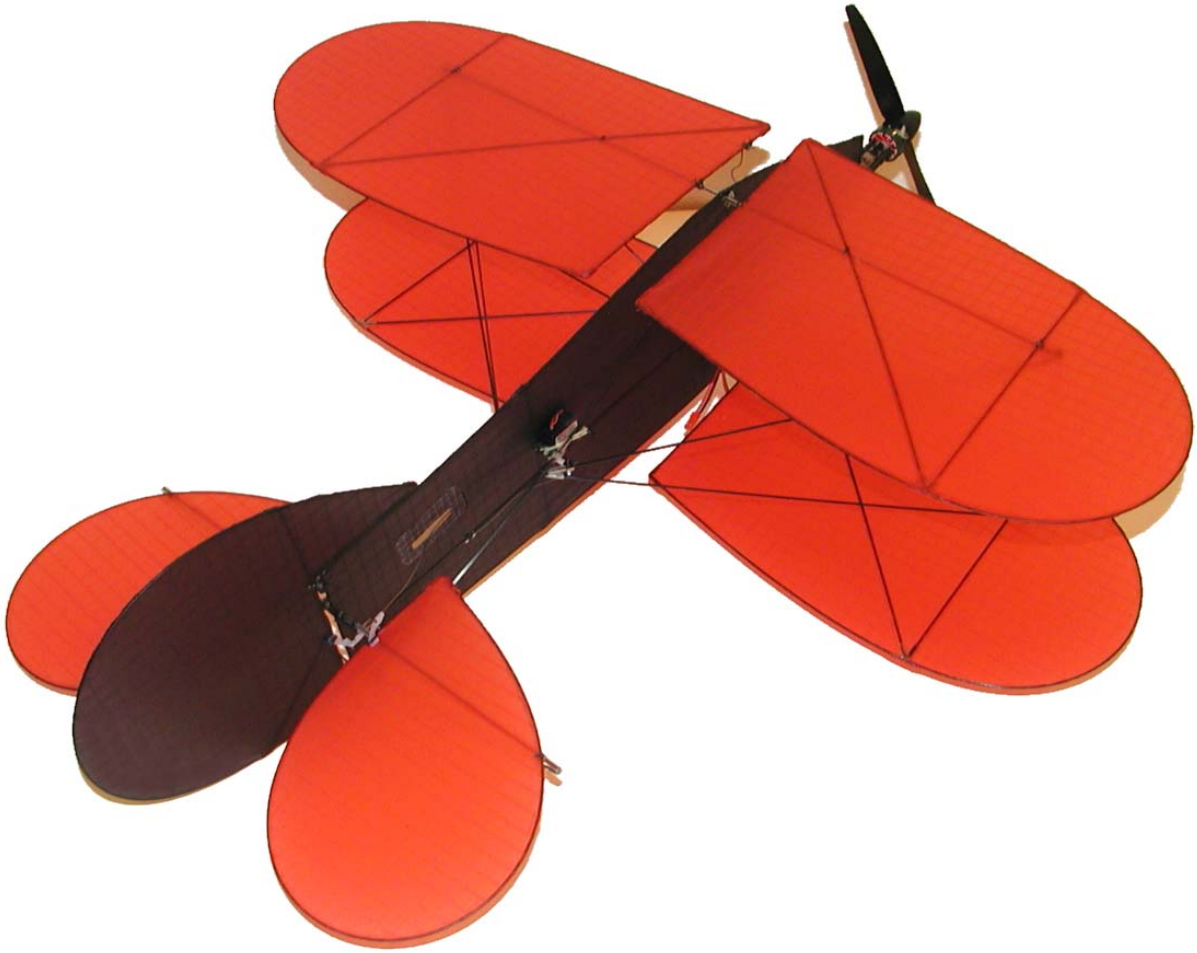
Carbon Traveler Convertible™

The Ultra-light, Portable, Indestructible, Electric 3D trainer



MATERIALS KIT CONSTRUCTION MANUAL

Recommended for Intermediate Builders

An original Ace Sim RC creation

1. Carbon Traveler Convertible Assembly Guide

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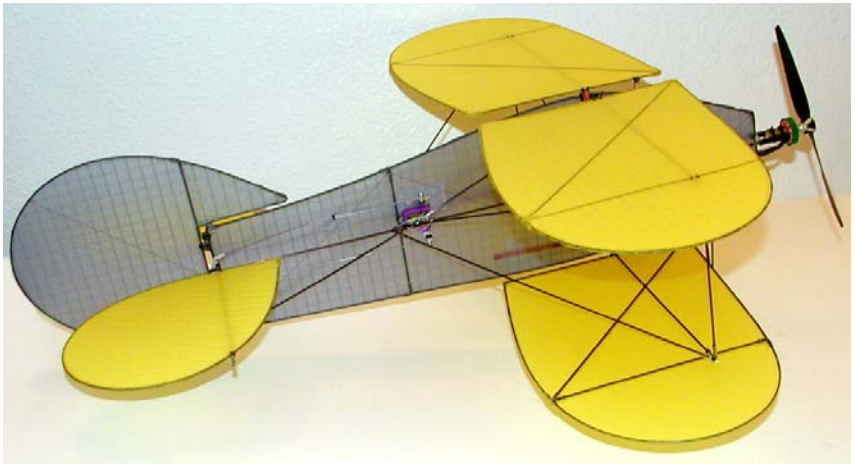


1.1 Thanks For Buying The Ace Sim RC CTC

We at Ace Sim RC are very proud of the Carbon Traveler Convertible. It's taken a long time to perfect, and much longer to kit, but we consider it a classic, timeless model that is durable enough to still be around to pass down to your grandchildren.

It lives up to its name by being easy to disassemble for flat transport without tools in just minutes and quickly converts to a high-wing sport plane for higher wind and wing loading flying when desired.

This kit is recommended for intermediate builders mostly due to the electronic installation experience needed. However with some help in that area, and devoting some extra time studying the instructions, the basic concepts are fairly easy to master and require no special skills or tools.

The construction steps once learned are mostly repetitive and are even considered therapeutic by some. For example, if you like to tie flies for pleasure, you'll love building this kit. ☺

How to use these instructions:

It's best to first read through the entire instructions prior to starting the project. An overall picture of the build is helpful prior to finding yourself scratching your head having missed something by accident.

Some options are included regarding gear selection and setup for different kinds of flight in the Owners Manual section at the end of the instructions. Do read this prior to construction as you might want to make small changes as you build based on how you want to fly.

Note that many pictures were taken from many builds to perfect the construction process so if your better judgment says to do something different, change the order or "improve" a step, be careful as you may get in too deep and then find out why we recommended doing it the way we did and in the order shown.

You may see pictures with parts installed that you haven't done on your plane yet, or missing parts you do have installed but just focus on the part of the picture for the step you are working on. Many of the models built for the pictures were not constructed in the final recommended order.

For example, some kits have you build the fuselage & wings then add the tail surfaces. For the CTC however, it's much easier to attach the rudder prior to installing the fuselage fittings. This is because once the fittings are installed, the fuselage can't be laid flat anymore for ease of rudder attachment and alignment.

Don't rush assembly. The build should take about a week of 2-3 hour evenings once you understand the steps. Unlike other 3D model kits, this bird should be around for years so it's worth taking your time and doing it right.

We're sure that if built and setup as instructed, you'll agree that this is a very special plane indeed!

1.2 Carbon Traveler Convertible Parts List

Carbon rods and assemblies:

Quantity	Description	Length - inches	Diameter
	WINGS		
4	Wing panels, complete (2 right - 2 left)		.
4	Wing pivot spars	9-3/8	.07
2	Wing outer uprights	5-5/16	.07
2	Wing diagonal struts	11	.07
2	Wing upper rear struts	12	.07
2	Wing lower rear struts	12	.07
	TAIL		
1	Rudder panel, complete		
2	Rudder hinge pins	3/4"	.07
2	Horizontal elevator panels, complete		
1	Horizontal pivot spar	13	.07
2	Horizontal diagonal struts	6-5/8	.07
	FUSELAGE		
1	Fuselage panel, complete		
2	Fuselage center booms	21-1/4	.08
2	Fuselage diagonal braces	14-7/8	.07
4	Fuselage boom connectors (1 spare)	1-1/4	.06
5	Fuselage servo rails (1 spare)	1-1/2	.06
	LANDING GEAR		
2	Gear strut – upper	7	.07
2	Gear strut – lower rear	5-1/2	.07
2	Gear strut – lower front	5-1/2	.07
2	Gear axle	1-1/8	.07

Materials included in kit:

Fittings:

6	1"	4 needed - LG fittings, LG hubs (2 extra)
20	3/4"	16 needed - fuselage fittings, wing struts, tail struts, LG (4 extra)
24	5/8" T	20 needed - center booms, tail struts mount (4 extra)
12	1/4"	8 needed - fuselage & wing linkage (4 extra)
10	1/8"	7 needed - wing pivot stops, wheel hubs, rudder connect (3 extra)

Bushings:

20	1/4"	16 needed - wings and elevator panels (4 extra)
1	2"	Sleeve for elevator spar attachment to fuselage

2 colors	1/2 oz. Polycarbonate Coated Ripstop Polyester Fabric
4 ft	Music wire .032 diameter for linkage
3	Linkage bushing sleeves
2	Wheels
1 bag of 100	Small diameter rubber bands
1 20 yd bobbin	Heavy polyester thread
16 inches	Ripstop clear reinforcing and repair tape
1 bag	Assorted motor mount parts

Dubro hardware supplied:

2 packs of 2	Mini E/Z connectors - #845 - (2 for wing servo, 2 for E/R)
2 packs of 2	Micro control horns - #848 – (3 horns needed)
1 pack of 4	Micro E/Z Link - #849 – (3 links needed)

1.3 Items You'll Need

1) 3-ounce bottle	DAP Weldwood Instant Contact Cement
	Sewing needle for lashing fittings
	Thin CA
	Velcro to mount gear

Tools Needed:

New single edge razor blades
Needle nose pliers to bend music wire (add band around handle to hold parts)
Sharp and pointed hobby knife
Sharp pointed scissors
Medium pencil
Yardstick and/or accurate ruler
Wire cutters (for cutting music wire - NOT for cutting CF rods)
Small screwdrivers for servo horn installation and adjustment
1/16 inch drill bit for enlarging servo arm and linkage connector holes

Handy but not required:

Fat, sharp needle for use as hole poker (can insert in wood dowel as handle)
Spring hook for pulling bands (can make from piece of music wire)
Hemostats
CA kicker
Wire strippers (to trim CF rod if needed - do NOT use wire CUTTERS!)
Medium sand paper (to round ends of CF rod for rudder pins)

NOTE: Specs and dimensions may change without notice to improve design and/or aid in construction.

