Timber Tiger Aircraft ST-L

Section 1: Tail Surface Kit

SAMPLE MANUAL ONLY

All information contained in this sample is to be superseded by content supplied with kits. DO NOT use the information in this sample manual to build your kit.

TIMBER TIGER AIRCRAFT

WARNING

In addition to things most veteran builders already know, the Introduction Manual also contains information that is specific to the Timber Tiger Aircraft ST-L. DO NOT skip reading the Introduction Manual. Skipping the Introduction Manual could cost you money or, worse yet, create a dangerous situation.

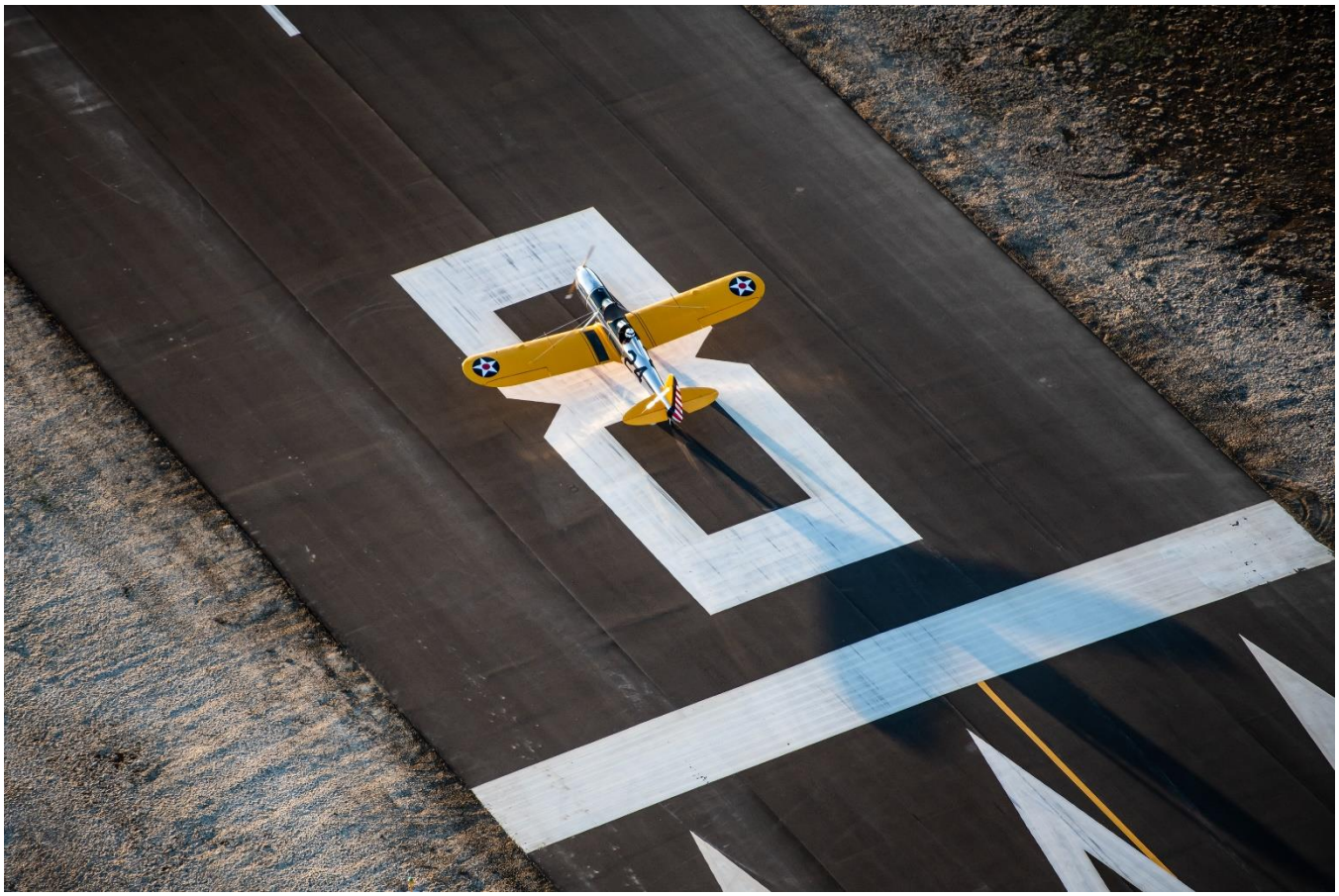
WARNING

The parts in this kit were designed to fit together very well. If parts aren't fitting together like you'd expect, that should be a warning that something needs another look. In such a case, do not modify parts without first contacting Timber Tiger Aircraft. A five-minute call to tech support could save you time and money, all while assuring a safe, high-quality level of construction.

WARNING

Before airworthiness inspection, it is the builder's duty to make sure the airplane conforms with all Service Bulletins. Service Bulletins can be found on the Timber Tiger Aircraft website. DO NOT forget to check service bulletins often. The sooner you know about them, the sooner and easier you'll be able to incorporate changes into your airplane.

ST-L Tail Surface Kit Manual Contents



Air-to-ground photo by Distant Thunder Aviation, LLC

1-1: Stabilizers-Layout and Fixturing

A quick note:

The tail surfaces are somewhat ultralight-ish in form…identical in nature to how Ryan built the tail surfaces of the original ST. We didn't venture far from original here. Like anything in the ST-L kit, Timber Tiger Aircraft has gone to great lengths to make your life easier. The ribs are all pre-formed, the front spars pre-bent, all weldments are factory-finished, and all leading and trailing edge curvature formed right here at the factory. All you have to do is lay it all out, drill some rivet holes, notch the ends of the spar tubes, and it's ready for the final deburring, priming, and riveting.

As easy as they truly are, the tail surfaces are considered the most difficult part of the airplane to build, which makes them a fantastic primer for completing the rest of the airplane. So measure twice, cut once, and you'll find everything goes very smoothy. *You'll find out you can do this and the rest will come easily!*

Full size assembly layout:

Your worktable should be large enough for your project. If the table is to be used for your wings, 14' x 4' is plenty. A working height of 37" to 38" seems comfortable for most people. The table should be surfaced with something smooth, such as 3/4" MDF. Some people like to surface their tables with melamine. It looks nice, but markings tend to come off, making MDF superior for this particular use. The table will get drilled and cut, so don't spend big money on your table surface. The table can be shimmed to eliminate twist. A string drawn down the top, about 6" in from the edges will tell you if the table surface is bowed. Try and get any twist and bows to less than 1/16".

Transferring the stabilizer drawings to a worktable is easier than it sounds and will help you visualize the construction process to come. Make sure you have plenty of room on the table for your full-size drawing. Using the measurements provided in the blueprints, you can start by drawing the spars directly on the table. We'll use the vertical stabilizer as an example.

Draw the spars on the table, noting that all measurements are on tube centerlines unless otherwise called out in the drawings. Leave room for the hinges between the vertical stabilizer spar and the rudder spar so you can later pin the hinges while the parts are on the worktable.

Once the spars are drawn on the table, you can locate and draw critical components along their lengths. Hinges, sockets, etc. Now mark the rib locations, making sure the flanges are pointing the correct directions. In the case of the vertical stabilizer, all flanges face downward, aside from the bottom-most rib.

Because the ribs are pre-notched and the leading/trailing edges are supplied with roughly the correct curvature, there is no need to draw the leading and trailing edges of the stabilizers. As long as your ribs are correctly placed along the span of the stabilizers, everything will fall into place nicely. To finish up, go ahead and draw the two secondary spars of the vertical stabilizer.

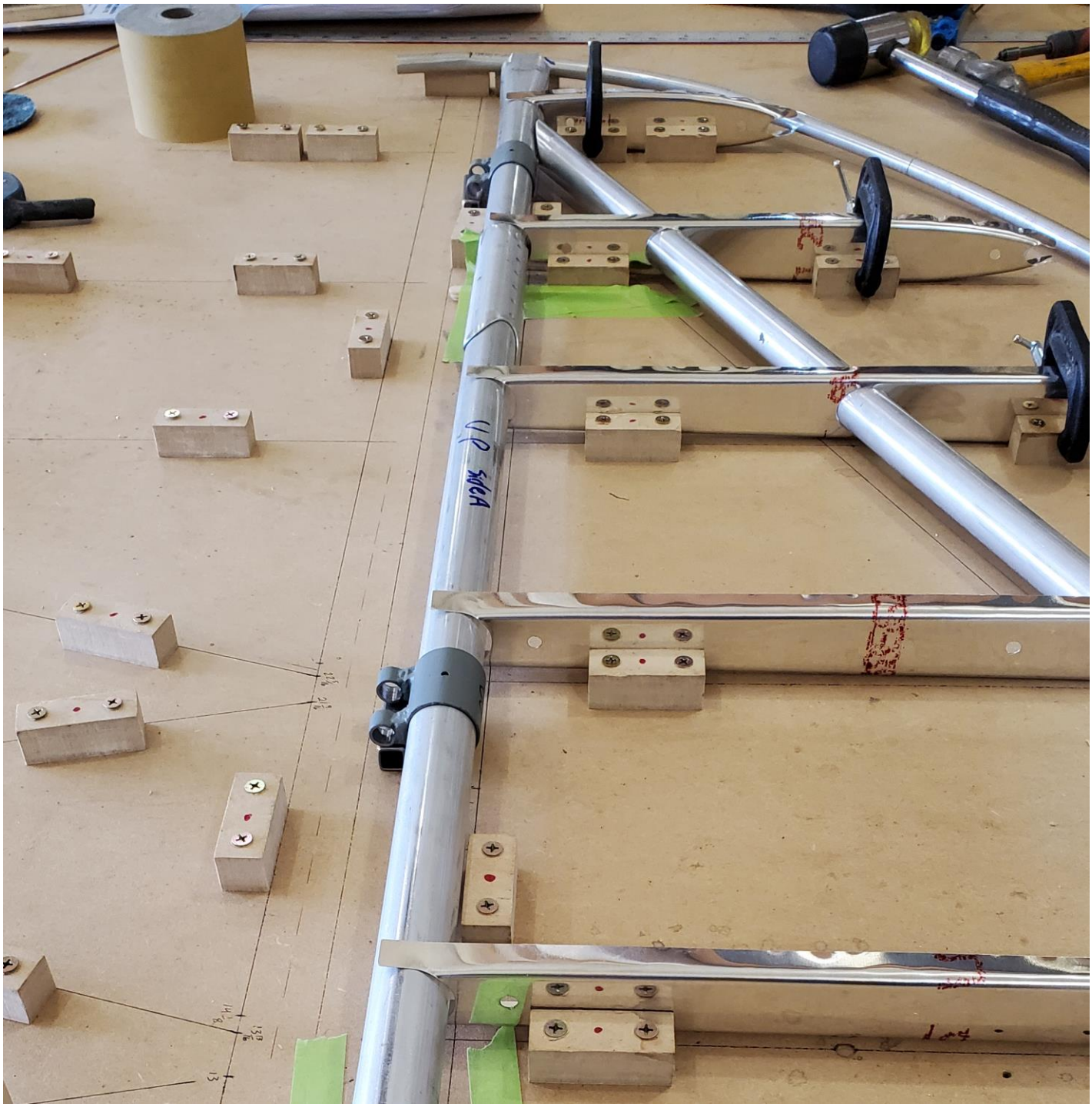
Locking everything down:

It is important to keep all parts aligned during construction. To accomplish this, we use wooden blocks which are screwed to the building table, which we will call fixture blocks. Usually a part requires at least three blocks, two if the part can be directly clamped to the block. The exact number isn't critical as long as everything is held securely in place.

The fixture blocks can be 1x2s with a couple of screws run through them and the shims used are typically an assortment of 1/16" and 1/8" shims. The smaller the blocks, the easier placement will be.

Go ahead and screw some blocks to the table now in locations that make sense for securing your parts. Make sure the fixture blocks won't interfere with any of the structural components that might come later. We like to block the flat side of the ribs in two locations. We will typically block the spar tubes in three locations: two to set the correct alignment within the drawing, and one block on the opposing side of the tube to lock the tube in place. Where possible, a fourth block makes things extra secure.

Because the tubes that make up the stabilizers are of varying diameters, it will be necessary to shim the smaller tubes off the table during construction. This will be detailed as required in the next section.



An example of layout drawings and fixture blocks.

1-2: Stabilizer Ribs, Leading/Trailing Edges, and Fabric Braces

Before beginning, please note that the stabilizer assemblies use both BSP/BSPS and BSPQ blind rivets. These are not interchangeable, so pay close attention to which you are using! In addition, if you are confused by any of the text here, study the drawings, as that is likely to give clarity. This text is meant to supplement the drawings, which have far more detail than could be shown here with pictures.

The goal here is to produce a vertical stabilizer and rudder that are straight. You are required to shim the leading edge, trailing edge, and hinge tubes the correct distance off of the work table and make sure the shims and fixture blocks are always doing their jobs properly. If you don't shim these tubes off the table to a common centerline, you will have built a stabilizer that is twisted beyond repair. For shimming, you can use something as simple as paint sticks and popsicle sticks. If you want a really nice setup, use wood screws as shims. To set their appropriate heights, the screws can be turned in or out of the table.

1) Finish fine-tuning the factory-formed rib flanges to 90 degrees using the flange tool you built as described in the Introduction Manual, Section 0-3.

2) Drill the hinge barrels to accept 3/8" outside diameter bronze bushings, which will be installed later. For these parts, the drilling can be done by hand in a vise or on a drill press. No matter how the drilling is accomplished, the hinges must be clamped to avoid damage to the part (or you).

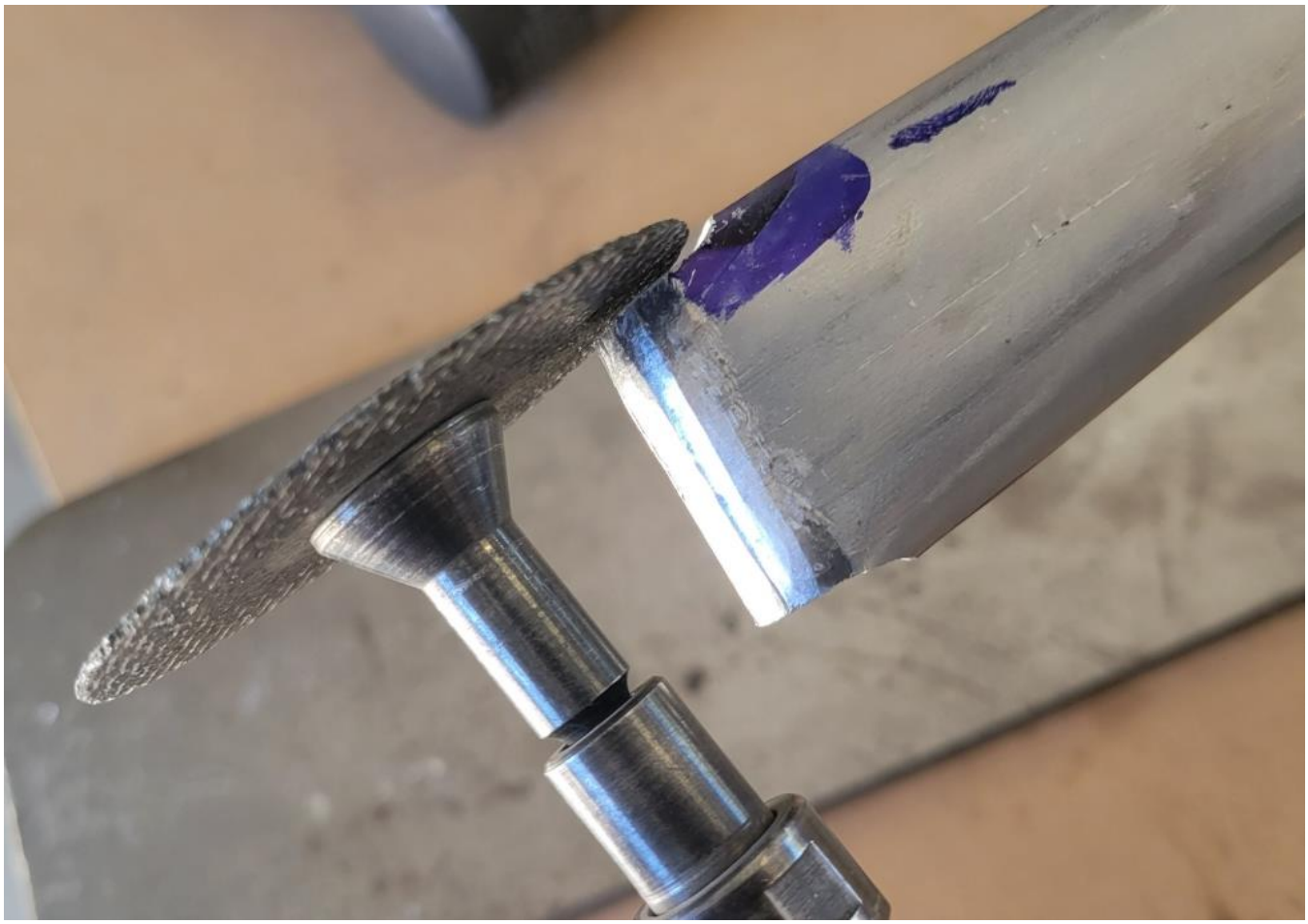
3) Now “notch” the main spars to accept the leading and trailing edges. Note the stabilizer leading edge is 1/2” diameter and the rudder trailing edge is 5/16” diameter. To “notch” the spars, you can simply drill them to accept the appropriate diameter leading or training edge, compress them as shown in the next step, then trim away the excess material.

Compress the spar ends in a vise or shop press until they match the leading/trailing edge diameter. To compress the spars evenly, proper positioning of the spar in the press is important. To make things easier, put a bock of hard wood on both sides of the spar and compress the blocks off-center in the press, smashing the spar in between them as they come together at an angle.

Drill the spar tip for the leading or training edge at the appropriate diameter and approximate angle.

An example of compressing a tube with a shop press. Along with the typical safety cautions, it is also important that the corners of the compressing blocks don't contact the tube. Contact with the corners of the blocks will result in a dented tube.

