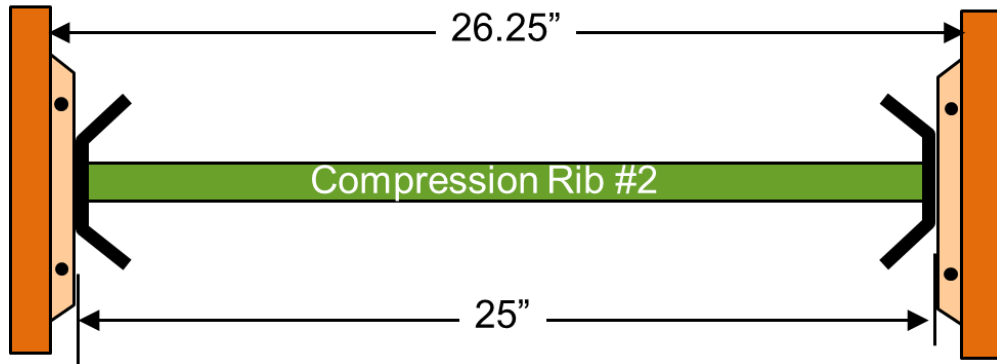


Figure 15: Compression Rib #2 Measurement

Before you glue your Anchor Pads in place, **check this measurement!** If you used thicker or thinner pads, make sure the Compression Rib was re-sized to ensure the 26.25" inside distance between the spars.

Assuming everything is OK, Figure 16 show the process for attaching the Anchor Pads. After drilling all the holes in the spar, position one of the pads so that the Compression Rib bolts go right through the center (between the vertical bolts). Glue the pad into place. Give the glue a day or so to cure properly, then, using the existing spar holes, drill through the pad.

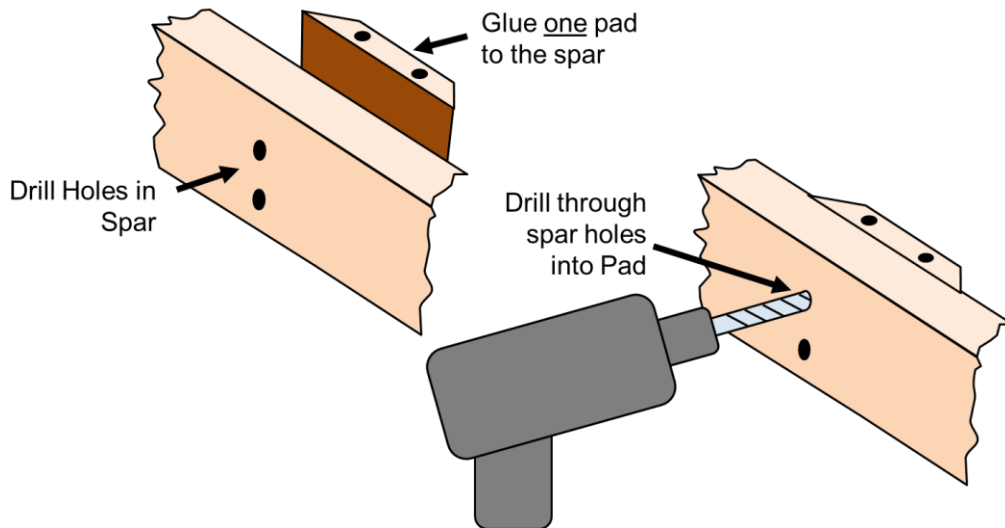


Figure 16: Attaching the Wire Anchor Pads

After the first side's pad is in place, figure out the position of the pad on the opposite side of the spar. If you're using the traditional wing bracing system (with the flat plates on top and bottom of the wing), consider using the plates to establish the exact position of the second pad (Figure 17). Otherwise, count on drilling the wing plates to match the final hole locations.

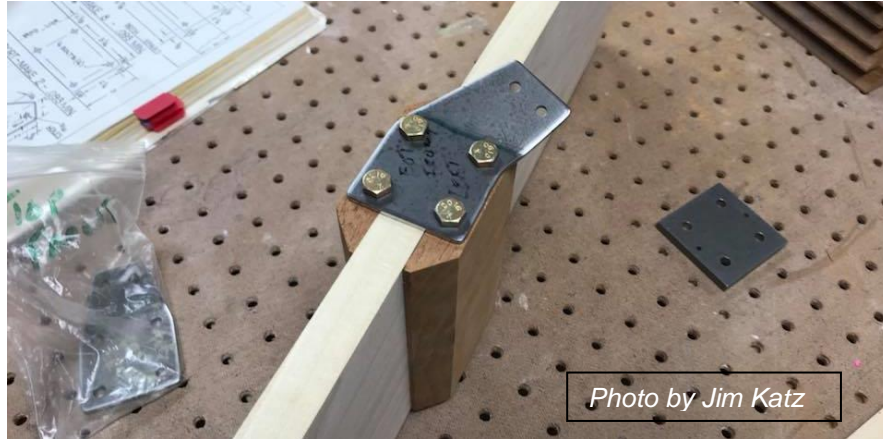


Figure 17: Using Wing Plates to Establish Location of Anchor Pad

Note to users of the alternate wing brace system: While the alternate system (described in Guide #1) does not use the vertical bolts of the stock system, the design still requires the same sort of pads to provide the appropriate standoff. The pads should be the height of the face of the spar to which they'll be glued, and sufficiently wide to support the straps of the alternate system. The actual width is not critical, but the edges should be beveled on the sides like the stock anchor pads. See Figure 18.

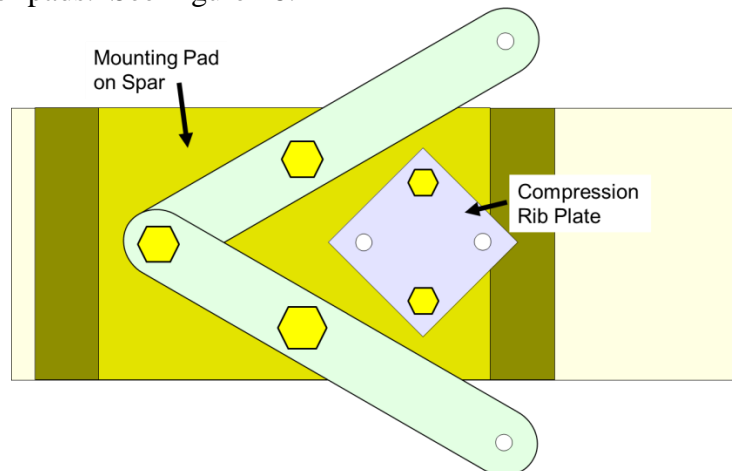


Figure 18: Mounting Pad for Alternate Wing-Brace System

4.2 Wing Assembly

With the holes drilled and the anchor pads in place, the wing is ready for assembly.

4.2.1 Protection

All the fabricated steel parts should be painted or otherwise coated for corrosion protection. As part of this protection, the spars should also be varnished wherever steel parts are going to be bolted to them.

However, apply the varnish only in areas which will not be glued. Basically, you need to varnish inside all the holes drilled in the spar, as well as the areas around the holes that will be covered by metal fittings such as the Compression Ribs or Spar Plates. These areas are highlighted by the red boxes in Figure 19.

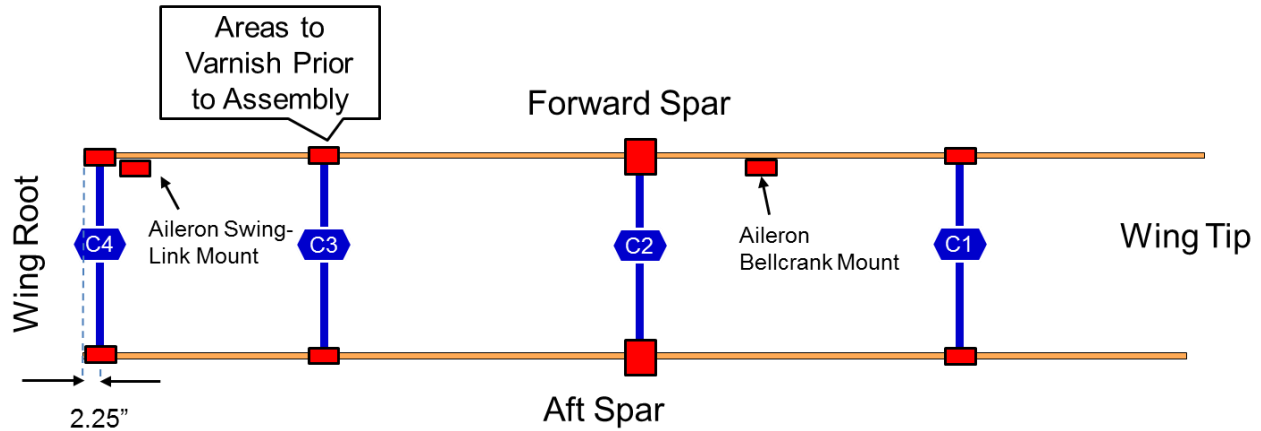


Figure 19: Varnish Spar Areas Prior to Assembly

However, be cautious around the root areas of the spars. If you look at Figure 4-16, you'll see that the spar plates come very close to the bottoms of the spars, and close to the top of the aft spar as well. A root rib will need to be installed in this location. Prior to varnishing in this area, apply some blue painter's tape to the areas above and below the plate locations at the very ends of the spars. It's not a major issue if small areas are unvarnished under the metal plates (after all, they'll be painted) but try to ensure that bare wood is available to glue the root rib.

Figure 20 illustrates this pre-varnishing process. Note the darkened areas under the bolt heads/washers on the forward spar, and under the Compression Rib end on the aft spar.



Figure 20: Example of Pre-Assembly Spar Varnish

This photo is of the alternate wing-bracing system. The additional holes in the anchor pads will be varnished prior to the steel plates' installation.

4.2.2 Wooden Ribs

OK, time to start putting things together. Pete recommends starting by setting the spars atop a couple of sawhorses, and illustrates this in Figure 4-15 on the top left of Page 7 of Article 2.

Why sawhorses, when you've got a perfectly good work table? Because the lower capstrips of the ribs actually go below the spars, so the spars can't just sit on a table. However, you could certainly put small board under the spars to lift them off the surface enough to clear the capstrips on the ribs (Figure 21).

