Companion Guide: "Building Fly Baby"
Article 6: Tail Surfaces

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and the Fly Baby Community

This Companion Guide is written to accompany the sixth of Pete Bowers' Fly Baby construction articles in EAA SPORT AVIATION magazine. This article covered the building of the tail surfaces. In addition, the seventh article, mostly about powerplant installation, also included some details on horizontal stabilizer installation. For a "cleaner" experience, all the tail surface documentation is addressed in this Guide.

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 1-1" (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, William Beauvais, Olan Hanley, 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

One might think at this stage, six articles into the construction series, that things might be getting a bit routine. That the tail feathers aren't that much different from all the structure you've put together so far. . The first five articles (and the Guides) resulted in the builder learning a lot of new construction techniques.

Surprisingly, there are a few new things here.

This Guide addresses the construction of the horizontal stabilizers, the elevators, the rudder, and the vertical stabilizer. Note that Pete usually refers to the vertical stabilizer as the "Fin".

Note that this Guide is not a substitute for the articles in the EAA magazine series. It provides amplifying information at a greater depth, but builders must use the magazine articles for both step-by-step directions and the diagrams showing dimensions.

1.1 Note about Illustrations

To make things clearer, I have drawn up a lot of sketches to illustrate some of the aspects of the assembly. Peripheral details on these sketches are just there to complete the drawing—they may not, exactly, match the original Pete Bowers figures. My sketches always are in color; Pete's are black and white.

Where there is a difference between my sketches and those from the Pete Bowers articles, assume the original article sketches are correct.

If two pieces in my sketches are supposed to be the same size but look different, just assume that was an error.

1.2 Workmanship

Let's 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 (double-plywooded forward section, etc.) before they are 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

2.1 Fin Offset

The vertical stabilizer spar was already added to the fuselage as part of the Article 3 work (Figure 1). In this Guide, the rest of the fin structure is added to match.

Figure 1: Vertical Stabilizer Spar

One of the questions I get asked occasionally is about offsetting the vertical fin.

Most production aircraft include a slight offset to the rudder, to compensate for the P-Factor effect of the engine (usually erroneously attributed to as "torque"). The Fly Baby doesn't.

Why? Pete never says. But Pete was always open to the installation of different engines on Fly Babies, and the amount of offset required for an A65 may not be the same as that of an O-200. No one amount of offset could cover all possibilities.

And, of course, not all engines rotate in the same direction. Adding "N degrees" of left offset to the horizontal stabilizer for a US engine may not be in the right direction for a belt-driven auto engine conversion.

But you've got a nice little C85 pickled and stored in your garage. Since you know what engine's going in, should you add some offset?

I'd say no. P-factor can be handled by a small piece of metal on the rudder as a fixed trim tab. You're not sure, right now, how much offset would be needed…and if you build it in, you can't change it. An external tab, as shown in

Figure 2: Fixed Trim Tab

3 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.

3.1 Changing the Shape of the Tail Surfaces

One of the more common cosmetic alterations of the Fly Baby are changes to the shape of the rudder and elevators. As long as they changed units have the same sort of internal structure, and don't vary broadly from the total area of the stock surfaces, this sort of thing doesn't make much difference.

A few builders have made larger tail surfaces, extending the total width of the horizontal stabilizer, or making the fin taller. Again, as long as this is kept within reason, there shouldn't be a structural issue.

Figure 65 illustrate a rudder modified to make the it look more like a WWI aircraft. This is larger than a stock rudder, and would probably be more sensitive, but it's not likely to make that much difference. The top of the vertical stabilizer has been altered as well, to continue the upward line rather than curving back to horizontal like a stock fin. The owner reports no difficulties in handling

Figure 65: Modified Rudder Shape – Curved

Figure 66 shows another tail modification. In this case the elevators as well as the rudder have been squared-off. These changes make little difference as long as the *approximate* areas of the original surfaces are retained. Judging it by eyeball is probably adequate.

Figure 66: Modified Rudder Shape – Squared

Oh, by the way…the photo was taken during final assembly. The ailerons aren't hooked up yet, thus they are both in the down position.

3.2 Extended Aft Inspection Panel

Getting the elevator control cable horn into the aft fuselage can sometimes take some work. If, for some reason, it has to be removed after the plane is completed, it can be quite difficult.

One way around that is to modify the aft inspection hole on the left aft fuselage. The stock inspection hole can be seen in Figure 65 above. This hole is there to provide access to the lower cable connection on the elevator control cable horn (an inspection plate in the fin provides access to the top.

Figure 67 provides an option. Notice the back edge of the inspection hole is merely extended a couple of inches to reach the cross-hole for the elevator tube. Remember, the elevator tube system is connected *only* to the elevators; a hole like this has no effect on it. But it should make it a lot easier to insert and remove the elevator control cable horn.

Figure 67: Modified Inspection Hole, can be added after completion and adjusted based on personal preferences. If a left-turning engine is eventually installed, the tab can just be bent the other way.

So build a straight vertical stabilizer without offset.

3.3 Vertical Stabilizer/Rudder Hard Points

The designs of the rudder post on the fuselage and the rudder spar are practically identical. They are closed wooden boxes, with reinforcements inside to support the hinges.

Figure 3 shows the basic shape of the rudder post with the “hard points” where the hinges attached highlighted. The rudder spar is similar, though slightly narrower. And of course the hard points are in the same location!

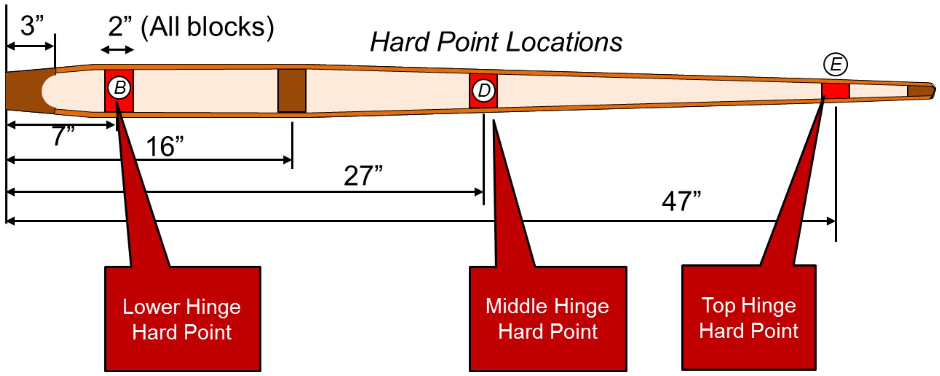

Figure 3: Rudder Post Dimensions

Figure 4 shows how the rudder post is installed at the back of the fuselage, and how the vertical stabilizer is built up. As mentioned in Guide 3, there is a problem with the fin structure: The diagonal spar for the fin intersects the rudder post right at the spot where the hard point for the top rudder hinge is supposed to be installed.

As mentioned in Guide #3, the builder needed to figure out how to handle this issue. The block on the rudder post might have to be moved up or down, or expanded to cover a wider area to give more flexibility.

Whichever solution you select, don't forget that the RUDDER POST will need to have the same hinge locations. So if you built the rudder post with the top reinforcement a bit higher, the reinforcement on the rudder spar will need to match.

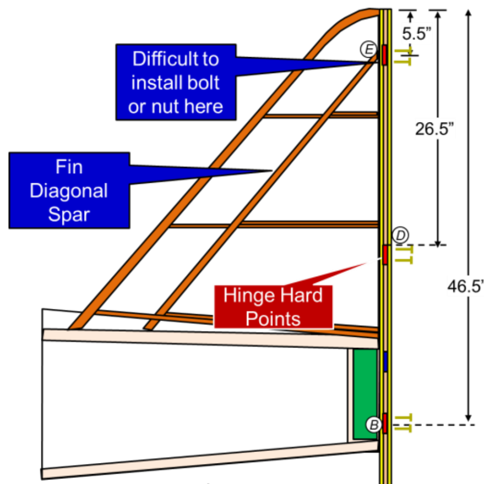

Figure 4: Interference Issue with Upper Hinge Point

3.4 Horizontal Stabilizer Diagonal Spar Interference

As you might figure, the design of the vertical and horizontal stabilizers is very similar. It might then occur to you, "Hey, is there an interface problem with the horizontal stabilizer diagonal spar interfering with the hinge there, too?"

Why, yes there is. As Figure 5 illustrates, the diagonal spar of the horizontal stabilizer could produce some interference with the outboard hinge. Not a major issue. The horizontal stabilizer main spar is a "C" cross section, so additional reinforcement can be easily added if the hinge location has to move a bit. Remember to do the elevator hinge location to match.

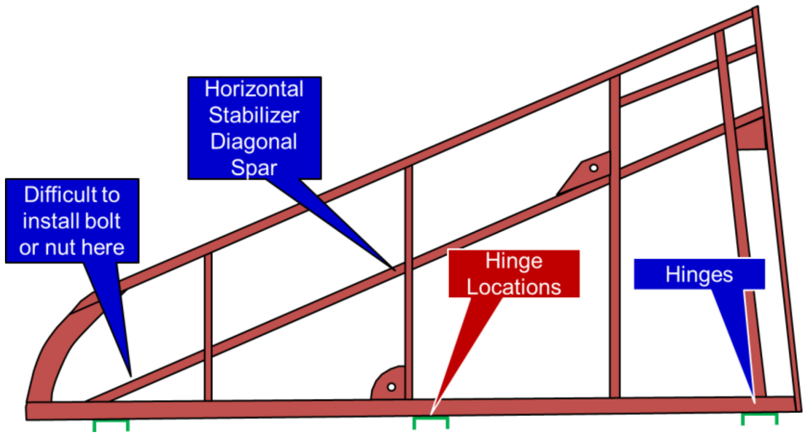

Figure 5: Horizontal Stabilizer Hinge Point Interference

3.5 Horizontal Stabilizer Hinge Reinforcement

Everywhere that a hinge is installed on the aircraft, Pete specifies reinforcement of the wood at that point.

Everywhere except the horizontal stabilizers. There are reinforcements added to some location on the stabilizer spars, but, curiously, not at the hinge locations. He does show such reinforcement on the equivalent positions on the elevators themselves.

This is just a tad weird. If I were building, I'd add a little 2"-long block at the hinge installation locations on the horizontal stabilizer main spar.

3.6 Vertical Stabilizer Leading Edge

It's kind of weird, but where Pete does address the wood strip that forms the leading edge of the vertical stabilizer (fin), he doesn't actually say what size it is! It's cut from 3/8" wood, and is 5/8" deep. However, the depth is not critical. Some folks find it easier to make 3/4" wide, instead. It extends the fin imperceptivity.

3.7 Rib Cap Strip Notch

Figure 3-2 on Page 9 consists of patterns for the nose ribs for the vertical and horizontal stabilizers. There is a notch on the end of the rib to connect with 1/4" square strips glued to the center section of the rib.

However, Rib 4, and the one directly adjacent to it, will be covered with 1/8" plywood once installed. Hence, the "notches" in the back of the nose rib have to be 3/8" deep, not 1/4". This change is shown in Figure 6.

All the other ribs have the right-size notches on the template..

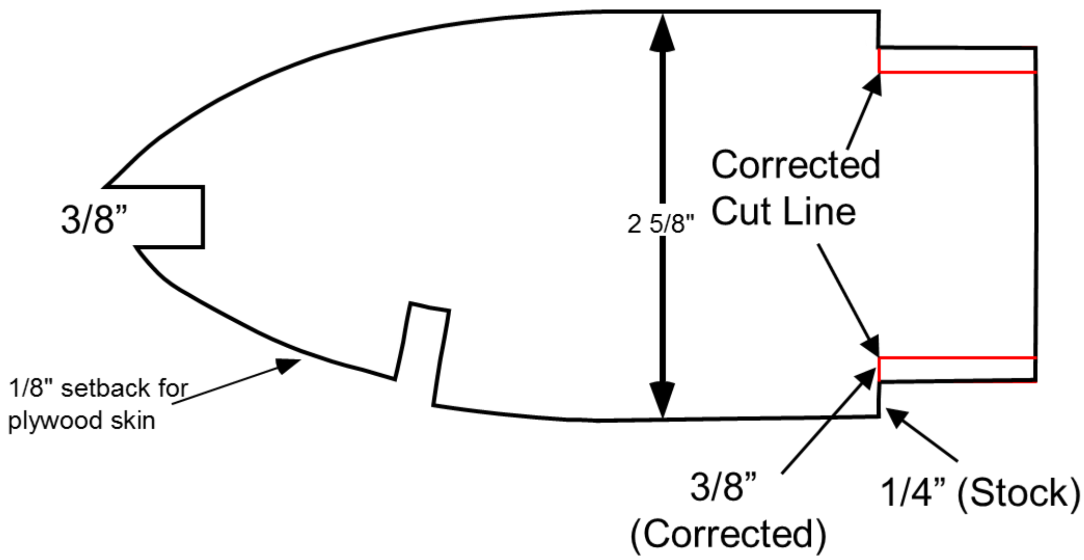

Figure 6: Corrected Outline: Stabilizer Rib 4

3.8 Elevator Horn Tube Size

Figure 3-8 on Page 11 illustrates the dimensions of the steel components associated with elevator control.

The "Inner Elevator Control Horn" at the top of the picture consists of a flat piece of steel with a steel tube welded to it. The inset caption describes this as a '1/2" ID Tube'. This is in error, the tube should be one inch inside diameter (Figure 7). It's pictured in Figure 8.