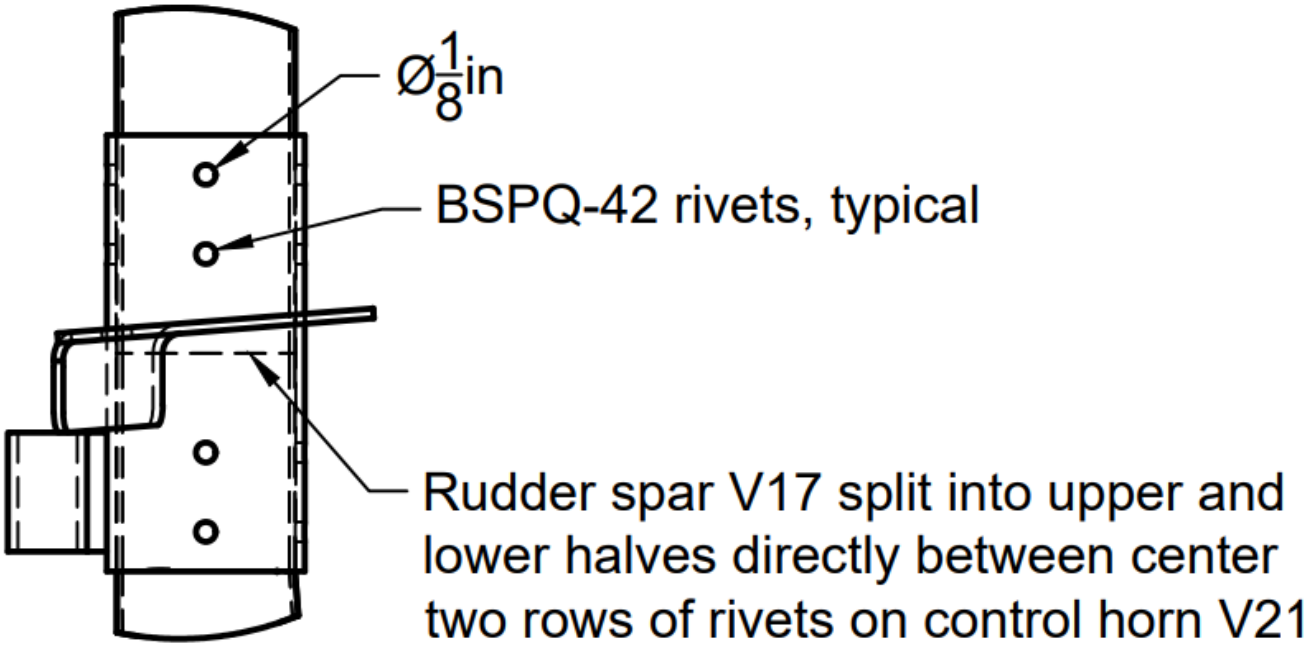
Cut off the excess spar tube and gently hammer the ends over a scrap piece of rod or tube that represents the leading or trailing edge.



A little more finish work.

A finished spar tip, courtesy of builder Glenn Gordon.

4) You will note at this time that the rudder spar is made of an upper and a lower part. The seam between these two parts is exactly between the center two rows of rivets on the rudder control horn.

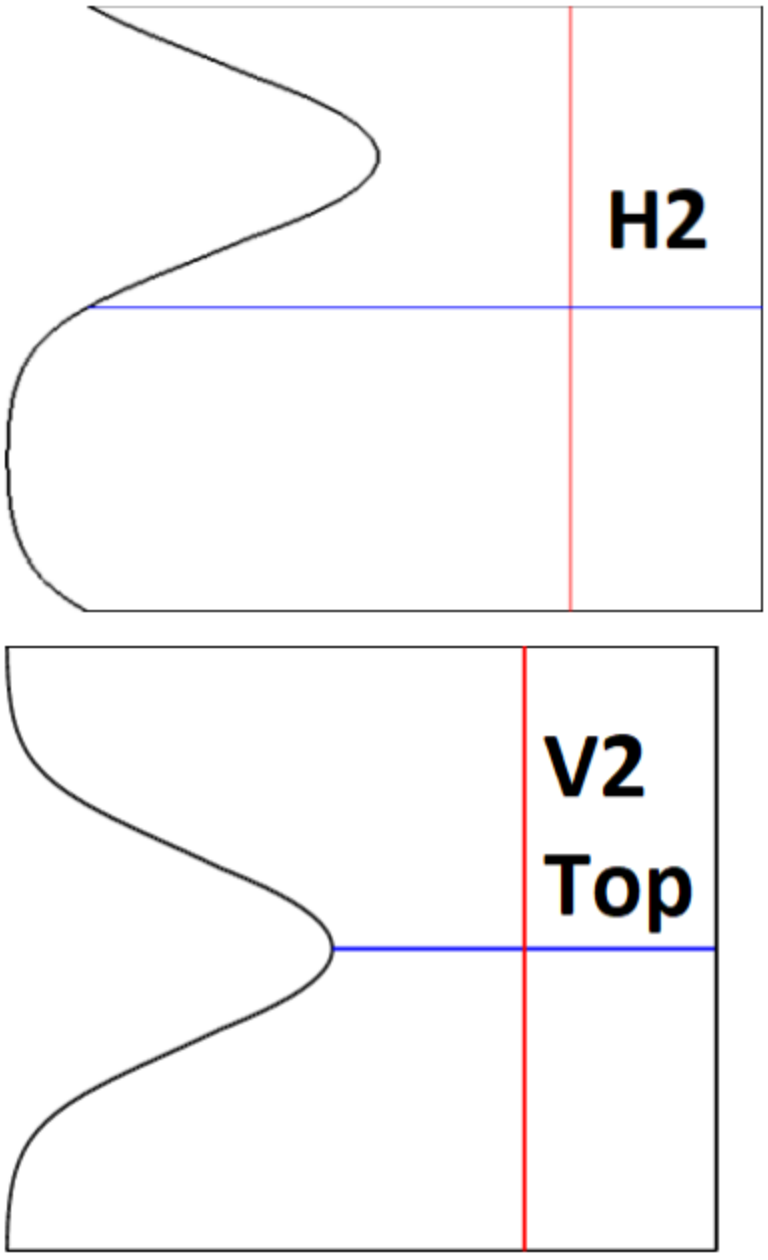


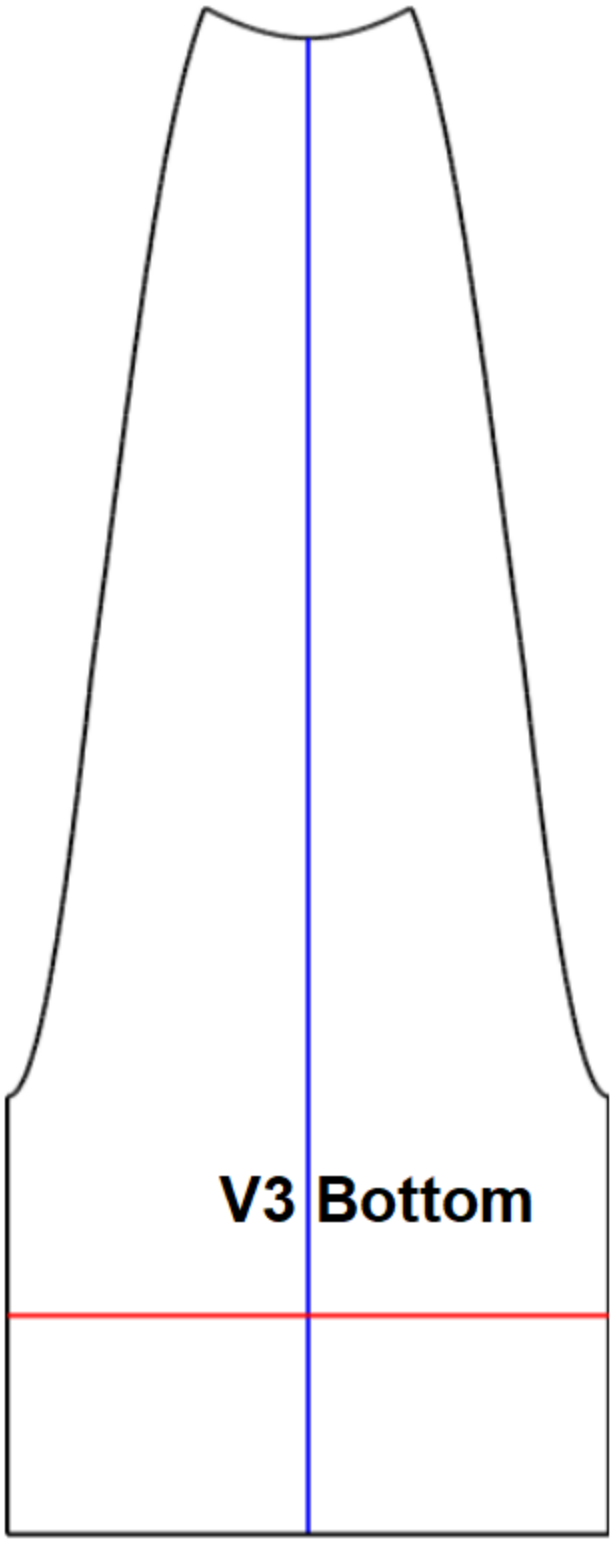
Tip: compress the lower part of the rudder spar while it is in the control horn. This will keep the tube round where it needs to be.

5) Remove any nicks and scratches from the spars and prime them.