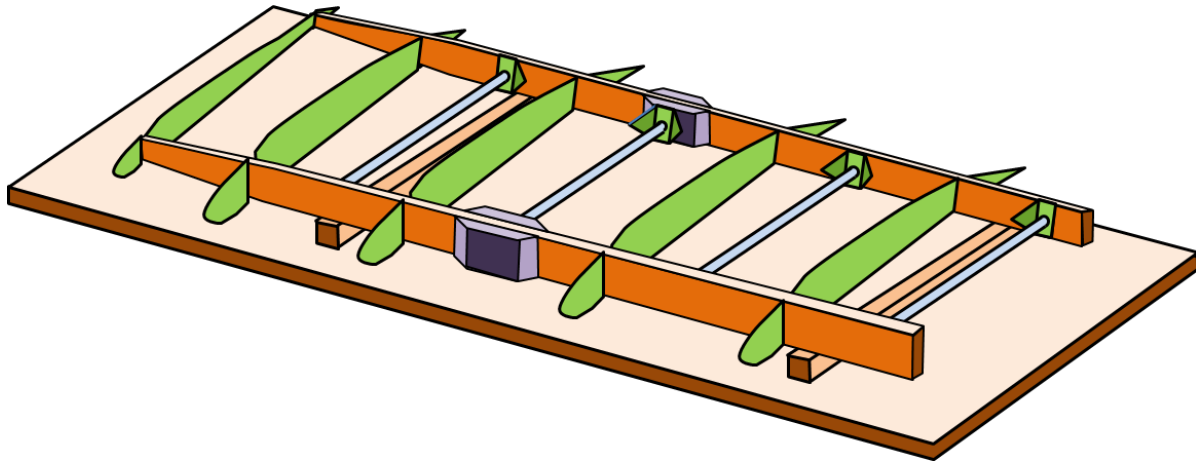


Figure 21: Wing Assembly on a Work Table

Slide the wooden ribs onto the spars, roughly positioning them at the locations marked during the process described in the first Guide article. Don't install Rib 11 (the root rib) for now.

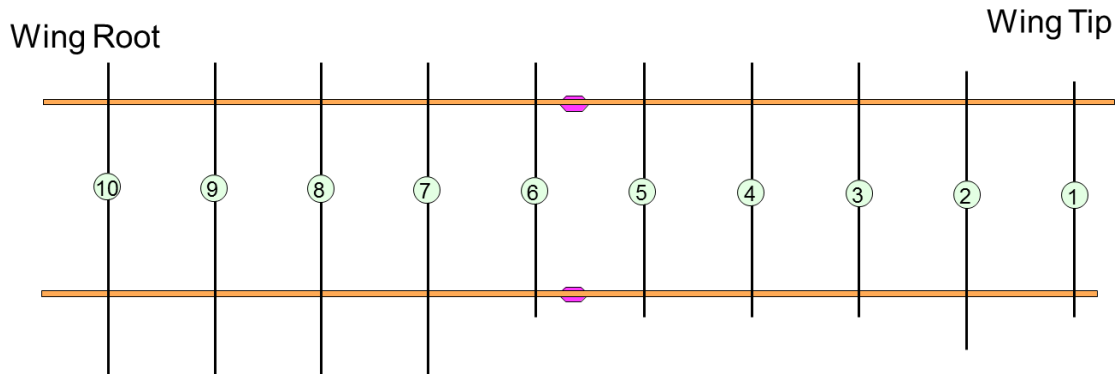


Figure 22: Wooden Rib Positions

4.2.3 Spar Plate Backing

The root end of the spars also receive some reinforcement in the form of 1/8" thin plywood. This can be seen on the top of Figure 4-16.

Pete calls this "reinforcement," but the main purpose is to match the thickness of the fuselage bulkhead that the spar plates attach to. The bulkhead has a core thickness of 3/4", and has two 1/8" facings applied. So our 3/4" spars also need some 1/8" plywood installed here. If 3 mm plywood is being used, it will still match the thickness of the bulkhead.

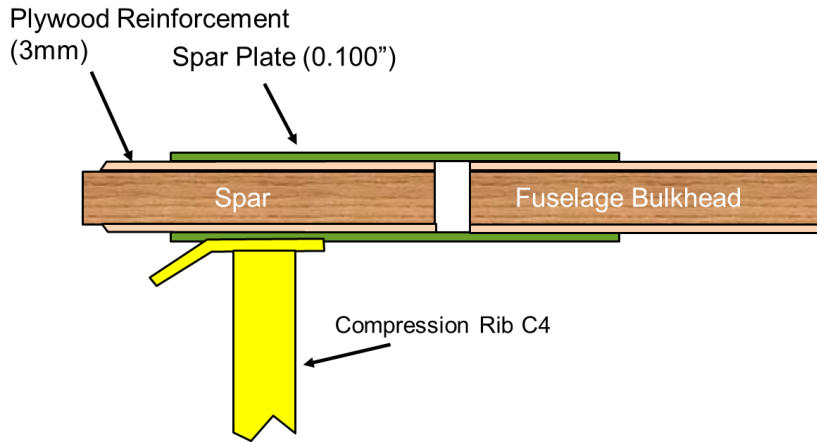


Figure 23: Spar Roots

Pete calls for these to be glued on separately and drilled in place like the wire anchor pads. I don't think it's really necessary. Cut each piece to fit in its spot, clamp it temporarily in place, and drill through the hole in the spar to make the hole in the plywood. You could even use the metal spar plates as a template. If the spar holes don't quite match, just enlarge the hole in the 1/8" plywood.

As shown in Figure 23, bevel the edge of the plywood on the opposite side of the wing root.

4.2.4 Compression Ribs

Now comes the fun part: Install the Compression Ribs. Set them in their proper places, and bolt them down with AN3-12A (3/16) bolts. Anywhere the bolt head or nut will be against the wood, use a wide washer (AN970) instead of the normal sized-one. This will minimize crushing the wood when the bolt is tightened. The Compression Rib at the wing root (C4) takes a 1/4" bolt (AN4).

Standard aviation practice is to put the head of the bolt up, or forward, as appropriate. When the head of the bolt is against steel (such as the aft fittings of the Compression Ribs) it is not necessary to put a washer under it.

The process is summarized in Figure 24. In addition, you may want to read the "[Nuts and Bolts](#)" guide on the PB100 web page.

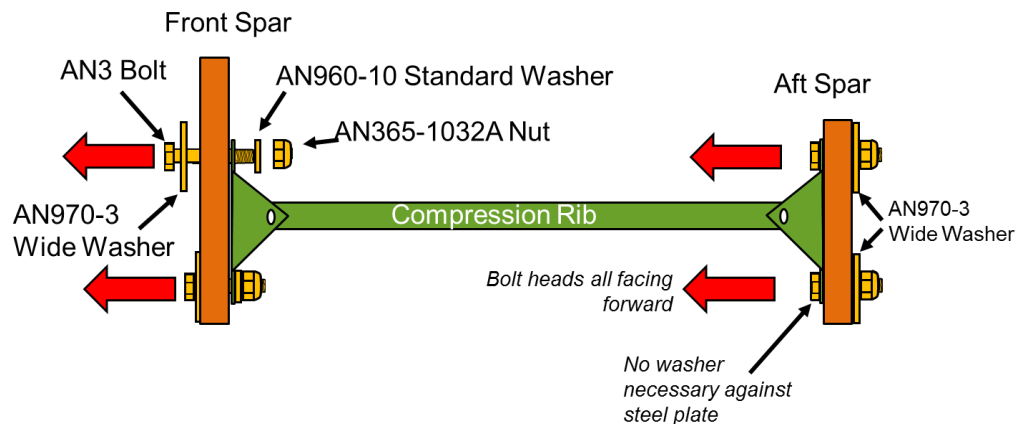


Figure 24: Compression Rib Installation (C1, C2, and C3)

Note that Compression Rib C4, the one at the wing root, is a bit different. This bolts over the spar plates, at the pair of holes closest to the wing root. It also uses 1/4" bolts (AN4) because that's what's used on the spar plates. See Figure 4-17 on page 7 of Article 2.

4.2.5 Cutting Bracing Wire Pass-Throughs in the Ribs

The diagonal bracing wires between the Compression Ribs will need to pass through the ribs, hence holes need to be cut in the ribs to allow this.

There are two ways to do it. Pete has you pin the ribs temporarily in place (using nails through the capstrips into the spars), then laying a straightedge between the compression struts and marking where the cable will need to pass through each rib (Figure 25). Then use a 1" hole cutter to make a hole 2.25" above the bottom of the ribs at the location.

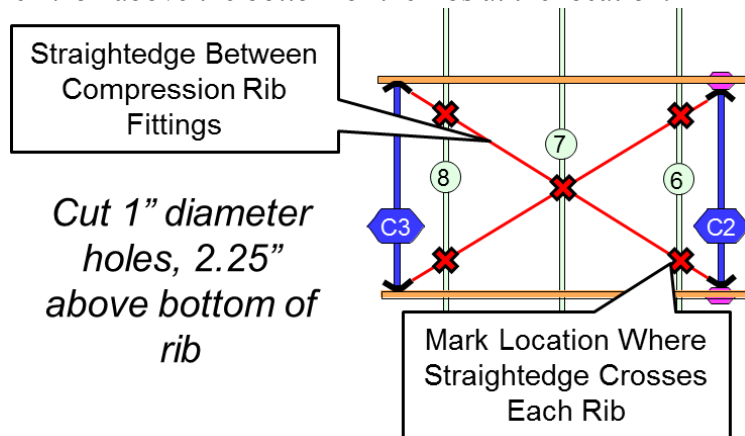


Figure 25: Marking Internal Bracing Wire Pass-Throughs on Ribs

Alternatively, Marco Pinto used a CAD system to determine where the holes should be in each rib. Just [download his instructions](#).

Being a belt-and-suspenders sort of guy, I'd combine these processes. I'd mark the locations that Marco computes, then throw the straightedge between the Compression Ribs and see how they correlate.

If you have to alter or widen a hole because it's a bit off, it's no big deal.

4.3 Bracing the Wing

At this point, the Compression Ribs are installed, the wooden ribs are loose but in place. The wing kit is ready to be turned into a braced, solid structure by adding the diagonal bracing wires diagonally between the Compression Ribs.

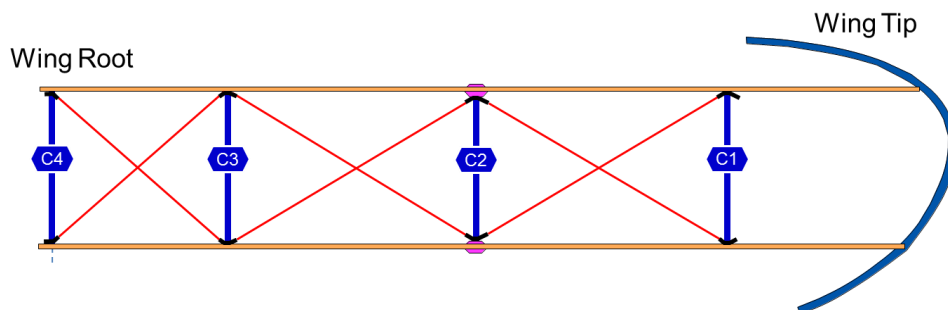


Figure 26: Diagonal Bracing Wires

Before starting, refresh your knowledge of aircraft cable in the [Nuts and Bolts](#) article.

4.3.1 Adding the Brace Wires

If you've read the article, you may have noticed a discrepancy in my description. In Article #2, Pete tells the reader to form 1/8" cable loops around half of the Compression Rib tangs prior to installation of the ribs. The cables are made ~6 inches too long, to permit each cable to be eventually be attached to the opposing tang via a turnbuckle, as shown in Figure 27.