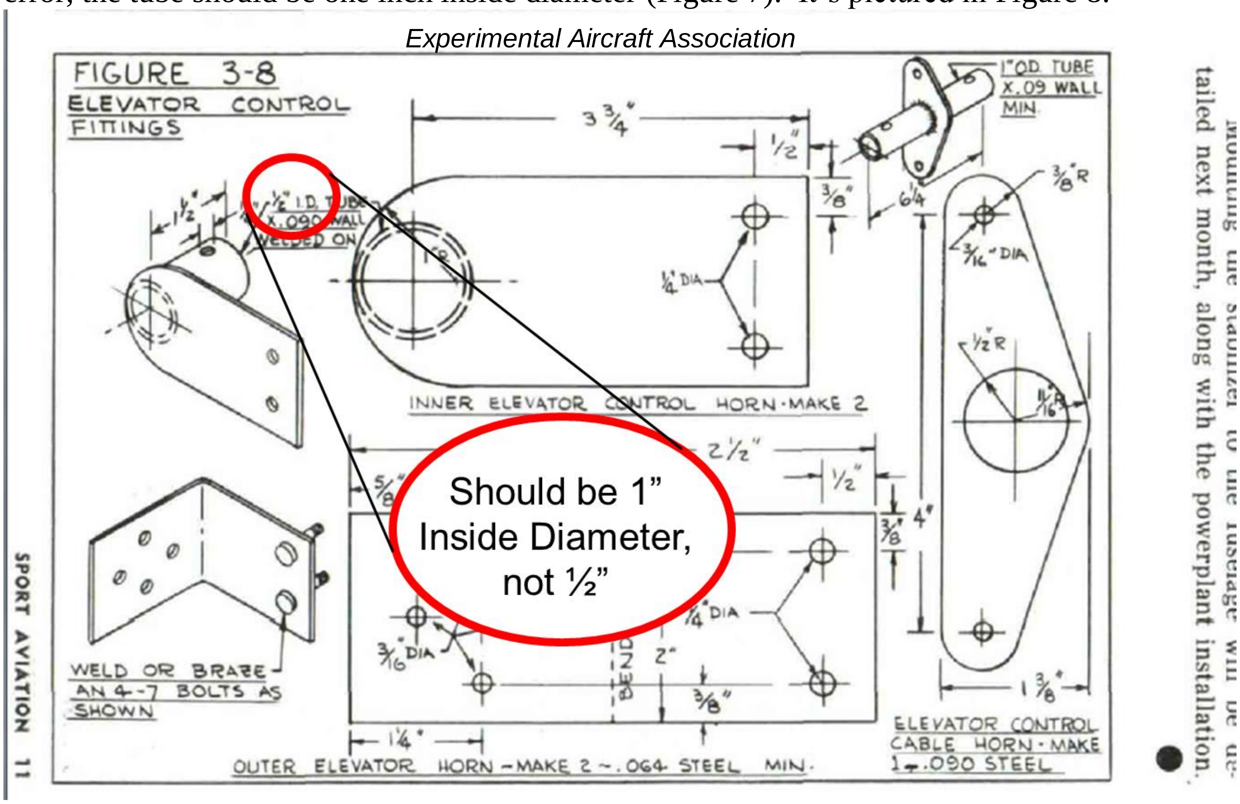

Figure 7: Correction to Figure 3-8

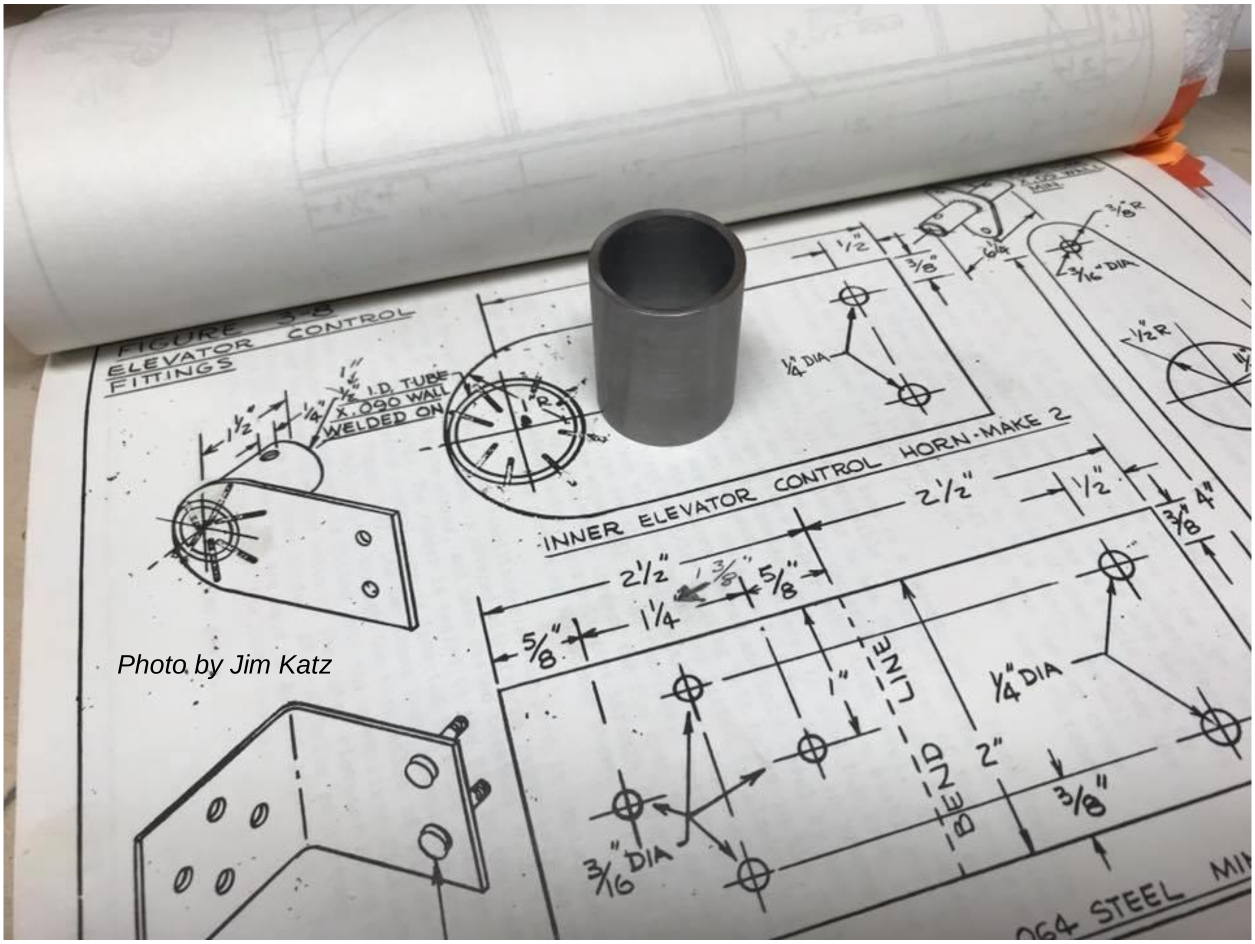

Figure 8: Elevator Horn Tube

Also Figure 3-8 does how show the width of the inner elevator control horn. It's two inches, same as the outer horn.

3.9 Welded Bolts in Elevator Horn

Figure 3-8 also shows that the AN4-7 bolts that hold the outer elevator horn to the innermost rib of the elevator should be welded or brazed in place. This allows you to remove external hardware after the elevator is closed up with plywood and fabric.

However, there has been one report that an AN4-7 bolt is too long; the builder was forced to add shims.

The lesson here is to not weld or braze these bolts until their length has been confirmed.

3.10 Horizontal Stabilizer Attach Point

Recall from Guide 3: In Figure 1-2, the Aft Fuselage Layout, there's a half-circular block installed forward of the tail post, aft of Station 8. That article shows the distance to the tail post to be 21 inches. This was changed to 19.25 inches.

Part 7 of the series (July 1963) added a Figure 3-9 to the Tail surfaces section, showing a change to the block location in Figures 1-2 and 1-3 for stabilizer installation. Figure 3-9 shows the correct, updated dimensions. These are also shown in Figure 9.

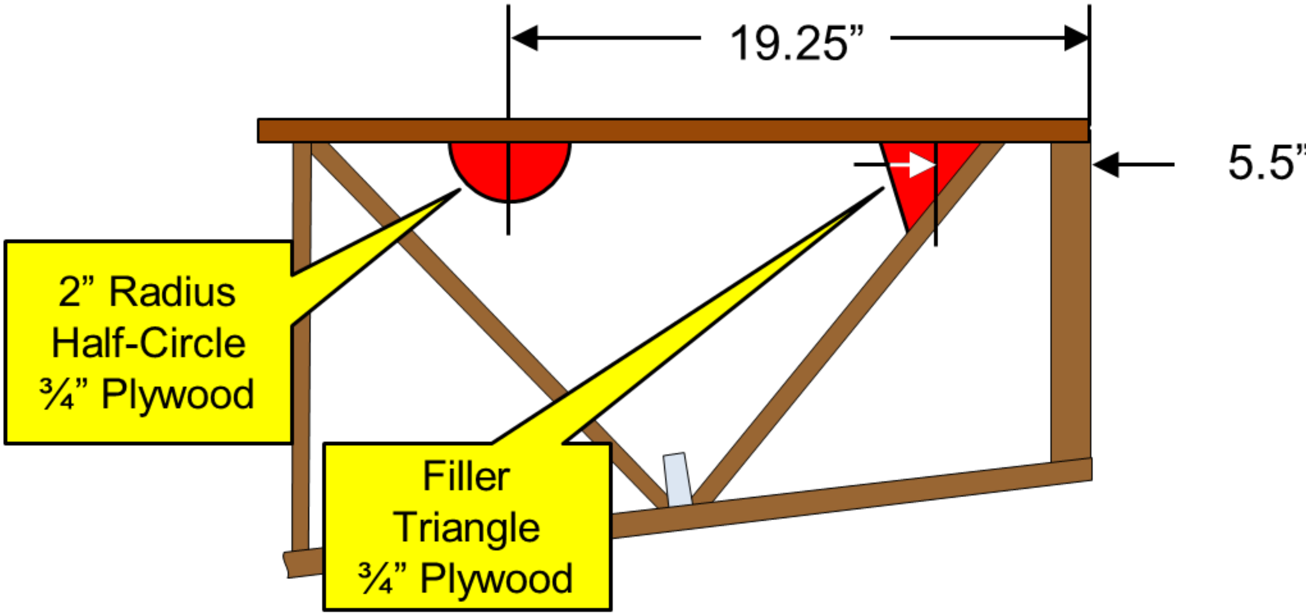

Figure 9: Horizontal Stabilizer Block Locations

4 SAFETY ISSUES

There are no major safety issues with the tail section, other than the usual need for good workmanship.

5 CONSTRUCTION DETAILS

This chapter addresses the construction of the vertical stabilizer, the rudder, the two horizontal stabilizers, and the two elevators. Construction is similar across the scope of the items.

5.1 Vertical Stabilizer (Fin)

The Fly Baby fin is relatively simple.

Figure 10: Fin Under Construction

Figure 3-1 on Page 8 of Article 6 shows the details of fin construction. The components are called out in Figure 11.

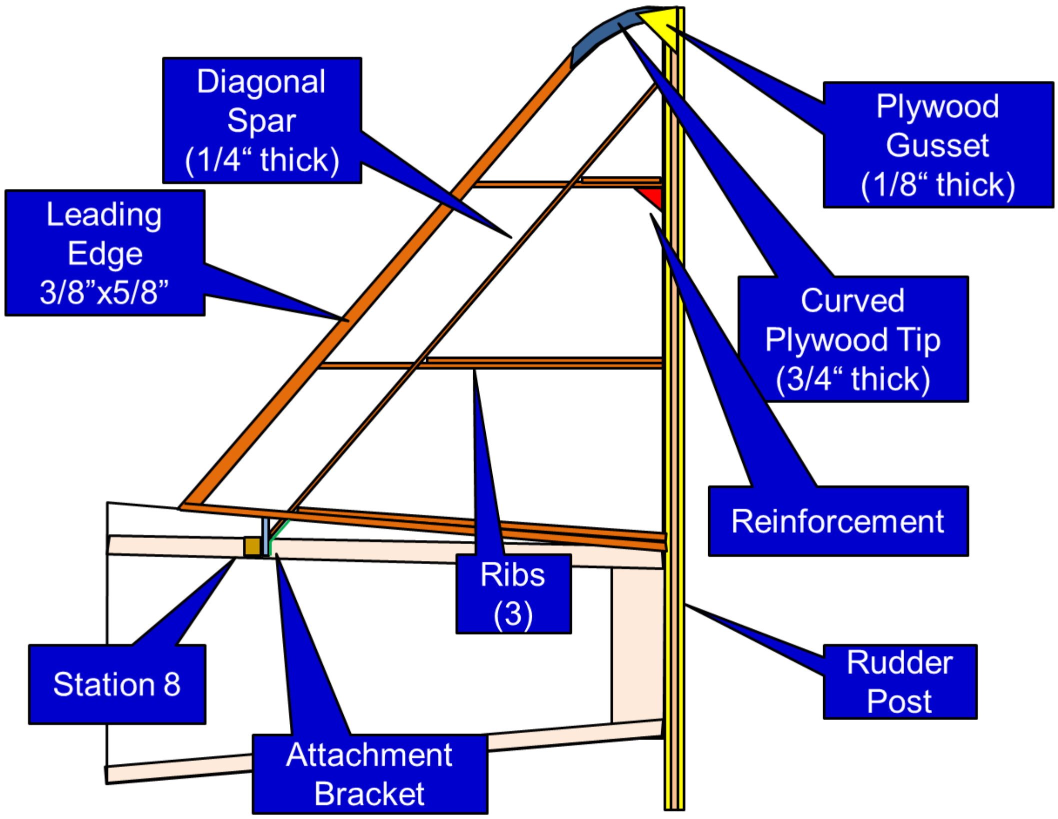

Figure 11: Fin Components

The rudder post is already installed on the aircraft at this point. Major elements are the leading edge, the diagonal spar, the three ribs, and the curved plywood tip.

The diagonal spar and the ribs are made using what I'll call "Cap and Web" construction: A section of plywood sheet (the "web"), with two square strips of spruce ("caps") glued at its edges (Figure 12)[1]. This basically creates a flange. The nose rib slides into the area where the strips stick out past the sheet.

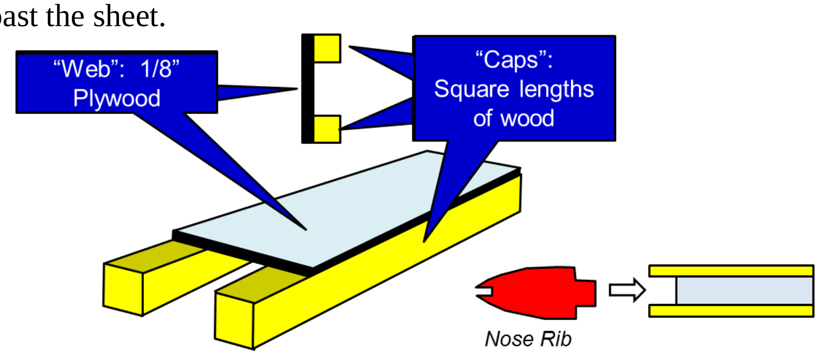

Figure 12: "Cap and Web" Rib Construction

The web is often referred to as the "face" or "face sheet." For the tail surfaces, the sheet will always be 1/8" plywood, while the strip size will be either 1/4" or 1/2".

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[1] Note that this is the same nomenclature already used for ribs. The implementation here is slightly different; on Fly Baby ribs, the caps have a slot that the web gets glued into vs. here, where they're just glued to the surface.

You'll need about 50 running feet of 1/4" square strip, and 32 feet of 1/2" square strip. While you could cut this on your table saw, it saves some time if you just buy the strip from your spruce vendor. It's sold as cap strip, and the price runs about 35 cents a foot for the 1/4x1/4 variety.

5.1.1 Vertical Stabilizer Diagonal Spar

The diagonal spar is a Cap and Web component, with the caps of 1/4" square spruce. Per Figure 3-1 in Article 6, it's 41 inches long (3' 5") and tapers down to 3/4" at the tip. The "wide end" includes a filler of 1/4" plywood that turns this end into an, essentially, solid block of wood for the first two and a half inches. Pete's drawings show this ending in an arc; the exact shape of that arc isn't important. The narrow end has a small block installed to close it out. Construction is summarized in Figure 13.

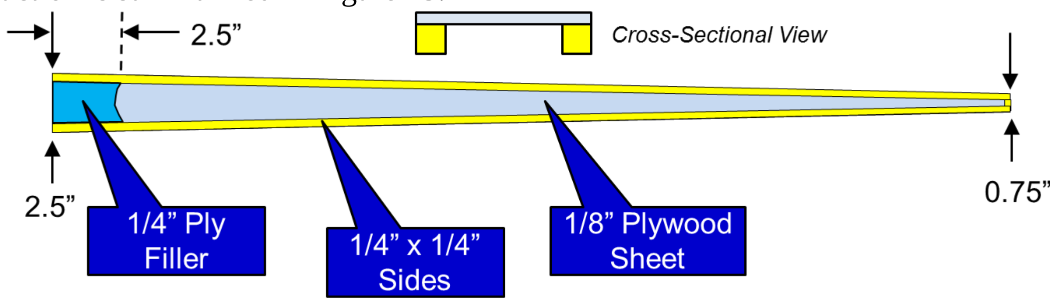


Figure 13: Fin Diagonal Spar

The diagonal spar is installed at an angle between just aft of Station 8 on the fuselage to five inches below the top of the rudder post. This is clearly shown in Figure 3-1. The top end is beveled to match the rudder post, and the bottom is beveled to match the small bulkhead at Station 8 (Figure 14). The sheet side is on top, as is obvious in the picture.

The "Five Inches from the Top" is not highly critical, so don't sweat if it's off by a quarter inch or so. Due to the beveling, it's possible you'll need to rework the ends once or twice, and it might get a bit shorter. Keep in mind the issue about the rudder hinge positioning in that location.

A 4130 steel bracket will be bent and bolted to the bottom, through the plywood filler and into the fuselage lateral.

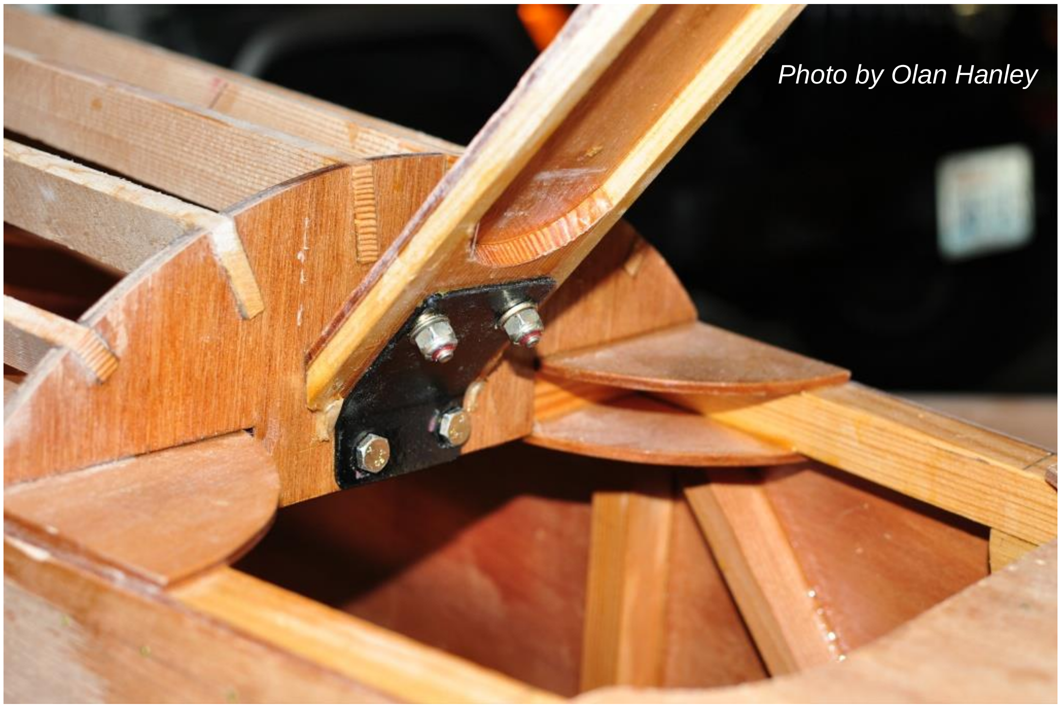


Figure 14: Attaching the Bottom of the Fin Diagonal Spar

As for the top end, Pete just shows this butted against the rudder post. This kind of bothers me, since there's relatively little area for the glue to take hold. Consider adding a triangular block under the intersection (Figure 15).