1.4 Definition Of Terms

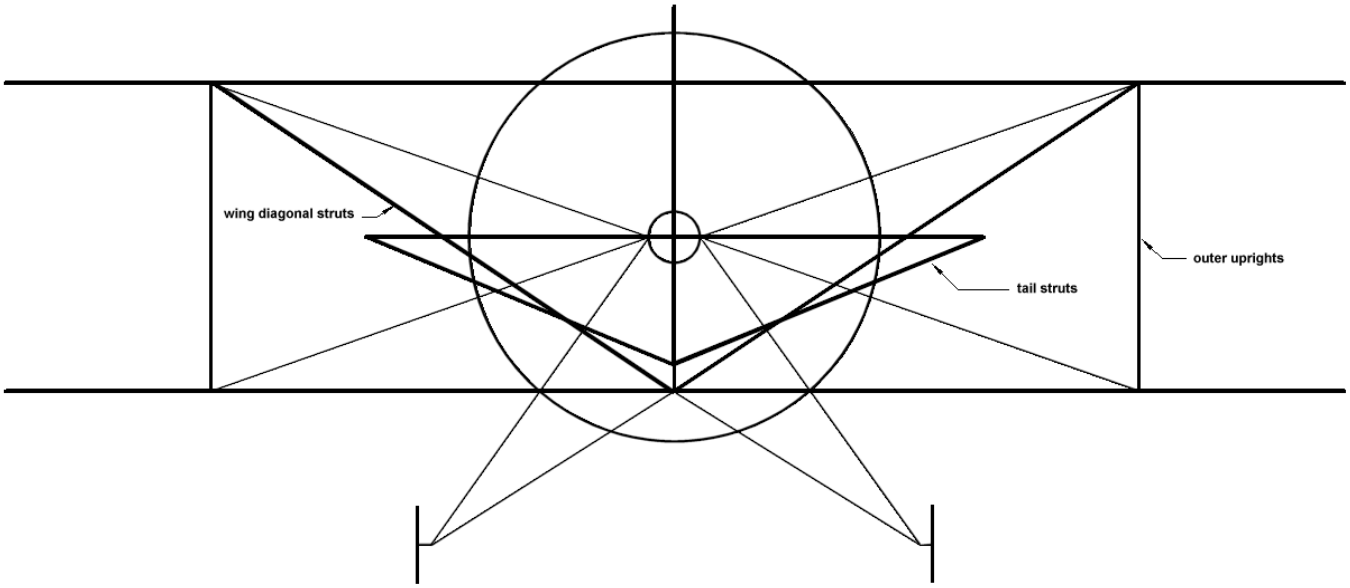
General Abbreviations and Terms

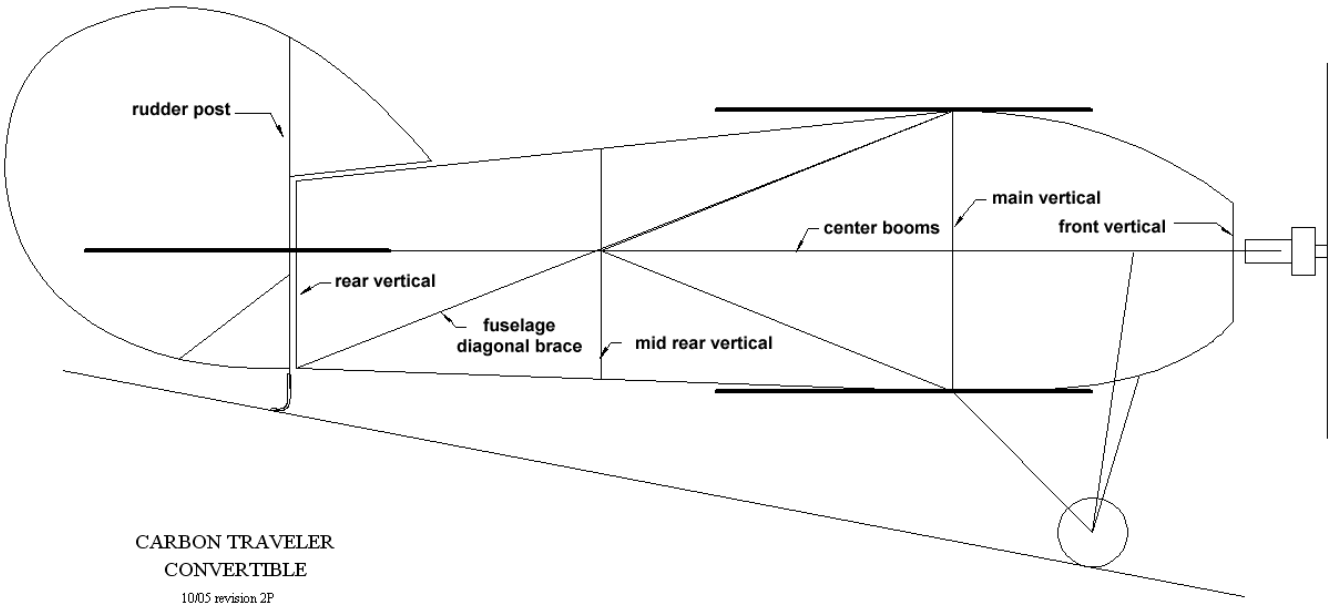
A of A = Angle of Attack - positive or negative angle wing is traveling through air
A/E = Aileron / Elevator - type of model using only these for control - with throttle uses 3 channel radio
ARF = Almost Ready to Fly - model mostly built but needing some construction and gear installation
AUW = All Up Weight - weight of plane and all gear needed to fly
BEC = Battery Elimination Circuit - part of ESC that lets receiver to be powered by motor battery
Brushless = type of light and efficient electric motor for model use - required brushless ESC
CA = (cyanoacrylates) - Hot Stuff, Crazy Glue, Zap, etc.
CF = Carbon Fiber - rod, tube, plate (also - Carbon Falcon™)
CG = Center of Gravity - location where model balances level on ground required for proper flight
Chord = distance of wing profile from LE to TE
ESC = Electronic Speed Control - circuit that controls motor speed with throttle stick signal
Full House - plane using ailerons, elevator and rudder control - with throttle requires a 4 channel radio
LE = Leading Edge - front edge of wing
LG = Landing Gear
LiPo = Lithium Polymer - light and efficient battery type used for RC models
mAh = Milliamp hour - 1000 mAh = 1 Amp per hour
Profile = type plane with no 3 dimensional shape to parts - also can refer to cross section of wing
R/E = Rudder / Elevator - type of model using only these for control - with throttle uses 3 channel radio
RC or R/C = Radio Control
ROG = Rise Off Ground (or Grass) - able to take off under own power
Root = front to back center line of wing
RTF = Ready To Fly - plane includes everything needed to fly and is fully assembled
SF = Slow Flyer
TE = Trailing Edge - rear edge of wing
Washout = wing twist - tips at lower A of A than root

Terms Specific to the CTC

Bow = outer circumference frame rod that shapes the panel
Bushing = rigid tube piece used as bearing surface around rod
Center Booms = two main structural rods running the length of the plane on each side of fuselage
Control Surface = rudder or elevator panel
CTC = Carbon Traveler Convertible™ of course!
Fitting = thin flexible tubing used to connect frame parts to form panel shape or connect panels together
Panel = built up frame piece from CF rod that when covered becomes a section of the plane
Spreader = rod within frame that holds the panel shape
Wingerons = type of aileron control for roll where entire wing moves

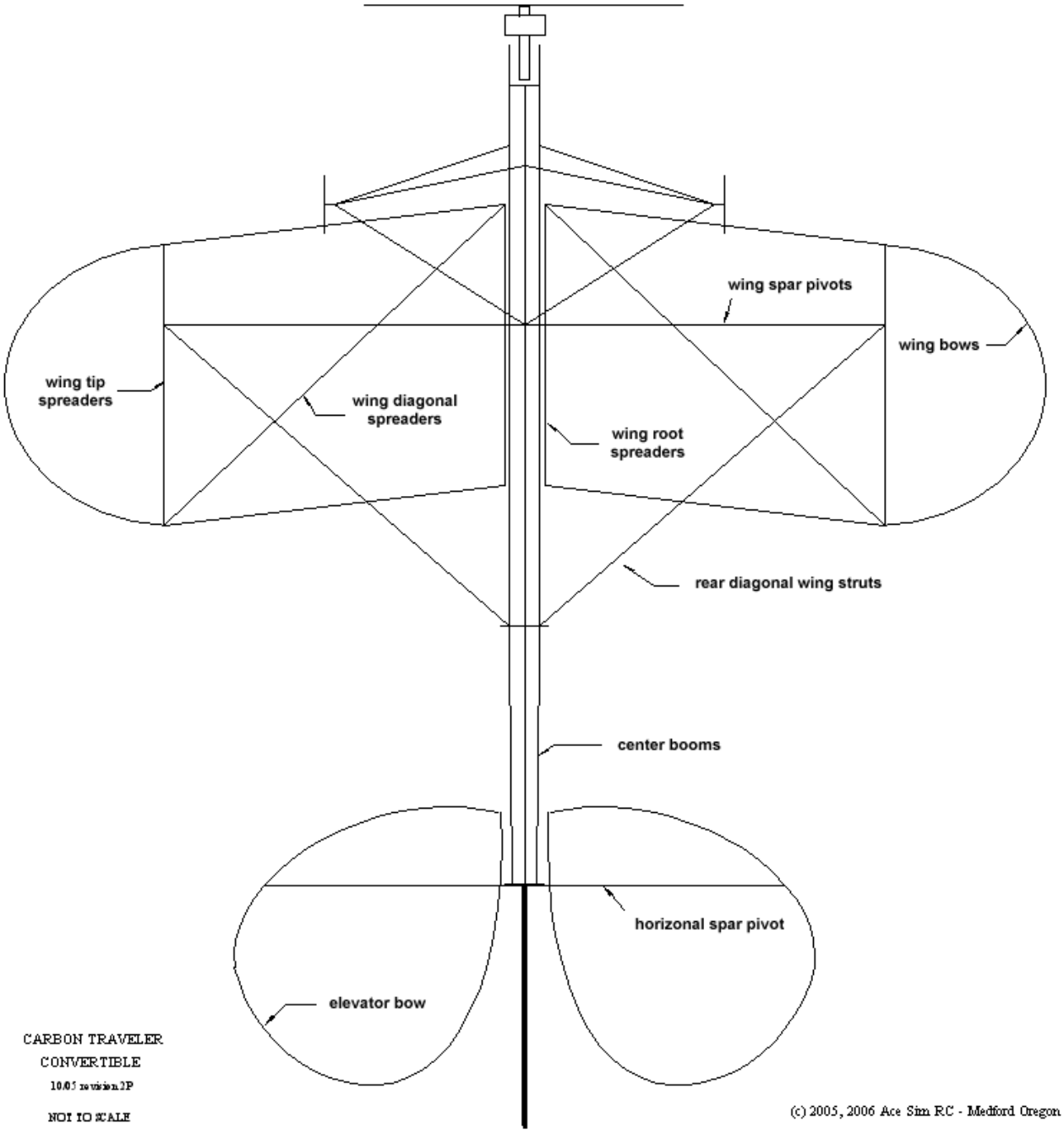
1.5 Parts Diagrams





CARBON TRAVELER
CONVERTIBLE
10/05 revision 2P

NOT TO SCALE



CARBON TRAVELER
CONVERTIBLE
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NOT TO SCALE

2. Attaching Ripstop Fabric to a Carbon Fiber Frame

The steps in this section apply to all panels. Any special requirements will be covered in specific panel assembly sections 3 through 6. Be sure to read and familiarize yourself with all sections before starting to cover any frame.

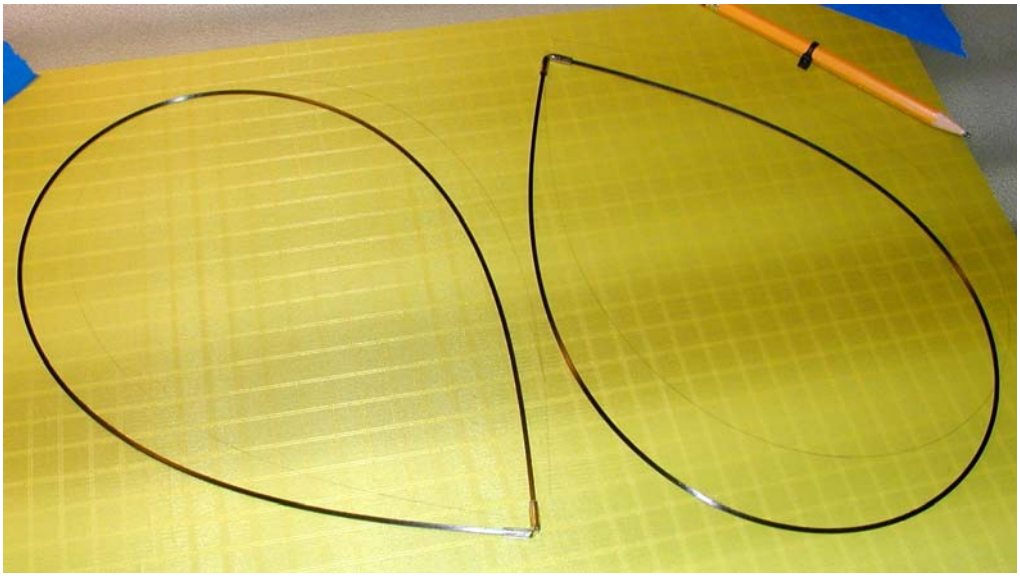
NOTE: For clarity, the pictures in this section show elevator panels.

2.1. Cut Fabric for Each Frame

OPTIONAL: Match or mirror fabric patterns as each pair of panels is cut for the wings and elevator. Consider the fuselage and rudder fabric panels as a matched set. This small effort at symmetry will produce a more polished appearance when completed.

Layout the fabric with the parts in position first to assure you won't end up coming up short. The four wing panels and elevators fit on the long length and the fuselage and rudder on the shorter piece. Divide up the excess between the panels for working room and cut the fabric appropriately.

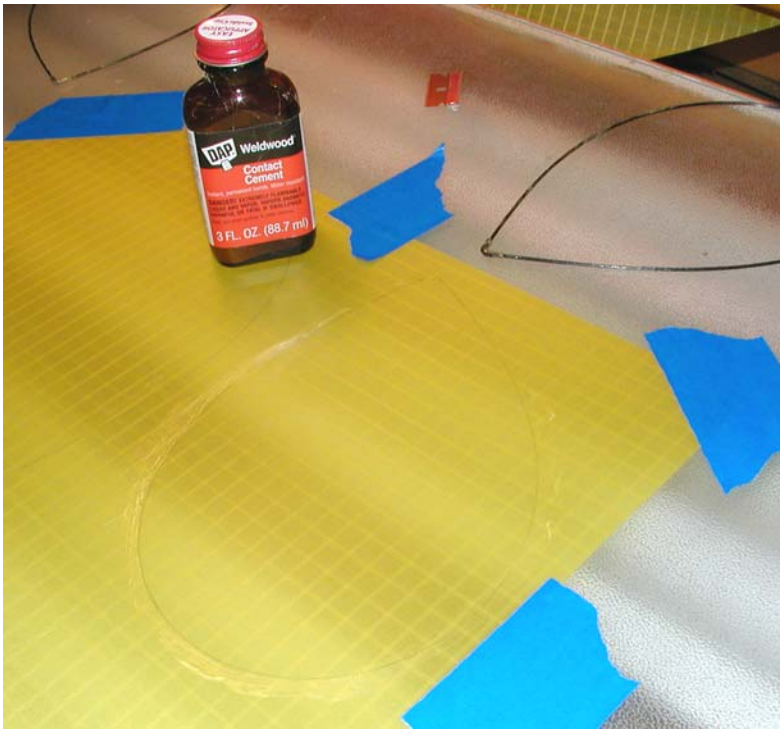
Cut fabric into rectangular pieces that are about one inch larger on all sides of each frame. This will provide room to work, as well as give you convenient corners for taping.



NOTE: Repeat the remaining steps in this section on a panel-by-panel basis. We recommend completing all covering steps on one panel before starting another.

2.2. Tape Fabric to Work Surface

Place each piece of fabric on a smooth flat surface and begin taping at the corners. Masking tape or blue painter's tape work well. The important thing is to use tape that will not pull up by accident, and will release without marks or residue. The fabric should lay flat without wrinkles, and, it should be snug, but not so tight that it pulls away from the tape. NOTE: if too tight you run the risk of having it contract if exposed to heat (hot car in sun, etc.) and fracturing a frame bow.



After taping the corners, fasten tape strips around all sides to even out the tension. Work center-to-corner on opposite sides as you work. Press the tape down firmly to be sure it will not work loose.

To test tension, try to move the fabric in the center with your fingertips. If it doesn't move, it's tight enough.

2.3. Trace Frame Outline onto Fabric

Place each frame assembly onto its fabric and, using a pencil, trace around the inside of the external frame. The objective here is to provide a guide for applying glue.

Trace both sides of all frame parts internal to each panel. External, or edge frame parts need only be traced on the inner side. (see following pictures)

2.4. Apply Contact Cement to Fabric

Observe all safety cautions on the glue container using only the brand and type recommended. Other glues are typically not instant and more difficult to work with.

Shake the glue well and apply liberally but neatly from the line traced at the perimeter outward at least a full 1/4 inch outside the line. If it tends to soak into the fabric without leaving a visible layer of glue, you've got mostly solvent there. Apply a little more glue in those areas.

Glue thickness can be controlled by picking up some of the extra glue near the mouth of the bottle. This glue is often thicker because the solvent evaporates faster near the opening. It gets lumpy after a while, but is still useable by dipping into the bottle, and mixing the thinner glue with the thicker glue at the neck. Be sure to close the container when finished with each gluing step.

Stay neat and within the lines of any inside straight rods. It is easier to stay in the lines now than to clean up a mess later. Thinner leaves dull spots on the fabric as well. Using a skewer or toothpick to apply a thin straight bead of glue can work well if you have a steady hand.

2.5. Apply Contact Cement to Frame

Decide which "side" of the frame will be next to the fabric. Glue should be spread evenly to all parts of the frame that will touch the fabric.

Apply additional glue around the exterior of the frame, covering all areas. If it slops over onto the non-fabric (inner) "side" of the frame, just wipe off big globs before it begins to set. Excess glue can be removed later with thinner if desired.

Hang the prepared panel so it won't get stuck to anything and allow it to cure for about ten minutes, depending on temperature, humidity, etc.

After you build a panel or two you'll have a feel for the amount of time required for the glue to begin to set. The glue will not fully dry for a couple hours, but it's much easier to work out wrinkles and problem areas in those first few minutes. Once fastened, it quickly gets very difficult to separate fabric and frame for repositioning without using thinner.

2.6. Position Frame onto Fabric

Have the fabric and its corresponding glue-coated frame ready to assemble.

Confirm that all tape holding the fabric is still tight, and that the fabric is flat, smooth and wrinkle-free.