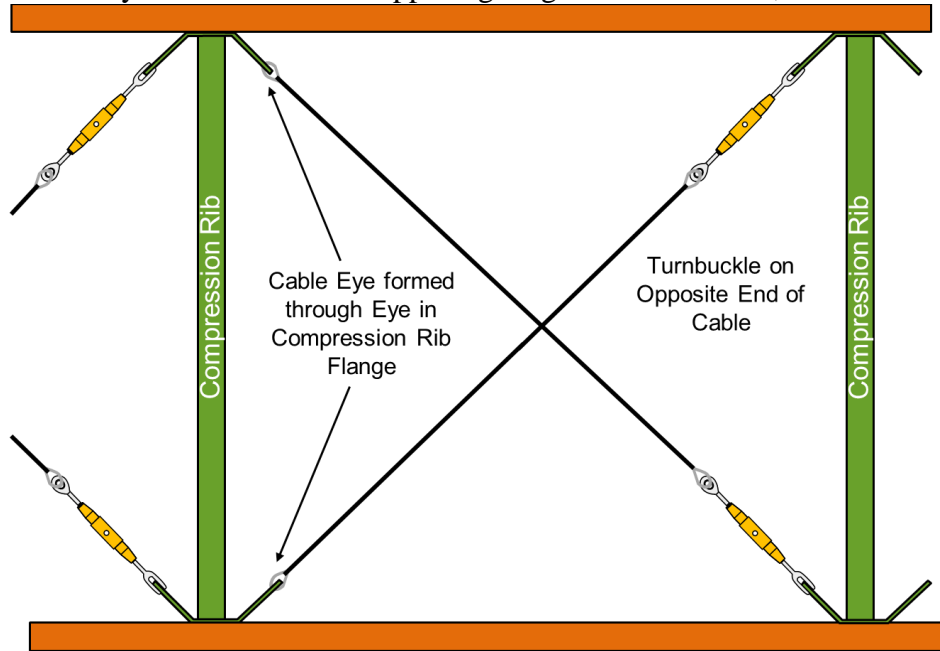


Figure 27: Typical Bracing Implementation

Nothing really wrong with that approach. Unless, at some point in the future, you have to replace one of the bracing cables. You'll be stuck trying to cut the cable INSIDE the wing, through a little dinky 3" inspection hole.

Or, for that matter, unless you make a mistake in the original installation. It'll be much easier to cut the cable and the thimble at this point, but it still will be fairly awkward.

Instead, why not include an AN115 cable shackle? Not only will this make replacement of the cable easier in the future, but it's generally better structurally (Figure 28).

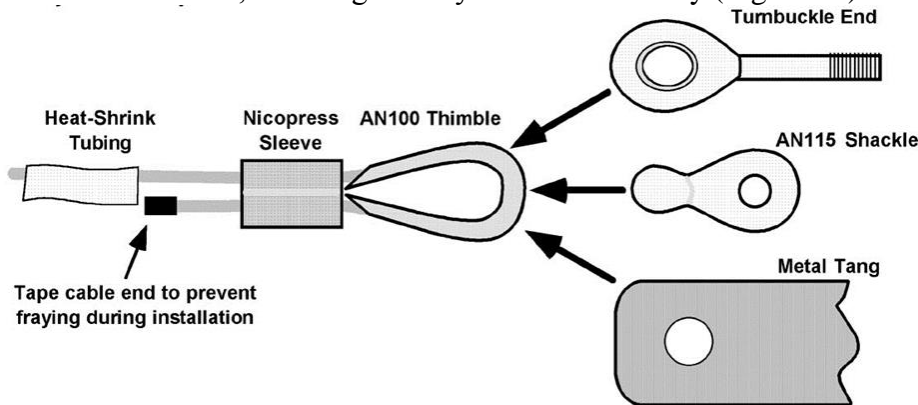


Figure 28: Attaching Cables to Fitting

With all the Compression Ribs installed, add the diagonal bracing cable. Each cable must have a turnbuckle at one end. Set the turnbuckle so that four threads are showing when the cable is in place. This should leave you plenty of leeway for tightening.

4.3.2 Trammelling

Next step is to tighten the turnbuckles on the internal braces in a way that doesn't distort the wing shape. This process is usually referred to as "trammeling."

Mark a reference point on the top of the spars aligned with the center line of the Compression Ribs. These are your Trammel Marks. Then use a Carpenter's Square across the ends of the spars, and make sure they're aligned. This setup is shown in Figure 29. The figure also includes an arbitrary designation for each rectangle enclosed by the two spars and a pair of Compression Ribs... "Bay 1", "Bay 2", and "Bay 3."

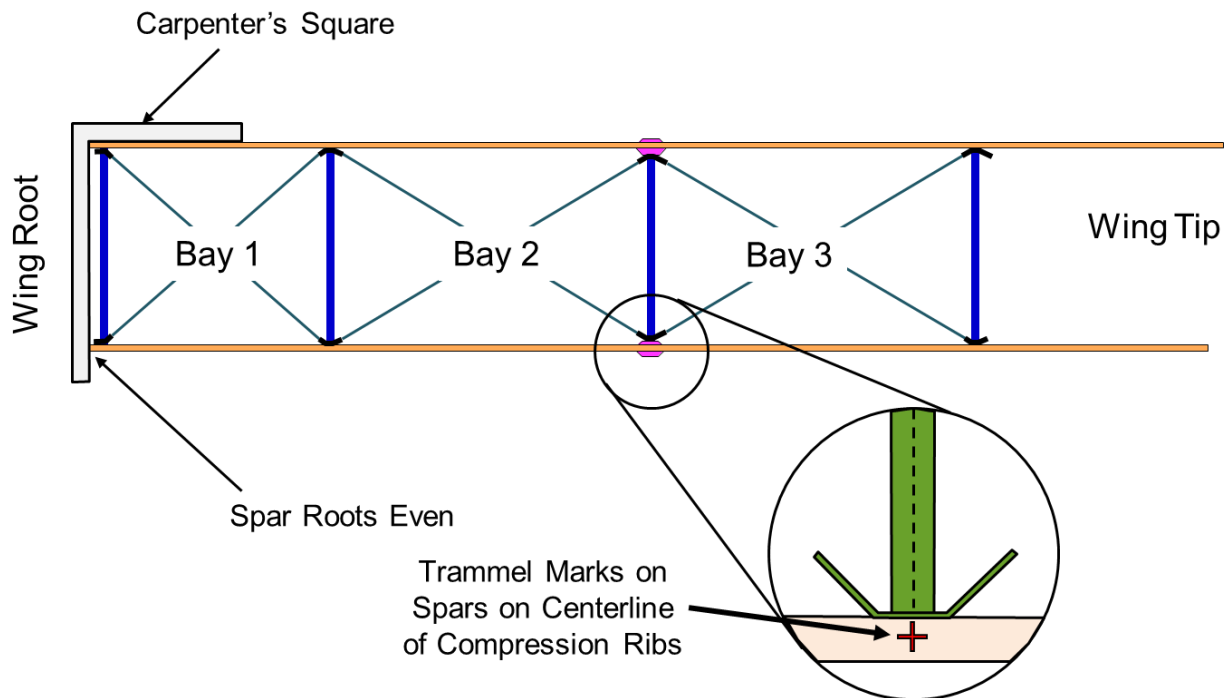


Figure 29: Preparing for Trammelling

We'll designate the Trammel Marks as to whether they're on the Front or Rear spar ("F" or "R") and number them by which Compression Rib they're associated with. Figure 30 illustrates these definitions

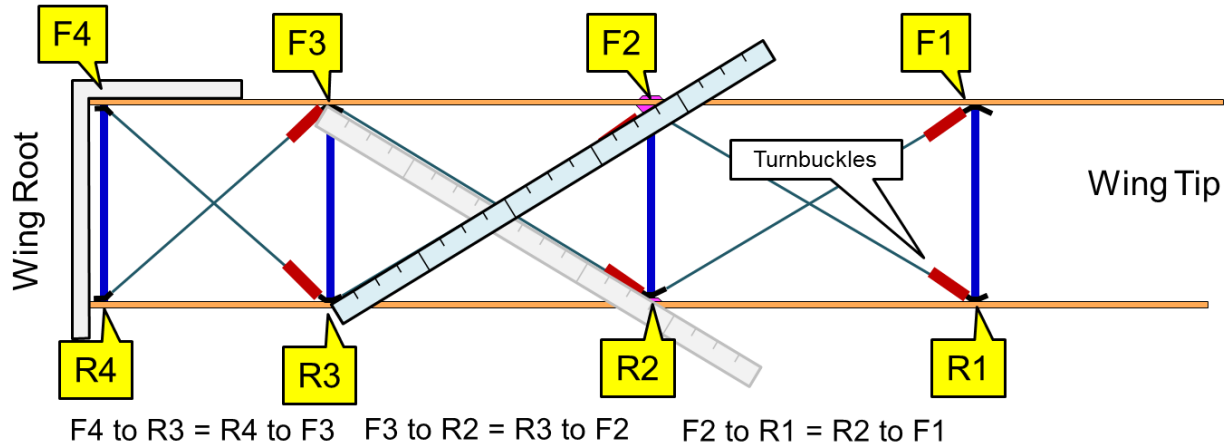


Figure 30: Trammeling Points

Tighten the turnbuckles as far as you can get with your fingers. Then start measuring the diagonal distances in each Bay of the wing, and adjust the turnbuckles in that Bay until the measurements are the same. For instance, “F4” to “R3” should be the same as between “R4” and “F3”. If it isn’t, adjust the tensions of the two turnbuckles until the distances are the same.

It will probably be impossible to get ALL the sets of dimensions to be equal. Do as good as you can.

The main thing is that the root end of the two wing spars be even.

4.4 Gluing the Wooden Ribs

At this stage, it’s time to glue wooden ribs 2 through 10 into place. Slide each rib slightly out of its position, put some glue on the spars where the rib goes, then slide it back. Glue triangular corner blocks on both sides of the ribs, and use nails or staples to hold them in place until the glue cures. Note that the corner blocks are not necessary for “normal” nose ribs. They’re pinned in place by the cap strips on the top and bottom.

If you are using non-beveled spars, you’ll need to glue little wooden wedges to fit under the cap strips atop the spar to close the gap (Figure 31).

Glue Cap Strips to Spar

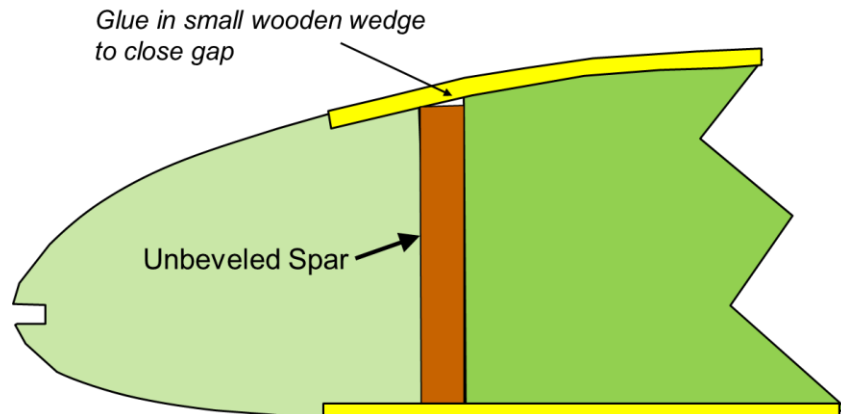
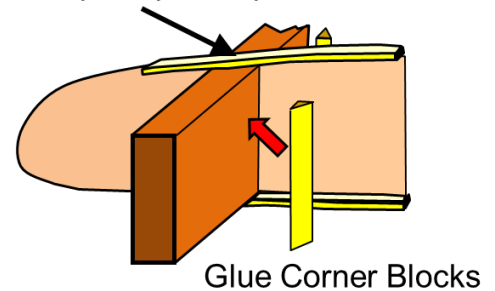


Figure 31: Fill Gap is Non-Beveled Spars are Used

Don't glue Rib 1 (the one closest to the wingtip) yet. This one may need to be adjusted to match the wingtip bow and the aileron box structure.