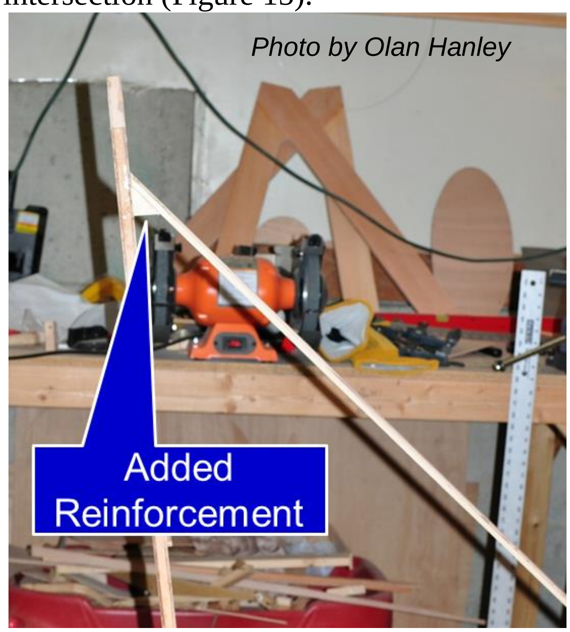


Figure 15: Block Added to Top of Fin Diagonal Spar

5.1.2 Fin Ribs

Next step is to add the ribs. You'd think these would be assembled the same as the wing ribs…but no. It's actually a pretty slick system.

The ribs are cap and web component in the center section, with a separate 1/4" plywood nose rib added. The nose rib is the only component with a curve; the center sections are all rectangular (though the plywood itself will be notched). The ribs go together as seen in Figure 16—the strips join the 1/8" plywood sheet and the 1/4" nose ribs, form-fitting around the broad "U" shape of the diagonal spar.

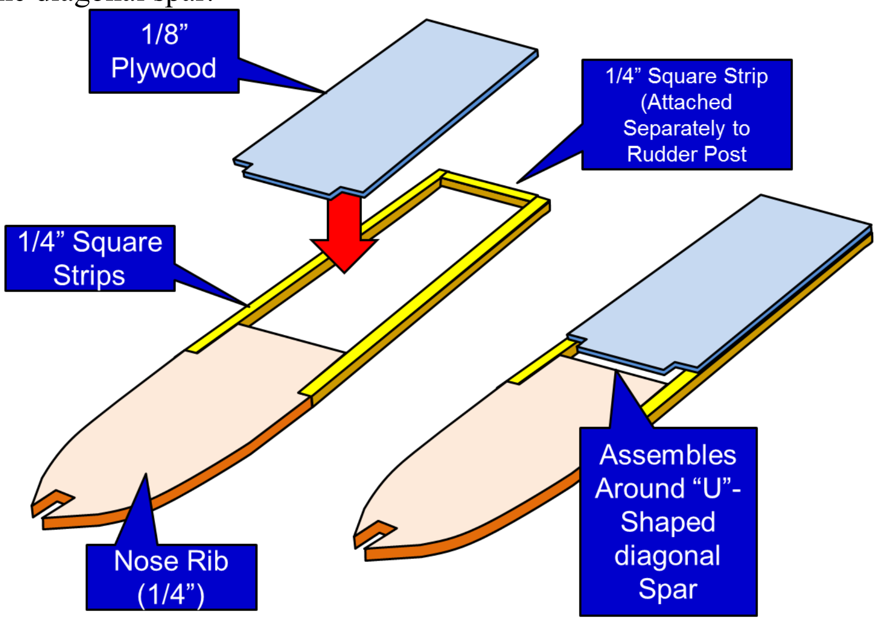


Figure 16: Fin Rib Layout

You'll notice that Pete provides templates for the nose ribs (Figure 3-2 on page 9 of Article 6) but doesn't tell you the dimensions for the plywood sheets. They're basically cut-to-fit; they're the width of the greatest width of each nose rib, but the length will be dependent upon where the rib is installed. Sample completed ribs are shown in Figure 17.

Figure 17: Completed Fin Ribs

Notice that there's something subtle in the ribs in the photo. The slot in the nose rib is slightly beveled. This makes since, since it accepts the leading edge at an angle. However, with modern epoxies, you'll be able to get a decent fit with a straight cut.

Note that the flat sheets aren't featureless. The bottom rib needs a pretty big slot for the elevator horn, and the two top ribs need some train holes. The nose ribs should have a drain hole, too. Watch the positioning of the drain holes; they have to be at least 1/4" from the edges of the sheet or they'll be plugged by the quarter-inch strips the sheet rests on.

While the majority of the ribs are cap and web construction, they're actually built onto the airplane rather than being assembled separately like the diagonal spar. Rib installation begins with a section of 1/4" strip attached across the rudder post at the locations shown in Figure 3-1 in Article 6. This strip is 1/2" narrower than the rudder post at that height. Might use nails or staples to hold this in place while the glue sets.

Two more 1/4" strips are then attached, between the cross-strip on the rudder post and across the sides of the diagonal spar (nail/staples probably a good idea, here). The 1/8" plywood sheet is then laid across this area. The front of the sheet is notched to fit along the 1/4" strips on the sides of the diagonal spar.

Finally, the nose rib is glued to the side strips and diagonal spar.

This sequence is summarized in Figure 18.

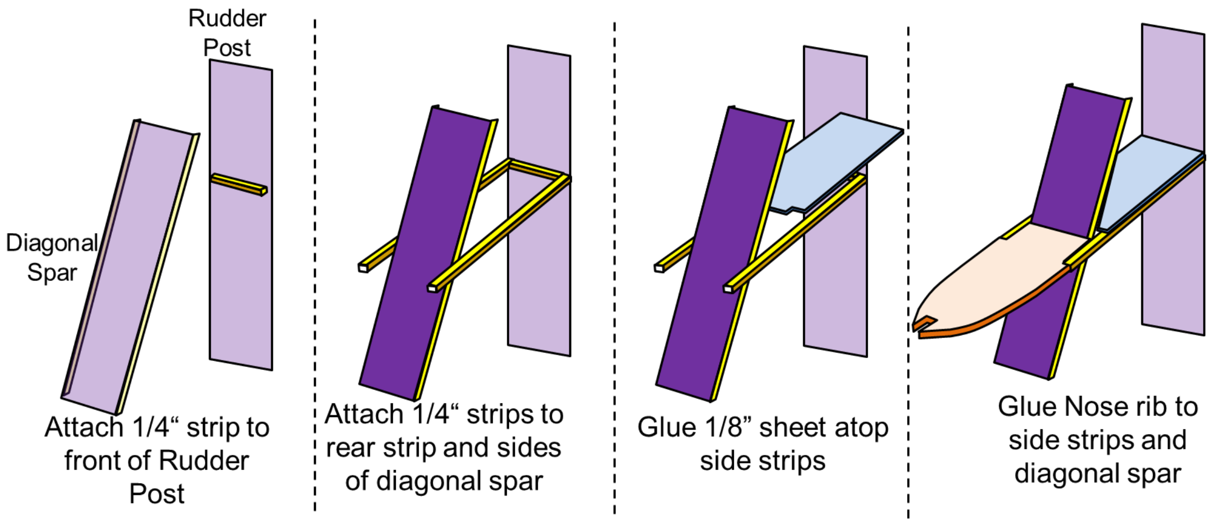


Figure 18: Fin Rib Assembly Sequence

The lower rib is actually a bit different—it rests on the top of the fuselage forward of the Station 8 bulkhead (Figure 19). It'll actually be on top of the aft fuselage. You'll add a small metal fairing before covering the fuselage and tail.

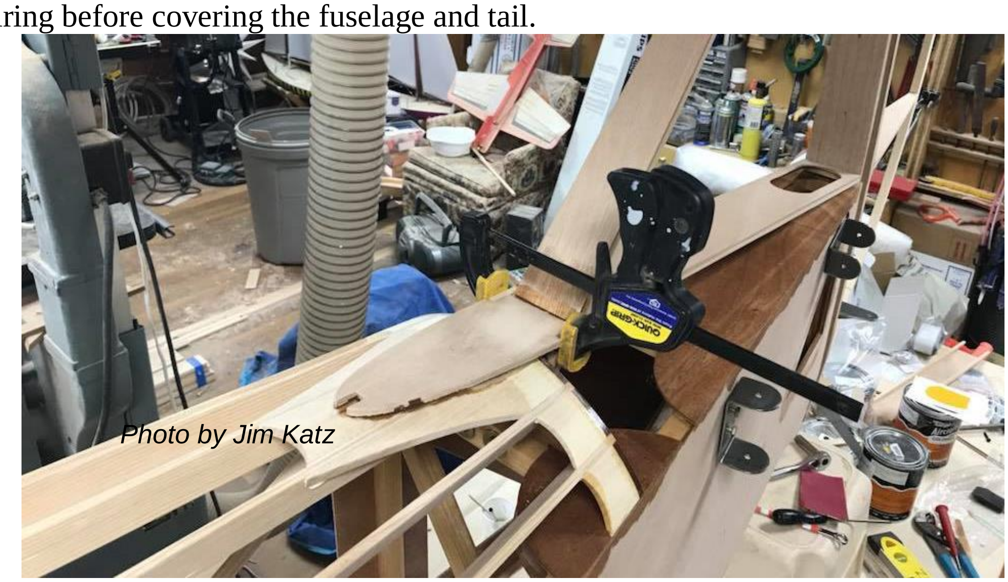


Figure 19: Lowest Fin Rib

5.1.3 Filler Strips

Glue 1/4” filler strips atop the diagonal spar between the ribs to make all the surfaces equal (Figure 20). Prior to covering the airframe with fabric, metal or plywood is wrapped around the leading edge of the fin to produce a smooth surface. The filler strips provide a continual surface for the wood or metal to attach to.

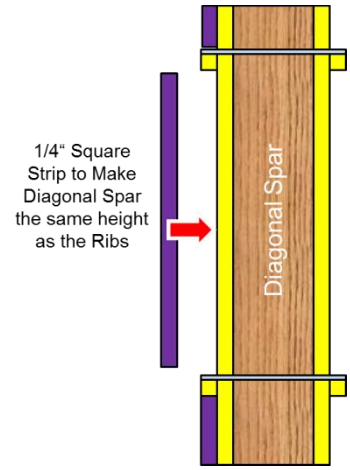


Figure 20: Filler Strips

5.1.4 Fin Leading Edge and Fin Tip

Next, add the leading edge and curved tip of the fin. The leading edge is 3/8” thick and 5/8” wide. Spruce is what Pete specifies, but traditional substitutes are of course acceptable. That big ‘ol hunk of wood won’t bend, of course, so it’s joined to a piece of 3/4” plywood cut to the desired tip shape (Figure 21).

Pete’s Figure 3-1 shows the two pieces joined in a near-conventional scarf joint. You could do this, or come up with some other way of joining the pieces. The main goal here is to just create a solid, pleasing line for the vertical stabilizer.

Pete’s Figure 3-1 shows the two pieces joined in a near-conventional scarf joint. You could do this, or come up with some other way of joining the pieces. The main goal here is to just create a solid, pleasing line for the vertical stabilizer. Once the glue dries, use hand or power tools to shape the tip into a smooth surface.

Figure 21: Fin Leading Edge and Curved Tip

Once the glue dries, use hand or power tools to shape the tip into a smooth surface (Figure 22).

Figure 22: Shaped Rudder Tip

5.2 Horizontal Stabilizers

Waitaminute. We just spend six pages looking at construction of the vertical stabilizer. Shouldn't we address the accompanying rudder, now?

Well, yes, we certainly could. That's the sequence Pete uses, both in the magazine article and in the plans.

I'm going to address it here, because the horizontal stabilizers are constructed very similarly to the vertical stab. It makes a little more sense to tackle these while the memory of the fin is still (perhaps painfully) fresh.

The horizontal stabilizers are a bit more complex than the fin. The rudder post for the fin was already in place on the aircraft; you're starting from scratch on the fins, needing to build a pair of main spars. The stabilizers include hard points for attaching the diagonal bracing wires as well as an optional block to secure the wings when folded. Since the stabilizers are bolted to the aircraft and are separable, there are hard points at the root where the brackets attach. In addition, there are closed-box section near the root for strength and to aid ground handling.

But there's the same sort of diagonal spar, and the ribs are built almost identically. The basic construction for the horizontal stabilizers is shown in Figure 23.

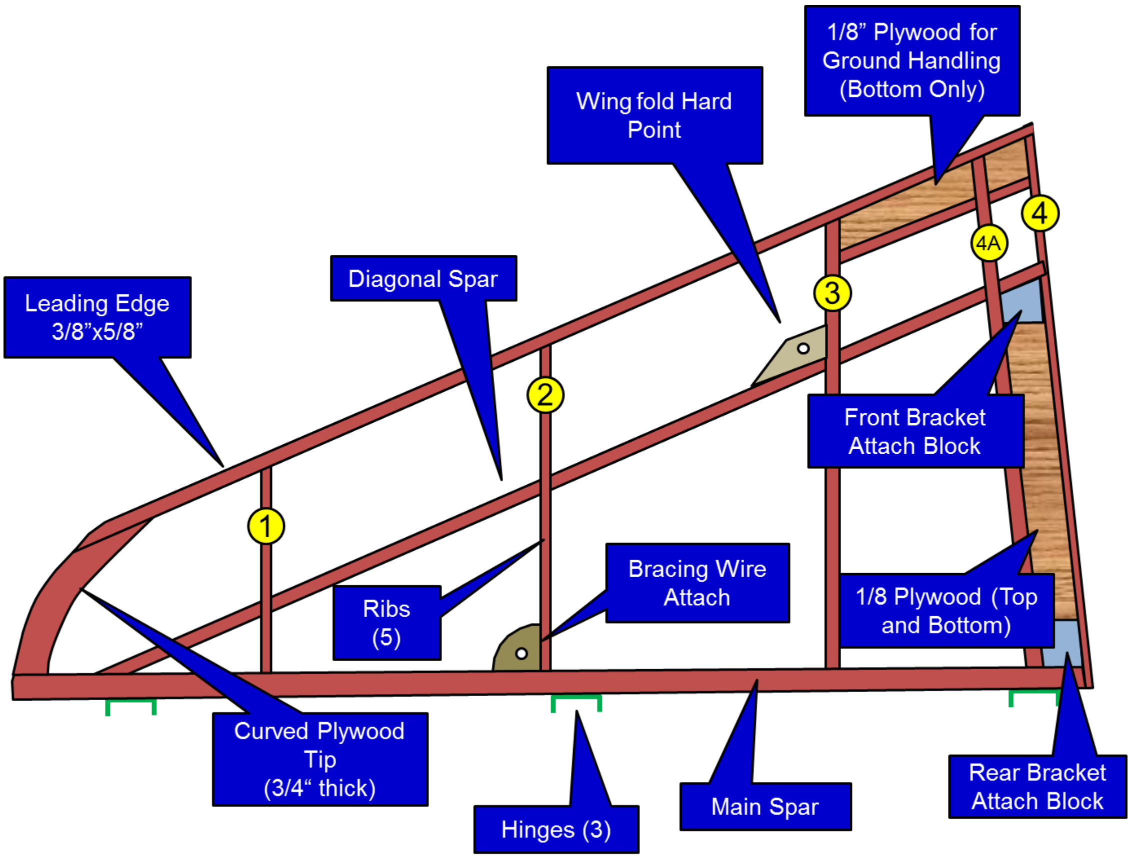


Figure 23: Horizontal Stabilizer Components

Most of the horizontal stabilizer components are cap and web construction. This includes the main spar, although the main spar uses 1/2" square spruce, instead of 1/4".

Figure 24 shows how the face sheets are oriented on the horizontal stabilizers. The yellow rectangles show the strips, while the heavy black lines show the 1/8" plywood sheets.

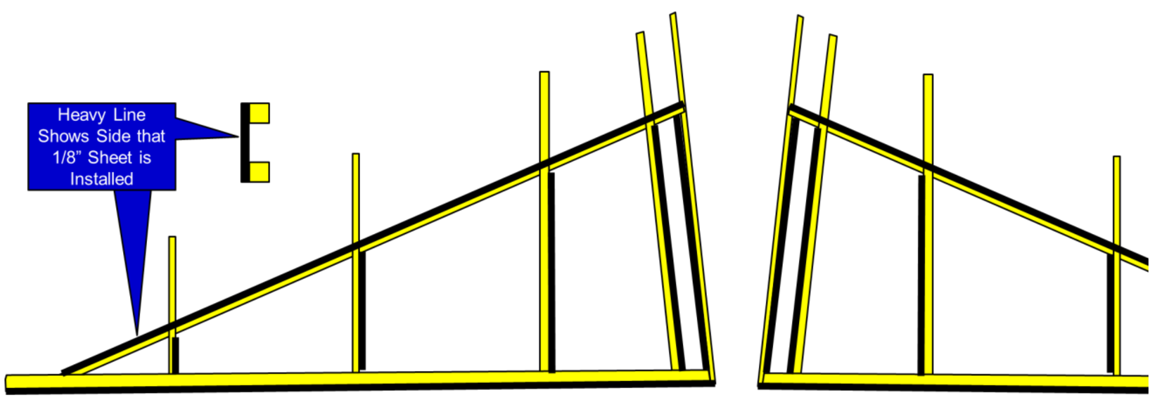


Figure 24: Face Sheet Orientation on Horizontal Stabilizers

So the strip and sheet for the main spars have the sheet on the aft side, and the diagonal ribs have it on the front. Most of the ribs have the sheet inboard; the exception is Rib 4 (the root rib) where it is on the outboard side.