Carefully position the frame over the tracing but don't let anything touch yet. Slowly lower it onto the tracing as close to the outline as possible.

Once seated, press the entire frame down firmly with your fingers, moving around the outer bow and along any interior rods.

2.7. Apply Fabric to Frame

Careful work and attention to detail in this section will pay off in a much nicer finished model.

As you release each piece of tape from the fabric start tugging the fabric up and around the side of the frame. Hold the frame down firmly as you pull up working around the entire frame.

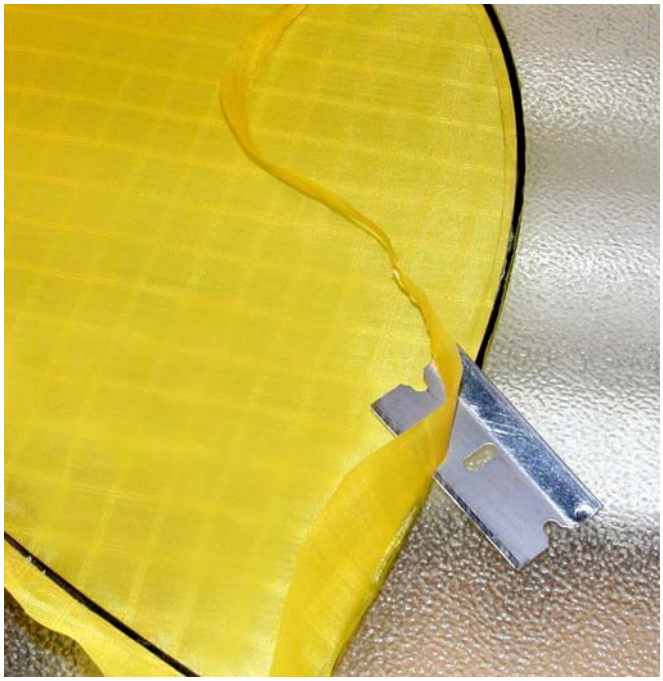
Hint: If any puckers appear, they can be removed by placing the loose area over the table edge with the fabric on top, and pinching down on the edge of the problem section outside the frame, while pulling outward, and working it back around the edge.

Once satisfied with the result, work around the entire edge again to ensure that it is drying properly and will hold tension evenly.

2.8. Trim Excess Fabric

Double-check all panels on the fabric side one last time for any slippage. It won't hurt to re-tug around them all again just to be sure.

With a new single edge razor blade, start cutting fabric with the blade horizontal and resting on the frame and with the frame held down.

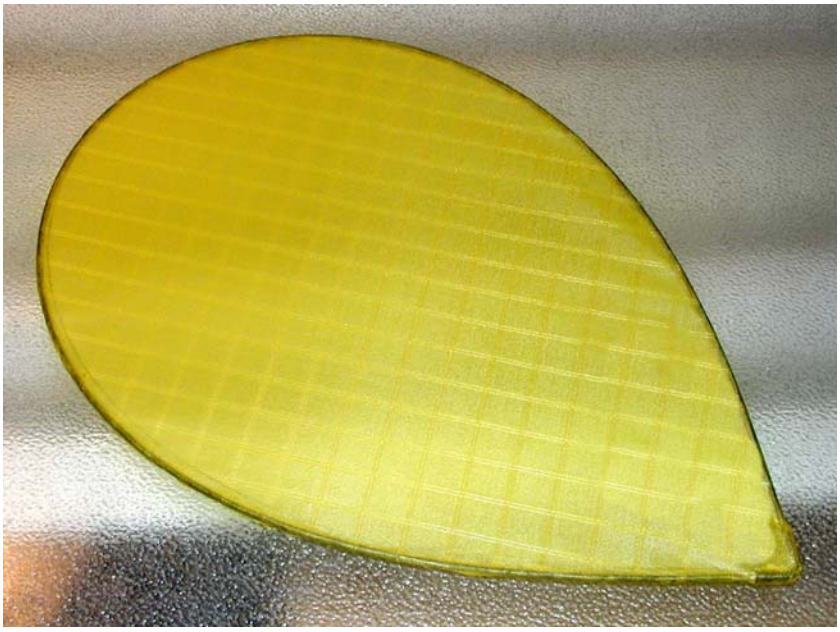


Caution: Ripstop fabric tends to tear or shred when cut. Hold tension on the fabric scrap as you go to make for a cleaner cut. A sharp blade will cut cleanly.

Caution: Be careful when cutting fabric at the fittings since they are raised slightly. Raise the blade at the fitting and continue on until it drops off the other end. Also avoid cutting tensioning and shaping strings with the blade.

After trimming is complete, pinch and roll any remaining fabric up and around the outside of the frame. Any large amount of excess fabric still existing can be trimmed with a small scissors.

Now, lay the panel on its open frame side and press down all around the perimeter as well as along any interior frame components to ensure good contact everywhere.

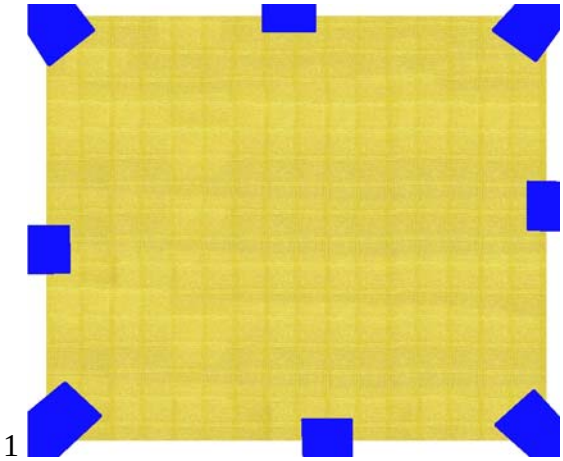


2.9 Covering the Elevator

CAUTION: Compressing the frame with your fingers when positioning the frame down on the fabric to glue will result in uneven tension in the fabric. Once it is in position over the tracing, start by touching the point of the frame to the fabric. Carefully align the frame with the trace as you work around the edge while lowering it into position.

2.10 Covering the Rudder

Position the rudder with its hinge line to the left and with the top up, covering the rudder on its right side which will match the fuselage.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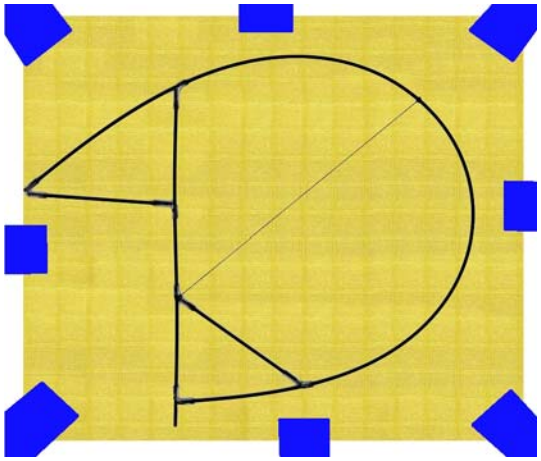
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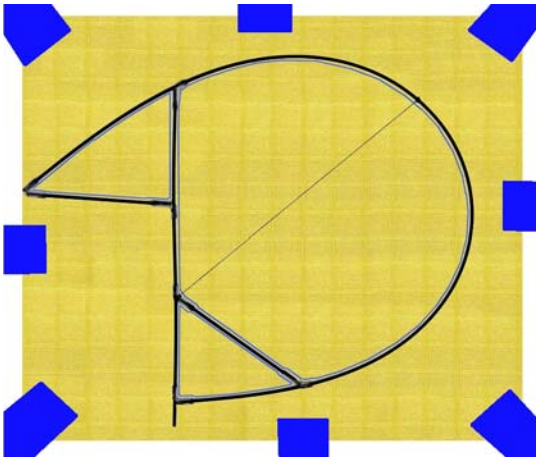
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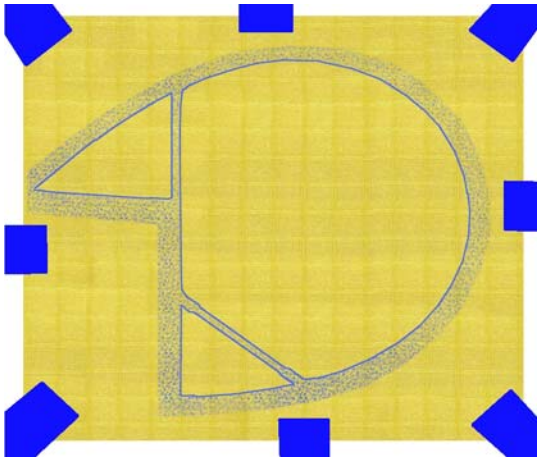
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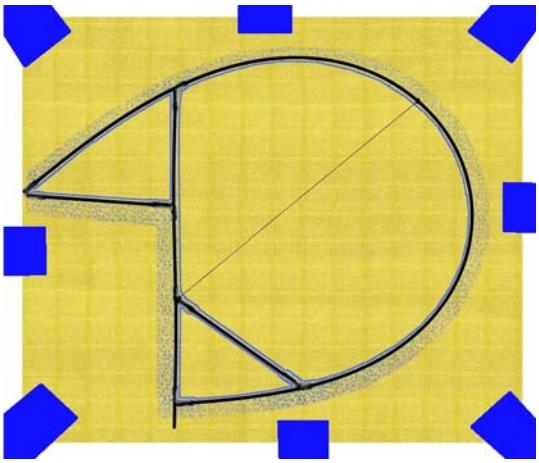

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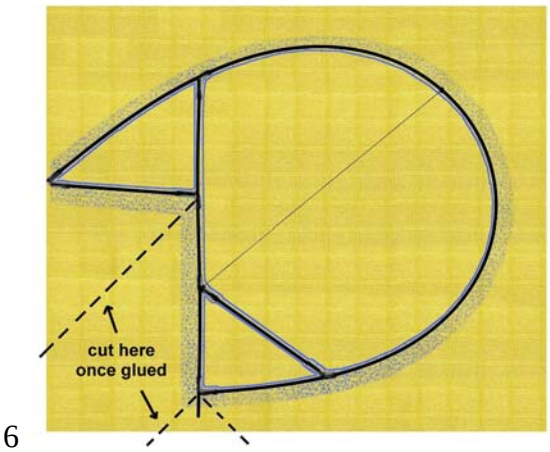

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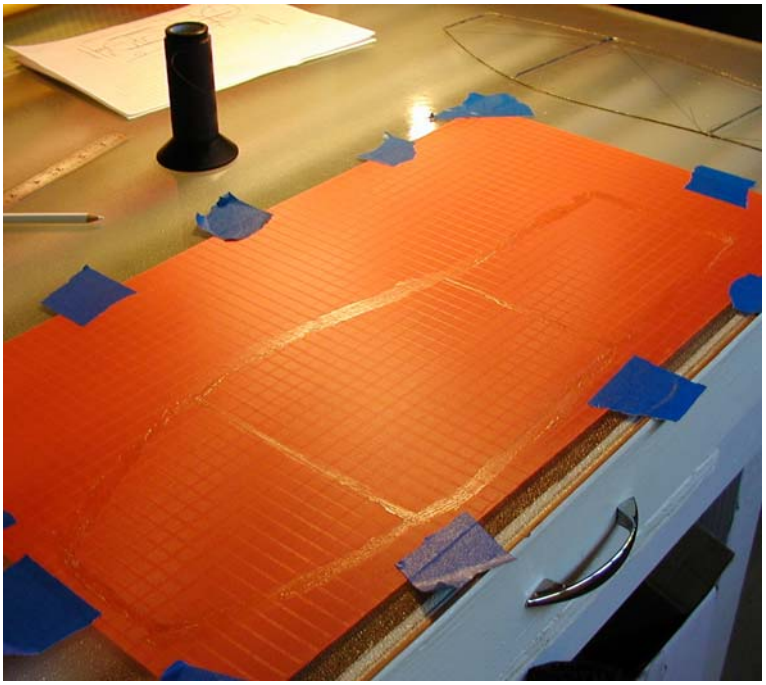
Once the frame is glued down to the fabric, finish by slicing a line in the fabric diagonally from the corner of the balance tab bottom where it meets the rudder hinge post. Cut outward away from the corner. This allows the fabric to be wrapped up around both rods. Split the fabric at the rudder hinge post extension at the bottom and wrap it up and around each side as well.

2.11 Covering the Fuselage

Position the fuselage frame with the larger bow on top and nose to the left, covering the fuselage on its right side, matching the rudder.

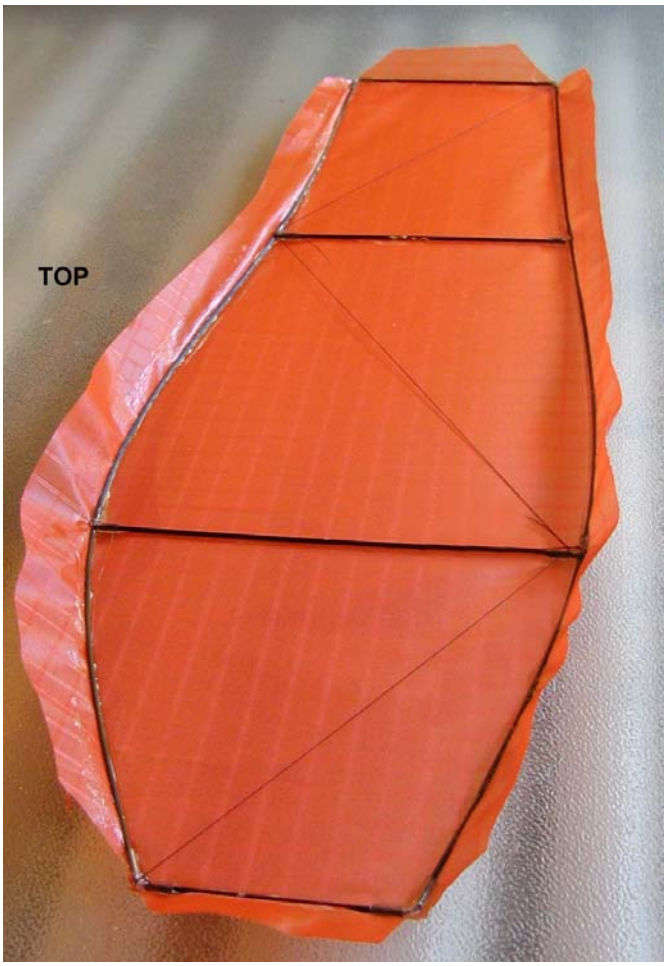
When tracing the fuselage frame onto the fabric, lightly compress the bows between the vertical spreaders.