4.4.1 Rib 10

Remember, Rib 10 on the left and right wings are actually different. Make sure you have the correct one. The thin strips on the top and bottom face AWAY from the wing root, as shown in Figure 32.

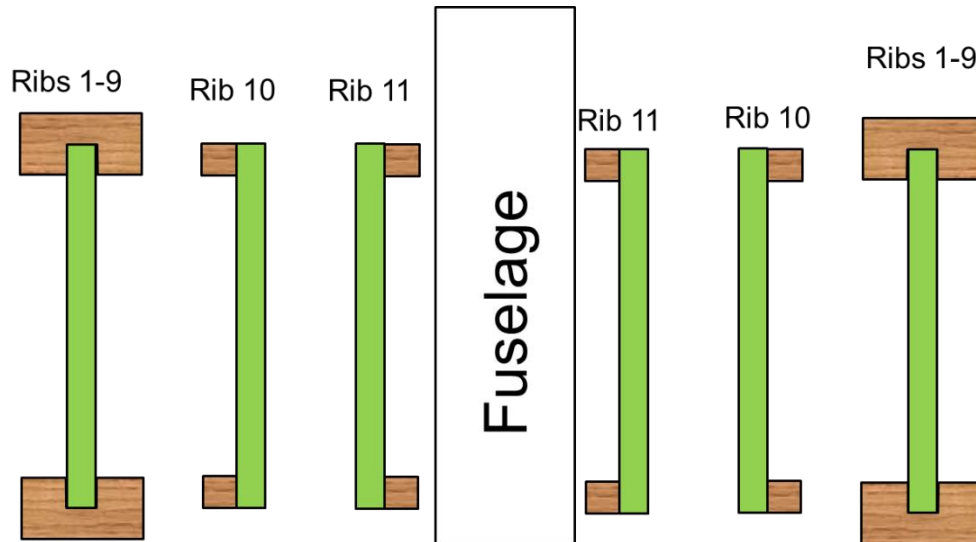


Figure 32: Cross-Section View of Wing Ribs

In Article 1, I recommended not attaching the nose rib to Rib 10 prior to installation. Use corner blocks on the Rib 10 nose rib, and pin down and glue the thin strips from the middle section. At some point, you'll need to add thin plywood to the top of the wing in this area to bring the level to match the other nose ribs.

4.4.2 Rib 11

Rib 11 is the ultimate "weird rib" on a Fly Baby. Like Rib 10, there are left- and right-side Rib 11s. See Figure 32.

If you followed my suggestions in Companion Guide #1, you hadn't assembled the two Rib 11s. Figures 4-28 and 4-29 on page 9 of Article 2 (and Figure 61 in this document) show why...the nose rib is actually offset into the wing slightly, to leave room for some of the wing-fold hardware. The nose rib for Rib 11 is actually clamped between the wing-fold support structure bolted to the wing root and the brackets for the rod that does into the fuselage. Pete does show a notched triangular corner block to help support this nose rib, as seen in Figure 4-29 in the Article.

You'll need to trim a bit away from the ends of the middle section due to the spar plates and plywood installed on the ends of the spars. In addition, cut some ~4" holes in the middle section of Rib 11 to allow access to the aileron linkages and spar plate bolts/nuts even after the wing-walk plywood is installed (Figure 33).



Figure 33: Access Holes Added to Rib 11

As discussed in the first Companion Guide, the trailing edge of Rib 11 is “reflexed” upward slightly. This wasn’t for aerodynamic purposes—it was just to get the root of the wing matching the lower longerons (Figure 34).

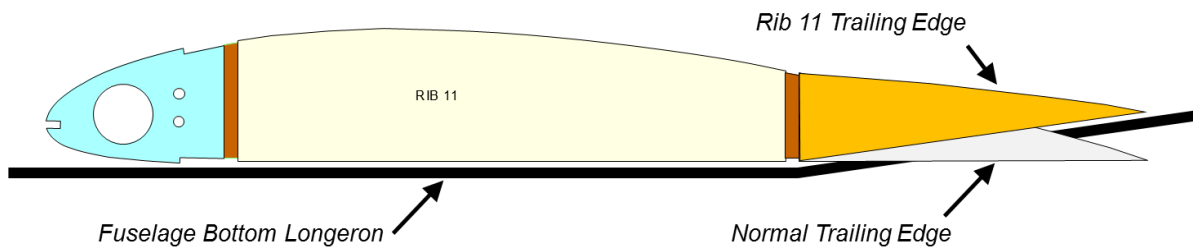


Figure 34: Rib 11 Trailing Edge

A pattern for this trailing edge is included in the [Trailing Edge Rib template package](#), but this is, basically, an estimate. Pete says this rib could be just a “normal” trailing edge installed upside down.

A more precise match to your lower fuselage could be accomplished by waiting to make this rib until you can perform a test fit with the fuselage. This is, in fact, what Pete suggests in the plans. If you go this route, though, you won’t be able to close up the wing-walk area or add the leading-edge covering until the fuselage is completed.

4.4.3 Installing False Nose Ribs

“False Nose Ribs” go ahead of the front spar to help support the leading edge against the pressure of the relative wind. The false nose ribs are held in place by triangular corner blocks.

Hold off on installing the “2F” false rib (See Figure 10). This will actually be modified as part of the wingtip bow lamination process.

4.4.4 Leading Edge Strip

The leading edge strip is a 3/8” x 5/8” piece of spruce, eleven feet long, that is installed in the “notches” on the front of the nose ribs. Figures 4-15 and 4-19 (both on Page 7 of article 2) show the strip. Note that it goes from the wing root to just slightly past false rib 2F.

4.5 Laminating the Wingtips

The graceful curve of the wingtips is one of my favorite features of the Fly Baby, reminiscent of the Spitfire and other classic airplanes. This is not achieved without some effort. The basic wingtip shape needs to be laminated in place, and then carved and sanded to fit.



Figure 35: Stock Fly Baby Wingtip Shape

The each wingtip lamination consists of twelve pieces of 1/8" thick, 2½" 10-foot long spruce or cedar.

Start by modifying Nose Rib 2 and 2F. They need to be cut back 1½" due to the eventual depth of the laminations.

That thin spruce or cedar is very flexible. The process uses the first strip like a drafter's flexible spline to define the wingtip shape. Five points of contact are defined: The tip of False Rib 2F, the tip of the regular nose rib for Rib 2, the front spar, the aft spar, the trailing edge of Rib 2, and a temporary extension of the trailing edge of Rib 4. This is shown in Figure 4-18 on page 7 of Article 2.

4.5.1 Laying the First Lamination

Clamp and explore the fit of the first lamination (Figure 36). It should be centered on each of the points of contact. When satisfied, glue it into place, using a nail or staple to hold it. Make sure the nail/staple is NOT sticking out, as it'll interfere with the subsequent laminations.

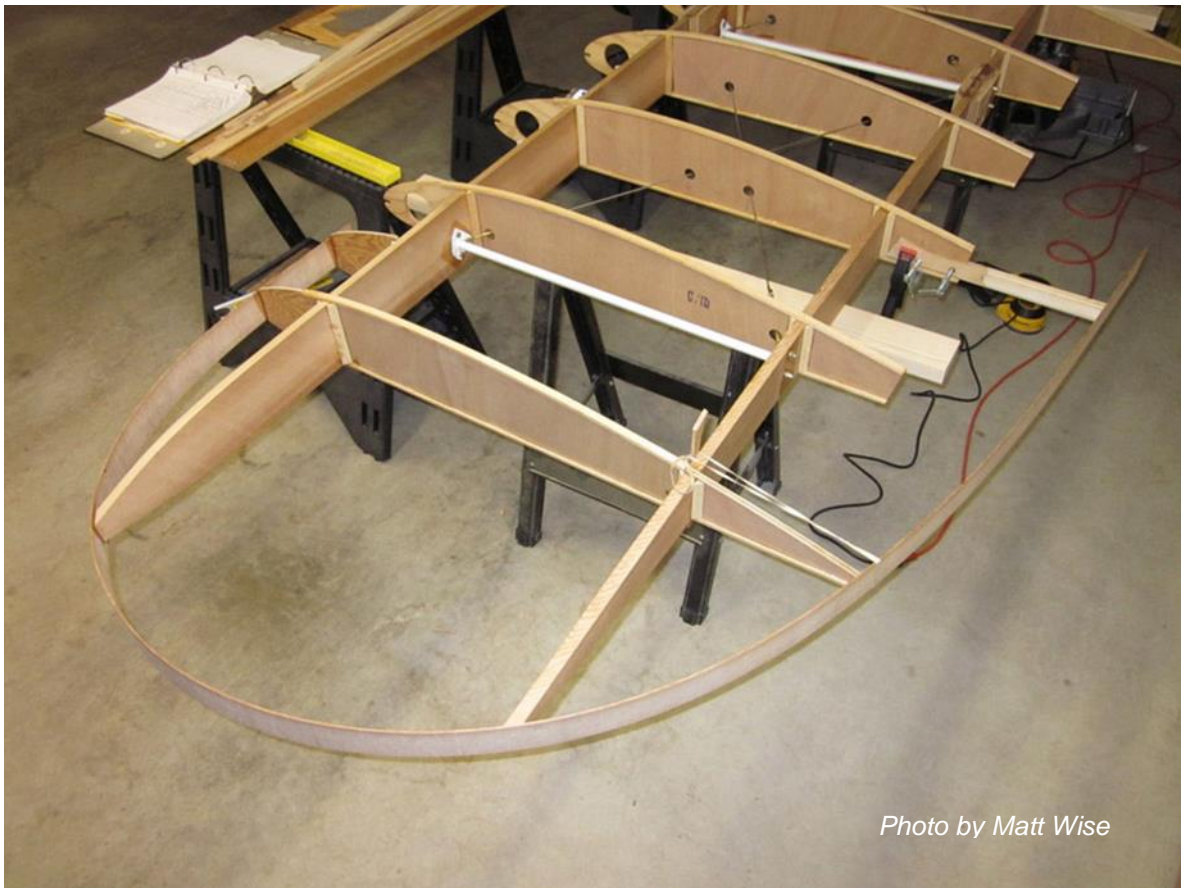


Photo by Matt Wise

Figure 36: First Lamination

Personally, I think I'd let the glue cure for that first lamination before continuing.