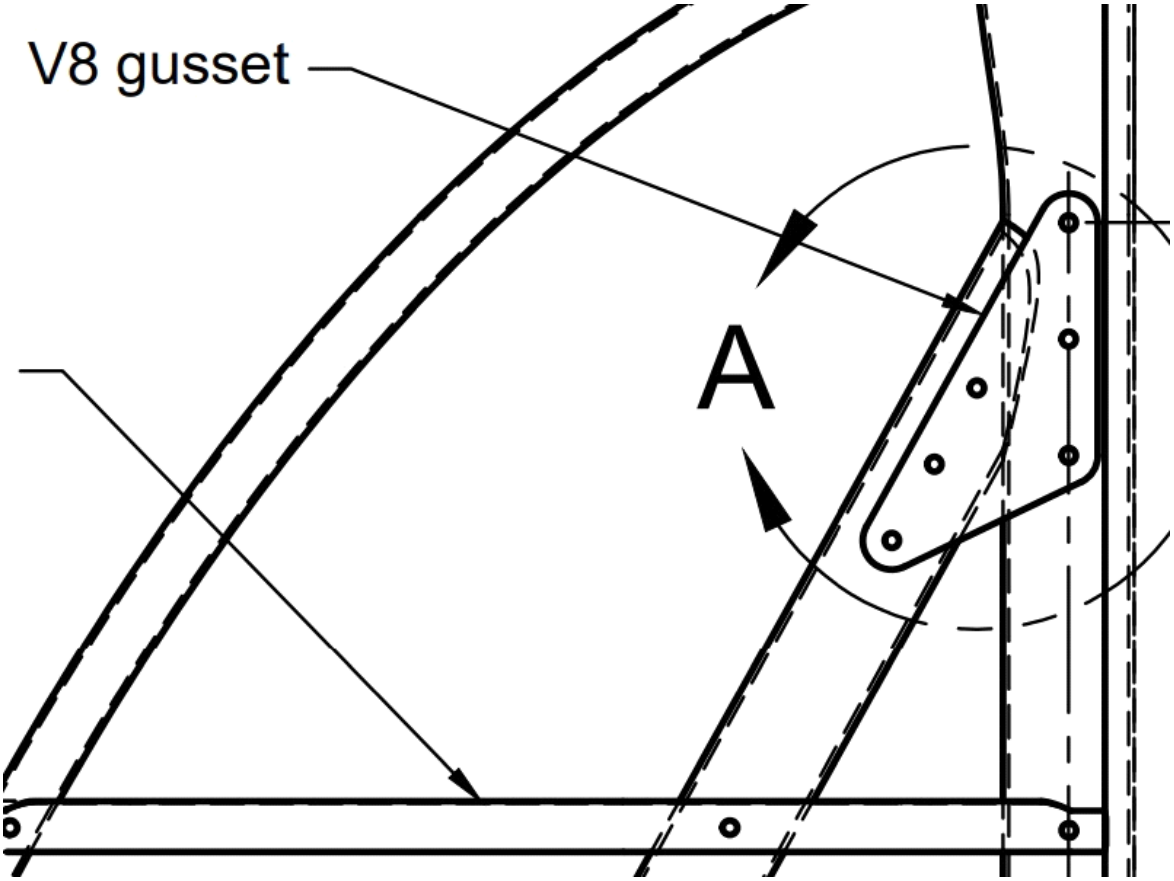
6) Put the spars into the jigging fixture, making sure they are pressed against a fixture block at their tips with their leading and trailing edge tubes in place. You will notice the bottoms of the spars are too long. This is okay for now.

7) The vertical stabilizer has two secondary spars, V2 and V3. The larger of these two spars, V2, must be notched to fit around the main spar. Notching patterns for the vertical and horizontal stabilizer spars are included below. Mark a centerline on the tube (described in the Introduction manual), tape the pattern around the spar with the blue line lined up with the tube centerline, trace the pattern, and cut the tube using shears or a lubricated cutoff wheel. Adjustments can be made with a file or lubricated carbide bit on a die grinder. Make sure to deburr the tube properly.


H2
V2
Top


V3 Bottom

9) With V2 held <u>firmly</u> in place against the main spar and shimmed properly off of the worktable, match drill gusset V8 with 1/8” holes, locking V1 and V2 together on their left sides. Cleco the holes as you go to ensure perfect alignment. Remove the parts from the fixture, deburr the tubes and gusset, spray the mating surfaces with your primer of choice, and rivet them together with BSPQ-42 rivets.



10) Flip the assembly on the table, making sure to shim all tubes to an appropriate centerline height as required. If V2 was firmly pressed against V1 when the gusset V8 was match drilled, the assembly does not need to be secured with fixture blocks. It should have proper alignment.

11) Once again, press the secondary spar V2 against the main spar V1, match drill the other side with gusset V8. Disassemble, deburr, prime, and rivet just like you did on the other side.

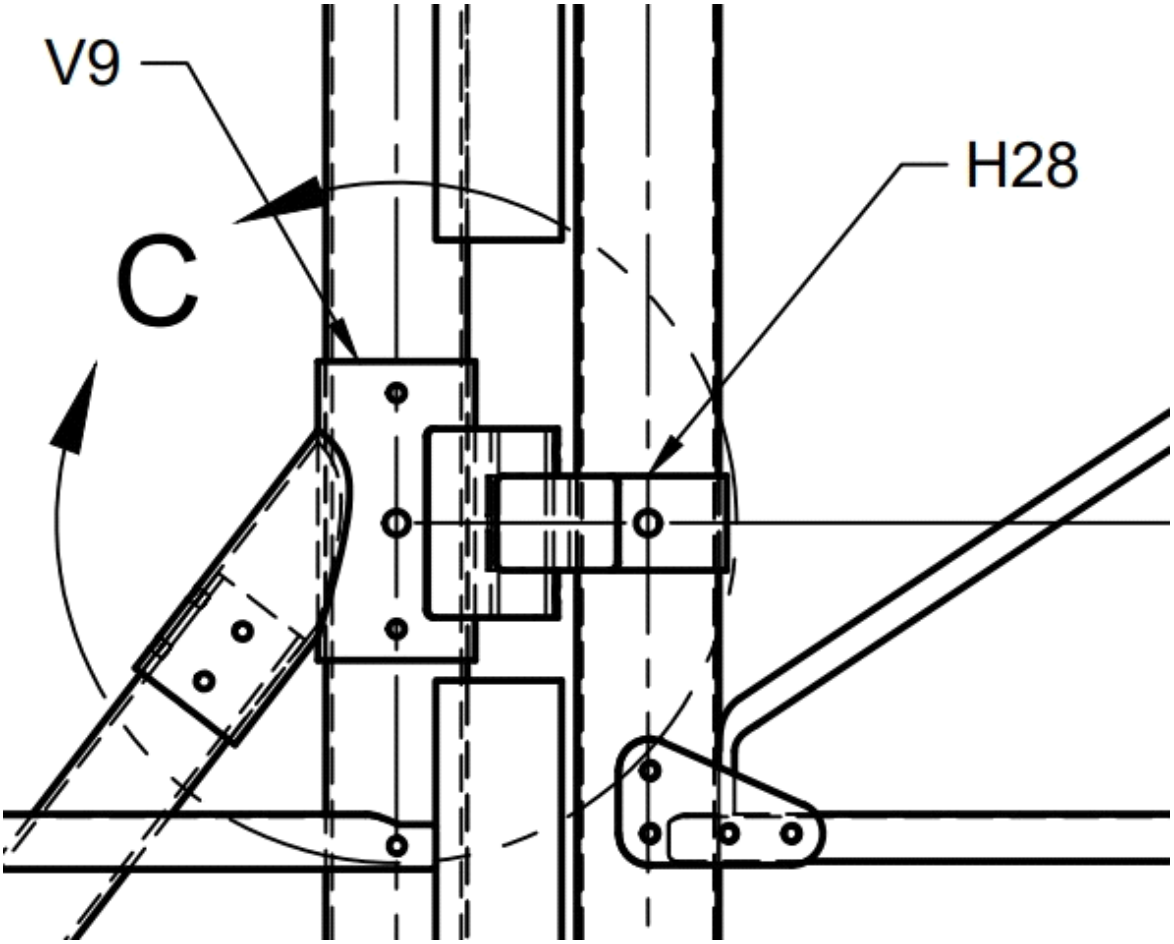
12) Slide the rudder hinges onto the stabilizer and rudder spars. Honing out some primer may be required. Use 240 grit sandpaper or finer. Put the hinges in their correct positions, but do not yet match drill them.

13) Set the assembly back into the fixture, shimming V2 off the table with 1/8” shims. You’ll notice now that the smaller of the secondary spars, center spar V3, needs to be notched at the bottom side. Using the included template, notch and deburr V3. The top of V3 is cut square and does not need a template.

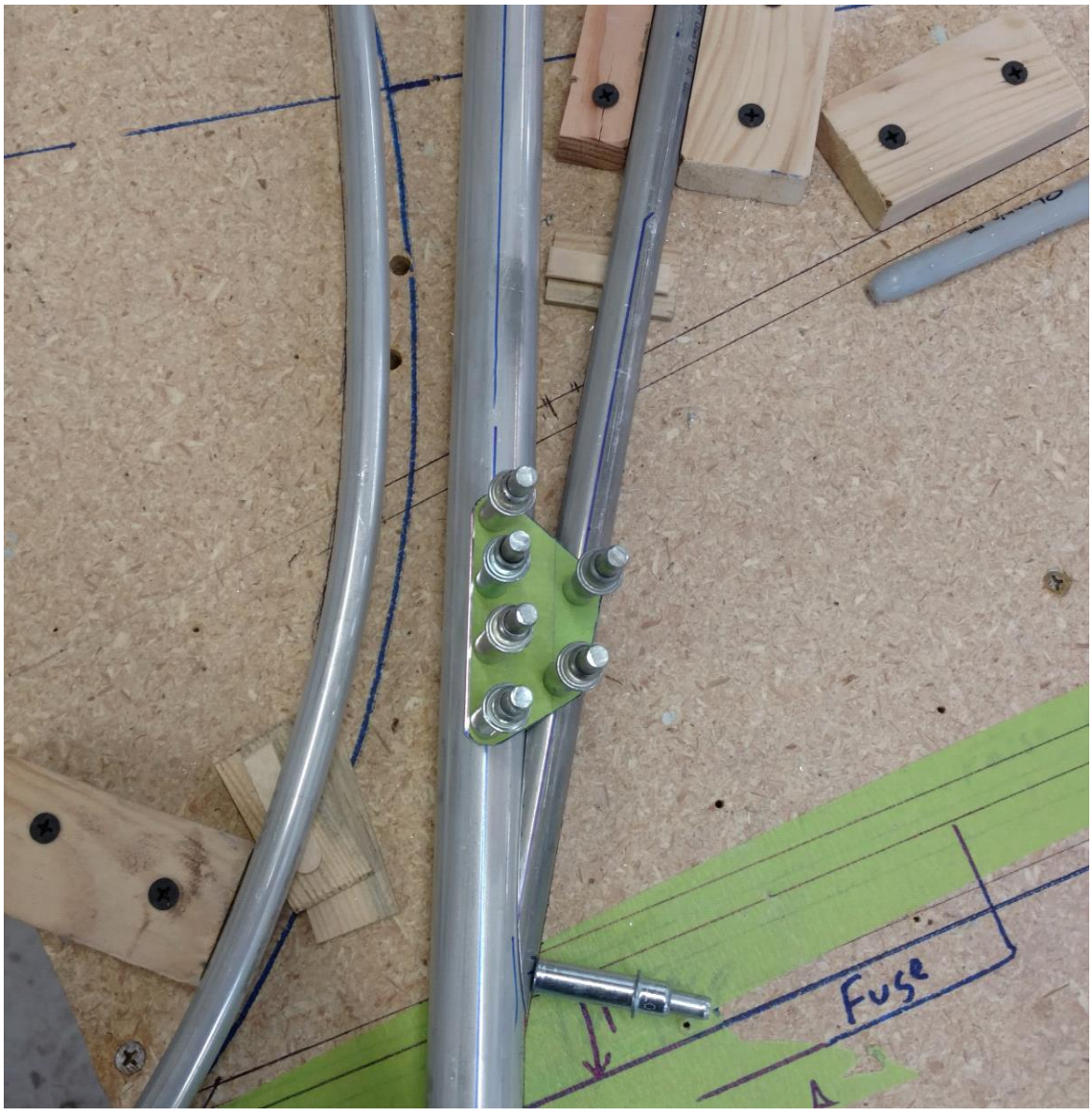
14) Cut the bottom of the main stabilizer spar V1 to fit all the way inside saddle V11. Make sure V11 is in its correct vertical location according to the drawings or it won’t fit the fuselage later.