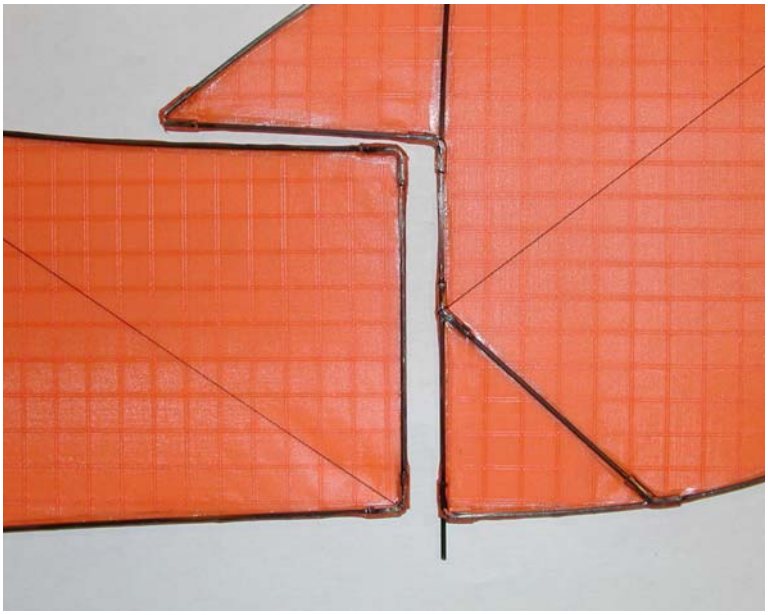


When placing the pre-glued frame onto the fabric, start from one end and work your way along.

Don't let the fuselage frame shift diagonally as it is being applied. The tension threads should stay taught as you go.

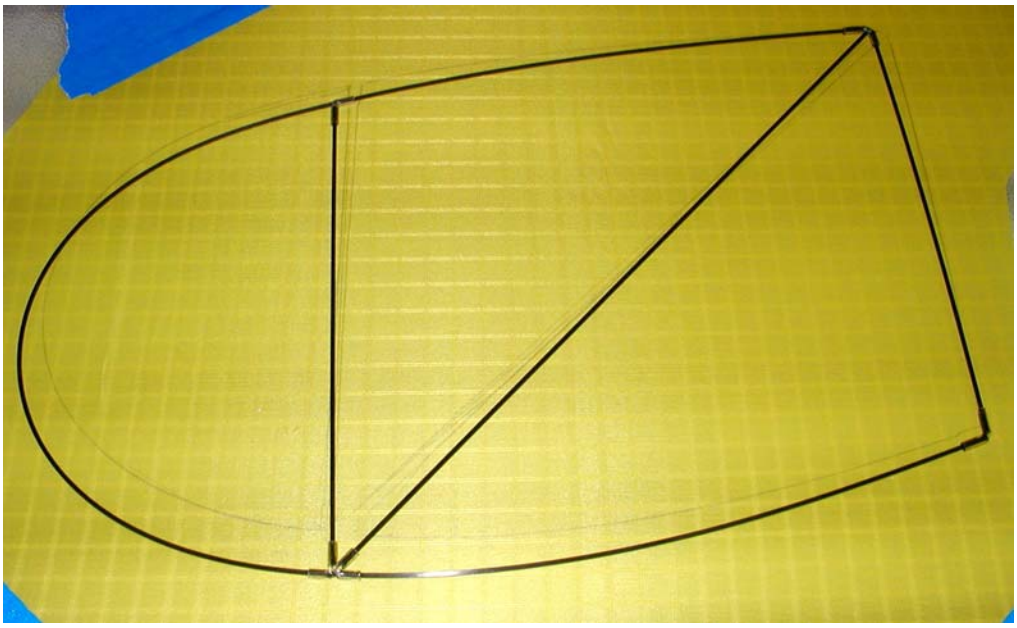
As the fuselage frame is lowered, lightly compress upper and lower bows between uprights, matching your tracings. This gives the fabric added tension in the vertical direction.



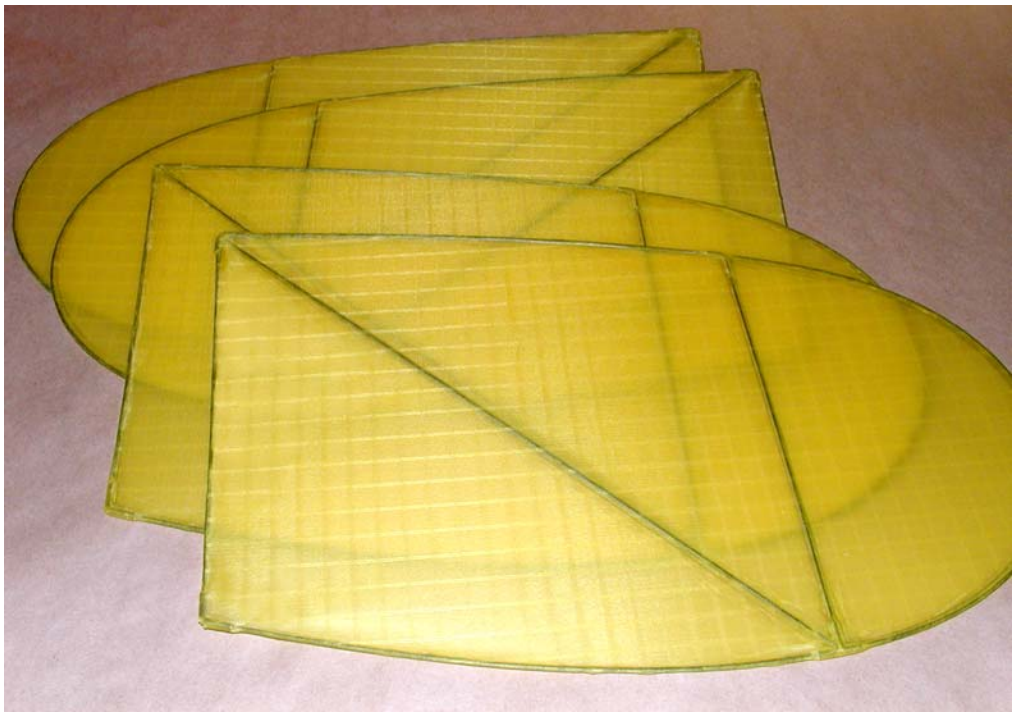


2.12 Covering the Wings

Mirror the pairs of wing panels. Since they are interchangeable from top to bottom diagonally, just lay them out with two lefts and two rights. It's easy to forget and end up with three of one and one of the other. Be careful when laying the fabric out as well as when coating the frames.



Compress each wing frame about 1/4" at the LE and TE and also slightly in on the root rod as you trace the frame. This will add some extra tension in the chord and span directions. When applying the frame to the fabric, repeat the compression to align it with the tracings.



3. Fittings

All fittings and bushings are supplied pre-cut to general lengths in sufficient quantity to construct a plane plus extras. Due to variances in diameters of both the carbon fiber rods and fitting hose itself, every effort is made to supply materials that require some force to push on and requiring a thumb-nail pull on the fitting end to release the rod for disassembly. This is sort of like the Chinese finger trap toy you may remember from your childhood.

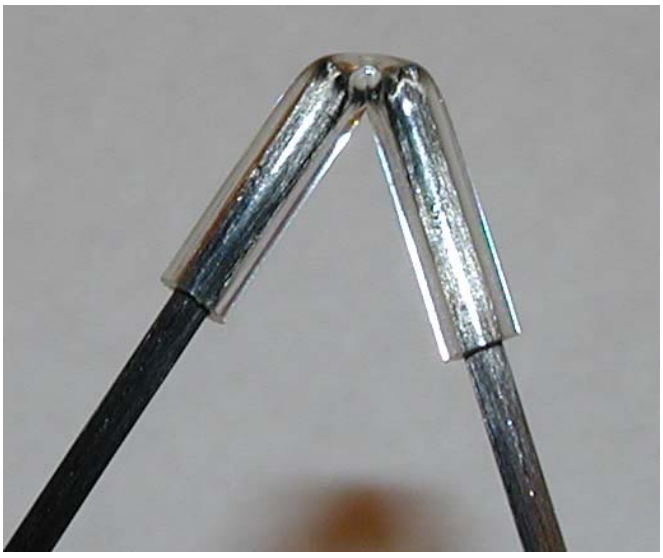
If you find that the rod is too loose in a fitting and isn't one that needs to be removed for transport, it can be glued in of course. If it is a fitting that will be left removable, you can make the fit tighter by dipping the rod end in CA and allowing it to dry fully to fatten it up a little for a tighter fit. Dipping the wet rod end in baking soda and removing the excess power is another method of increasing the diameter and creating a snug fit if really loose. It can be light sanded down to achieve just the fit you want that can still be removed for transport. This is good for landing gear struts that want to disconnect too often on hard landings.

The connection method is strong as well as being forgiving of crashes and will release if the loads are severe enough. In most cases, no glue is required except where noted to keep the plane secure in the air yet safe enough to not break anything on even hard impacts with terra firma. An added bonus to this type construction is that all joints are shock mounted. For more information, see the "Owners Manual" section.

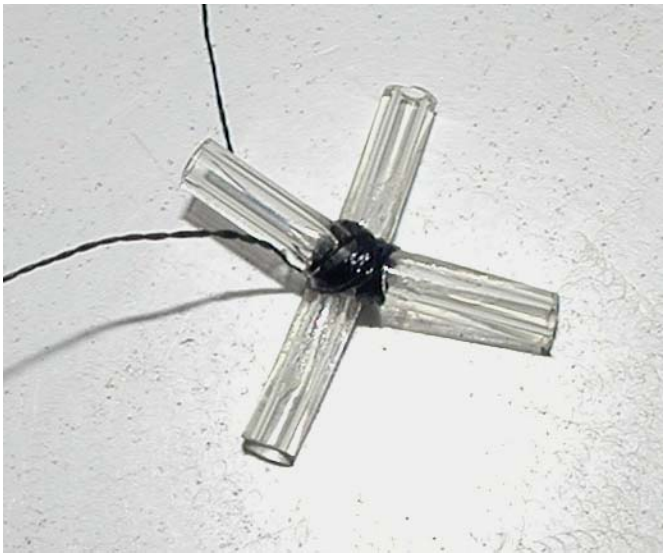
3.1 Fitting types

There are basically three types of fittings used in the construction of the Carbon Traveler:

1) Elbow - a length of flexible tubing that connects two rods together either at a corner or used as a joining sleeve. These are also used to connect struts and wings to the fuselage. These are usually 3/4" in length but some are 1" long.



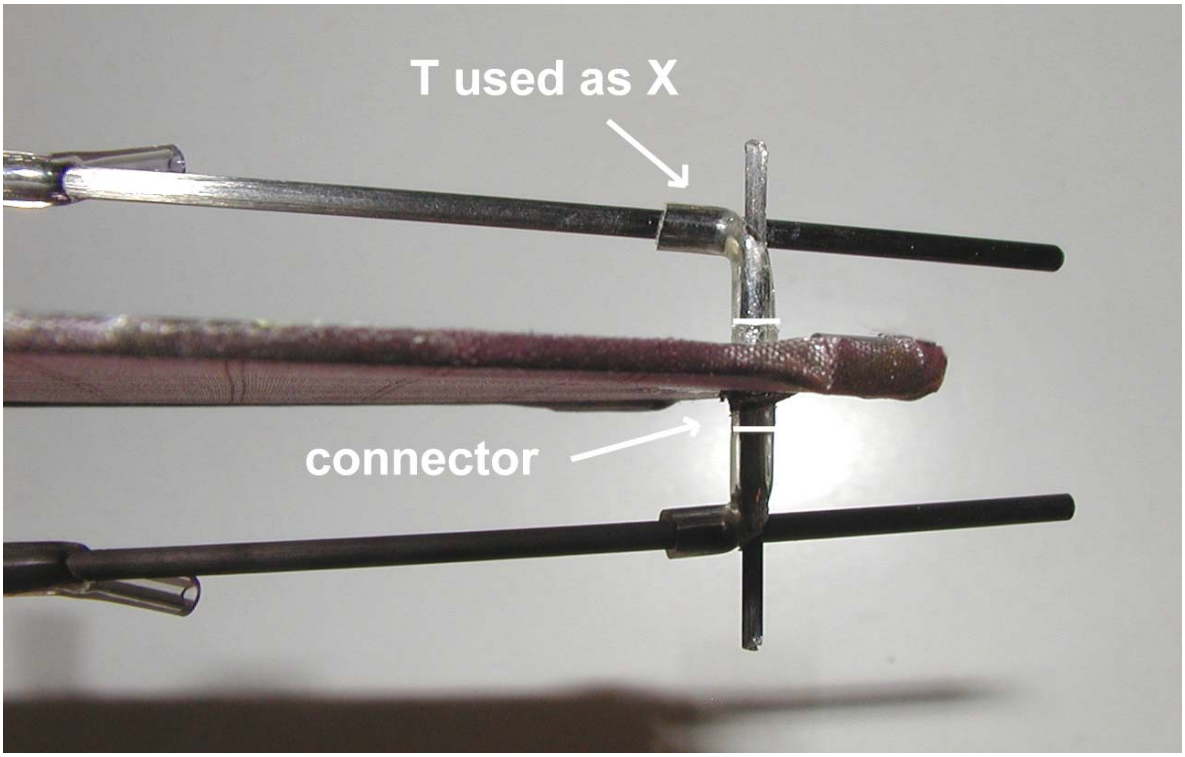
Two elbows lashed together form an X and are used to connect multiple struts to one junction:



2) "Ts" - a length of flexible tubing that has a hole in one side. When inserted on a rod out through the hole it becomes a T. These are 5/8" long with the hole at about the 1/3 length location. The shorter end gets slid along the rod to the location needed becoming the top of the T. The longer end then becomes the leg of the T that can be used for a perpendicular connection or virtually any angle attachment.