4.5.2 Laying Subsequent Laminations

It'd be great to assemble all twelve laminations at the same time. However, there are several contradictory issues.

First, it's important to clamp the laminations together for best strength. But it's hard to wrangle 12 separation laminations—covering them with glue, sticking them together, and clamping the whole shebang at once.

The second issue is your glue. If you're using modern epoxies, "Pot Life" becomes an issue. "Pot life" is the amount of time before the glue starts setting up. It's typically on the order of a half hour or so for epoxies. Obviously, if you're trying to glue all twelve laminations during the same session, the epoxy might end up curing in the mixing bowl before you're ready to use it.

Discussing this with the Fly Baby community revealed some surprising insight. At least two builders didn't use epoxy on the wingtip laminations. They used Titebond III. There's no mixing, and it had a bit longer Pot Life. It does require good clamping while it cured.

One builder laid up four laminations at a time, but another did them one at a time. They applied the Titebond with a 2-inch brush. They then applied lots of clamps and let the glue cure. Figure 37 is a rudder bow, not a wingtip, but does show the type of clamping that would be needed.



Photo by Jim Katz

Figure 37: Clamping Laminations

That's not to say you COULDN'T use epoxy for your laminations. When ready, lay the next lamination, with lots of glue and lots of clamps for temporarily holding it while the glue cures. Figure 38 isn't a Fly Baby, but does show how simple spring clips can be used with epoxy.

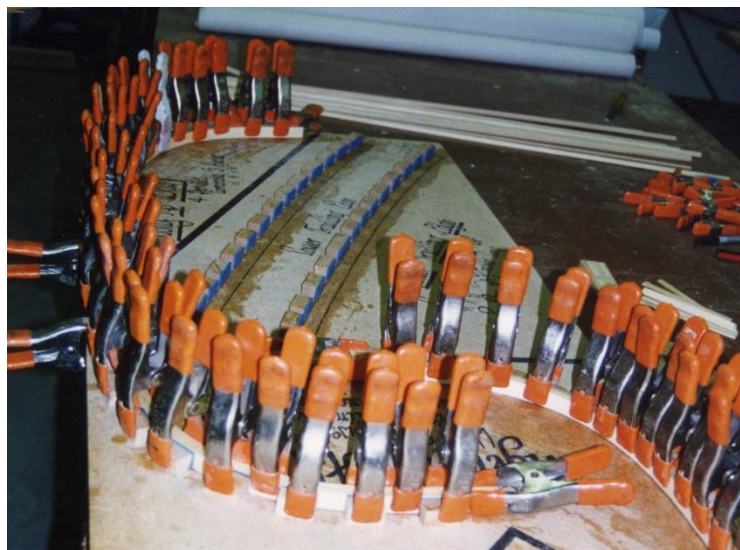


Figure 38: Spring Clips Holding Laminations

This may be overkill, as the bows in this case are being laid up without a form. But more clamps will almost always be better.

Obviously, if you laminate one piece or even four pieces at a time, that wingtip will spend a lot of time while the glue is curing. Consider holding off some tasks previously described (like gluing down ribs 3-10) and switching to them while the wingtip laminations cure.

Here's a close up of a lamination in process.



Figure 39: Close-Up of Lamination

While Figure 40 shows a wingtip in the middle of carving, it does illustrate what the completed wingtip lamination looks like.



Figure 40: All Laminations Applied

You'll notice that, at the leading edge, the 2½" high lamination results in a piece actually smaller than nose rib height. This is the reason for Pete's direction, "...scab on scraps to build

top and bottom up to depth of nose ribs, and scab extra thickness to a point 6 inches aft of front spar.” He could have specified wider laminate strips, but it’s not needed for most of the bow.

Figure 41 shows Matt Wise’s addition to the top of the lamination, as well as the carving in process. Note the “notches” in the laminations where they interface with the leading edge strip.



Photo by Matt Wise

Figure 41: “Scabbed-On” Wood

4.5.3 Carving the Wingtip

And now the work starts.

You’re basically going to match the nose rib’s leading edge shape in front, taper the sides to match the spar heights (see note below), and change it into a nice trailing edge shape in back. While you’re at it, you taper the wingtip to provide a smooth transition to the spars (as seen later in Figure 44) and to the aileron support boxes. Pete doesn’t provide any patterns—just do what looks right to you.

Figure 42 is a shot of my own airplane that illustrates the shaping of the wingtip. My wingtips are carved rather “pointy” on the sides. It’s not a big issue, but if you make them too sharp there might be issues later with the fabric covering.



Figure 42: Sample Wingtip Shaping

He leaves the tools to the builder... a wood plane, rasp, or spoke shave, and to that I'd add a draw knife. Plus the trusy old power sander, but be careful: it's much easier to make precision strokes with a draw knife than control a big 'ol belt sander. I'd count on using a pad-type sander to smooth things at the end.

And if you DO cut too much off, don't sweat it. "Scab on" another piece of wood to thicken the area back up, let the glue cure, and have at it again.

My own editorial comment: The trailing edge shouldn't be "pointy" too quick. Figure 43 is a good illustration. The lamination here has been cut off at Rib 2 to be used on the aileron trailing edge, but notice that the remaining lamination here is still pretty thick. To finish it off, you'll use the draw knife, rasps, spoke shave, or even (shudder) the power sander to round this off, but the heights are about what you should be shooting for. But you do want to round this off. Not only will it look better, but sharp edges will need a lot of pinking tape or they'll carve their way through the wing fabric.



Photo by Matt Wise

Figure 43: Trailing Edge Close-Up

Now, a note about matching spar heights. There's going to be a 1/8" thick piece of wood glued to the tops and the bottom of the spars to fill the area between the ribs. So the carve the laminations at the spar interface so they're 1/8" higher than the spar itself (Figure 44). You can see this in Figure 4-6 on Page 24 of Article 1.

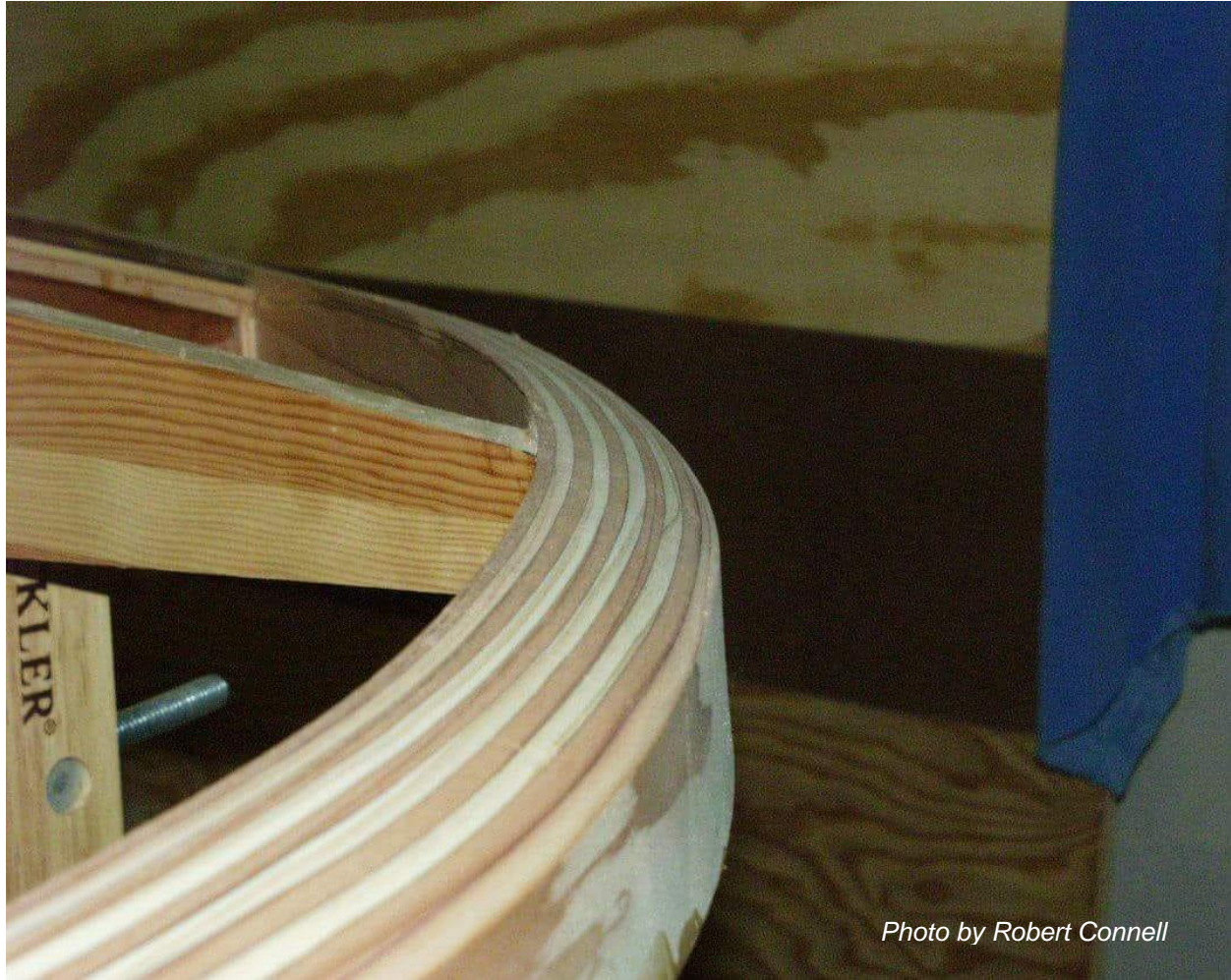


Photo by Robert Connell

Figure 44: Lamination is 1/8" Higher than the Spars

And if you don't, the world doesn't end. At this part of the wing, this is all non-structural. It has to stay together in the relative wind, but it's not supporting the weight of the aircraft. Add wood if it didn't match right, sand it down to a pleasant shape.

Even when we consider then as not being a structural element, those laminated wingtips are WAY strong. Rarely, in photos of crashed Fly Babies, are the wingtips damaged. Figure 45 is a good example. The airplane crashed into hangar on takeoff (the pilot survived), both wings are smashed away from the fuselage...and both wingtips appear largely intact.



Figure 45: Wingtips Intact After Hangar Crash

Once the glue on the wingtips has cured, you can permanently install Rib #1.

4.6 Aileron Support Structure

While it may not be obvious with a casual glance, the Fly Baby’s ailerons do NOT attach to the aft spar itself. There is actually a support structure (“Aileron Mounting Spar” is what Pete calls it) ~six inches aft of the spar that needs to be built (Figure 46). Two “False Ribs” are added, a nearly vertical bulkhead is installed at the ends of the angled ribs three through six, and the structure is “boxed” to make it good and stiff. It’s mostly 1/8” plywood, except for some rectangular pieces of spruce to define the shape.