5.2.1 Horizontal Stabilizer Spars

The horizontal stabilizer spars are made of strip and sheet construction, using 1/2” square spruce instead of 1/4”. Dimensions are per the top portion of Figure 3-6 in Article 6. It’s one inch wide at the tip, 2 5/8” wide at the root, and 46 inches long. Notice that the root end is relieved by 1/8”, as shown in Figure 25. This leaves space for the 1/8” plywood that’ll be installed between the two inboard ribs. This is shown on Figure 3-6, but due to the small size it isn’t all that clear.

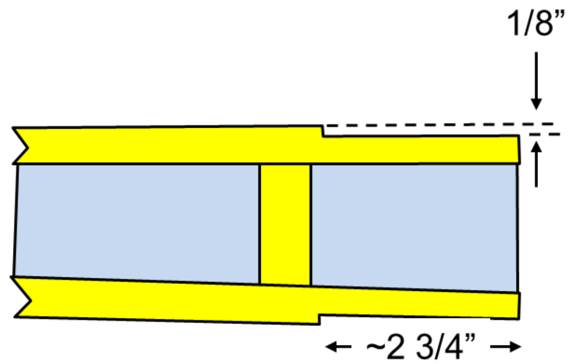


Figure 25: Detail of Spar Root

The figure shows this being 2 3/4 inches wide. Pete doesn’t say what the actual width of the relieved section should be, but that matches the spacing of the two inboard ribs and the similar relieved area on the diagonal spar.

Figure 3-6 shows several 1/2” thick blocks installed between the strips on the spar (one visible on Figure 25 above). These are basically to fill the flange of the spar where ribs and other components attach; giving it a true rectangular cross-section instead of the “C” flange shape. It lets the components glue to a lot broader area rather than just the two strips at the top and bottom.

One of the kinda weird things about the horizontal stabilizer spar is the fact that Pete doesn’t show these blocks where the hinges bolt to the stabilizer spar. He does show such reinforcement on the equivalent positions on the elevators themselves. Personally, I add some 2” wide 1/2” thick blocks at the appropriate locations.

5.2.2 Horizontal Stabilizer Diagonal Spar

The diagonal spar for the horizontal stabilizer is made like the one for the fin. It’s 11/16 inches wide at the tip, and $2^{1/8}$” wide at the base. As Figure 3-6 shows, it, too, needs to be relieved by 1/8” at the root end to accommodate the plywood planking at the root.

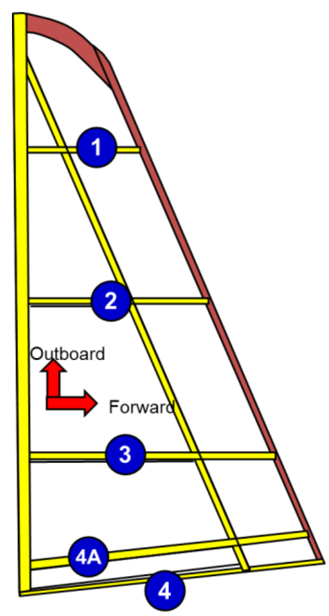


Figure 26: Rib Nomenclature

5.2.3 Horizontal Stabilizer Ribs 1-3

Ribs for the horizontal stabilizer are made the same way as those for the fin. The template for the 1/4” nose ribs is provided in Figure 3-2, and the main section of the rib are “strip and sheet” using a 1/8” plywood face sheet and two 1/4” wood strips.

The main section of the rib is, basically, rectangular. Like the vertical stabilizer ribs, the sheet will need to be notched. Since these are vertical, drain holes aren’t necessary.

On Ribs 1, 2, and 3 (the three outboard ribs) the sheet is the width of the nose ribs: $1^{3/8}$” for Rib 1, $1^{13/16}$” for Rib 2, and $2^{1/4}$” for Rib 3. This should correspond to the width of the spar at that location.

5.2.4 Horizontal Stabilizer Rib 4 and 4A

There are two ribs at the root of the stabilizer, installed $2^{3/4}$” apart. Rib 4 is the rib at the stabilizer root itself. Oddly enough, Pete didn’t assign a designation for the second, outboard rib. Let’s call it rib 4A.

After installation, the space between the two ribs is then covered with plywood to form a solid box structure. The height of the main spar and the diagonal spar in this area is actually relieved by 1/8" on top and bottom so the surface will be smooth after the plywood is in place.

Because of this, the "web" (center section) of the rib is not the same height at the nose rib. The rib height is the same height as the (relieved) main and diagonal spars at the installation location. For Rib 4, that's $2^{3/8}$". Rib 4A will be slightly less due to the taper of the spars—measure the actual height, and sand it down as necessary. Rib 4A also gets some ventilation holes, too.

The nose ribs for Ribs 1-3 have 1/4" notches on one side to fit the 1/4" strips on the center rib. Because of the center web is slightly less wide for Ribs 4 and 4A, the notches on the nose ribs is 3/4" deep. As Figure 27 shows, this leaves a nice little inlaid area to accept the 1/8" plywood. Note that the views of these two ribs are opposite… the 1/4" sticks (yellow rectangles on the figure) on Rib 4A would be on the OPPOSITE side, from this point of view. The installation is face sheet to face sheet (more explanation in a bit).

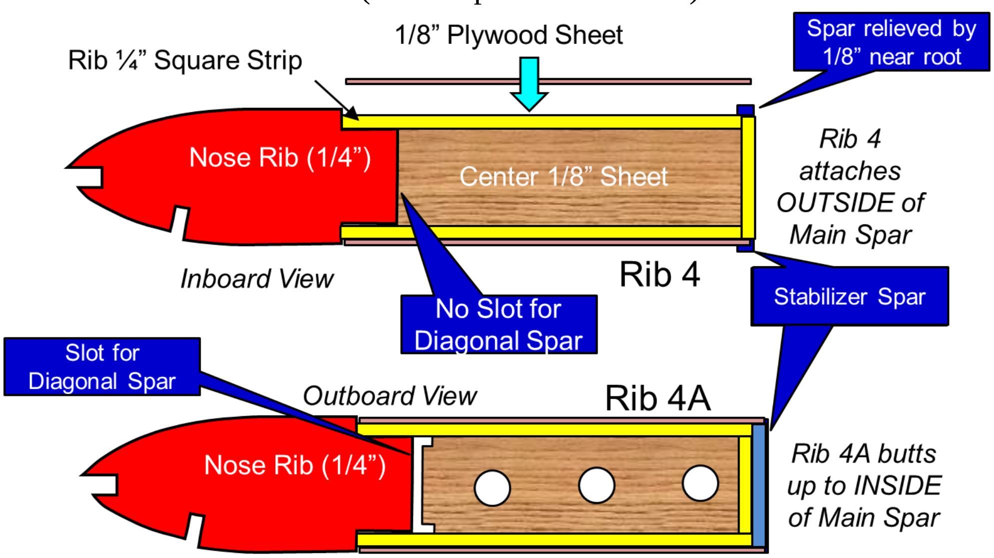


Figure 27: Horizontal Stabilizer Ribs 4 and 4A

Figure 27 highlights the differences between Ribs 4 and 4a. The main difference is that Rib 4, the one at the very root, installs on the outside of the spars, rather than against them like the fin ribs. So Rib 4 is actually ~1/2" longer to cover the butt end of the main spar.

Assemble the cap-and-web portion of Rib 4 before continuing with assembly. This is different from normal tail surface rib installation.

Rib 4A installation is performed like that of the fin ribs: Assembled in place. The short segment of 1/4" strip is attached to the spar, then the longer strips are laid into place. Finally the plywood web and the nose rib is added.

Finally (there's more?) since Rib 4 installs against the two spars, it doesn't need the "U"-shaped slot to accept the diagonal spar.

5.2.4.1 Rib 4 Length

OK, now here's a bit of weirdness. Pete doesn't specify the length of Rib 4.

Ribs 1-3 and Rib 4A are cut-to-fit; they are installed between the main spar and the diagonal spar.

But, as mentioned, Rib 4 gets installed outside the spars. So there's nothing really to reference length.

It'll be clear as we move ahead, but for now, make the cap and web for Rib 4 about 18 inches long. Don't install the cross-piece at the end, yet, since we'll cut this rib down as the final fit become clearer.

5.2.4.2 ALRIGHT, WHAT'S THE NOTCH?

Bugs ya, doesn't it?

You look at Figure 27 and see there's a weird notch under the rib. If you look at Figure 3-2, you'll see there's a similar notch under Rib 3.

What's going on?

It's pretty simple. You'll glue a glorified cap strip into these slots, across the three ribs, and apply 1/8" plywood from the underside of the diagonal spar to the leading edge.

It's a bit of reinforcement for ground handling. With this area reinforced, it'll make it easier to lift the tail to reposition the plane when you're working in your hangar.

5.2.5 Stabilizer Assembly

5.2.5.1 BASIC STRUCTURE

The fundamental structure of the horizontal stabilizers is the triangular connection of the main spar, the root rib (Rib 4) and the diagonal. Pete recommends a temporary assembly of these components first, using a few nails. Once the fit is verified, the nails can come out and the structure glued. The main structure of the stabilizers is symmetrical, so you can rig up a jig and use it for both units.

Both ends of the Diagonal spar and the end of the main spar will need to be beveled, but eyeball this as you're test-fitting the pieces.

Temporarily attach Rib 4 to the outside of the main spar and the diagonal spar, with the end of the plywood web 17 inches forward of the front face of the main spar. Then adjust the position of the free end of the diagonal spar up and down the main spar until the root rib has the two inches of offset as shown by Figure 28.

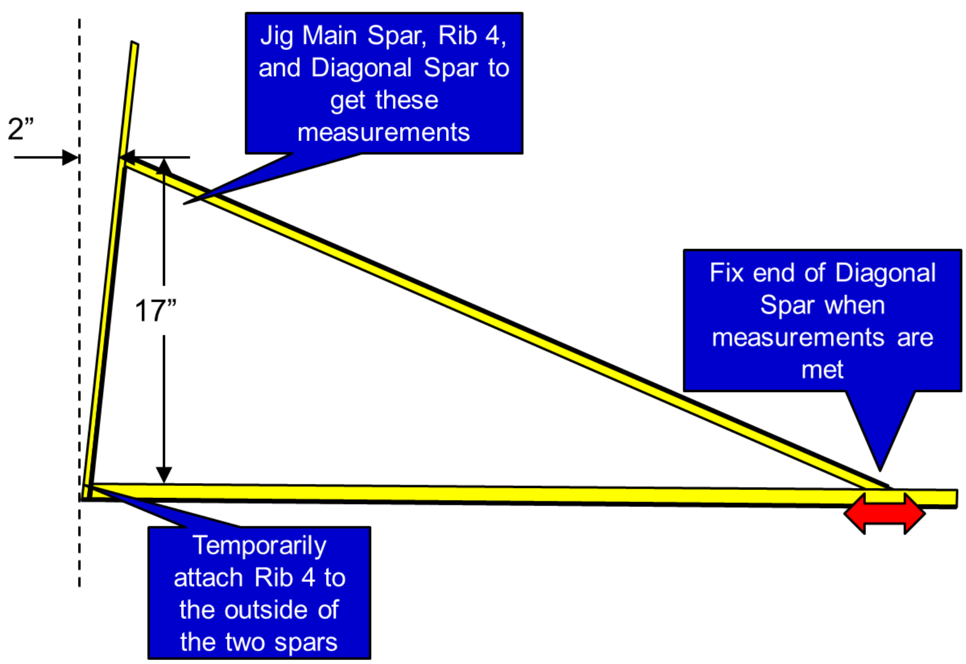


Figure 28: Stabilizer Fundamental Structure

Figure 29 shows another view of this process. The web of the diagonal spar should touch at the end of the web of Rib 4. The distance from this interface point to the front of the main spar should be seventeen inches.

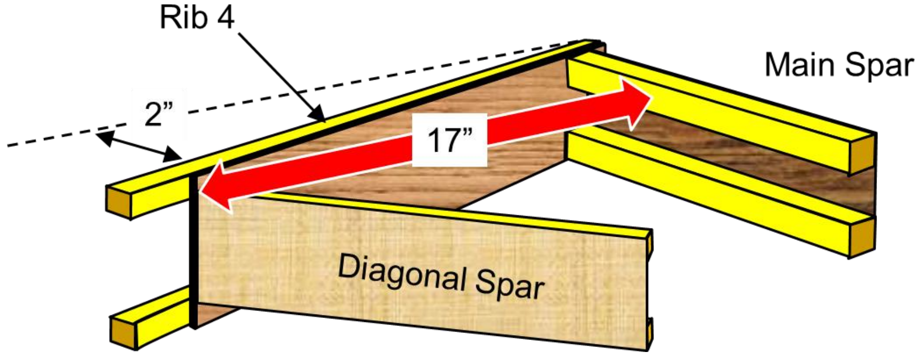


Figure 29: View of Rib 4/Diagonal Spar Interface

Because there are no right angles here, you’ll have to depend on the provided measurements. The only key issue is the angle between the main spar and Rib 4. If the diagonal rib is off a bit, that’s not a problem. But you need that two-inch offset to match the fuselage taper where the stabilizer mounts.

Use nails as temporary clamps to hold things in place and check the fit. Then glue it up. When the glue is cured, try a test-fit against the fuselage to see of the angle is about right. There are ways to correct minor errors. Trim off the extra length of Rib 4 (the length behind the main spar) and install the short cross-piece between the two caps.

5.2.6 Horizontal Stabilizer Ribs and Leading Edge

The rest of the assembly is mostly like the fig. Install the rest of the ribs, including the nose ribs. Lay-in the leading edge, and cut the curved section at the tip to the right shape and carve them to a smooth curvature (Figure 30).

Figure 30: Horizontal Stabilizer Tip (Pre-Carving)

5.2.6.1 FILLER STRIPS

Like on the fin, the diagonal spar needs filler strips added to raise its height equal to the ribs. Figure 31 illustrates this process.

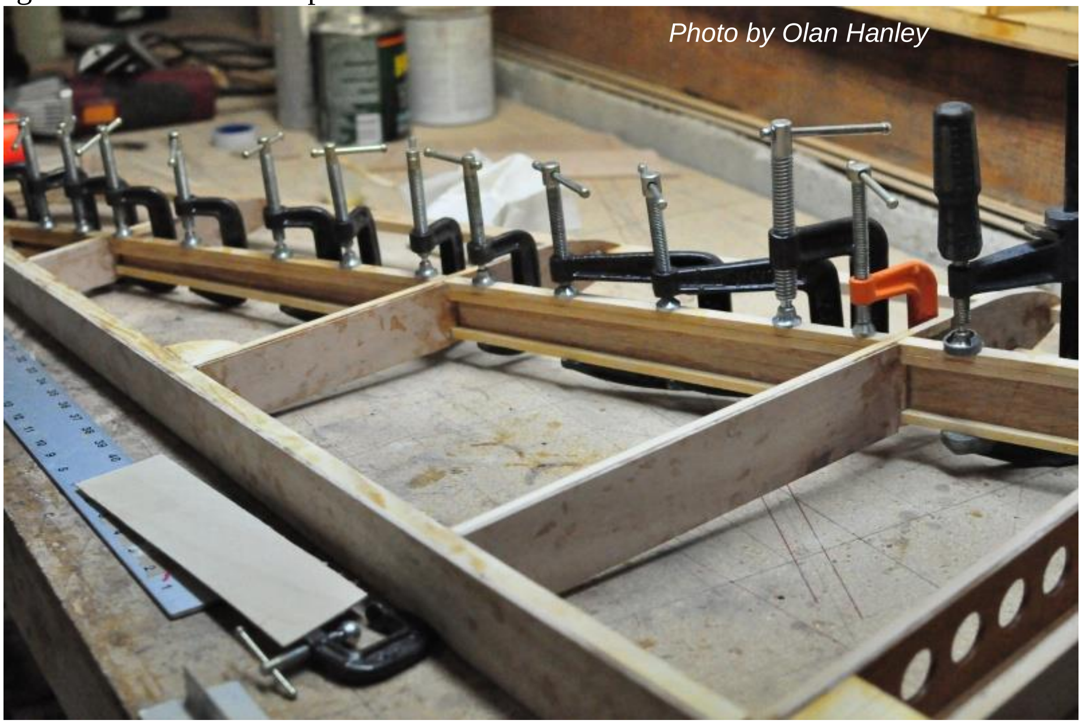


Figure 31: Installing Filler Strips atop the Diagonal Spar

5.2.7 Stabilizer Miscellaneous

Two more reinforcement blocks to be added, one mandatory, the other optional. They're both shown in Figure 3-6.

The wire anchor block is the mandatory one – you can see it in Figure 50. It tucks into the main spar and Rib #2, and is where the diagonal bracing wires attach. Obviously, this had to tuck inside the C-Shaped main spar, and thus either takes a single carved piece of wood or three sections glued together. As Figure 32 shows, we know the top and bottom are 1/2" thick (because that's the thickness of the spar cap) but since the spar tapers, the height between isn't something we can call out right now. Figure 33 shows a close-up view of a completed, installed block. You can see how the center portion goes between the spar caps.