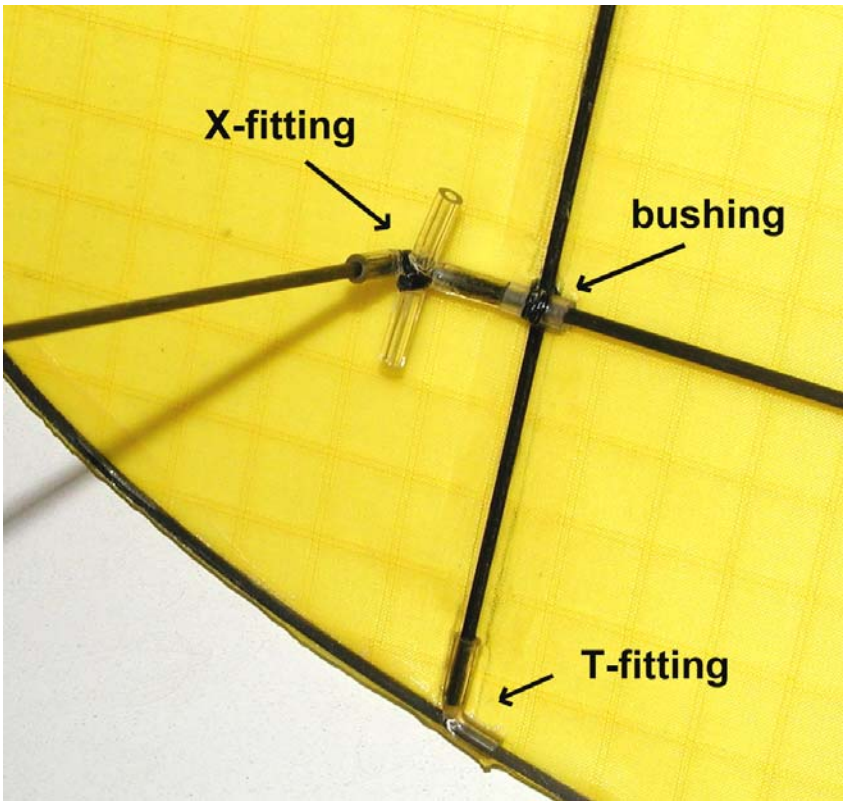
When used with the joining rod slipped out through the hole they become a type of "X" fitting. (see figure below)

3) Connector fitting - a short, straight length of flexible tubing that is used with a short rod inserted through it to connect other fittings to. Used to connect the fuselage to the center booms allowing easy removal for service. Also used for the rudder hinge attachment and wing control linkage attachment. These are usually 1/4" in length but some are trimmed shorter for a better fit where needed.



3.2 Bushings

These are cut from a rigid control rod sleeve material. Most are 1/4" in length and are used as bearing surfaces for the wings, elevators and rudder. They provide a slip fit to pivot on a .07 diameter rod. A longer length is lashed to the rear of the fuselage frame to connect the elevator assembly to.



4. Lashing Fittings and Bushings

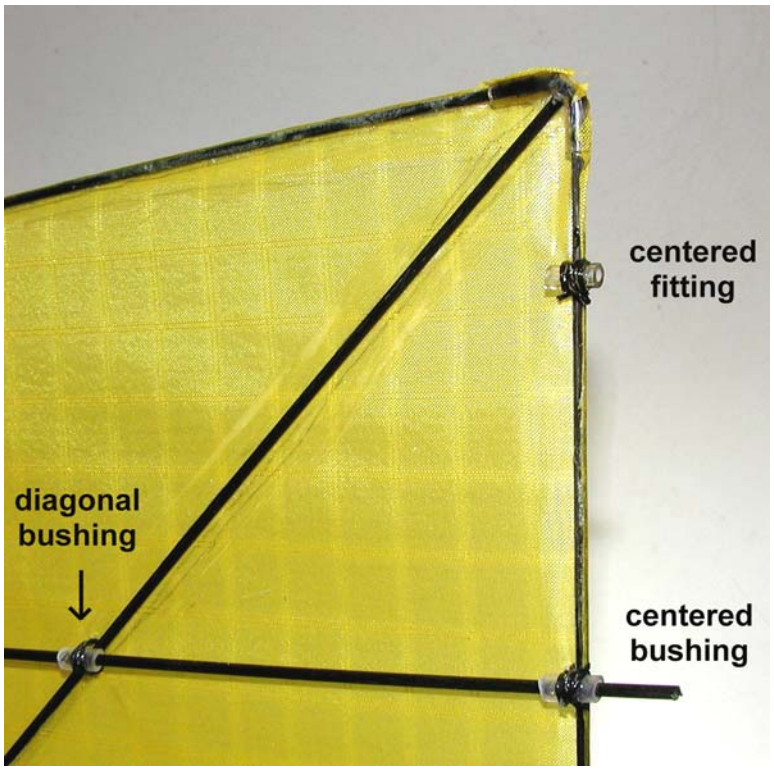
4.1 Glue station

Setup in advance a "glue pot" for your thin CA. I use either an old plastic servo package propped up with a few drops in the corner to work with or you can use a baggie pressed into a tape roll, etc. Don't use plastic wrap as the CA will dissolve it. Use a toothpick, thin stick or skewer with a wedge end cut on it as an applicator. You'll need to dip it in a few times until some glue builds up since at first it just soaks into the stick.

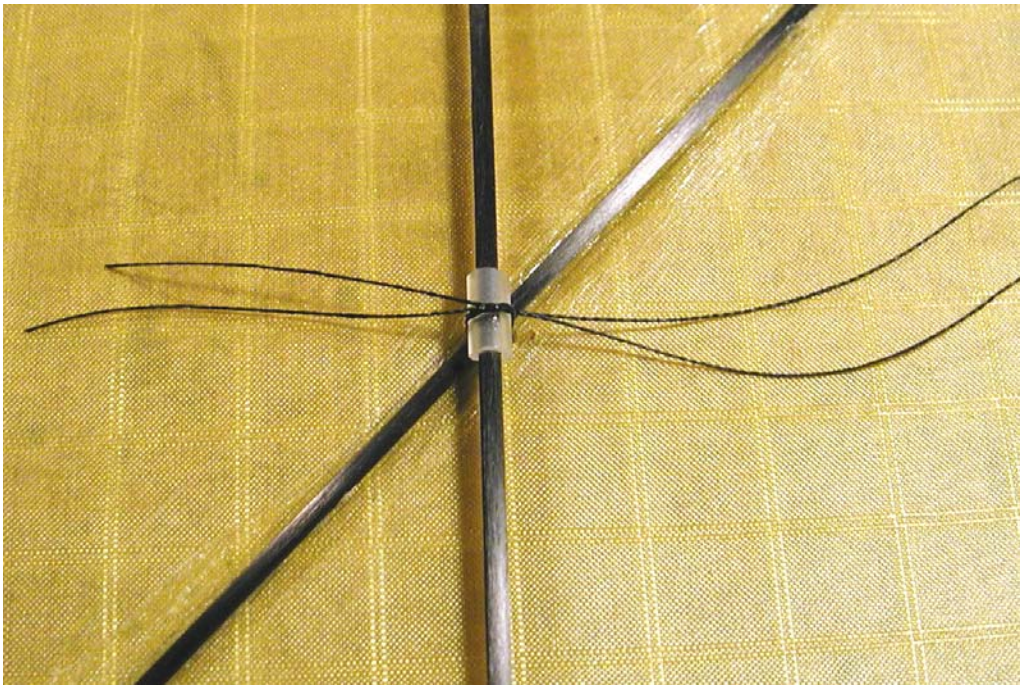
This method works very well, doesn't waste glue and allows accurate "painting" of the lashings without getting excess glue onto bearing surfaces.

4.2 Lashing types

There are two types of attachment methods for wings and elevators. One is where the fitting or bushing is centered, perpendicular and about square on a panel rod or bow. This type gets lashed in a figure 8 pattern around the bushing, wrapping the rod it is on at both sides to hold it square.

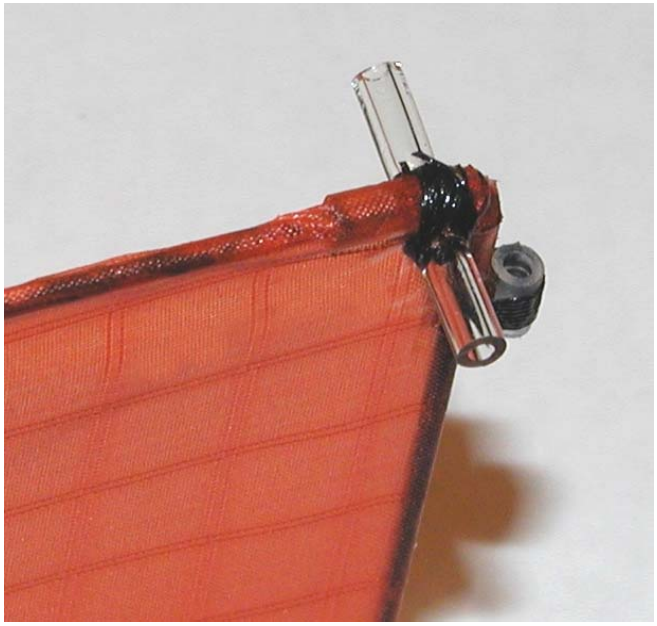


The other type is angled on the rod or a diagonal strut and only needs to be wrapped around the middle and the rod.



All wing and elevator fittings are mounted on the uncovered side of the panel.

All fuselage fittings run perpendicular to the panel except for rudder bushings that are parallel to the fuselage rear post.

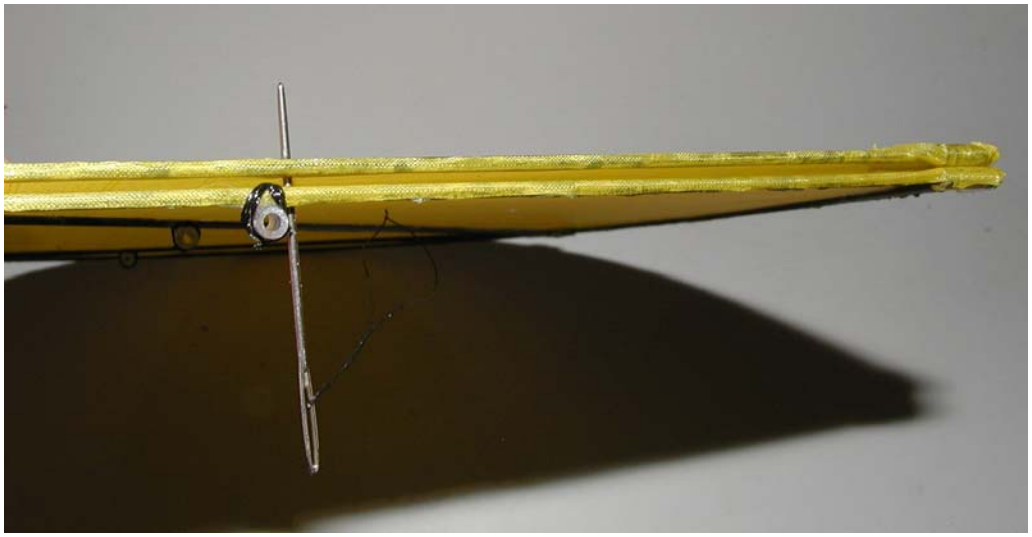


For bushings or fittings on wings or elevators, extend your panel out over the edge of your worktable with it positioned up. This gives you room to sew but keeps the panel flat and stable.

For all bushings, have their pivot rod inserted when lashing to the panel to assure they are properly aligned to each other. Use masking tape to secure the rod to the fabric to hold the bushings in position.

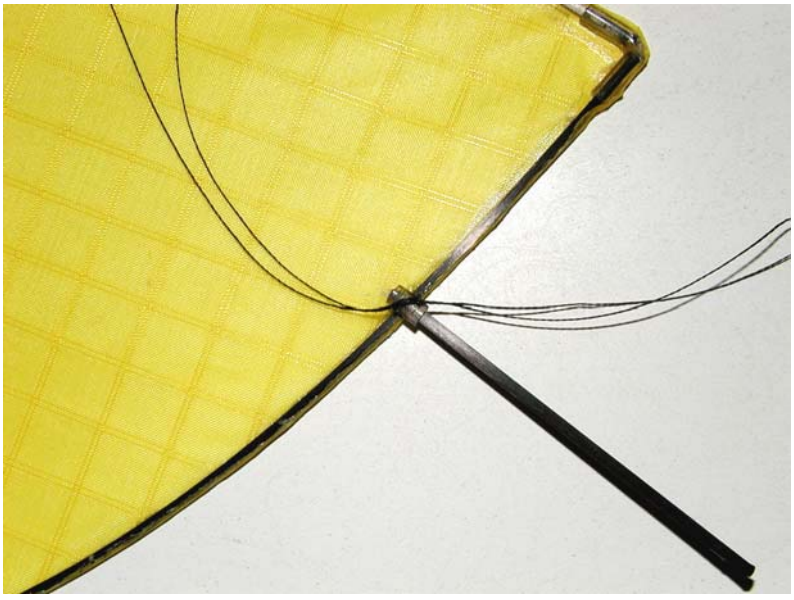
Wick thin CA under the bushings to tack them in place before lashing being sure they don't move out of position.

Lash one panel and then match it up with its opposite in pairs back-to-back to make alignment starting holes for lashing the matching panel with your needle. This assures equal placement of the bushings and fittings between sides.



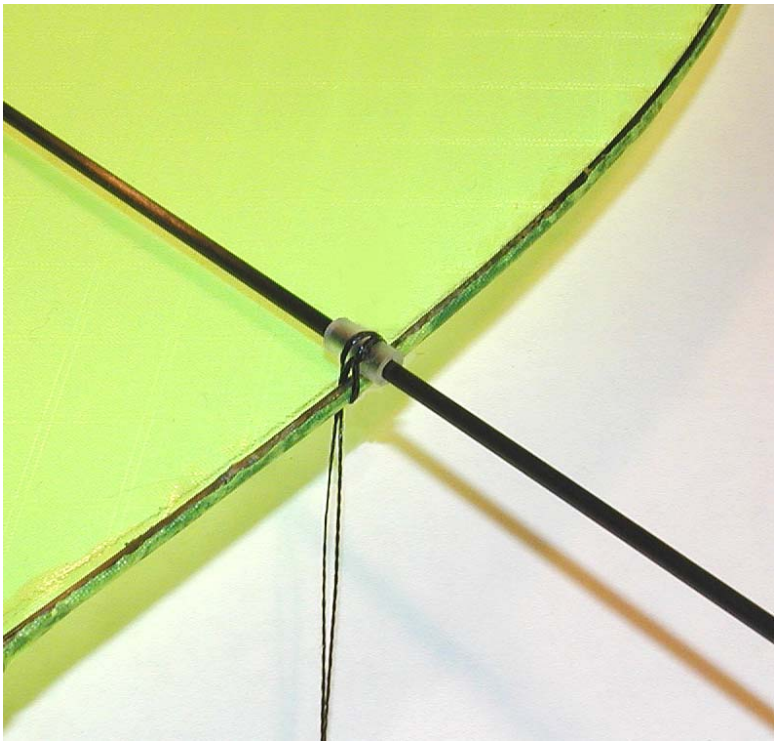
4.3 Lashing apply

With about 6 inches of doubled thread (12 inches total) on the needle, start by inserting the needle down through the fabric next to the bushing and against the panel rod it's located on. When you get near the end of the doubled thread, lay the ends over the bushing and hold. Wrap the thread up from under the panel against the frame or if the bushing is not on an edge, up through the fabric around the rod on the same side of the bushing you started.