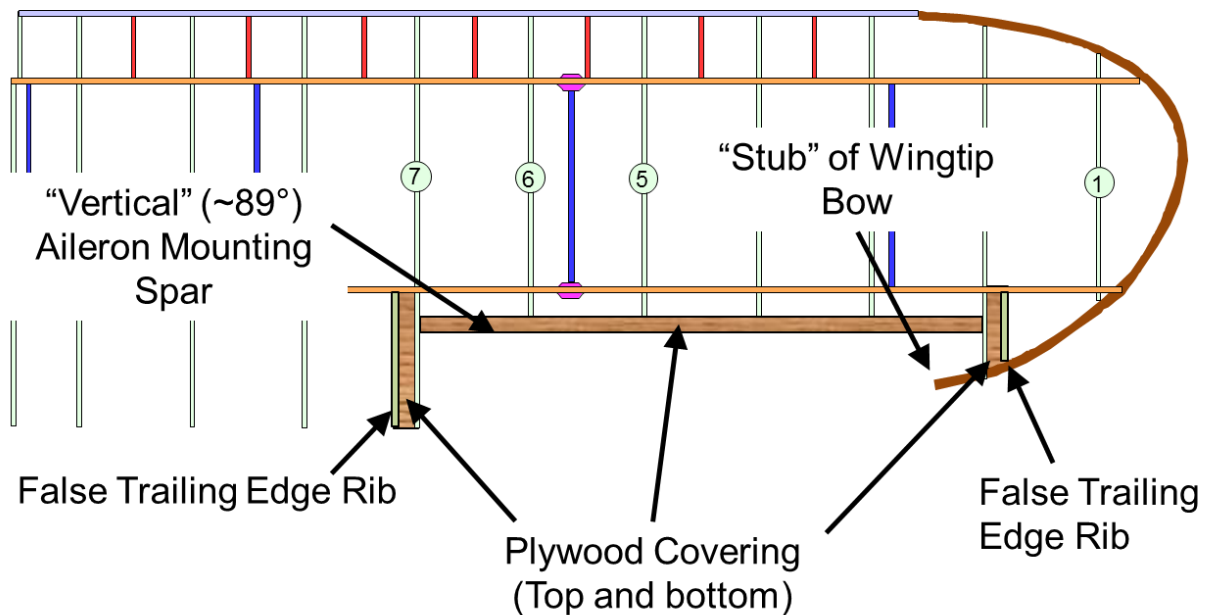


Figure 46: Aileron Support Structure

The Aileron Mounting Spar is off-vertical slightly; I measured the drawing at 89° but that’s just an idle check. The actual angle is set by the dimensions of the trailing edge ribs for Ribs 3-6. You don’t need to hit a particular angle.

The makeup and construction of this structure is well-illustrated in Figures 4-22 and 4-23 on Page 8 of Article 2. It’s basically a square of 3/8” spruce sticks, overlapping the cap strips on the ribs and with reinforcement blocks installed. Note, too, the small doublers added to act as mounting points for the aileron hinges.

Each aileron has four hinges, made up of a section of Piano hinge (AN257/ MS20257P). I’d get the 2” wide type. Each section of hinge is 4 inches wide, and will need a doubler added as shown in Figure 4-22. A sketch of a portion of the Aileron Mounting Spar is provided as Figure 47.

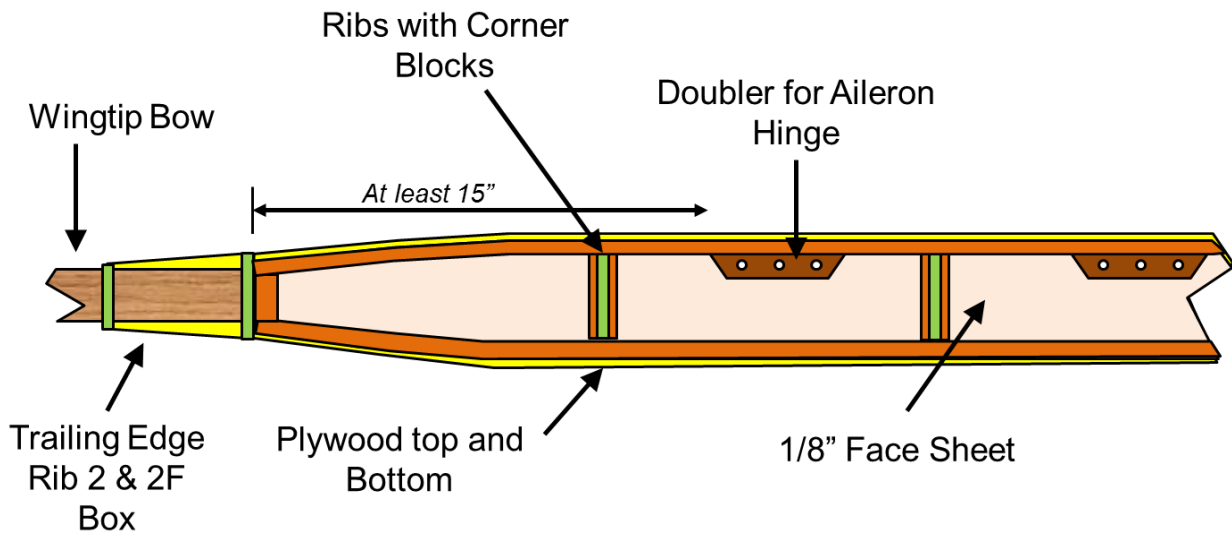


Figure 47: Aileron Mounting Spar

Because of the tapering of the aileron, all the mounting doublers for the Aileron hinges should be located inboard of Rib 3. Don’t put a hinge closer than ~15” to the outside of the aileron area. After the Aileron Mounting Spar is varnished, install anchor nuts to the rear of the aileron hinge mounting screw holes. Pete says the holes should be 3/16” (#10 sized), but others have used #8 instead. Put one of the doublers near the inboard side of the aileron—you can see an example in Figure 50.

Outboard and inboard of the opening for the aileron are the two box structures that use, basically, double ribs set 2.5 inches apart (see Figure 4-1 on page 21 of the Part 1 article).

The Rib 7 false rib can be identical to the “normal” trailing edge rib for Rib 7. The False rib for Rib 2 will need to be custom-shaped for the area. Fiddle with cardboard to determine the shape, then cut out the plywood.

Both false ribs need holes cut in them. This is to allow ventilation inside to prevent wood rot from starting. You can see the holes in Figure 4-22 on Page 8 of Article 2.

BEFORE ENCLOSING THESE AREAS, make sure you varnish inside the boxes! As usual, ensure varnish is not applied to the areas which will be glued.



Pete doesn't mention the "stub" of the wingtip bow; the remaining bow area that goes past Rib 2 into the aileron area. You're actually going to use this on the trailing edge of the aileron itself (Section 4.7). Saw it off once the glue is cured at the wingtip bow/Rib 2/2F intersection.

4.7 Aileron Construction

Pete says the ailerons can be constructed any time; they're basically built to fit the wing. So you can play things by ear a bit. Figure 4-1 on page 21 of Article 1 shows the critical dimensions.

The basic component of the ailerons is a box spar, illustrated in Figure 4-30 on page 9 of Article 2. It's very similar to the Aileron Mounting Spar (Figure 47) except the 1/8 plywood is on the front AND the back. The cross-section of this spar is shown in Figure 4-23 on Page 8 of Article Two.

Start by cutting the a face sheet from 1/8" plywood to match the Aileron Mounting Spar on the wing. Since the aileron spar is true vertical (vs. the 89° angle of the Mounting Spar), the face sheets will be a bit shallower. Note that the spacers are both 3/4" wide, but the one on the top is 5/8" high while the one on the bottom is 3/8"

The aft face sheet is cut to match the shape of the wing, and the 5/8" high spacer on the top is beveled to fit the vertical taper of the wing as well.

Install doublers in the aileron spars at the same location as on the Mounting spar. Do NOT drill them through so the holes on both side match. You don't want the bolt heads to interfere with the closing of the hinge, as shown in Figure 48

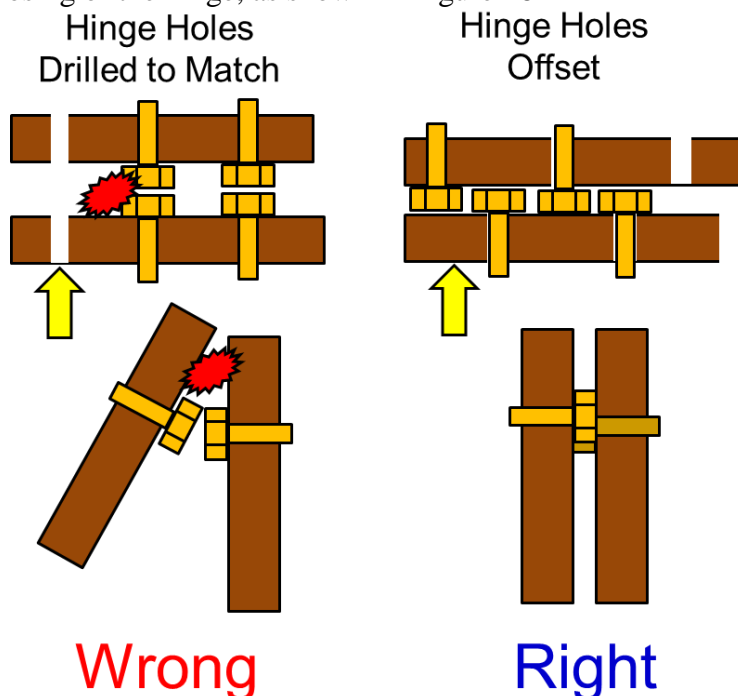


Figure 48: Drilling Hinge Holes

It's certainly OK to drill both sides' doublers at the same time, as long as one of the doublers is mounted offset to achieve the needed clearance.

Pete doesn't give a recommended position for the aileron hinges. I measured the spacing of my own airplane, and that's shown in Figure 49. It's not necessary to hit these distances exactly; the distances shown are approximations.

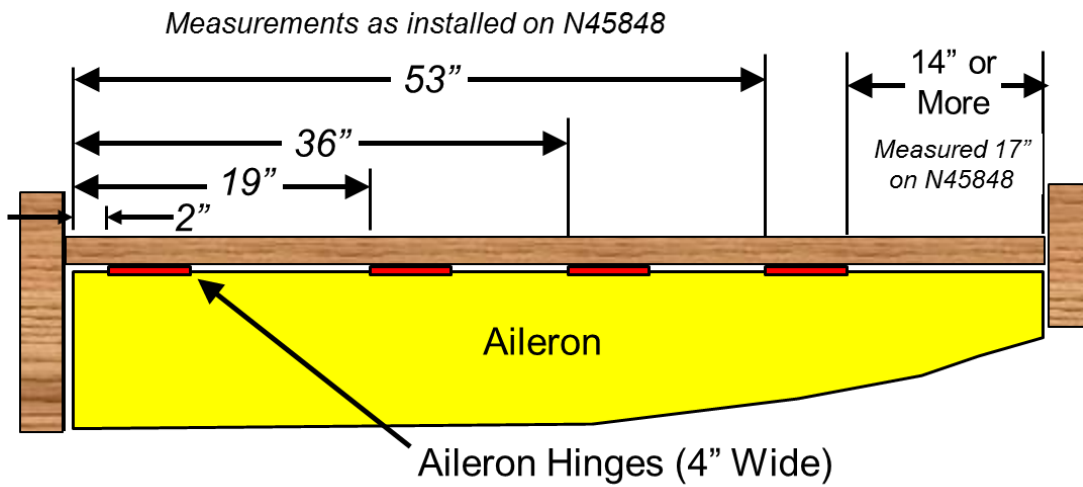


Figure 49: Aileron Hinge Locations

However, end of the outboard hinge (the one closest to the wingtip) should be no closer than 14 or 15 inches from the end of the aileron. This is due to the tapering shape of the aileron.