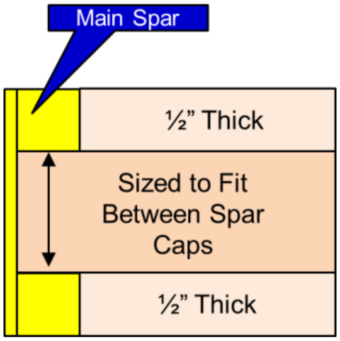


Figure 32: Wire Anchor Block Cross-Section

Figure 33: Wire Anchors

The second block is the wing fold pin block. Pete designed the wings to have a short section of threaded rod sticking out the leading edge. When the wings were folded, this rod would go through this reinforced area on the horizontal stabilizer and a nut applied to hold the wing tightly in the folded position.

I've seen few Fly Babies that actually HAD this block…or the rod in the leading edge.

One thing to keep in mind is the vertical shaking when the Fly Baby is being towed. I'm not sure I want the wings to be pounding down on the horizontal stabilizers.

I recommend you install this block, but don't drill it. That way, it's there if you ever need it, and you can probably drill it even when the plane is covered (with a reinforced patch applied afterwards).

(Hint: It also makes a jim-dandy hard point for mounting a GoPro….)

The wing fold pin block needs to be cut at a slant to match the diagonal spar and Rib #3.

5.3 Rudder Construction

The Fly Baby rudder is built with a box-type main spar, a curved shape achieved through using laminated strips, and ribs like the vertical stabilizer.

The rudder spar is shown in Figure 3-4 on Page 10 of Article 6. One-eighth inch face sheets, 1/2" cap strips, and hard points built in for bolting the hinges on. At the bottom of the spar, the cap strips won't bend to match the shape of the bottom of the spar, so run 'em off straight and fill the gap with a piece of 1/2" thick wood. Varnish the inside before closing it off.

Not much to add to Pete's description of the process of making the rudder bow, here. Draw out the rudder shape full scale on your workbench, cover with wax paper to keep from sticking to it, then lay out the shape using 1/8 inch by 5/8 inch wood. As Pete says, there's a LOT of these laminations, and just about any wood will do. There's ten laminations, and you can lay them up just like the ones for the wingtips. Clamp them and let them cure. Notice the nails in Figure 34; these are the ones used to set the position of the first strip.

Figure 34: Rudder Bow Construction

Jim Katz used an alternate approach. He made a form block from a piece of plywood and laid up the strips along the edge. The block had large holes cut in it to fit the clamps.

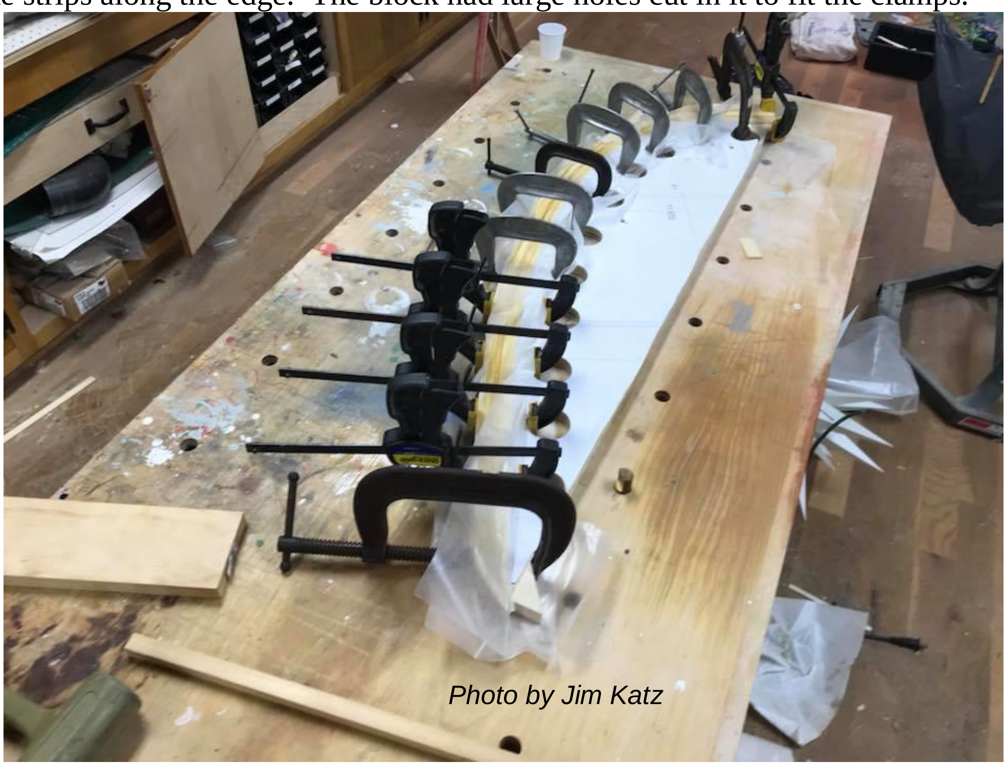


Figure 35: Form used for Alternate Lamination Process

Either approach should work. Unless you greatly deviate from the plot on Figure 3-4, the actual shape won't make that much difference.

When completed, cut the bow to match the top and bottom of the rudder spar, add the reinforcements (triangular wood shown in Figure 3-4). The ribs are similar to the vertical stabilizer, except there is no "nose rib" and they taper rather than being rectangular.

Pete shows the bow notched to accept the ribs. I'd do this with a razor saw and a 1/4" chisel.

Once all the glue is cured, shape the trailing edge in a fashion similar to the trimming of the main wing bows (Figure 36).

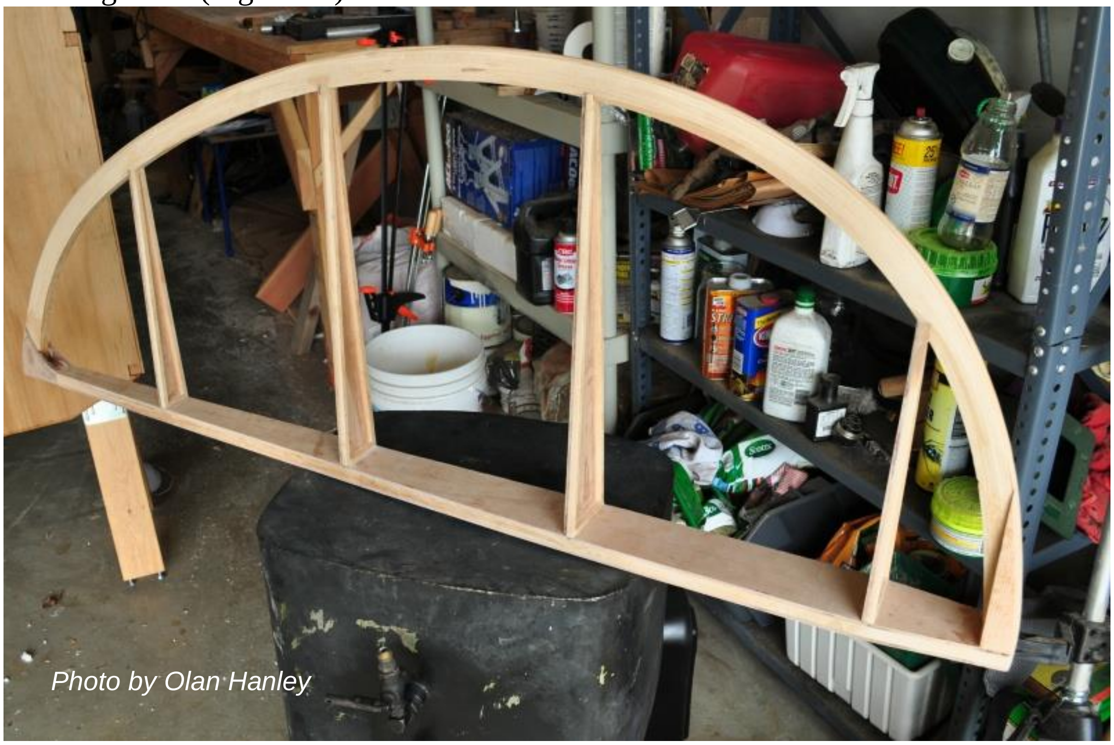


Figure 36: Completed Rudder

5.4 Elevator Construction

The elevators? You've completed the rudder, go thou and do likewise. Only twice.

The spars, shown in Figure 3-7, are similar. Again, you've got a box structure with 1/8" face sheets and 1/4" cap strips between them. You'll relieve by 1/8" the last two inches of the top and bottom of the root of the elevator spars (for the usual reason…later attachment of plywood sheet). The root of the elevator spar has a 4-inch long reinforcement block. You might make this a little longer, depending on where you end up installing the innermost hinge (See Section 5.5.6).

The only thing is, the bow doesn't run the full length. As Figure 3-7 on Page 11 shows, the elevator has basically a "notch" at the root to clear the rudder travel. This is composed of a diagonal rib that attaches to the end of a stub rib. The inner stub rib and the diagonal rib are added once the spar, elevator bow, and the longest rib have been glued together. Figure 37 shows how the weight of two water-filled plastic bottles could be used to hold the bow in contact with the main inner rib.

Also, at the root, the width of the elevator spars have to be shaved 1/8” per side for two inches to allow plywood to be glued.

Figure 37: Elevator Construction

Once the glue is set, add the short root rib and the diagonal root rib. There’s a pair of triangular pieces of plywood applied on the top of the root ribs. Don’t install those yet; you’ll need to get the metal parts in place, first.

5.5 The Metal Parts

5.5.1 Hinges

The hinges are made from 4130 steel, 0.064” minimum. Construction is shown in Figure 3-5 on Page 10 of Article 6. Eighteen total hinge assemblies are necessary, with each assembly consisting of two halves. Nine pieces have $2^{1/8}$” between the bends, nine have 2”. This allows the hinge halves to overlap each other, as seen in Figure 39. Usual practice is to install the “wide” hinges on the stabilizer or fin spars.

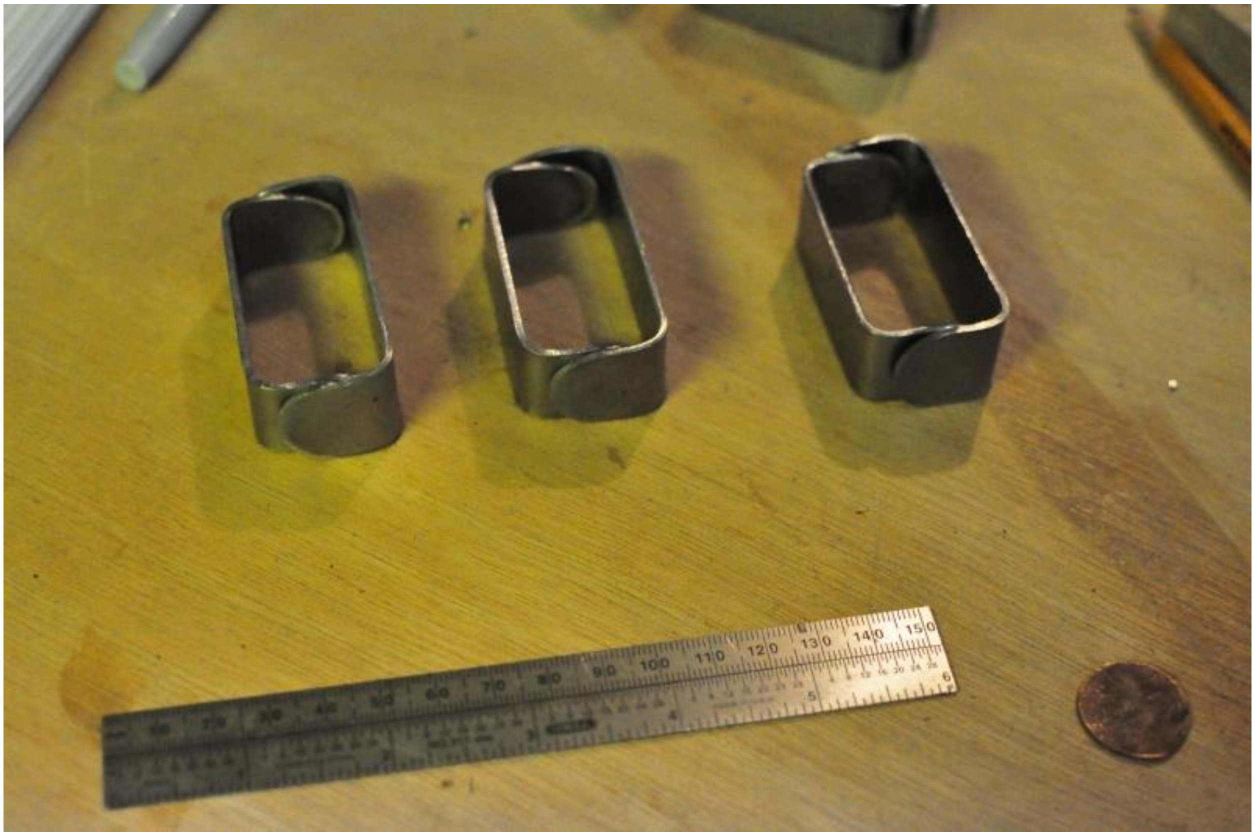


Figure 39: Hinges

Mark the holes to drill prior to bending the hinge pieces; you might even consider drilling the pilot-drilling the holes before forming them.

Ideally, there'll be no variation in the hinge pieces. Practically, of course, there may be some small variation. When you're doing test fitting, it's probably a good idea to mark the hinges so they go back to the same locations for final installation.

Each hinge assembly receives an AN394-81 clevis pin as the hinge pin. You might be tempted to use an AN4 bolt instead. If so, use a drilled bolt and NOT a self-locking nut. The hinge action will cause the nut to back off. Since you have to use a cotter pin anyway, might as well use the specified clevis pin.

Each surface has three hinge assemblies, and of course it's vital that the center axes of these assemblies line up! Figure 38 shows how to do this; use a long piece of 1/4" rod to line up all the holes prior to drilling into the spars. The WIDE hinge units get installed to the stabilizers, while the narrow ones will be attached to the rudder and elevators.

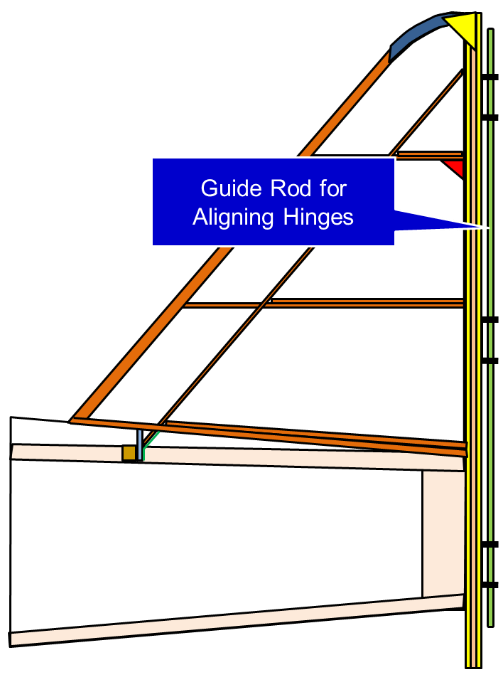


Figure 38: Hinge Installation

You shouldn't need the long rod when installing the other side of the hinges. Ensure they're bolted to the stabilizer spar, then run the clevis pin through them to have them in position while marking the holes to drill on the rudder or elevator spar. The hinges are attached using AN3 (3/16”) bolts. Probably AN3-12A, but check that length. Figure 40 shows a hinge in position.

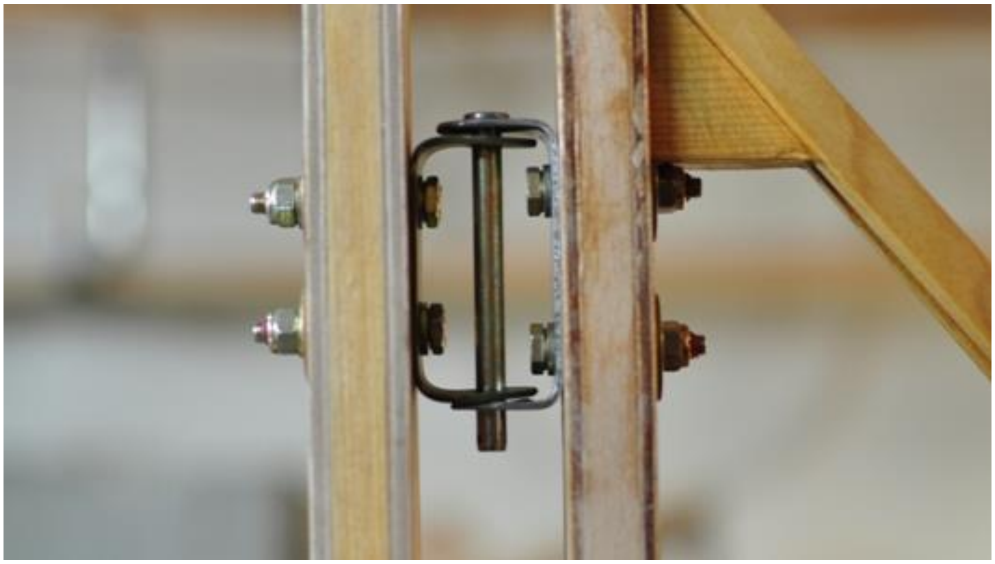


Figure 40: Installed Hinge

Now…Pete has you use ordinary locking nuts (AN365) to hold the hinges in place. You might consider using anchor plates, instead…this would allow you to remove and replace the hinges will little trouble, once the surfaces are covered with fabric.