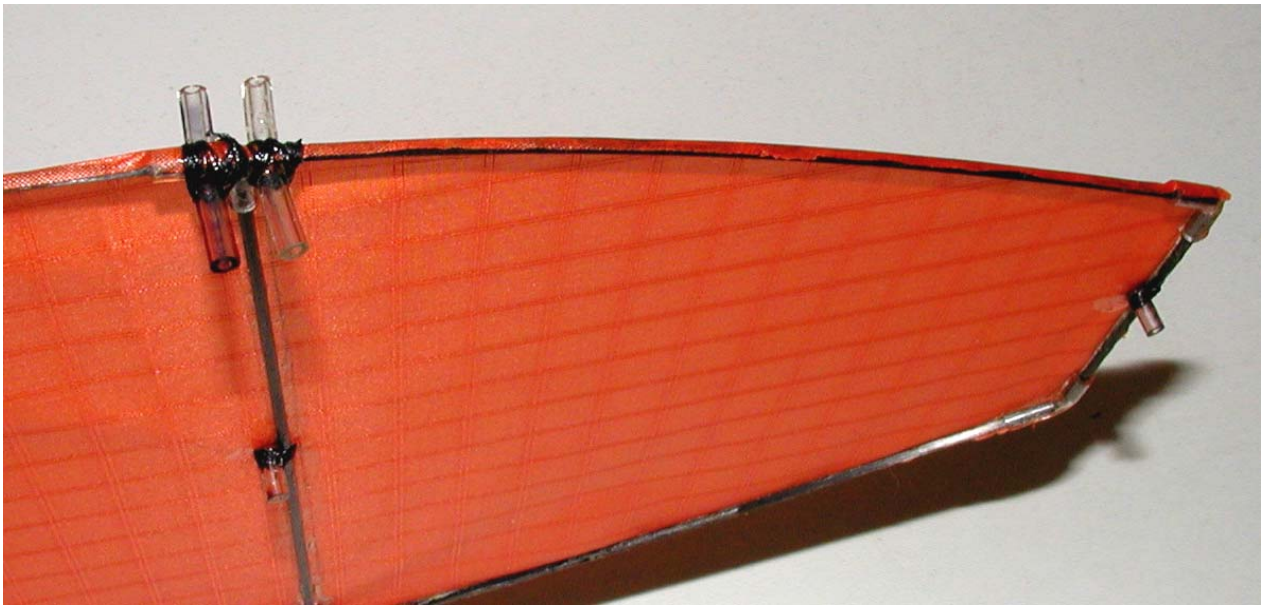
Next lay the thread diagonally back over the held ends tightly and it will lock the loop until you can tack it with CA. Continue lashing down through the other side of the bushing, back up the other side around the rod, over the top of the bushing and back through the hole you started with. Continue this figure 8 pattern a few wraps keeping them tight as you go.

I've found it is best to end the lashing after the needle comes out the bottom through a hole. Just tack it there, paint the lashing all around and trim the excess thread flush with the fabric and it's done.



The wing control linkage fittings are done the same way. Each individual section that follows shows detailed pictures of what the finished fittings should look like for each area.

For all the fuselage fittings that go just inside the outer frame bows and sit perpendicular to the panel, start with a slip knot in the thread, insert over the fitting to its center. Insert the fitting through the fabric and wrap in a figure 8 around the ends of the fitting and over the frame. Be sure to push the loops up close to the fabric and keep the wraps tight as you go. Also, be sure the fitting stays centered and square to the frame.

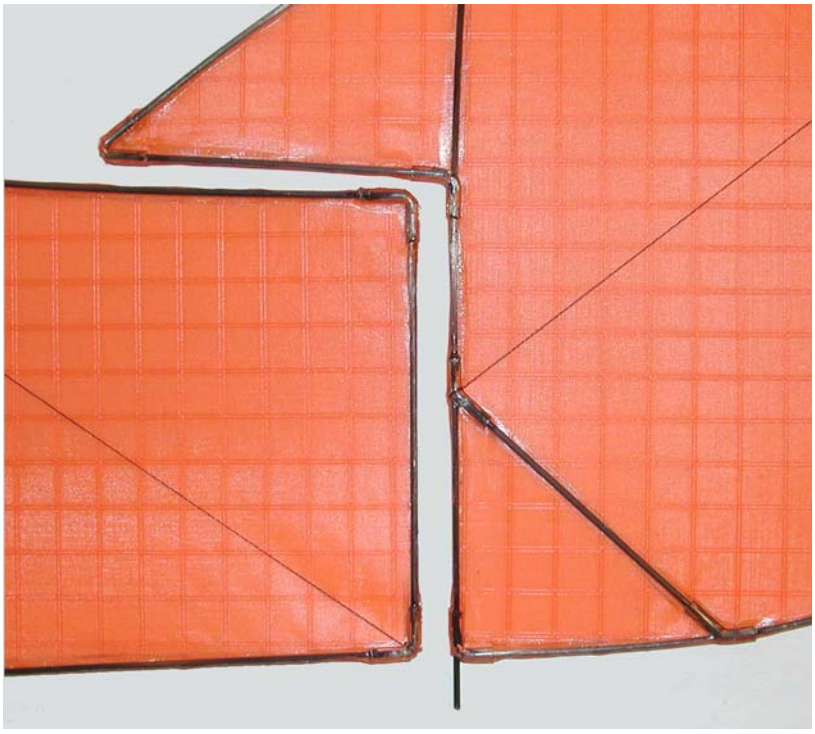


For the short fuse boom connector fittings on all the fuse uprights down the center, insert their connecting rods first so they don't collapse when lashed. For the two that go at the middle of the fuse on the uprights, you'll need to use needle and thread to go through the fabric as well as around the posts. Use the same pattern as the rest but lace it carefully through the fabric as you go again keeping it very tight and hold square both up and down as well as front to rear as you coat with CA.

5. Rudder Construction

5.1 Layout

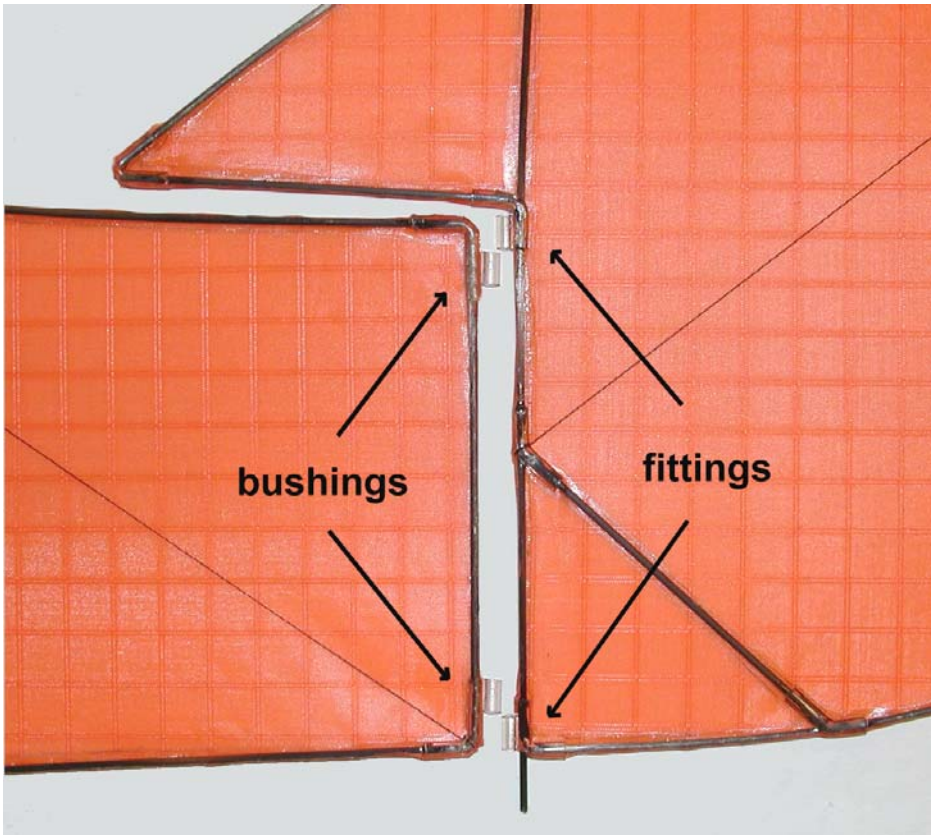
Layout the fuselage and rudder panels with their fabric sides down, lining them up together. Add about 1/8 inch space between them and between the rudder balance tab and the top of the fuse. This should leave the bottoms of both panels close to being lined up.



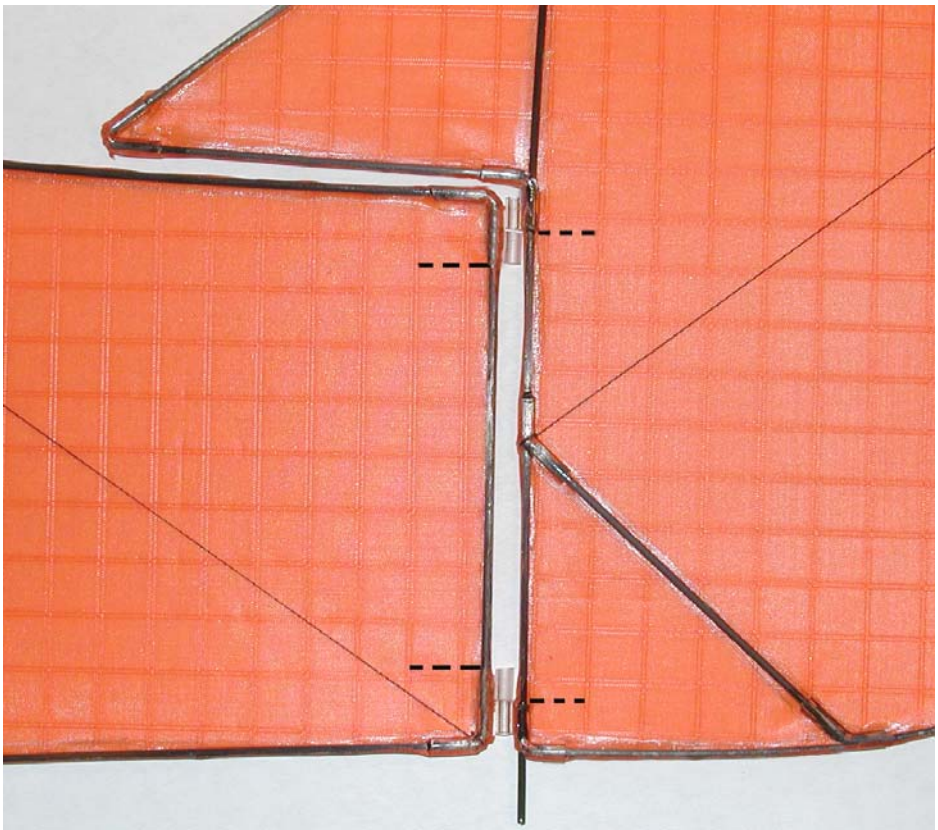
OPTION NOTE: If you don't need to have a removable rudder to allow for a shorter transport package you can elect to skip the following fitting installations and just use hinge tape or the supplied repair tape to attach the rudder to the fuselage. (see section 5.6 picture below) Apply tape to both sides leaving a 1/16" gap between the rudder post and rear fuselage vertical for good freedom of movement. Try to get the tape stuck to itself in the gap for best results. Skip to section 5.5 to continue with the control horn installation.

5.2 Fittings

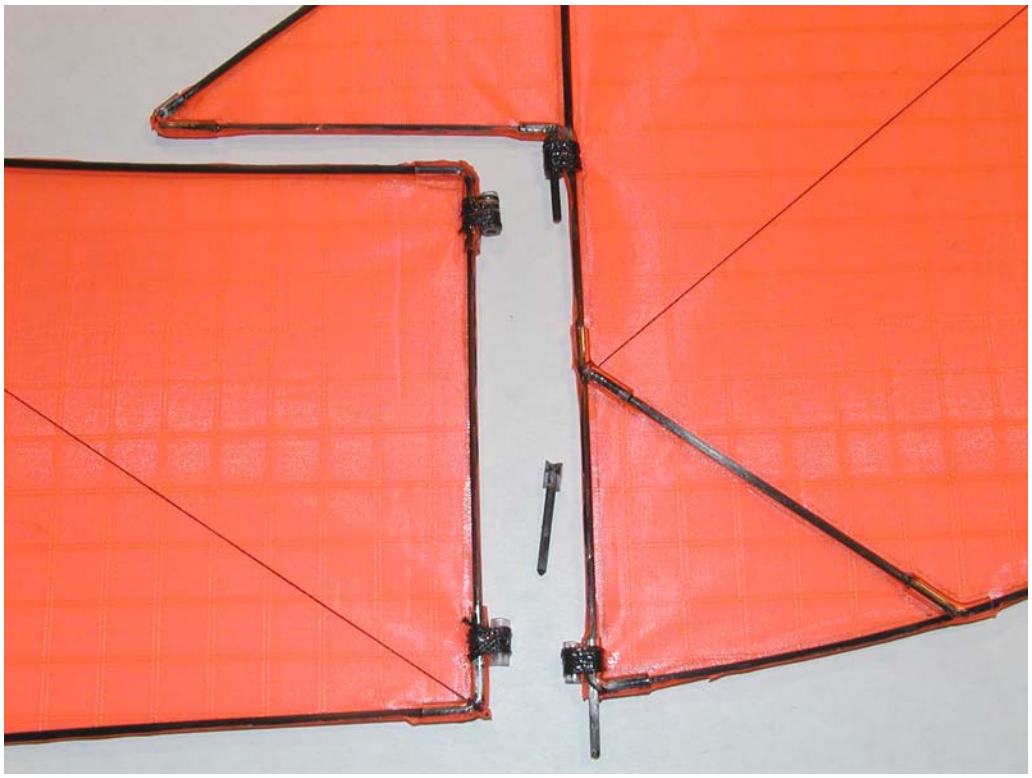
You want a pair of 1/4 inch long soft fitting sleeves on the rudder and a pair of 1/4 inch bushings on the fuse. Align them so the fuselage fittings are inside the ones on the rudder. Take the 3/4 inch short rod stub and insert it into the upper rudder fitting extended down. The other short rod stub gets a 1/8 inch slice of fitting material on one end as a stop and "handle". Glue this "handle" piece on well so it won't pull off and glue the shorter rod into the rudder fitting.



Ideally you want the rudder fittings to be mounted on the elbows right to their ends so the lashings from the bushings on the fuse will have clearance next to the rudder post.



Start with the fitting that has the pin glued in and locate it close to the top of the rudder with the pin down and bottom edge of the fitting aligned with the end of the rudder elbow there. Tack with CA. Use the thick type if you have it and let dry well. Insert the disconnect pin part-way into the lower rudder fitting and locate the fitting close to the bottom of the rudder and try to line its top up with the rudders elbow edge.