However, when making the aileron, make sure you leave plenty room on the left and right sides to ensure it fits in the wing gap without interference. Remember that both the wing and the ailerons will be covered with fabric and painted, which will cut down the gap.

My aircraft was built with rather small gaps. During a very hot day, the ailerons and wings swelled enough that the aileron was striking the side of the aileron mounting area. Leave a good gap, on either side of the aileron.

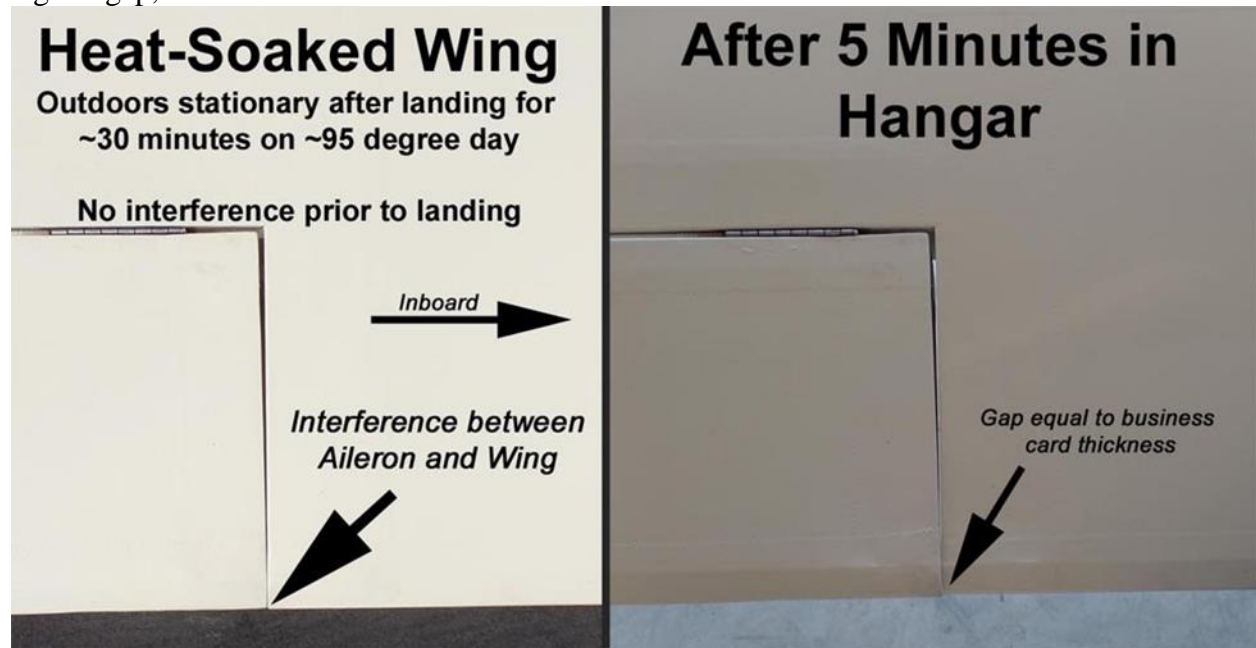


Figure 50: Aileron Interference

Before you glue the last aileron face sheet on, varnish the inside of the spar box.

The rest of the aileron uses sections of trailing edge ribs and cap strips, like the ribs on the wings themselves. Figure 4-30 on Page 9 shows the construction.

4.8 Aileron Hinges

Each aileron gets four hinges, 4 inches long, made from Piano hinge (AN257/MS20257P). Get the kind that's 2" wide when spread...that's "wings" about 1 inch on each side (Figure 51). Notice the offset bolt holes, as discussed earlier.

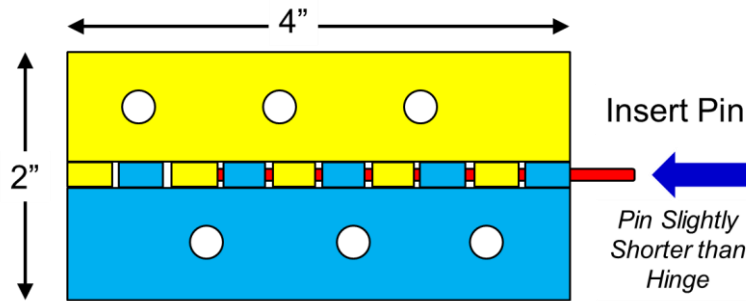


Figure 51: Aileron Piano Hinge

Jim Katz came up with a slick way to position the hinges and drill the aileron spar and the mounting spar. He drilled all the mounting holes in both wings of the hinges and bolted the hinges to the aileron mounting spar on the wing using longer-than-normal hinge pins

Then he got the aileron ready for mounting, added a couple of dabs of glue to the outside of the hinges (Figure 52), and clamped the aileron in place (Figure 53). Once the glue was dry, he removed the temporary hinge pins. The wing on the aileron side is held in place by the glue, and the aileron can then be drilled through for the bolts.



Figure 52: Glue for Temporary Aileron Mounting.



Photo by Jim Katz

Figure 53: Clamping Aileron in Place

When the holes are drilled, remove both wings and install the final hinge pin. For the Fly Baby ailerons, cut the pin slightly short, slide it into the hinge, center it, and slightly crimp down the outside “holes” in the hinge to trap the pin (Figure 54).

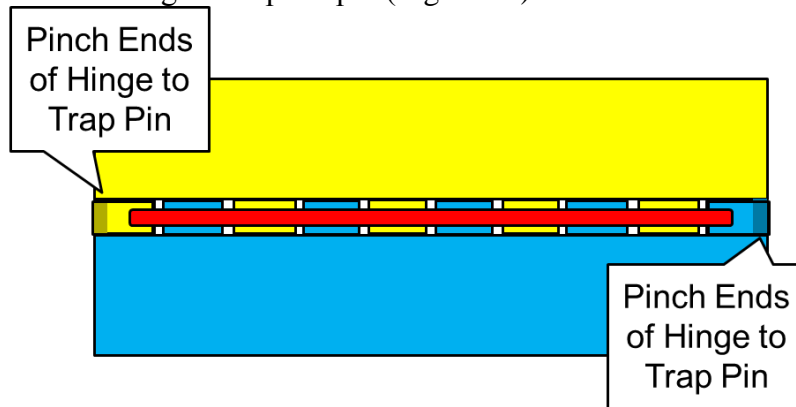


Figure 54: Trapped Hinge Pin for Aileron

Why trap the pin? Because otherwise, you’ll have to come up with other schemes to hold the pin in place, to make sure it doesn’t gradually work free. Sure, you can’t get the pin out if you trap it...but the aileron hinges are pretty basic, easy enough to just replace one if you have to.

4.9 Front Spar Filler Strips

Eventually, the leading edge of the wing will be covered to maintain its shape under the aerodynamic pressure of the relative wind. To give a smooth surface, the front spar must present a level surface for the entire wingspan. A filler strip is added, per Figure 4-22 on Page 8 of Article 2. This strip is 1/4" high, and about 3/8" wide (although the width isn't critical). It's shown in Figure 55 below. This essentially travels from the wingtip to Rib 10 (the second from the root)



Figure 55: Forward Spar Filler Strips

If the wing has been built with non-beveled spars, the filler strip will need to be beveled to match the curve of the rib capstrips.

4.10 Aileron Hardware

Install the aileron swing link and its supports, and the bellcrank and its support. Also, attach the horn to the aileron in the proper position for a the pushrod from the bellcrank to the horn.

Ensure the wood under these pieces is varnished between bolting the metal in place, and use the wide-diameter washers when in contact with wood.

4.11 Tiedown Ring

One of the things Pete neglects is the provision for tying down the wings when parking outside. It really doesn't take that much...just a strip of stout steel looped in a U- shape, and bolted to either side of the spar, hanging down low enough to allow you to thread a rope through when parking.

However, a fixed loop like this does complicate things when the wings are covered with fabric.

I like Greg McCormick's solution, as shown in Figure 56. A long L-Shape of steel is bolted to the wing spar, and a nut fitting a standard tiedown eyebolt is welded to the bottom of the "L". Note that Greg added a little bit of reinforcement to the side of the "L". Also note a little bit of 1/4" plywood around the bottom, to glue the fabric down.

With the nut welded in place, the eyebolt can be screwed in and out. They can be removed and the wing covered with fabric in the normal fashion, then the hole can be opened up and the ring screwed back in place. Use a little Loctite if worried about the tiedown ring coming out on its own, but as Greg's photo shows, that ring would have to turn a LOT before actually coming out.



Figure 56: Tiedown Ring

4.12 Preparation for Storage

Pete recommends waiting to construct the trailing edge of Rib 11 and the attachment of Rib 11 to the wing until the fuselage is available for a fit check. This means the wings will have to be stored for several months; even a year or more, depending on how fast construction is happening.

Due to this interval, the wing should be mostly varnished prior to setting them aside. Basically, anything that still requires gluing must not be varnished:

Do Not Varnish the Following Areas Prior to Storage:

- The areas where Rib 11 will be glued to the spars (near the root of the wing)
- The areas where the wing-walk plywood will be glued to the wing. This is the top of the cap strips for Ribs 10 and 11
- The area atop the spars between Ribs 10 and 11.
- If the wing leading edge will be something other than metal, do not varnish the tops of the nose ribs or the spar filler strips atop and below the front spar.

Depending on the covering system to be used, any attachment areas for the fabric to be used may need to be left free of varnish as well. This would include rib capstrips as well as the boxed areas around the ailerons, the wingtip bows, etc. In any case, ensure whatever varnish being used is compatible with the fabric attachment system.

4.13 Rib 11 Attachment

When ready to complete the wing, attach it to the fuselage, with appropriate structure/cables to hold it at the five degree dihedral angle.

The last paragraph on Page 6 of Article two shows the details. You actually tack the middle section of Rib 11 to the fuselage, trapped in place by the wing spars (Figure 57). The trailing edge is cut to match the shape of the lower fuselage, as seen in Figure 34.