And, of course: Paint the hinges, and ensure the wood beneath them is varnished, before you assemble them for the last time.

Install the rudder hinges at this time, but hold off a bit on the horizontal stabilizer.

5.5.2 Horizontal Stabilizer Attachment Fittings

The horizontal stabilizers are held to the fuselage by simple C-shaped fittings. They’re attached to the fuselage and bolt vertically through the solid blocks that were glued into the root area of the stabilizers (Figure 41). You can also see them in place back on Figure 50.

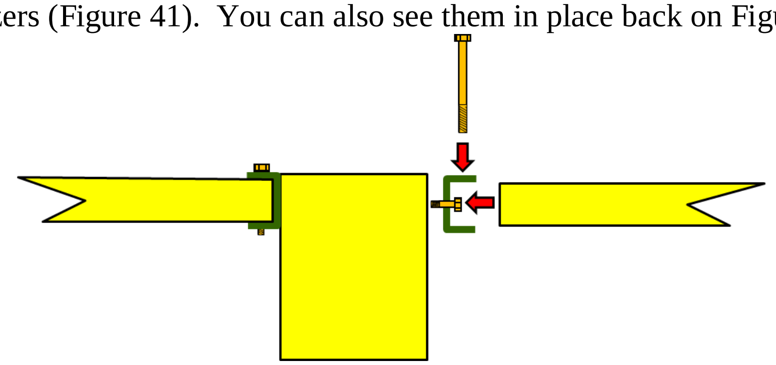


Figure 41: Stabilizer Attachment

You might be puzzled at the multiple holes Pete says to drill in the center section of these brackets. It’s simple…the small pair (3/16”) is used on the forward bracket, and the aft bracket is held on with a single 1/4” bolt. Figure 42 shows how this works. Make two of each kind of bracket; leave off the excess hole(s).

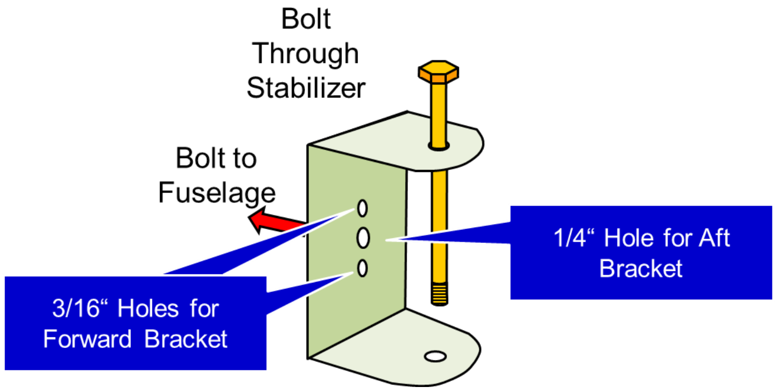


Figure 42: Horizontal Stabilizer Attachment Brackets

The hole in the top and bottom of the brackets are sized for an AN3 bolt (3/16"). Consider only pilot-hole-drilling this, to, say 1/8". It may make things a bit tighter later.

5.5.3 Brace Wire Attachment Fitting

The brace wires on the tail provide most of the strength for the horizontal stabilizer. Steel fittings are installed on the fin and the horizontal stabilizer for attaching the braces. The fit fitting sits atop the uppermost rib, and is bolted to the rudder post. There's a triangular reinforcement block added below, as well (Figure 43).

Figure 43: Fin Brace Wire Attach Fitting

On the horizontal stabilizer, a bolt through the wire anchor blocks has metal tangs top and bottom. The patterns for fin fitting and the horizontal stabilizer tangs are included in Figure 3-5 on page 10 of Article 6.

Brace cables are attached from the fin to the top of each horizontal stabilizer, and from the bottom of the stabilizers to the lower fuselage (Figure 44). The attachment to the lower fuselage is addressed in Section 5.6.7.

5.5.4 Elevator Hardware

When steel parts have been discussed in the past, it has been assumed that good practices have been used in assembling them, and that good-quality welds hold them together.

Nowhere is this more necessary than on the control hardware, and the elevator includes key elements of it.

The elevator system consists of two horn brackets that attach inside the elevators, two control horns that install between the elevator and the fuselage, and a control cable horn inside the fuselage.

The outer horn plates transmit the control load to the spar.

The control horn components bolt to either side of the innermost elevator rib, and the inner one include a short segment of tubing. This tubing slides over smaller tubing welded to the Elevator Control Cable Horn in the fuselage. Both elevators tie into this horn, a pair of 1/4” (AN4) cross-bolt holds the units together. Cables from the cockpit attach to the central horn. This system is illustrated in Figure 45.

Figure 44: Tail Bracing

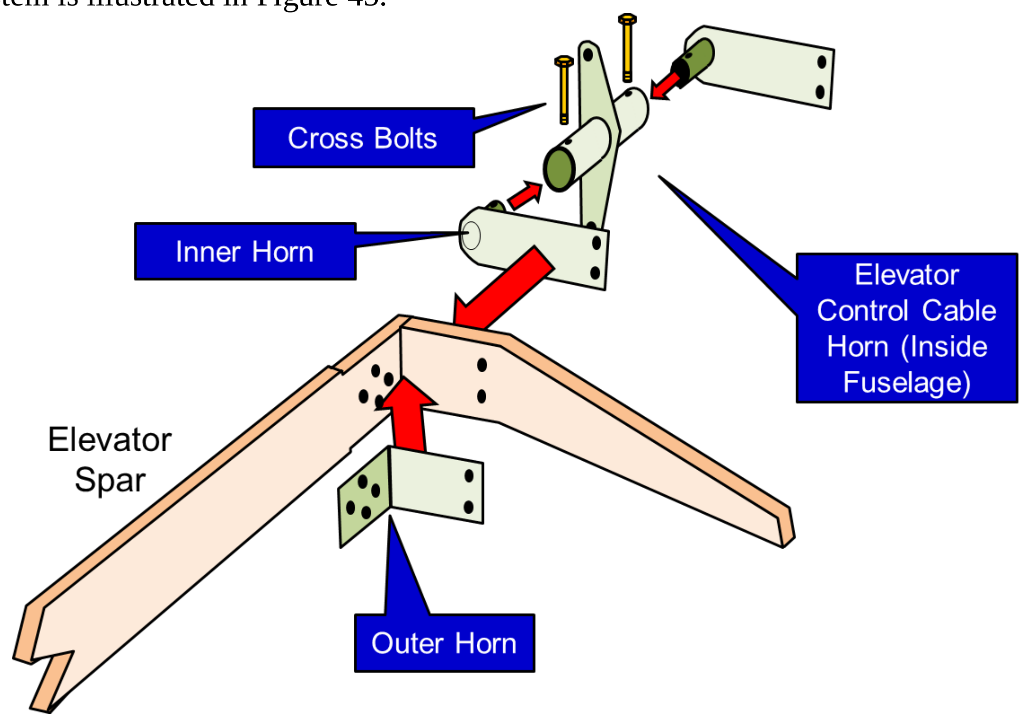


Figure 45: Elevator Control System

Pete has you weld or braze the two bolts in the side-facing end of the outer horn. This puts the nut in the open (e.g., outside the elevator) and facilitates removal of the hardware.

The instructions (Figure 3-8) calls for AN4-7 bolts to be welded or brazed in place. However, there has been a report that an AN4-7 bolt is too long; the builder was forced to add shims. The lesson here is to not weld or braze these bolts until their length has been confirmed.

The Elevator Control Cable Horn doesn’t attach to anything BUT the elevator horns; it’s free-floating inside the fuselage.

When you build the elevator control horns, only pilot-drill the cross-bolt holes (e.g., 1/8” or so). These will need to be drilled in place with both elevators to ensure they’re at the same angle.

The bolts that attach the outer horn to the elevator also hold the innermost hinge. This is shown in Figure 46.

Figure 46: Elevator Control Horn and Elevator Hinge

Install the elevator control hardware, and then you're ready for installing the hinges The builder in this case added a third bolt between the inner and outer elevator horns.

5.5.5 Stabilizer Hinges

At this point, you're ready to install the hinges on the horizontal stabilizer and elevators, and close out the tail parts.

We've waited so far because the position of the innermost hinge is set by holes in the outer elevator control horn. Install the inner hinge on the elevator, then attach the other two hinges to the elevator, using the guide rod as described earlier. Temporarily install the other halves of each hinge with a long bolt or clevis pin.

Lay the horizontal stabilizer on the work table, and place the elevator into position. Then mark the drill location for the hinge holes on the stabilizer main spar. If you've used the guide rod to install the elevator hinges, the stabilizer-side hinges should line up properly. Use anchor nuts for the inboard hinge…and it's not a bad idea for the rest of them, either.

When fitting the elevator to the horizontal stabilizer, there's a potential for a bit of interference between the elevator horn and the stabilizer spar. Pete says to just cut into the rear face of the spar as needed for proper fit.

5.5.6 Stabilizer Root Section Close-Out

All right, you're probably wondering. There's been a lot of unfinished work on the horizontal stabilizers. Why have we waited?

The horizontal stabilizers have a box-in section at the root, using 1/8" plywood to close in the area. Figure 47 shows the layout. Cut two pieces of 1/8" plywood to run from behind the nose ribs to over the top of the spar. Just fit them for now, because there's some important work that needs to be done.

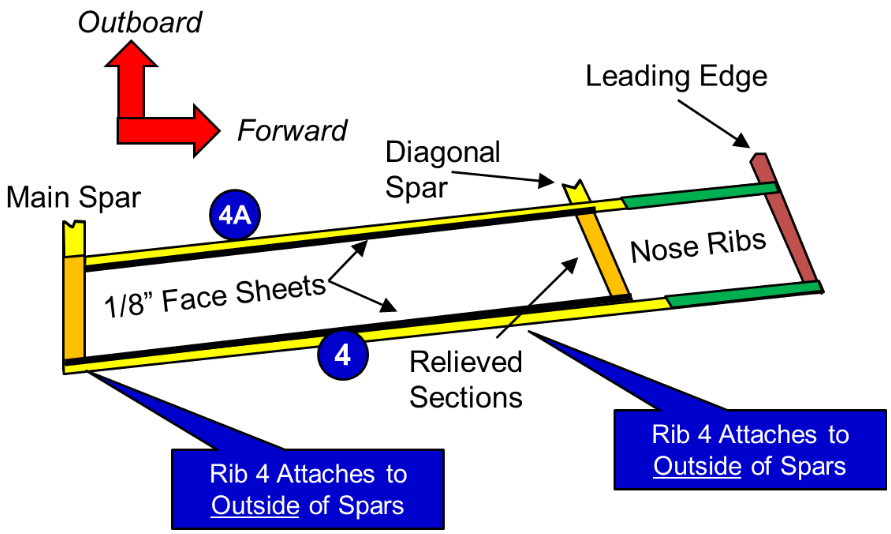


Figure 47: Horizontal Stabilizer Boxed-In Area

Your root section is just about ready to cover, but the filler blocks need to be installed. The blocks glue in between Ribs 4 and 4A, and either the main or diagonal spar. They are solid blocks of wood, roughly two inches square, that are just as high as the spar and ribs in the area they're installed in. They're very visible in Figure 48.

Figure 48: Root Section with Filler Blocks

These provide a solid connection to the stabilizer structure for the brackets that attach the stabilizers to the fuselage. These are mostly in compression, so if the blocks end up not quite high enough, you can glue thin plywood to the top or bottom.

Now, you should be able to see why we've waited up until now.

Notice the two holes in the main spar, at the lower right of the image. These are for bolting the innermost hinge in place. Notice one of the holes (which actually has a bolt in it) actually seems to go INTO the block.

So the hinges need to be installed before the spar root area is closed out. Even so, you can't just willy-nilly glue a block in here. Not only does it have to be cut to slide inside the caps on the spar, it has to leave space for the nut plate for the hinge. AND you have to remember to add that nut plate before gluing the block in place!

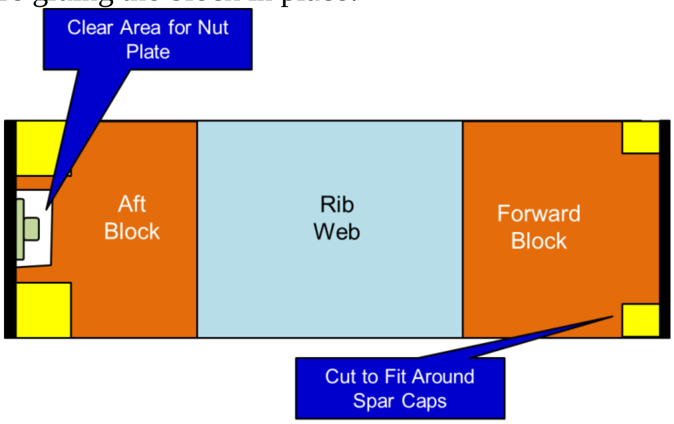


Figure 49: Stabilizer Blocks

Now you know why we waited for this portion.

There are two alternatives. First, just install the block and drill a hole all the way through it for the hinge bolt. This is actually what Pete says to do in the construction article. It's probably easier, though I kind of rebel at using an unnecessary ~$2^{1/2}$" bolt.

Or…do like the builder in Figure 50 and move your innermost hinges slightly outboard to clear the block. This might require the front arm of the inner elevator horn bracket to be lengthened, or you can just have the second hole through the wood, as long as you remembered to widen the reinforcement block between the sheets

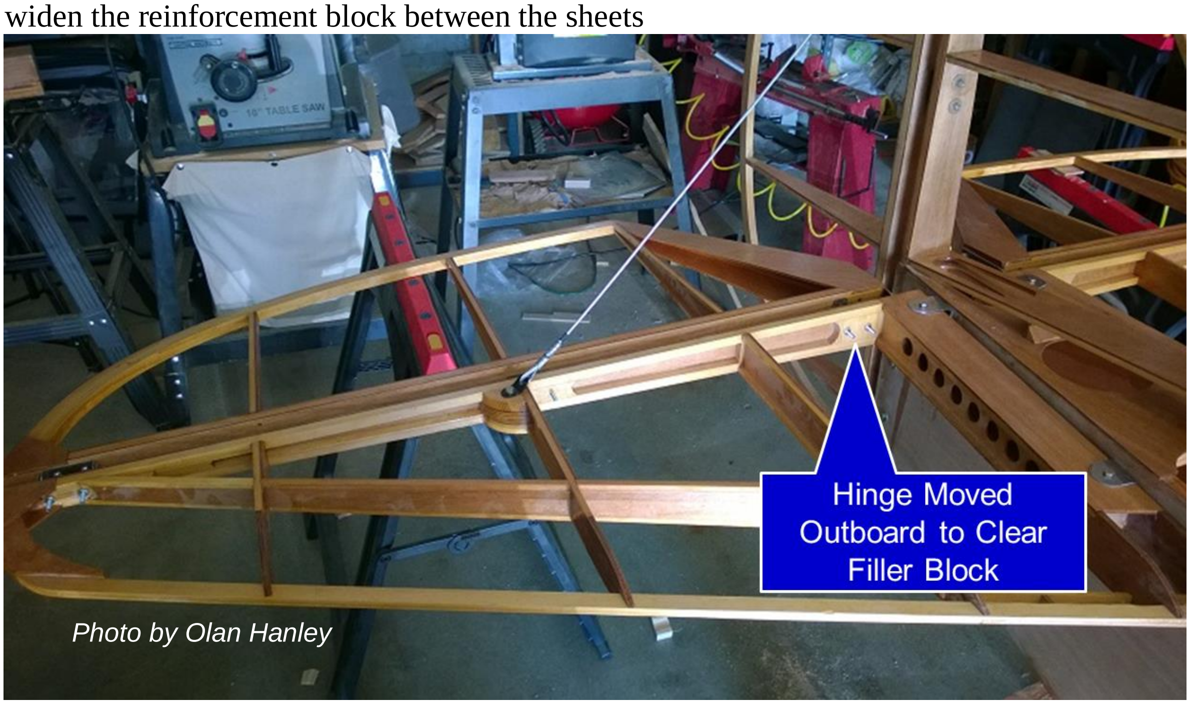


Figure 50: Moved Inner Hinge

Once the blocks are in place, varnish the inside and glue the top and bottom plywood in place.

Varnish the elevators, except the portion atop the root section. Paint all the elevator hardware and install it. Then glue 1/8 plywood down per Figure 3-7 and Figure 51.

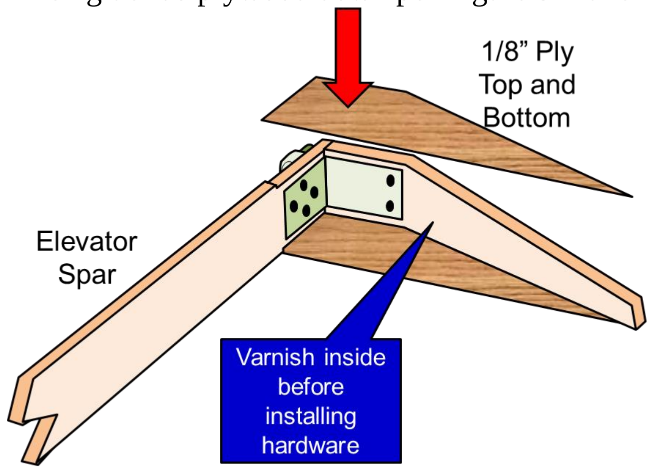


Figure 51: Elevator Root Plywood

5.5.7 Tail-Lift Support

We talked earlier about the weird notches on the bottom of Ribs 3, 4, and 4A, the innermost ribs. The curvature of the bottom of those ribs is relieved slightly…by that same 1/8" that must be haunting you right now.