15) Working slowly, cut and test-fit the top of V3 until it fits ALL THE WAY into its socket on rudder hinge V9 while sitting tight against V2 at the bottom. Please note that the location of V9 is rather critical, as you don’t want it to interfere with any ribs.

16) Shim rudder hinge V9 off the table by placing 3/8" of shims under the 1/2” diameter rudder hinge tube. This is the tube that holds the hinge pin. Get this shimmed as close as you possibly can to the appropriate centerline height. With this shim in place, match-drill rudder hinge V9 to the main spar V1 with 1/8” holes. Once these holes are match-drilled and Clecoed on both sides of the stabilizer, match drill the 3/16” bolt hole on both sides.



17) Now match drill center spar V3 at the saddle end. Press V3 tightly against front spar V2 and match drill the lower tip of V3 to V2 with a single 1/8" rivet hole. The rivet hole is located ¼" from the lower end of V3 (as measured from the rivet's center). For now, match drill gusset V7 on the left side of the vertical fin only. DO NOT RIVET THE GUSSET YET.

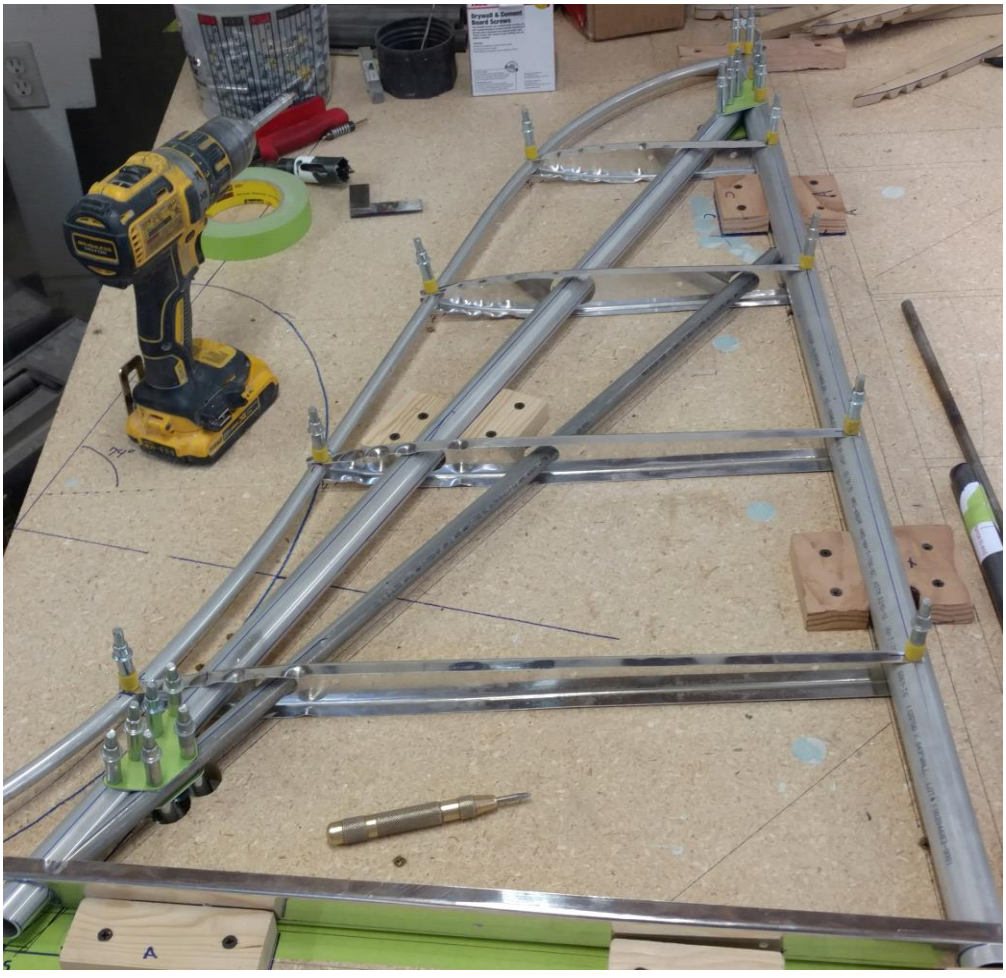


18) Remove spar V3 and gusset V7. Slide V9 up or down the spar and deburr the rivet and bolt holes. Rivet V9 in place with BSPQ-42 Cherry rivets. I like to put a 3/16" bolt through the assembly before riveting, just to make sure there aren't any small alignment issues. Deburr V3 and V7 and prime all mating surfaces.

19) Removing and reinstalling Clecos as required, slide all ribs into place. Install center spar V3 and gusset V7. Rivet both in place (rivet V3 at both ends) using BSPQ-42 Cherry rivets. Flip the assembly over. Pressing V3 firmly against V2, match drill V7 on the right side of the stabilizer. Remove the gusset, deburr, prime, and rivet. Double check to make sure the top of V3 is riveted at the top, as well.

20) Put the assembly back in the jig. Position the leading and trailing edges, carefully working them to shape by hand. Make absolutely sure the leading and trailing edges sit nicely within the ribs and require very little pressure to keep them in place. For the time being, we will not be riveting the bottom of the rudder trailing edge to the rudder spar. We will deal with this during control horn installation.

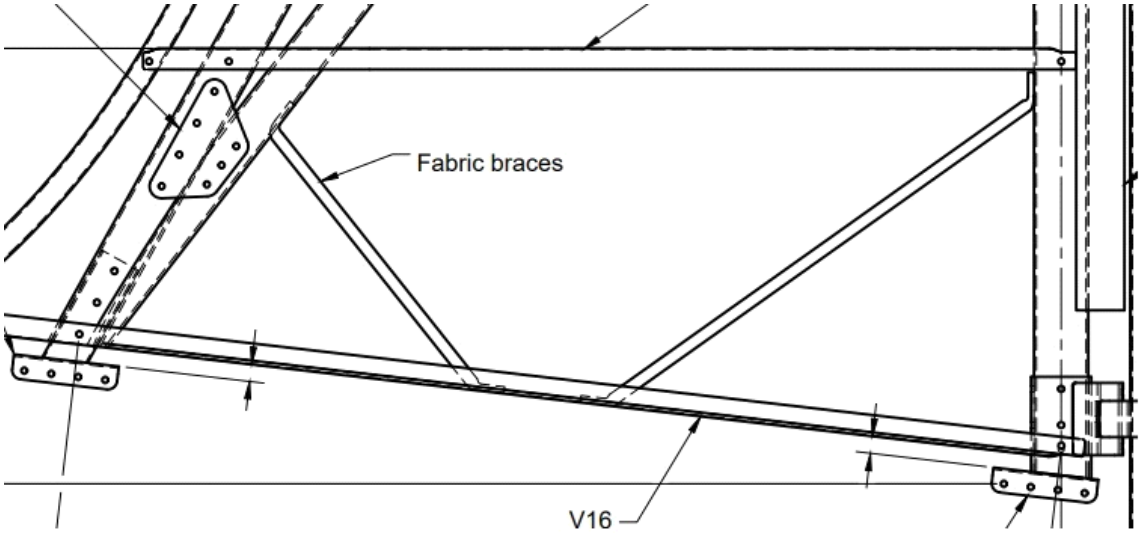
21) With the leading edge shimmed appropriately off the table, match-drill the left sides of the ribs to the spars and leading/trailing edges. Note the ribs are also match-drilled to spar V2 using 1/8" inside diameter aluminum tube to shim the rib/rivet/spar as required once everything is riveted together at a later time. When match-drilling the ribs, it is <u>critical</u> to make sure everything is pressed tightly together as you drill. Use masking tape to hold things in place if required.