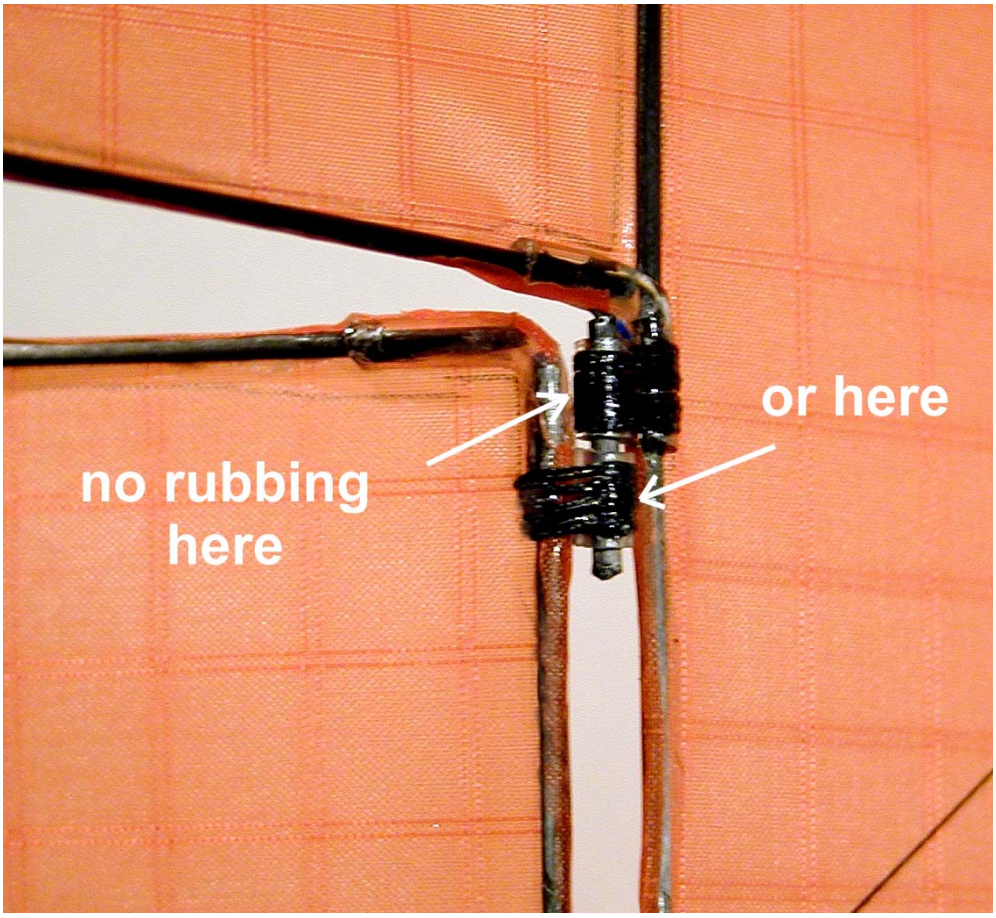


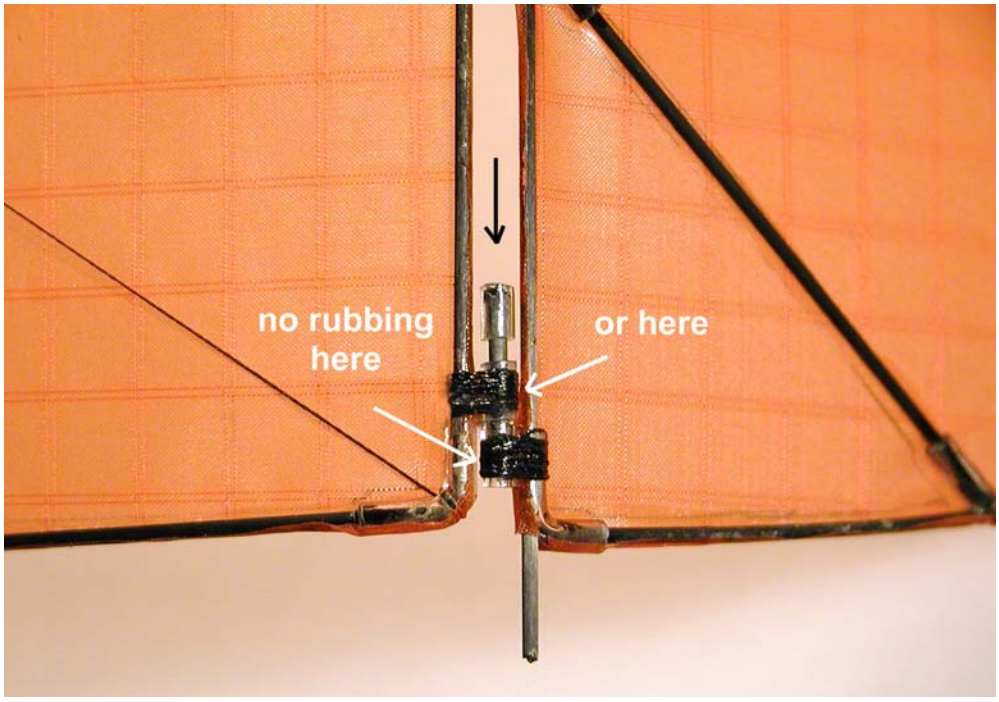
Once both are dry, lash each to the rudder leaving the disconnect pin inserted. Do not wrap the lower fitting so tightly that you can't remove the pin later. Try to make flat, even wraps so you don't get a lot of piled up thread that will restrict movement later.

Now tack the bushings on the fuse rear the same way with the rudder in position but disconnect pin removed. Leave a little space between the bushings and fittings for freedom of movement.

5.3 Assemble

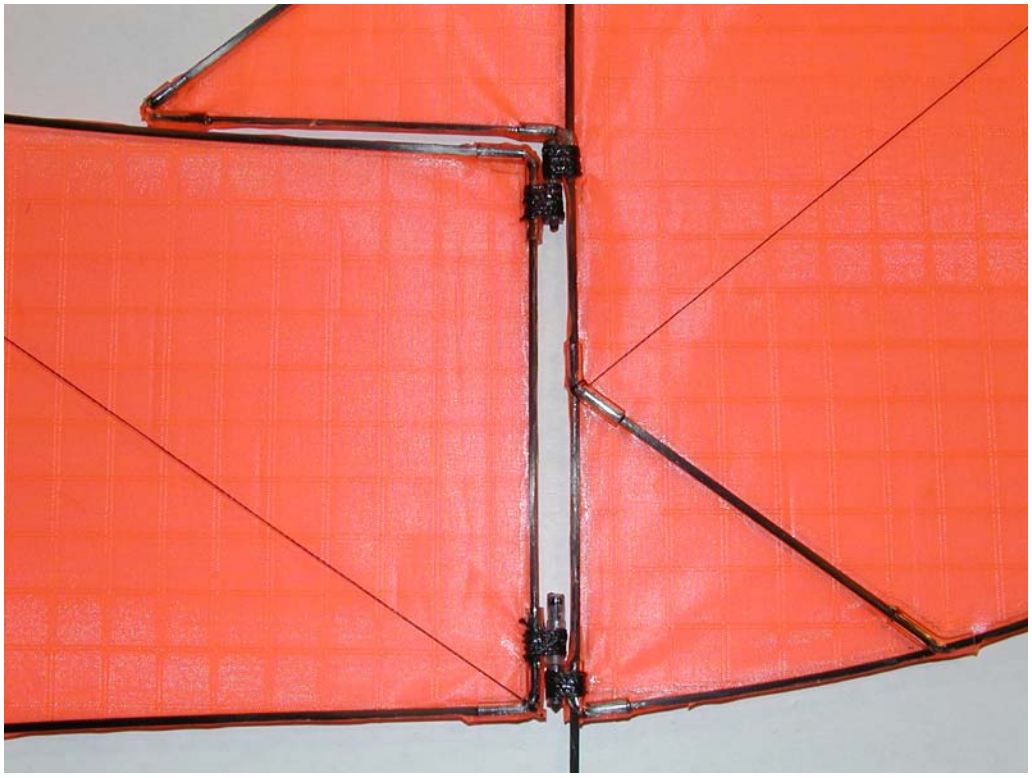
Once the bushings are lashed and dry, assemble the rudder and test for fit. Start by inserting the top pin in the bushing and line up the lower fittings. Insert the disconnect pin far enough into the lower fitting so that it can't fall out and check for freedom of movement.





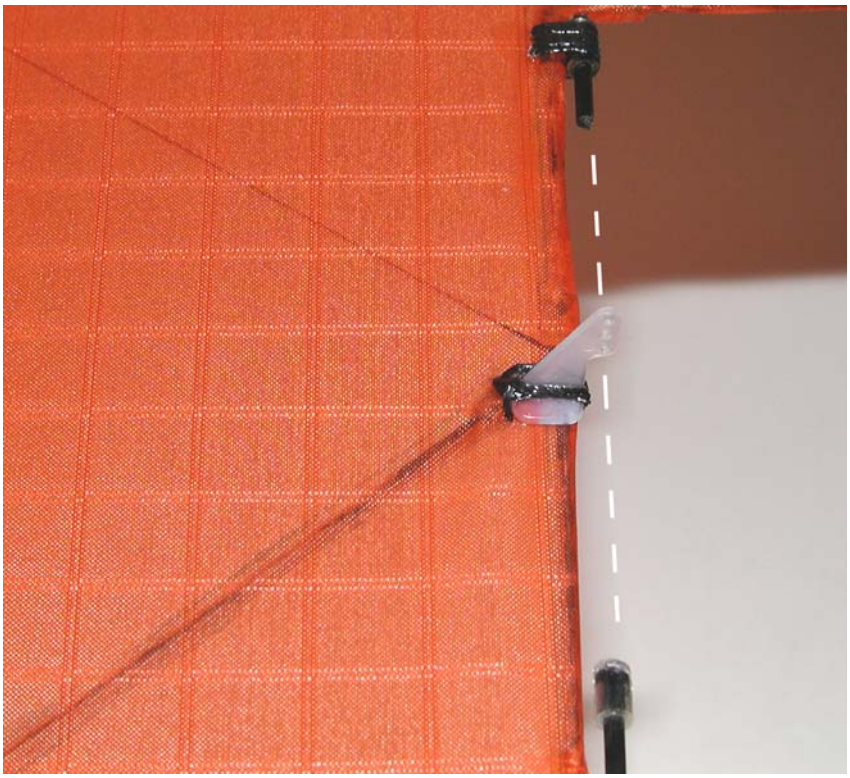
5.4 Trim

You will probably find some place that the lashing rubs and if so, just trim some of the elbow material back with a razor blade until you have clearance being careful not to cut the fabric.



5.5 Rudder Horn

Locate the V formed by the rudder post and lower diagonal brace. Poke a hole either with the horns' post or other sharp pointed tool right next to the rudder post and as high in the V as possible. You want the horns' base to sit on both the post and brace and have the linkage holes aligned as close to directly over the hinge line as possible.



Tack into position with the horn square to the rudder post. Lash around both sides of the horn, both sides of the horns' post on the backside of the rudder and through the rudder fabric behind the brace. This locks

it tight and square without allowing any slop between horn and rudder. Finally if desired, you can trim off the horns' post on the back of the rudder for neatness.

5.6 Tail Skid

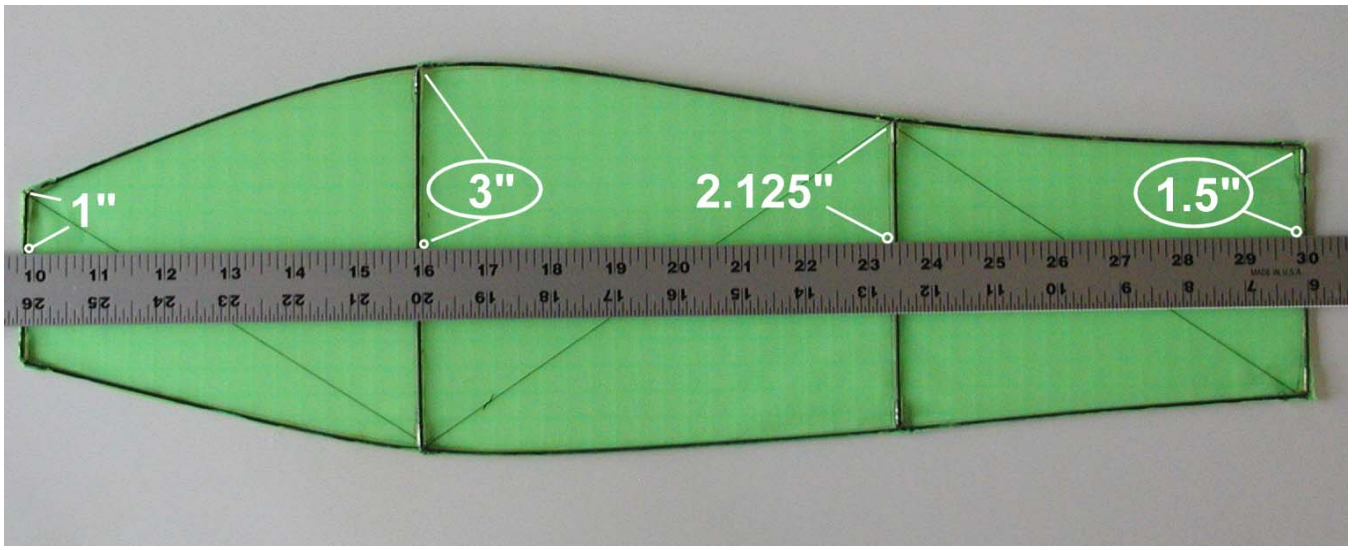
The rudder post rod extension from the bottom of the rudder can be used alone for a simple tail support or a length of fitting material can be added for more of a skid. To form a bend in the fitting material just hold it curved and heat slightly with a heat gun or other heat source. It doesn't take much heat to form it.

Otherwise a small tail wheel can be added if desired using a short length of wire formed in a U through the wheel and lashed tightly to the post.