These notches accept piece of wood 1/4" x 1/2" spanning across them then plywood is added from lower nose to the leading edge. By adding the reinforcement here, you have a "hard point" that you can use to pick up the tail.

It's a nice little feature, illustrated in Figure 52. It's also visible in Figure 48.

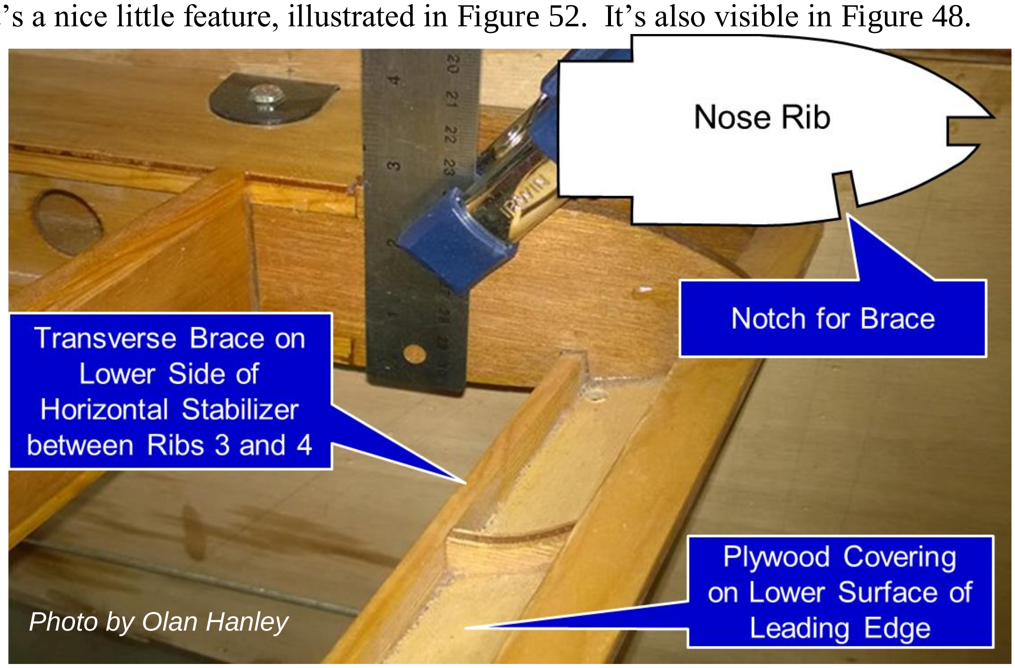


Figure 52: Horizontal Stabilizer Lift Support

5.6 Stabilizer Installation

Pete ran out of room in the June 1963 issue; stabilizer installation was combined with Powerplant installation in Article 7 in July.

On the surface of it, stabilizer installation seems easy…just bolt the stabilizers into the "C" brackets added to the fuselage, add the elevators, then add the bracing wires (Figure 53).

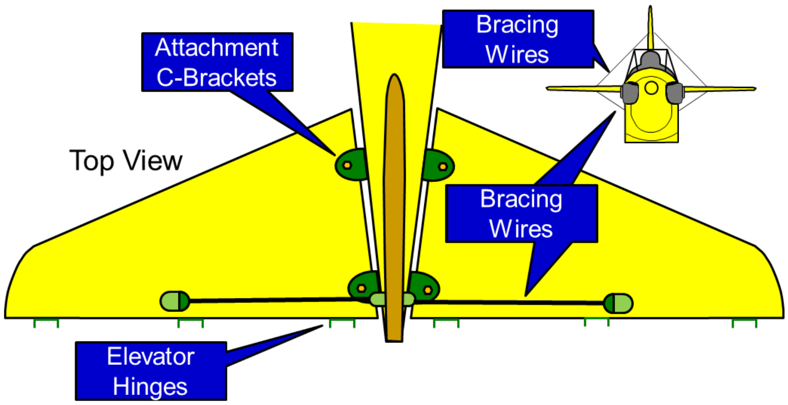


Figure 53: Horizontal Stabilizer Installation

Consider, though: What is the purpose of the horizontal stabilizer? An aerodynamicist will point to their vital contribution to providing pitch stability.

Certainly true. But from the pilot's point of view, the main purpose of the horizontal stabilizer is to support the elevator assembly.

Remember: The elevator *assembly*. Because those two elevators you built are going to be bolted to each other, joined by the elevator control cable horn. Each elevator has a horn with a short segment of tubing; these two pieces of tubing are slid over the 1" tube at the center of the control cable horn (Figure 54). Obviously, the elevator horns have to be precisely welded to ensure the hinge axes of the two elevators are aligned.

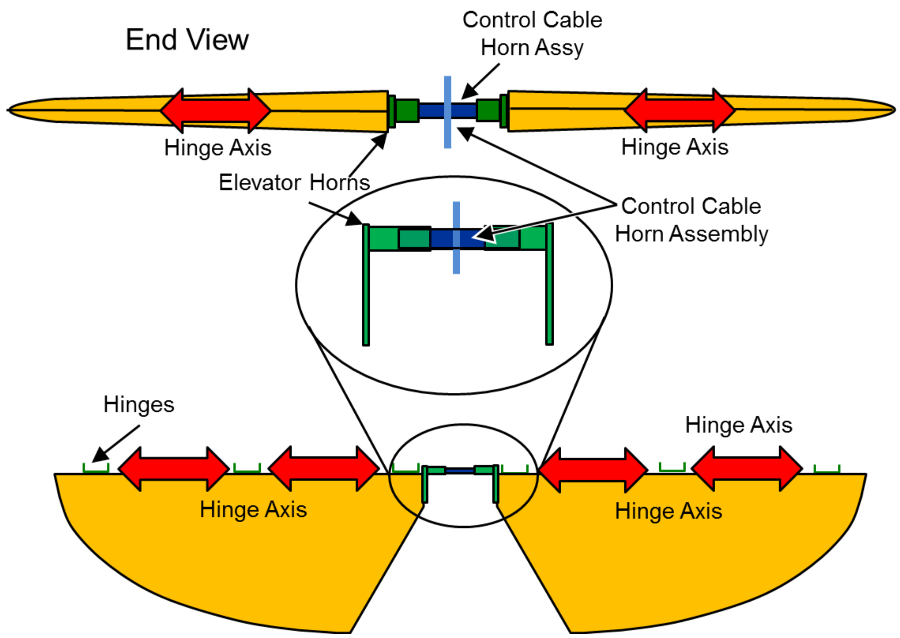


Figure 54: Elevator Assembly

Figure 55 shows some examples of how errors in stabilizer installation might affect elevator operation. If the tip of one stabilizer is slightly forward (center illustration) the hinge axis is thrown off you can't even connect the other half of the elevator to its hinges. Even if you were to push the other stabilizer's tip back to compensate (right image), the big bellcrank in the fuselage (the control cable horn) is now twisted slightly to one side.

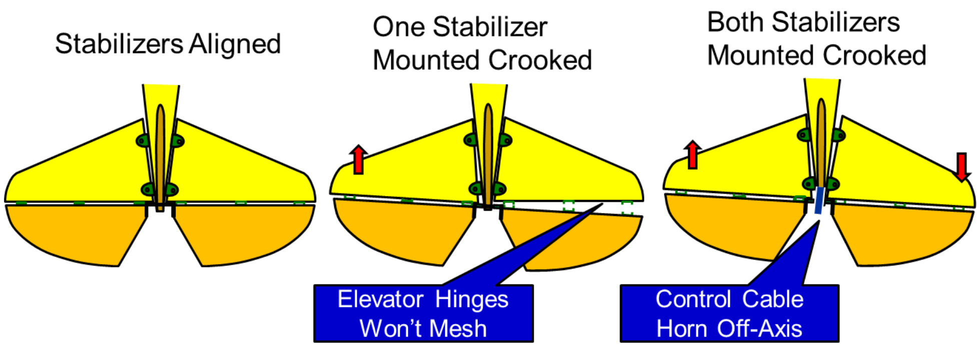


Figure 55: Sample Installation Errors

The stabilizers are supported by the bracing wires, and, obviously, problems here produce the same kind of mismatches. A stabilizer that droops, for instance, will again cause the hinge axes for the elevators to be misaligned.

Okay, it's critical. On the plus side, the C-brackets will support the stabilizers without bolting to them so you can get the positioning right prior to drilling, and it's certainly easy enough to rig up temporary bracing cables. However, this is probably not a job you can tackle alone. Get a helper or two.

Let's get started.

5.6.1 Control Horn Pass-Through Hole

First step is to cut a pair of holes through the fuselage, as shown in Figure 3-2. These are $1^{1/4}$" in diameter, so an ordinary hole saw will do the trick. Figure 3-2 is a bit busy, so I've reproduced the dimensions in Figure 56.

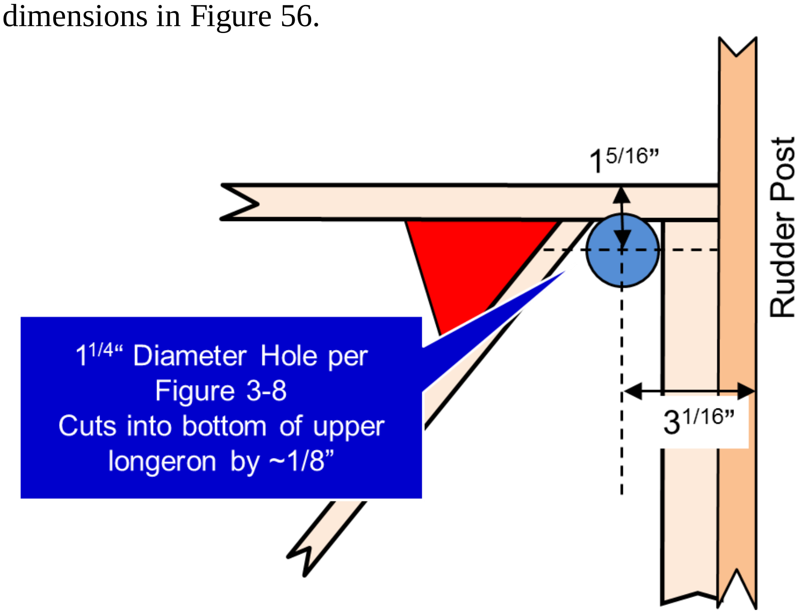


Figure 56: Control Horn Pass-Through Hole

Note that this position will actually carve a bit from the bottom of the upper longerons. You will, of course, varnish these locations after cutting the hole.

5.6.2 Installing C-Brackets

The C-Brackets are the brackets that actually hold the stabilizers to the fuselage. They bolt to hard points that were included in fuselage assembly, and, when all the positions are set, bolts go vertically through the top and bottom, through the big filler blocks included in the stabilizer roots.

Now…recall that Pete changed some dimensions here. He did correct them in Article 7, Figure 3-9. So assume Figure 3-9 is correct.

The top of the rear bracket is installed so the upper face is even with the top of the longeron. The top of the forward bracket is 5/8" lower than the top of the longeron. This is shown in Figure 57.

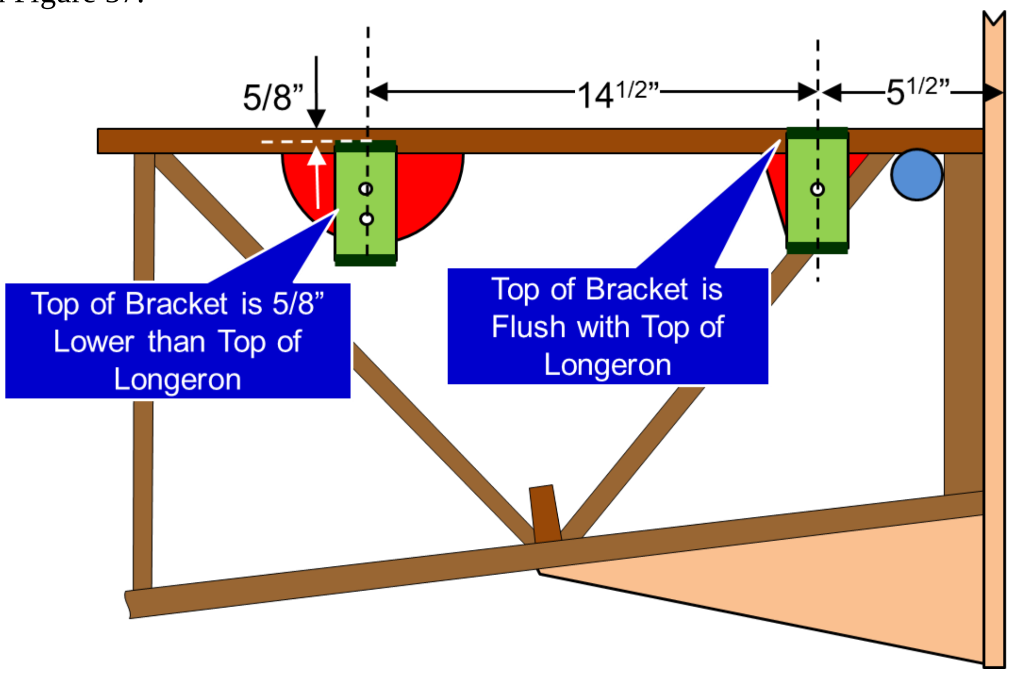


Figure 57: C-Bracket Positioning

Note that the front bracket has two bolt holes. They're 3/16", while the single rear bolt hole is 1/4". Thinking about it, when mounting the front bracket, I'd just drill the top 3/16" hole for now. That'll let the bracket pivot a bit if needed; add the second bolt when everything else is drilled.

5.6.3 Placing the First Horizontal Stabilizer

Rig up a temporary support wire, using the existing support on the rudder and an eyebolt or something through the stabilizer anchor bolt hole. You'll need to be able to adjust this.

Lift the left horizontal stabilizer in place. Seat it fully into the brackets.

The rear face of the stabilizer spar should be $3^{3/4}$" forward of the rear face of the tail post, as shown on the lower half of Figure 3-9 in Article 7. It should also be one inch forward of the centerline of the pass-through hole (Figure 58). Support the stabilizer with a temporary brace wire or a floor stand.

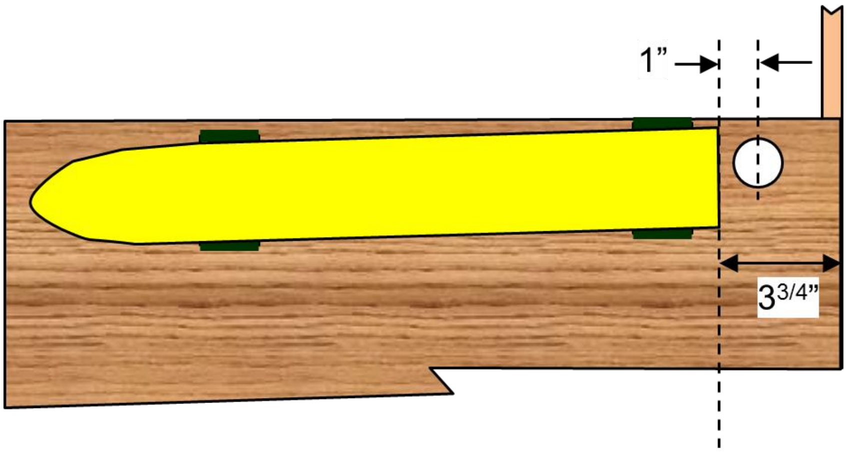


Figure 58: Stabilizer Positioning

As mentioned, add some support to the stabilizer to hold it in place.

5.6.4 Adding the Elevator

Next step will be to attach the elevator to the stabilizer via the hinges.

Before doing that, though, insert the cable horn into the fuselage so it’s ready to accept the tubes on the elevator horns.

Here’s an idea, though: Instead of using the cable horn, why not use just a plain piece of 1” OD tubing 6 1/4” long (same size as the cable horn tube)? This will be easier to manipulate through the attachment process.

As an additional fillip, consider sliding a short piece of 1 1/4 OD, 1” ID tubing over it…just long enough to go across the fuselage, via the holes you just cut.

With this setup, you know the elevator hinge line will be centered in the drilled holes…since it won’t fit in any other fashion.

This probably isn’t necessary, as you should be able to eyeball the centering of the elevator tubes. But might not be a bad thing to try.

Anyway, when you’re ready, attach the elevator to the stabilizer using the hinge pins. Slide the tube from the elevator horn over the cable horn tube (or the substitute). Use a couple of thin pieces of wood and C-clamps to hold the elevator in approximately the neutral position.

With the elevator connected to it, the cable horn tube should go straight through the middle of both holes in the fuselage side. Adjust the connection angle of the horizontal stabilizer to make this happen. Trim the 1/4” caps on the inner rib of the stabilizer to get it evenly matched with the fuselage side.