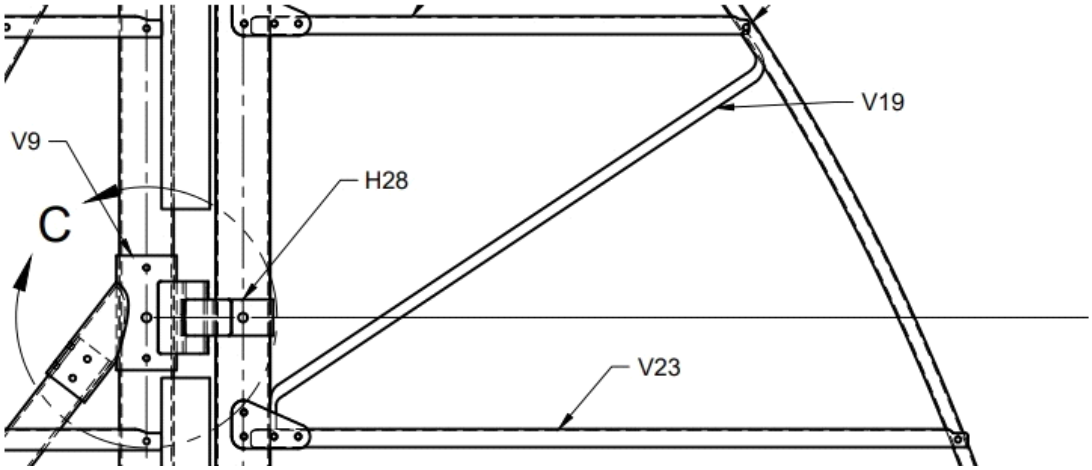


22) Once the left sides of the ribs and their gussets are match-drilled, deburr, prime mating surfaces, and rivet them to the leading edges with BSP-41 rivets and to the spar with BSPQ-42 rivets.

23) Flip the assembly over, keeping the appropriate shims under the leading and trailing edges. Match-drill the right side of the stabilizers. Deburr, prime, rivet. Place the assembly back in the fixture.

24) Flatten ½" of the ends of the fabric brace tubes. To flatten the ends of the tubes simply use a vise that doesn't have any sharp corners. Getting the tubes quite warm to the touch will help prevent cracking. Once flattened, the ends of the tubes should be roughly 1/8" to 5/32" thick. Bend the ends to the angles required and match drill/rivet in place with BSPQ-43 rivets. The drawings show the general locations of these fabric brace tubes, but don't worry about getting these exact. They're only there to prevent the fabric from pulling the rib out of shape.

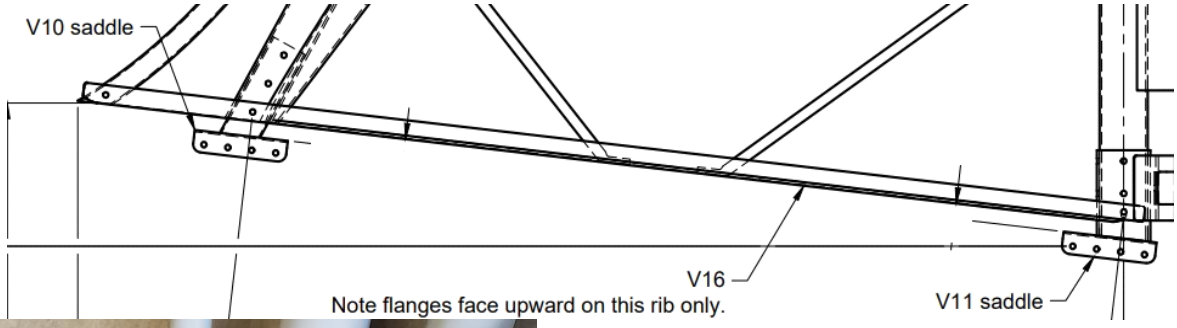

Fabric braces
V16

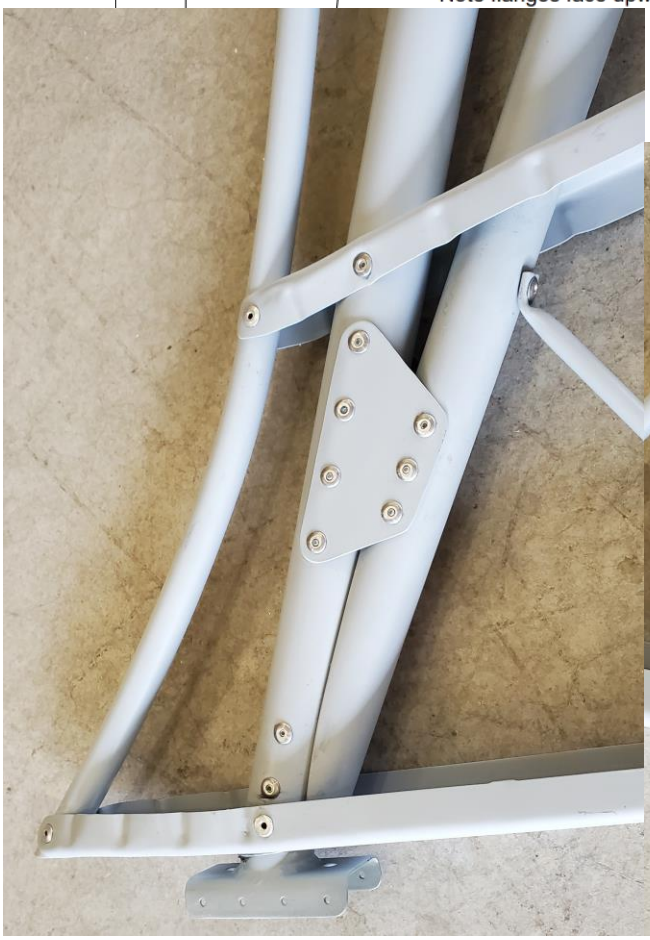

V19
V9
H28
C
V23

25) With everything back in the fixture and properly shimmed off the table, pin all stabilizer and rudder hinges together with some 3/8” bolt or pins. Place the hinges in their correct locations, shim them to match V9, and match-drill their 3/16" bolt holes. Deburr the holes with your Shaviv deburring tool and install the hardware called for in the drawings. If you plan on covering over the hinge nuts like the original ST, use a cutoff wheel to cut the bolt so only one thread shows beyond its AN364-1032 nut.

26) Saddle V10 can be match drilled to the assembly IF you use a long piece of square tube to ensure proper alignment with the lowest stabilizer hinge saddle V11. These saddles are meant to fit a longeron (vertical stabilizer keel) on the fuselage, so alignment is critical. Alternatively, you can match drill this part after the fuselage is built. It is critical to make sure the spar V10 fits appropriately inside V2, with both V2 and V10 being the correct distance from the lower rib.

    NOTE: some builders prefer NOT to match drill V2 to V10 at this time. They prefer to do it during mating with the fuselage, which is a good method for ensuring perfect alignment. With that in mind, if you have double-checked and verified all measurements, you’ll likely find that match-drilling at a later time is not necessary. The choice is left up to the builder.


V10 saddle
V16
Note flanges face upward on this rib only.
V11 saddle



27) Slide the rudder control horn V21 into place, making sure it is right side up. It is critical to make sure the control horn is in its proper position so two rows of rivets capture both the upper and lower rudder spars. Using a ¼" rod to ensure proper hinge alignment with the hinges that were previously installed (this can be done without the vertical stabilizer attached), and making sure the control horn is perpendicular to the rudder ribs, match drill the control horn to the spars and rivet using BSPQ-42 rivets. Now you can rivet the trailing edge to the lower spar.

28) Using a small C-clamp, press the bronze hinge bushings into the hinges.

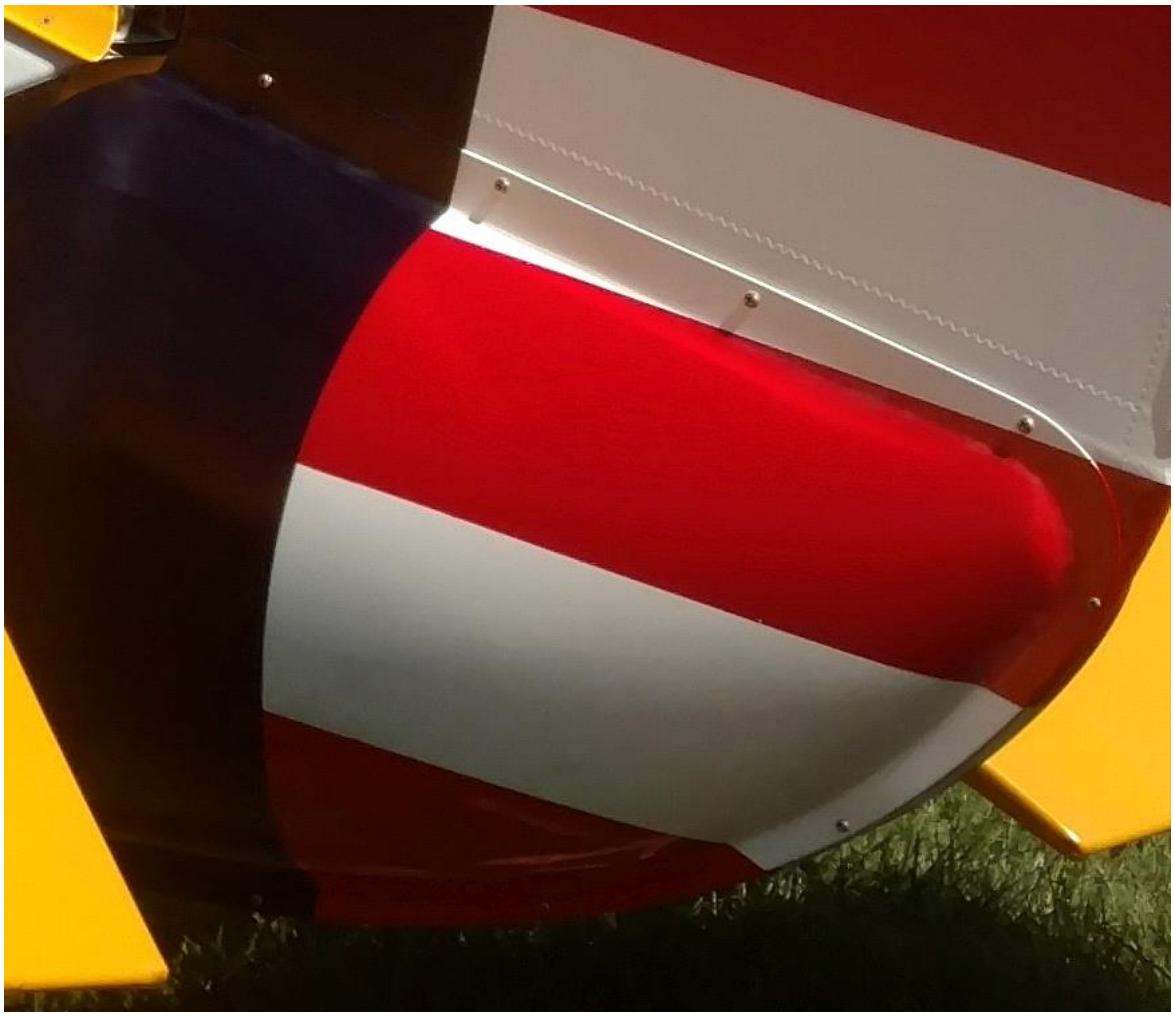
29) Cut the balsa wood gap seals to their appropriate lengths, leaving enough room around the hinges to install and secure the hinge clevis pins. Use a tube or dowel of the same diameter as the spar to create a sanding block. With 80 grit sandpaper affixed to the dowel and the dowl clamped to a flat surface, sand the balsa gap seal to fit the spar.