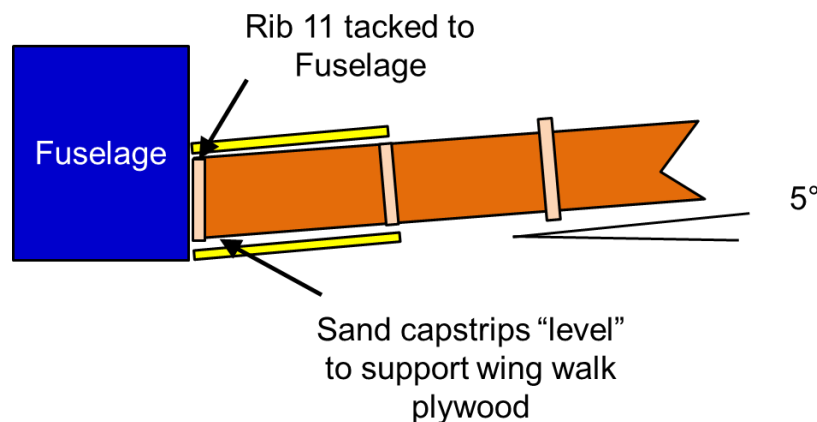


Figure 57: Rib 11 Installation

Cut some generous access holes in Rib 11, to allow reaching all the hardware that will be enclosed in the wing-walk area.

4.14 Covering the Wing Walk

Once the glue holding Rib 11 in place is cured, make sure it's de-tacked from the fuselage. The top and bottom of the cap strips on Rib 11 are slightly rotated from the line of the spar. Sand the capstrips carefully to provide a level support for the wing walk plywood (some guys don't bother with this; with modern gap-filling epoxies, it may not matter).

Two additions are necessary before attaching the wing-walk plywood. First, the areas atop the spars between Rib 10 and Rib 11 must be filled in to match the height of the Rib 10 & 11 cap strips. This is a piece of 1/8" plywood, as shown in Figure 4-28 on Page 9 of Article 2.

Second, a number of reinforcement beams must be added to the top of the wing-walk area, items that Pete calls "Intercostals." A sample can be seen page Figure 4-25 on Page 8 of article 2, and are clearly shown in Figure 58 below. These reinforcements only go on the top of the wing, for reasons that should be obvious.



Figure 58: Wing Walk Support Intercostals

Five are installed between the middle rib sections, three on the trailing edge, and one in the nose section. Note that the distance between the nose ribs is slightly less than the distance between the middle or trailing edge ribs.

Hold the top plywood in place, and mark where the glue areas will be. Then remove the top piece and glue 1/8" plywood to the bottom of the wing-walk area. The trailing edge of the bottom plywood should be beveled to accept the top plywood. Varnish the inside of the box area, plus the underside of the top piece of plywood except where it will be glued to the ribs and intercostals. Once the varnish is dry, glue the top piece on.

4.15 Leading Edge Covering

The covering on the leading edge of the wing forms a D-section, but this is non-structural. So the attachment merely must hold it in place. Note that the builder will need to run the pitot/static lines out through the holes in the nose ribs before adding the covering, and include the required support for the pitot/static mast.



Figure 59: Covering Leading Edge

Pete calls for "...0.016 in. to 0.020 in. half-hard aluminum flashing available from most hardware stores..." This really indicates how non-critical this material is; it doesn't even have to be a particular alloy.

I don't even know if the hardware stores of today sell aluminum like this, anymore. In any case, 0.016-0.020 aluminum is easily available at the aviation supply outlets.

If aluminum will be used, varnish the entire inside of the leading edge area before starting. With wood or fiberglass, varnish the leading edge area while protecting the areas to be glued, as usual.

Figure 59 show Matt Wise's wing in the process of having the leading edge covered. He did it sections, with a little overlap between. The slight bump at these overlaps will be covered with tape prior applying fabric. The aluminum is held in place by nails or staples. Figure 60 shows how he handled the wingtip area.

Aluminum isn't the only material that can be used. Thin plywood is a common choice; just be sure to varnish the inside before applying it.

My own airplane has fiberglass on the leading edge. It's heavy, but has held up just fine for almost 40 years. I'm not sure how it was applied, but I'm guessing the fiberglass was laid up on a flat surface, then wrapped around the leading edge and tacked on to allow to cure in place.



Figure 60: Metal Covering Around Wingtip

4.16 Trailing Edge

The last step is to apply bent aluminum trailing edges around the wing. These are available from Aircraft Spruce (part number 03-48900) or other sources. There won't be any stretches of continuous trailing edges longer than six feet, so you can have it cut down to save shipping costs.

5 ALTERNATE APPROACHES

The following topics have been discussed within the Fly Baby community. They may provide advantages to the builder, but have not been verified as viable.

5.1 Eliminating the Wing Fold

One of the criteria for the EAA contest in 1962 is that the plane had to have folding wings, so an owner could tow it home and store it in their garage.

The Fly Baby has folding wings (yay!). However, this is NOT a fancy pull-one-lever-and-the-wings-fold back system. It's actually a kind of hassle to fold the wings, and few people have ever done it routinely. You can get a detailed description at <http://www.bowersflybaby.com/tech/FOLDING.HTM>.

All right, it's a pain, and you're not likely to ever do it very much. Why not save time and effort while building and eliminate the folding-wing gear?

Figure 61 shows the extra work required to make the wings foldable. Everything in red is specifically to support folding. The four spar pins are 1/2" bolts that will need to have all their threads ground off and a handle welded to the head. Plus, note the way the nose rib has to be offset to leave room for the hinge tube and its brackets. Without the wing-folding system, this can be installed even with the mid-section of the rib.

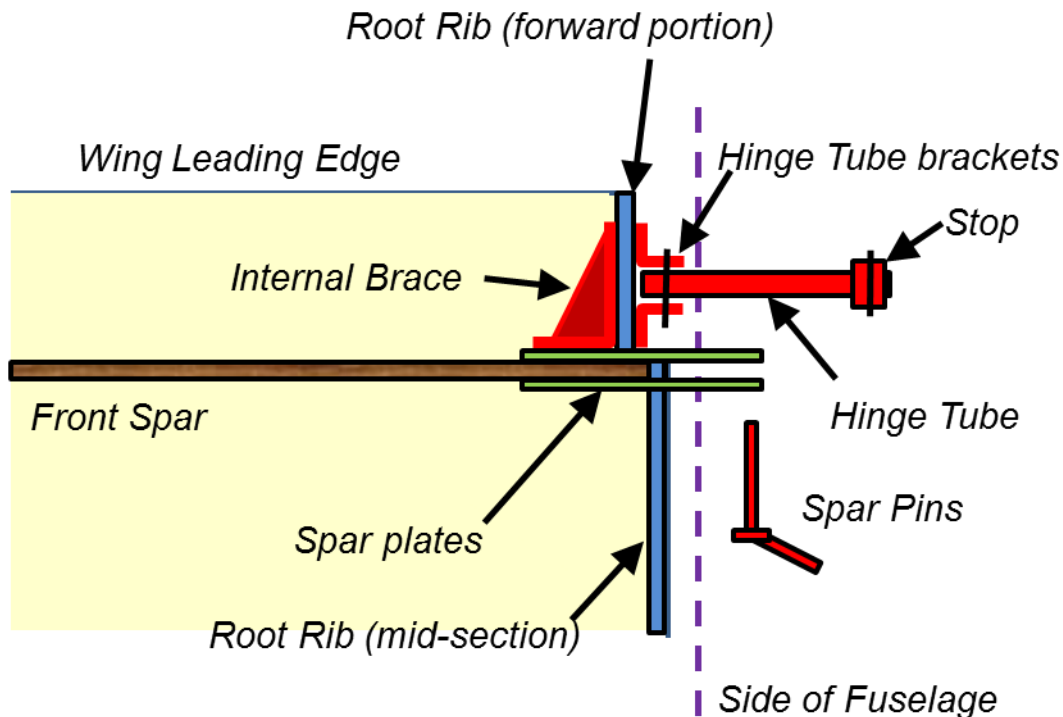


Figure 61: Parts Solely to Support Wing Folding

Now, even if you leave the wing-folding hardware off, it's STILL going to be fairly easy to remove a Fly Baby's wings if you need to put the plane on a trailer. The main change is deleting a bit of unneeded ironmongery in the wing root and using standard bolts to hold the wing instead of fabricating 1/2" thick pins.

5.2 Lightening Holes in the Ribs

The 1/8" sheet ribs aren't that heavy, but some builders like to save weight by carving out sections of the wood. I'm good with it, but make sure your lightening holes don't interfere with the internal diagonal bracing cables or the aileron pushrod pass-through.

Figure 62 shows what one builder did to lighten his ribs.



Figure 62: Wing Ribs with Lightening Holes

5.3 Rectangular Wings

The graceful semi-elliptical curve of the Fly Baby wingtip is one of my favorite features of the airplane.

However, it must be said that this takes a lot of work. The builder will be making laminated wing bows, each made up of 12 separate strips of spruce or cedar, then carving them to match the taper required for a wingtip bow. In addition, there's the required tapering of the spars, and the special tip ribs (Ribs #1 and #2) that are required.



Figure 63: Semi-Elliptical Wing of the Fly Baby

Now, depending on how much of a fan of the Fly Baby shape you are, there are some opportunities for a minor design change that will eliminate tens of hours of work.

Back in the '70s, 13-foot spruce spar stock became rare. Twelve-foot planks were still available, but the shorter wing would reduce the total wing area and affect the handling of the airplane.

The solution was to switch to a rectangular wing, rather than a tapered one. A sample is shown as Figure 64.

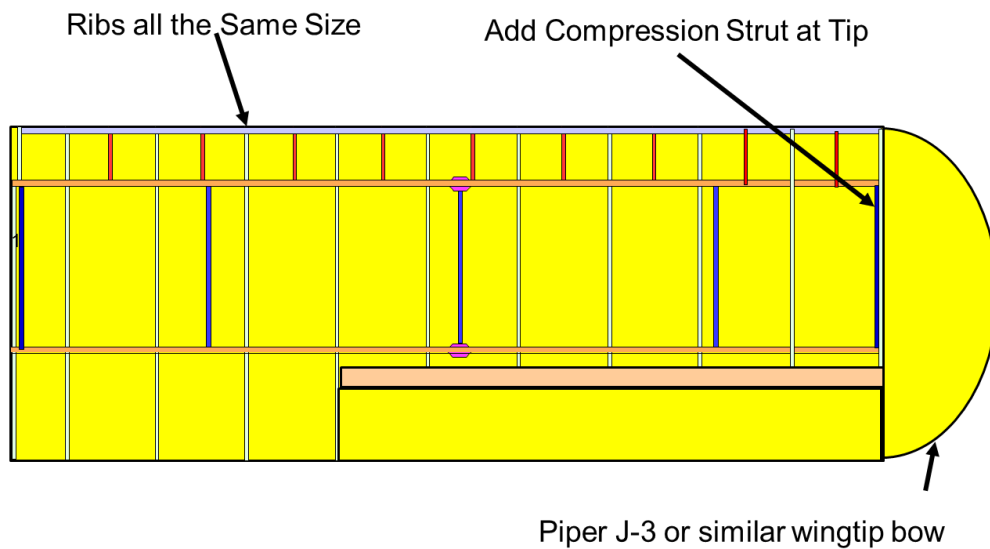


Figure 64: Rectangular Wing

There's a lot of simplicity in this approach. The spars don't have to be tapered at the end. All the ribs are the same size. The aileron area is actually a bit larger. And another scheme can

be used for the wingtip bow. It could be commercial bow, or just an arc of aluminum tubing like the Fly Baby biplane.

Anyway, it's something to consider.

END OF COMPANION GUIDE FOR ARTICLE 2