Don’t forget, you’ll need to adjust the tip of the stabilizer up and down to get the tube going straight through the hole in the fuselage.

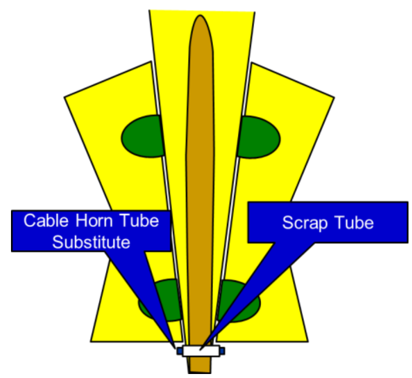


Figure 59: Using Scrap Tubes to Fit Elevators

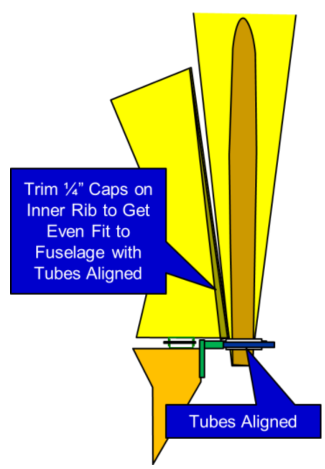


Figure 60: Trim Stabilizer to Match Fuselage

When things seem to be pretty good, get the stabilizer clamped in place and mark the (potential) drill holes for the C-brackets. Remove the clamps and strips of wood holding the elevator, and cycle it slowly up and down. You don't have to go far…the travel for a Fly Baby is 25° up and 20° down (Figure 61). That's just 45° total travel.

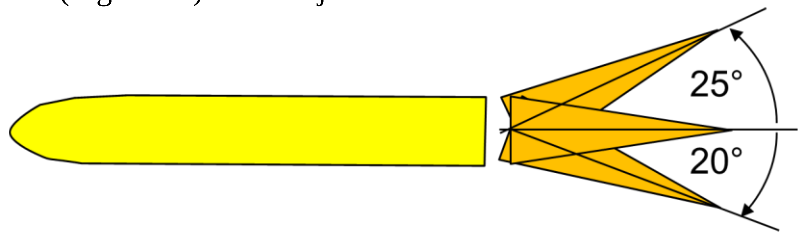


Figure 61: Elevator Travel

As you do this, watch the tubes going through the fuselage. If they make contact with the plywood, see if you can adjust the stabilizer position to eliminate the problem. If you still get a little bit of contact…well, I'd trim a bit more off the fuselage plywood, but don't take that too far.

Got it in place? Clamp it down, mark the holes through the C-Brackets, but don't drill yet.

5.6.5 Installing the Other Side

Keeping the first set on the airplane, mount the other horizontal stabilizer and elevator.

In Article 7, Pete suggests clamping some guides to the horizontal stabilizer spars to help with their vertical alignment. Take 6" long pieces of wood, and get two matching index marks on each. Clamp the piece of wood to the back of the horizontal stabilizer, with one of the index marks exactly on the centerline of the spar. You can then use the other index mark on each strip of wood to determine whether the horizontal stabilizers are straight. You can see this in Figure 62.

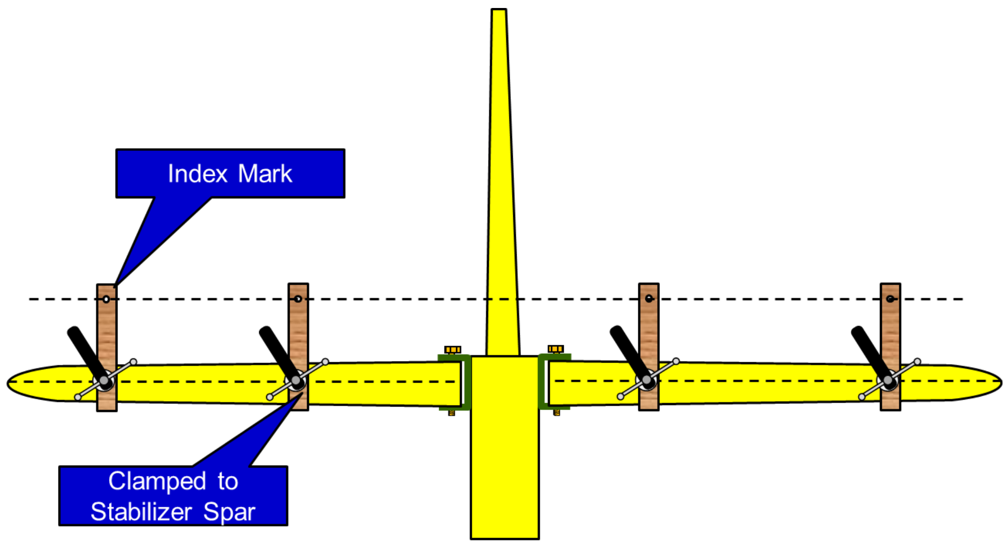


Figure 62: Horizontal Stabilizer Vertical Alignment

Pete would stretch a string across the index holes. But then, Pete wrote these instructions about fifty years prior to laser tools being common in home workshops. This sort of thing would be perfect.

Adjust the second stabilizer like you did the first. When you test the elevator travel, test both elevators together, not individually.

5.6.6 Final Assembly

Everything clamped in place? Elevators moving without interference?

Leave the stabilizers in place, remove the elevators, and replace that temporary cross-tube with the actual elevator control cable horn. Repeat the elevator travel test. Still good? Everything still aligned?

Well, you're ready to drill.

With the plywood on top and bottom, the filler blocks in the roots of the stabilizers are about $2^{1/4}$" thick. The holes have to be 3/16" wide, but it's best not to drill directly to that size. Drill halfway through from the top with a, say, 1/8" bit, then drill from the bottom. Drill though the entire depth with a slightly larger bit, then final drill to 3/16". Insert a bolt into each hole as it's completed.

Carefully match the elevator positions, left and right, and drill the cross-bolt holes where they attach to the center tube .

Figure 63: Cross-Drilled Elevator Tubes

With the holes drilled, it's time to disassemble and to prepare the parts for final assembly. Varnish all the area where the metal parts bolt to, and the inside of the bolt holes. Paint all the steel parts.

However, a caution on the elevator cable control horn. Remember, the individual horns slide over the ends. If you paint all the way to the end, the thickness of the paint may prevent the parts from joining. So be cautious, here.

When the varnish and paint are dry, reassemble everything. Check the elevator travel again.

5.6.7 Bracing Wires

The horizontal stabilizers are braced with 1/8” cable, including a turnbuckle on each. The top cables go from the stabilizer fitting to the anchor points on top of the stabilizers.

Pete says to drill a bolt hole across the bottom of the fuselage and add a pair of tangs. However, many builders merely extend the lower plate on the spring support clamp, and bent both edges upward to allow attachment of the bracing wires. Figure 64 shows what this looks like.

Figure 64: Bracing Wires Attached to Tailwheel Spring Clamp

I really like this modification. It eliminates some extra hardware in the tail, and the braces have a slightly better angle for support. N500F had this change performed when it was restored in 1982, and I did the same thing on my airplane when I repaired the tail post.

6 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.

6.1 Changing the Shape of the Tail Surfaces

One of the more common cosmetic alterations of the Fly Baby are changes to the shape of the rudder and elevators. As long as they changed units have the same sort of internal structure, and don't vary broadly from the total area of the stock surfaces, this sort of thing doesn't make much difference.

A few builders have made larger tail surfaces, extending the total width of the horizontal stabilizer, or making the fin taller. Again, as long as this is kept within reason, there shouldn't be a structural issue.

Figure 65 illustrate a rudder modified to make the it look more like a WWI aircraft. This is larger than a stock rudder, and would probably be more sensitive, but it's not likely to make that much difference. The top of the vertical stabilizer has been altered as well, to continue the upward line rather than curving back to horizontal like a stock fin. The owner reports no difficulties in handling

Figure 65: Modified Rudder Shape – Curved

Figure 66 shows another tail modification. In this case the elevators as well as the rudder have been squared-off. These changes make little difference as long as the *approximate* areas of the original surfaces are retained. Judging it by eyeball is probably adequate.

Figure 66: Modified Rudder Shape – Squared

Oh, by the way…the photo was taken during final assembly. The ailerons aren't hooked up yet, thus they are both in the down position.

6.2 Extended Aft Inspection Panel

Getting the elevator control cable horn into the aft fuselage can sometimes take some work. If, for some reason, it has to be removed after the plane is completed, it can be quite difficult.

One way around that is to modify the aft inspection hole on the left aft fuselage. The stock inspection hole can be seen in Figure 65 above. This hole is there to provide access to the lower cable connection on the elevator control cable horn (an inspection plate in the fin provides access to the top.

Figure 67 provides an option. Notice the back edge of the inspection hole is merely extended a couple of inches to reach the cross-hole for the elevator tube. Remember, the elevator tube system is connected *only* to the elevators; a hole like this has no effect on it. But it should make it a lot easier to insert and remove the elevator control cable horn.

Figure 67: Modified Inspection Hole

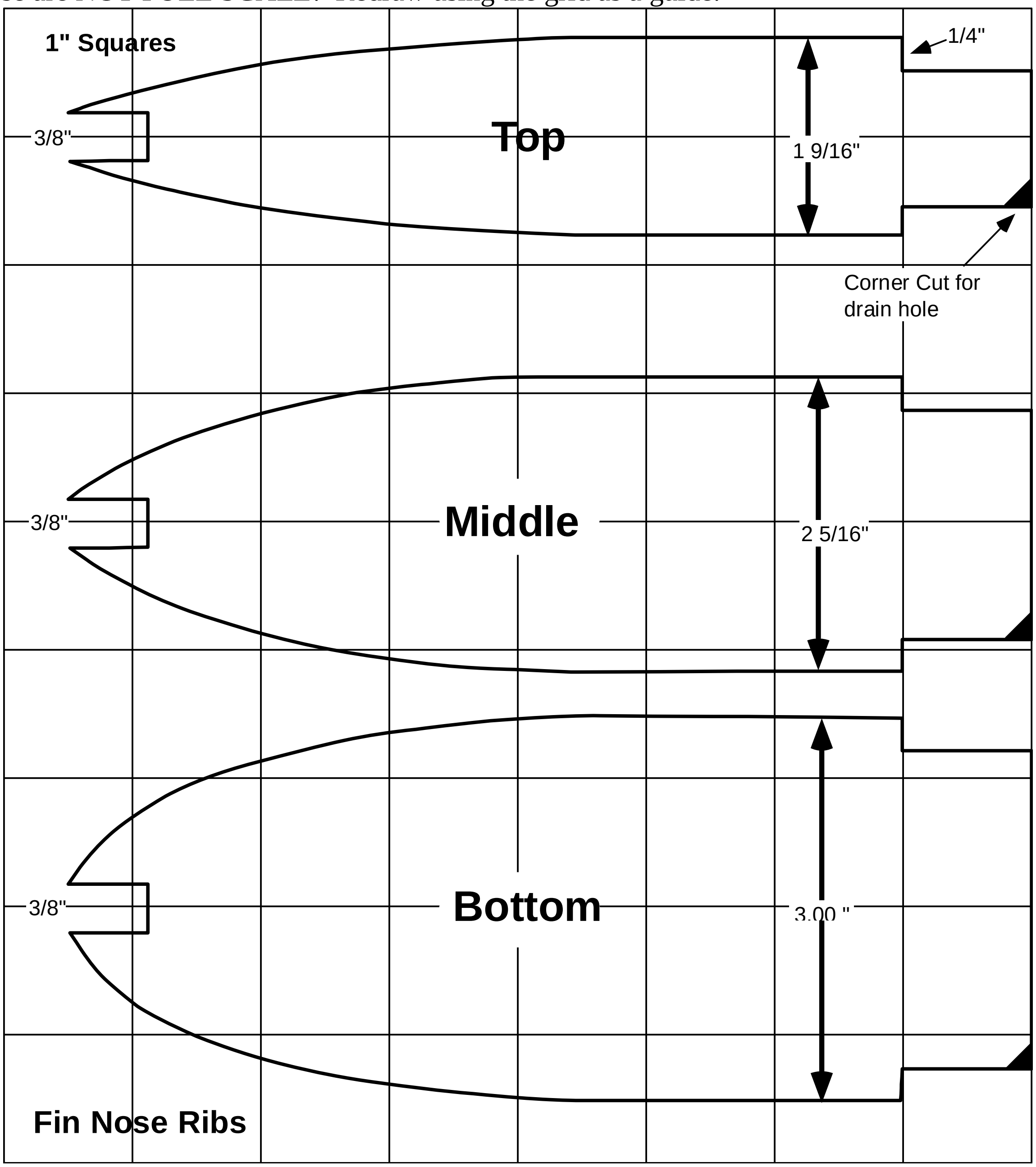
Now… as a caution, I would NOT make this modification until after the stabilizers and elevators have been installed. A bigger hole like this might mask some issues when you're trying to install the elevator system.

As a reminder, the 1/8" plywood fuselage in this location has already had a doubler installed to strengthen it.

7 APPENDIX – FIN AND HORIZONTAL STABILIZER TEMPLATES

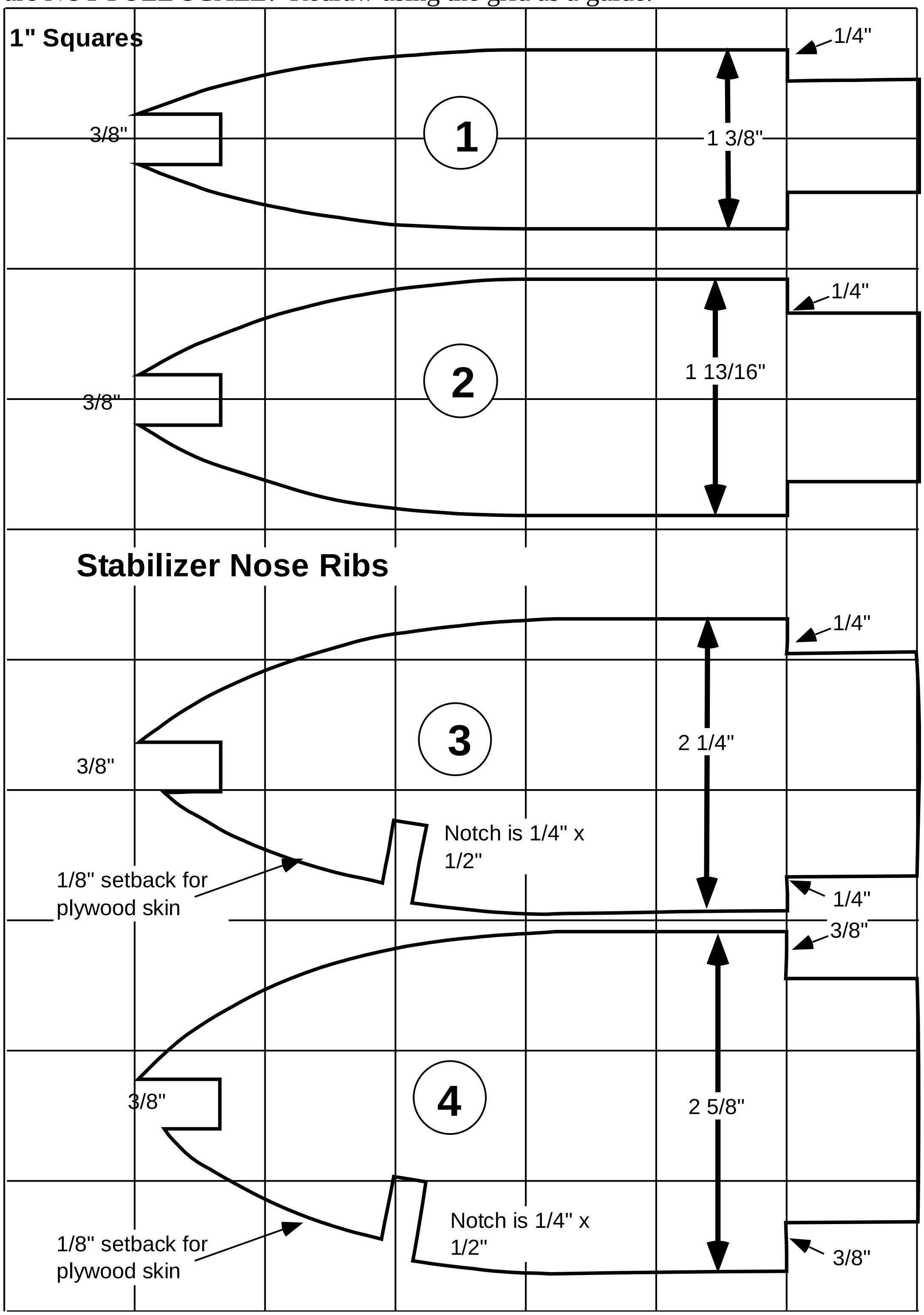
7.1 Fin Nose Ribs

These are NOT FULL SCALE! Redraw using the grid as a guide.



7.2 Horizontal Stabilizer Nose Ribs

These are NOT FULL SCALE! Redraw using the grid as a guide.



END OF COMPANION GUIDE FOR ARTICLE 6