Use paint sticks to create a 1/8” to 3/16” gap between the vertical stabilizer and rudder spars.

Once fitment is complete, scuff the vertical stabilizer spar and glue the balsa wood gap strip in place. Tape can be used to ensure proper alignment while the glue cures. Hysol EA 9430 is the recommended adhesive, but you can use any strong, flexible adhesive that is non-corrosive to aluminum.

30) The vertical structures are now done, but do not cover them just yet (see note below). Before covering can begin, it is important to fit the rudder fairing to the rudder using the four #4 screws on the appropriate rib, and four #4 screws on the trailing edge. These are included and detailed in the Finishing Kit.

Note: if you really feel the need to cover your rudder before installing the rudder fairing, people with more advanced technical skills will find it is possible to accomplish with extremely careful measuring.



1-3: Horizontal Stabilizers

Horizontal stabilizer general notes:

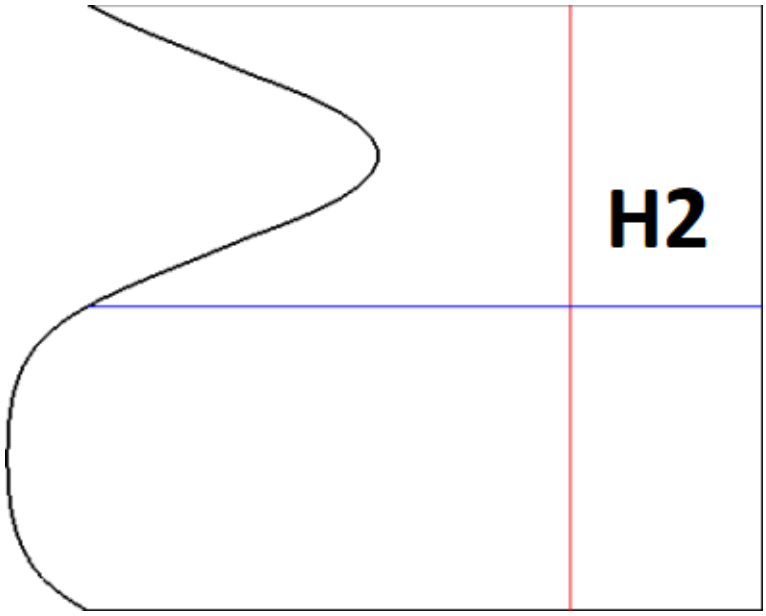
Because they are symmetrical, the left/right horizontal stabilizers and elevators can be built using a single jig. There is no need to build a left and right jig. Just be certain everything is shimmed up to centers using shims or screws set into the worktable.

The horizontal stabilizer ribs are accurately cut. The rib hole that captures the forward spar is accurately positioned but may need opened up slightly with a Shaviv deburring tool if fitment is too tight. Don't open this hole up more than 1/16".

Related to this, be sure your forward spar is very accurately positioned. Both ends of the spar need to be in their critical positions, with the inboard position (inboard of the spar's bend) parallel to the rear spar. All the while, the ribs should be a nice fit. If something is off, verify the miter on the outboard end of the front spar is in its correct location. Sometimes the location of this miter needs to be "crept up on" to get things fitting just right. In addition, verify the spar bend angle is accurate. This diagonal spar is very sensitive to lateral (left/right or inboard/outboard) positioning.

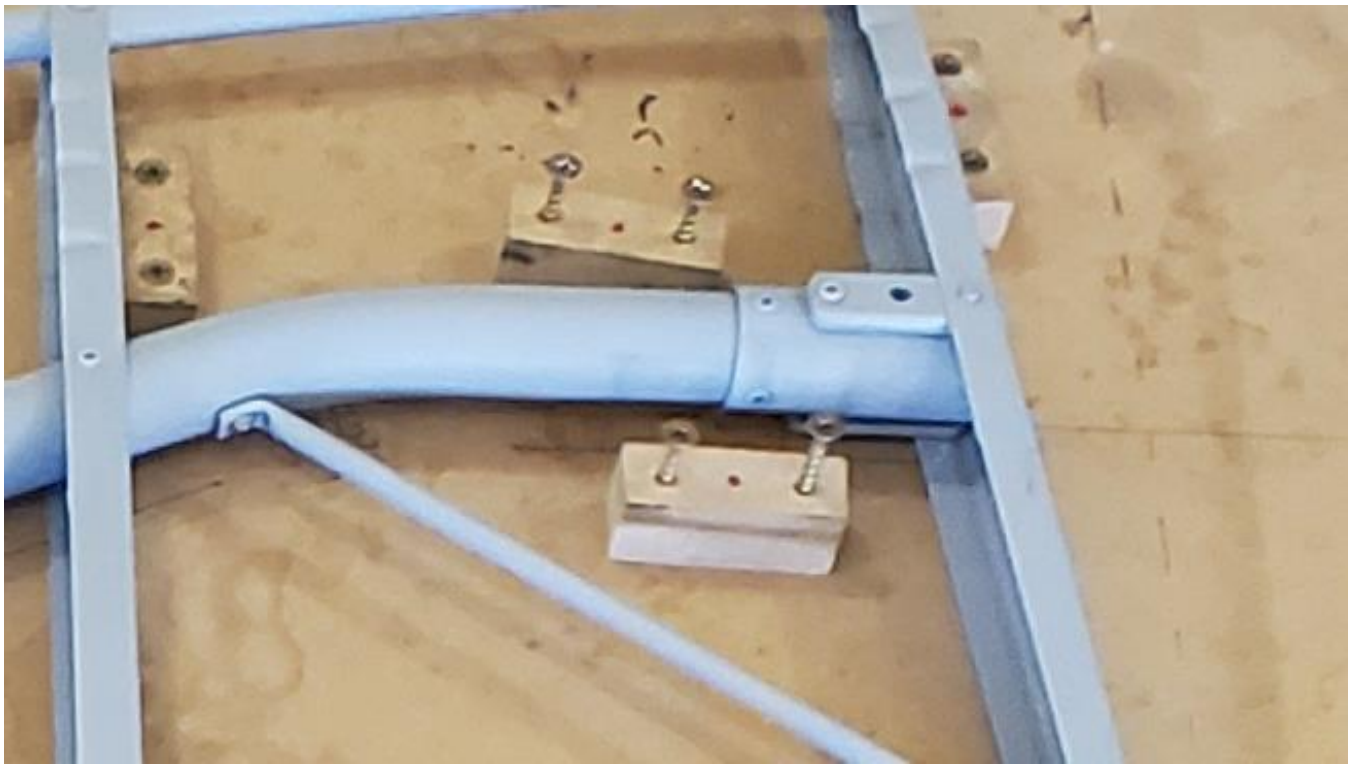
The horizontal stabilizers are built in the same general fashion as the vertical stabilizers, but with the following differences. The spar notching template is included here again.

Spar reinforcements H4 and H5 are detailed in the drawings. It is critical that the spar tube does not extend to the ends of H4 and H5, as there needs to be room for the head of the rib rivets to clear the carry-through tubes H33 and H35. The rib rivet used here is AN470-4-4. The shop head of the rivet must be compressed enough that it clears the carry-through tubes H4 and H5.


H2

Notice the offset of the spar within the reinforcement tube. Measurements are in the drawings. This offset allows the rib rivet to clear the stabilizer carry-throughs.

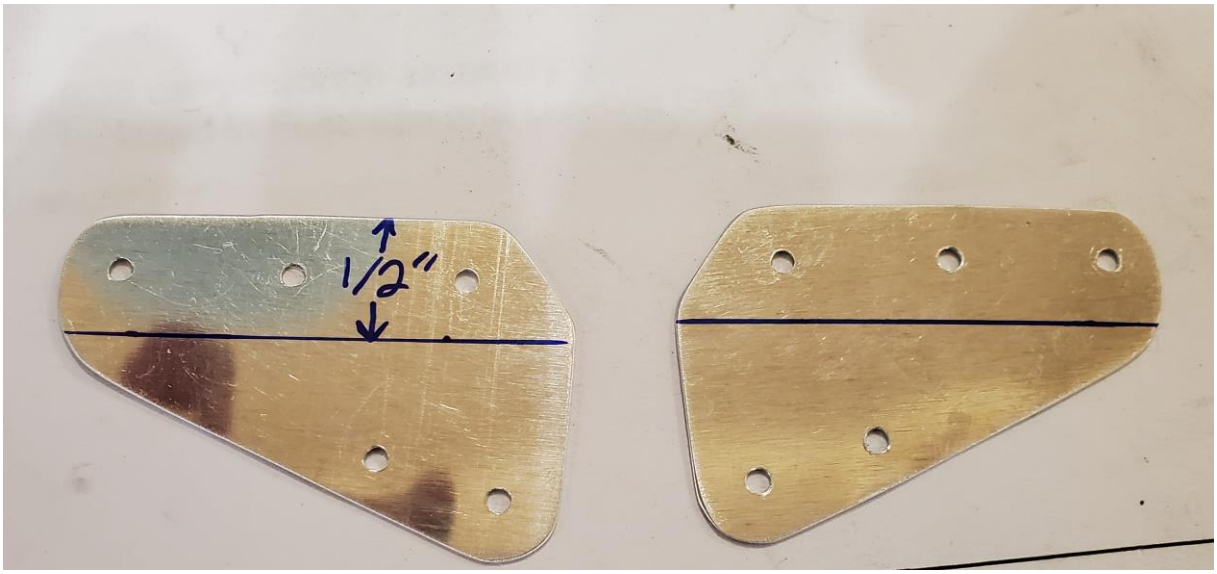
Notice that H4 has a 3/16” aluminum spacer surrounding its bolt hole. The sole purpose of this spacer is to keep the bolt from compressing the fabric. The spacer should fit nicely inside the rib.



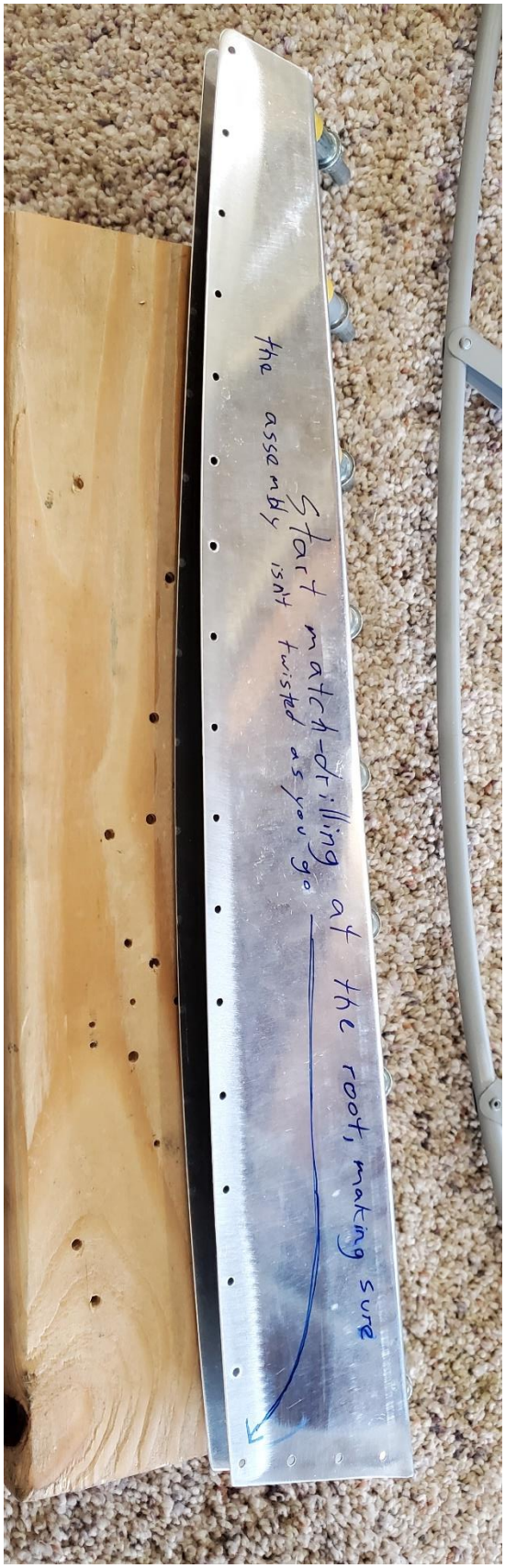
Elevator trim tabs:

The trim tabs are relatively easy to construct per the drawings. Just check to make sure the trailing edges of the trim tabs are straight as you match-drill them.

1) Deburr then bend the trim tab end caps to 90 degrees. Be sure to make a left and a right! The bend line position is shown here:



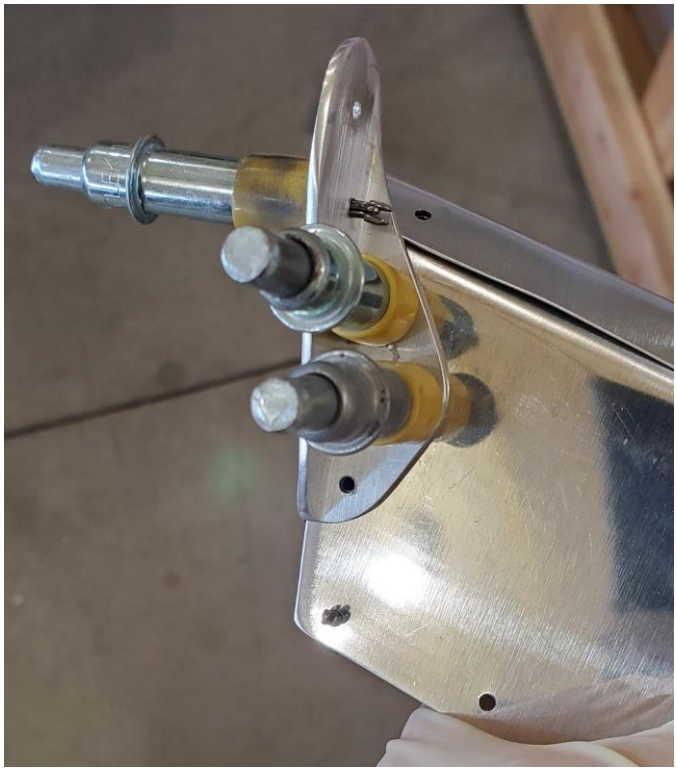
2) You will notice the tips of the skins should be bent slightly tighter than the roots. This bend can be adjusted with a soft mallet.

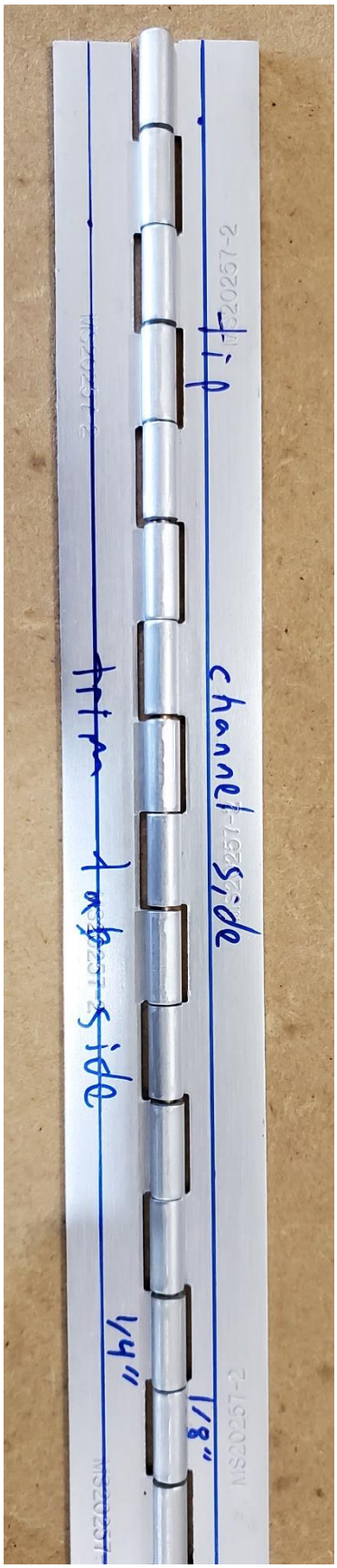


3) Cleco the upper and lower trim tab skins together at the leading edge.

4) Begin match-drilling from the root, checking for straightness as you go.

5) Fabricate the control horn per the drawings and attach it, along with the trim tab end cap, to the skins. Notice in this picture the control cable hole is undersized.





6) Fabricate your trim tab hinge. You will be required to match-drill this hinge to the trim tab support channel on the elevator, so be sure to locate the holes in places that clear the edges of the hinge itself, but also clear any structures on the elevator. Each airplane will be a little bit different, so hole locations are not provided. There must be eight rivets per hinge. Notice the rivet line spacing at the bottom of the photo at left. This spacing is measured from the base of the rounded section of the hinge barrel.

Mating the horizontal stabilizers to the fuselage:

Do NOT match drill the stabilizer carry-through tubes until the fuselage is built. The process for match-drilling is as-follows and assumes the carry-through tubes are installed on the fuselage. Double check for proper alignment at EVERY step.

- With the elevators attached to the horizontal stabilizers, slide the stabilizers onto their carry-through tubes, including control horn assembly H38.
- Using twine or mechanic's wire (preferred), rig the stabilizers so they are level with the fuselage. If you already have your stabilizer brace wires, use those instead.
- Set the elevators in the neutral position by lifting their trailing edges off the floor with blocks. Get the two elevator halves to as identical an angle as possible.
- Using a measuring tape, make sure the stabilizers are square to any point on the outboard ends of the rear wing stub.
- Now match drill the front spar on both stabilizers. Insert a bolt.
- Match drill the rear spar on both stabilizers.
- With the elevator control horn perpendicular to the elevator hinges, match drill one elevator spar to the control horn. After doing one side, double check to make sure the other side is still in alignment. Match drill the other side.


Elevator

In the next section, we begin building the ST-L wings.

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