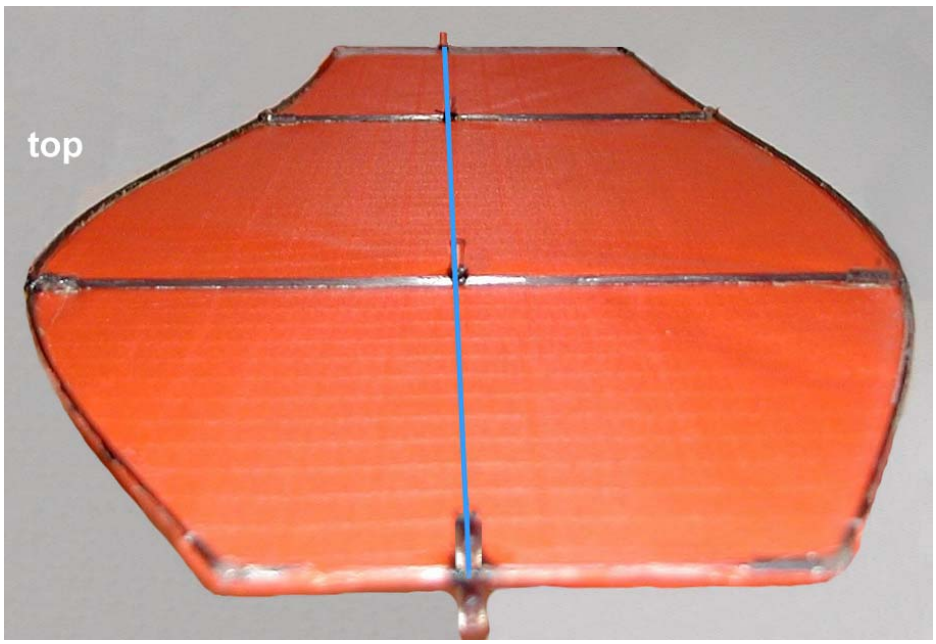
6. Fuselage construction

6.1 Boom connector fittings

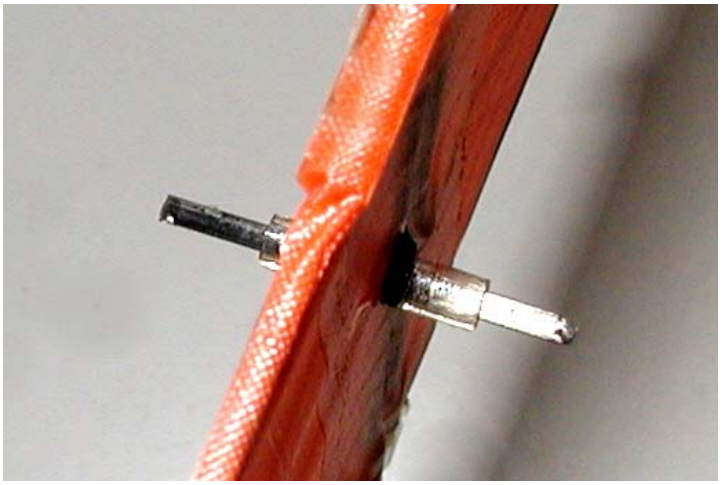
With the fuselage laying flat with the fabric side down position its top away from you. The top of the fuselage has a slightly bigger bow to it. Measure out the boom connection fittings.



Start at the rear and center of the fuselage panel and mark the locations. These two measurements are critical. Then lay your ruler over these marks and find the front and mid rear locations. If their measurements aren't exactly the same as shown, don't worry, as these two are non-critical locations and prone to vary somewhat between kit runs. Instead of trying to see a pencil or other mark, it's best to just poke a hole in the fabric next to the vertical with your needle. The main and mid rear vertical get their fittings on their inside toward the center. Once all four are located and checked for straight, enlarge the holes enough that the 1/4 inch long fittings can be inserted half way through the fabric.

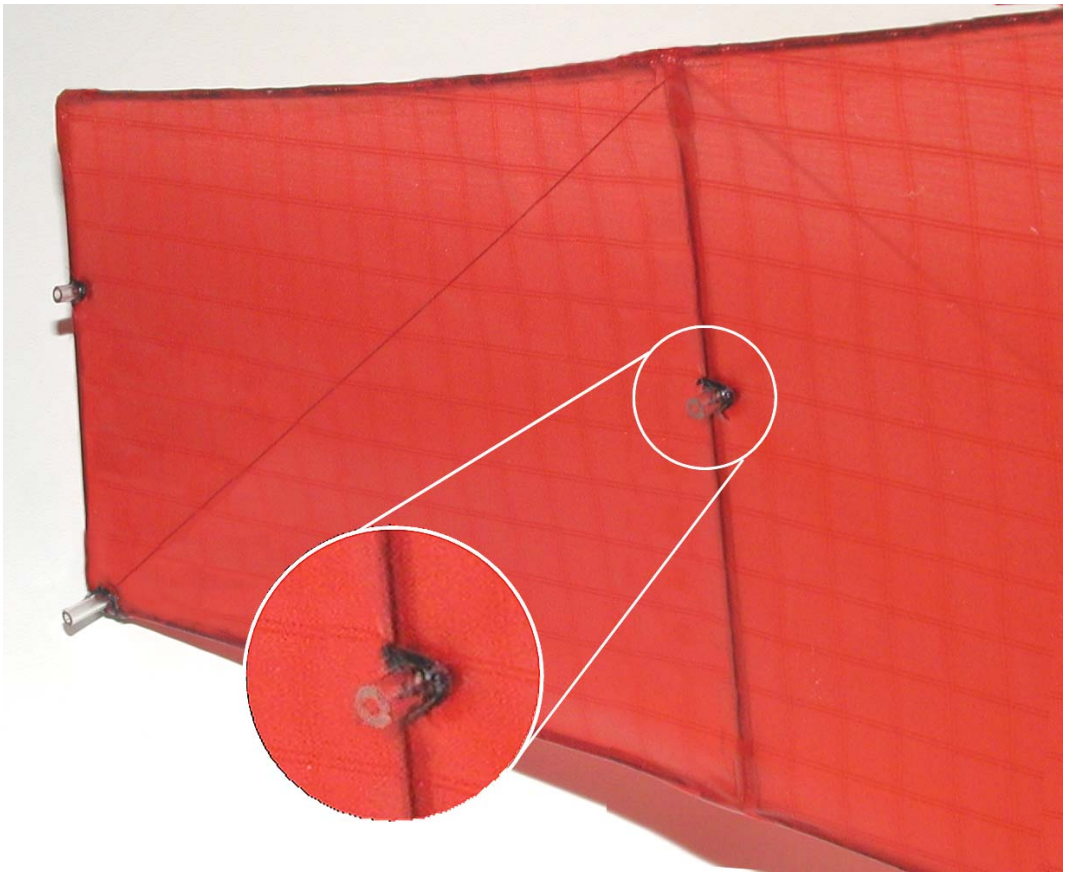


Insert the connector rods into the fittings. These will get lashed tightly and we don't want the fittings to collapse. Having the rods inserted also allow them to be held easier for lashing. Note that only one of the longer 1 1/2 inch connector rods is used in this step and that is used in the mid-rear location since it will double as a servo rail later. All the rest use 1 1/4 inch length connector rods.



Check again for alignment by sighting along them all before lashing and adjust the mid-rear and/or front locations as necessary. Be sure that when lashing they are held straight and square to the fuselage.

Lash the fittings as per the lashing instructions.

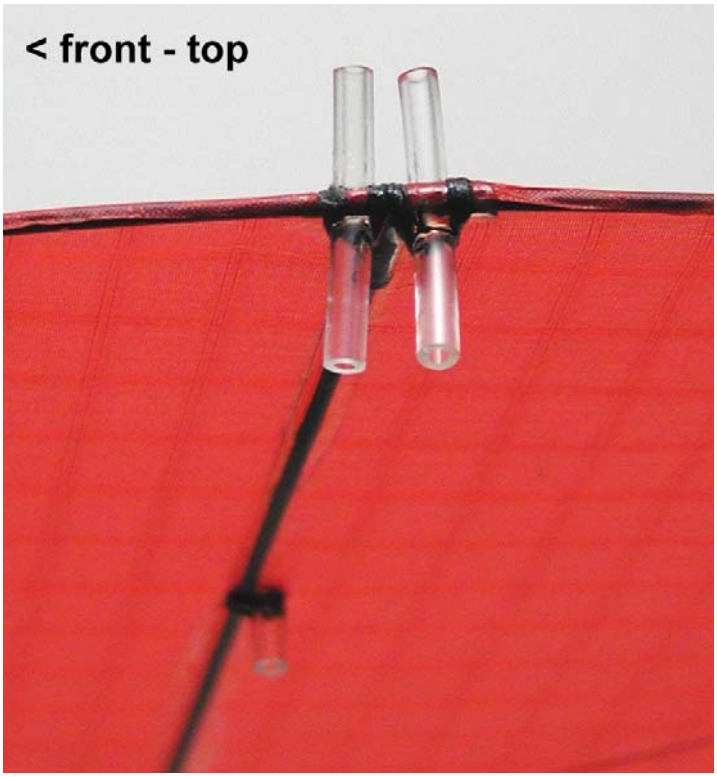


6.2 Fuselage fittings

Install 3/4 inch long wing mount fittings at top and bottom of the fuselage panel just behind the main vertical rod. Start by making a small hole right in the corner formed by the back of the longest vertical rod and the outer frame bow. Enlarge the hole until you can insert the fitting halfway through and make sure it is centered and square to the frame.

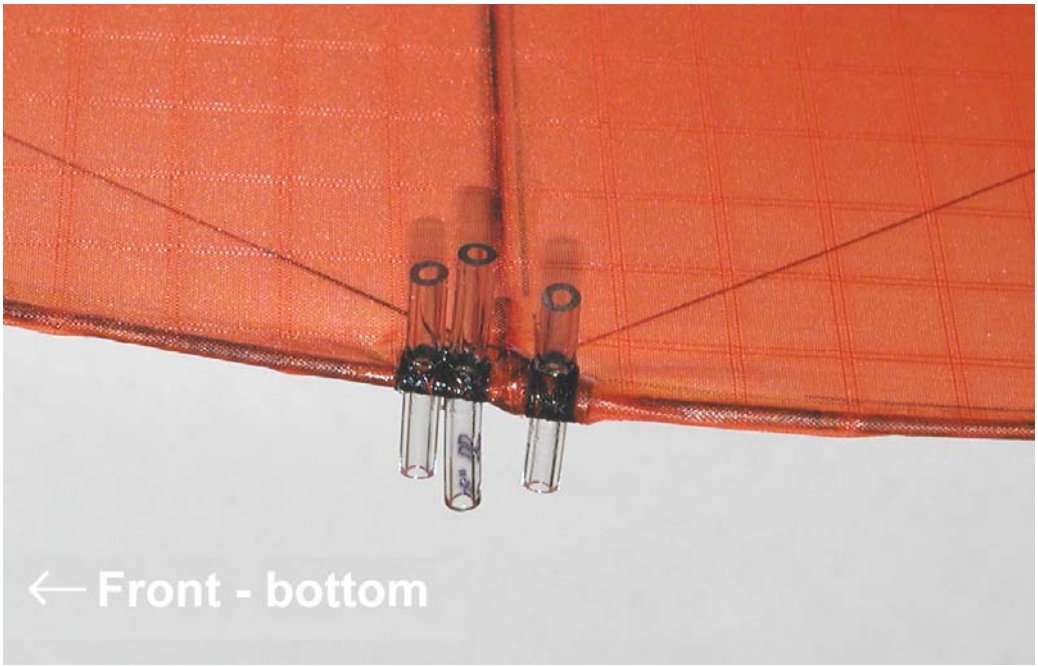
Lash very tightly as per the lashing instructions.

Next add one more 3/4 inch fitting the same way for the fuselage diagonals at the top just in front of the main vertical rod.

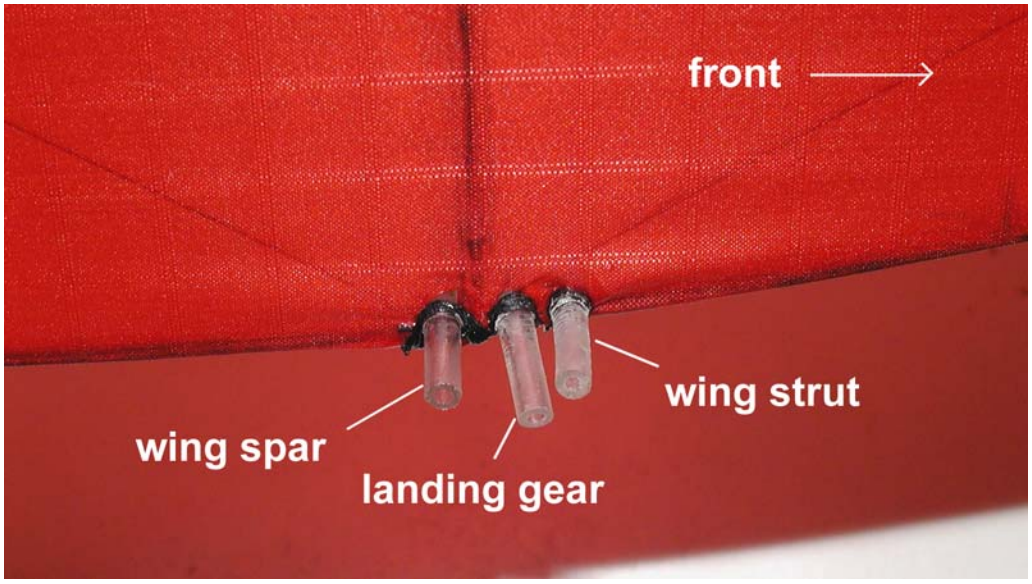


Now add one 1 inch long fitting at the bottom just in front of the main vertical rod for the landing gear rear strut.

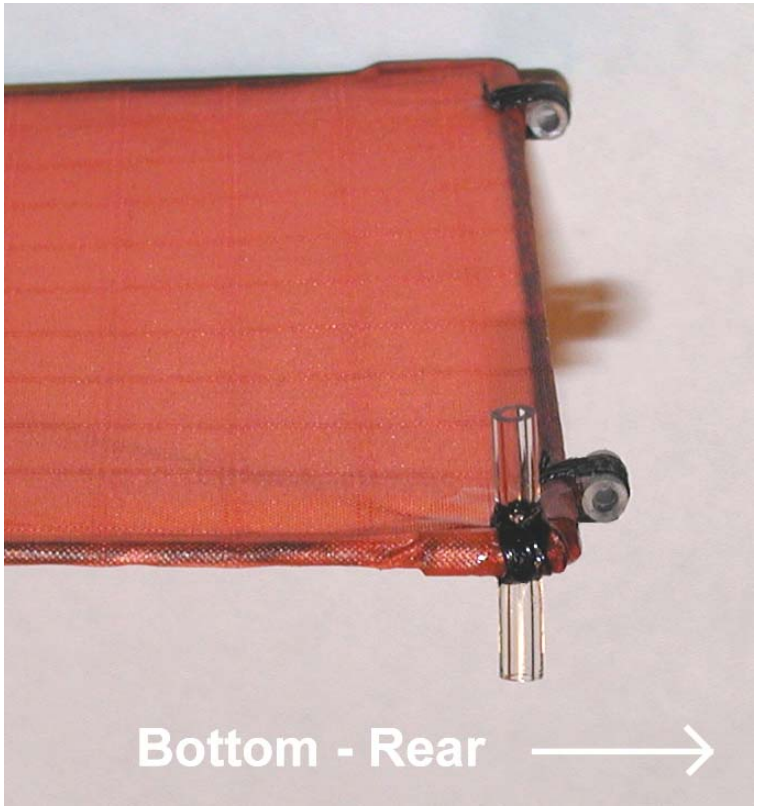
Finally add another 3/4 inch fitting just in front of the landing gear fitting at the bottom for the wing diagonal struts.



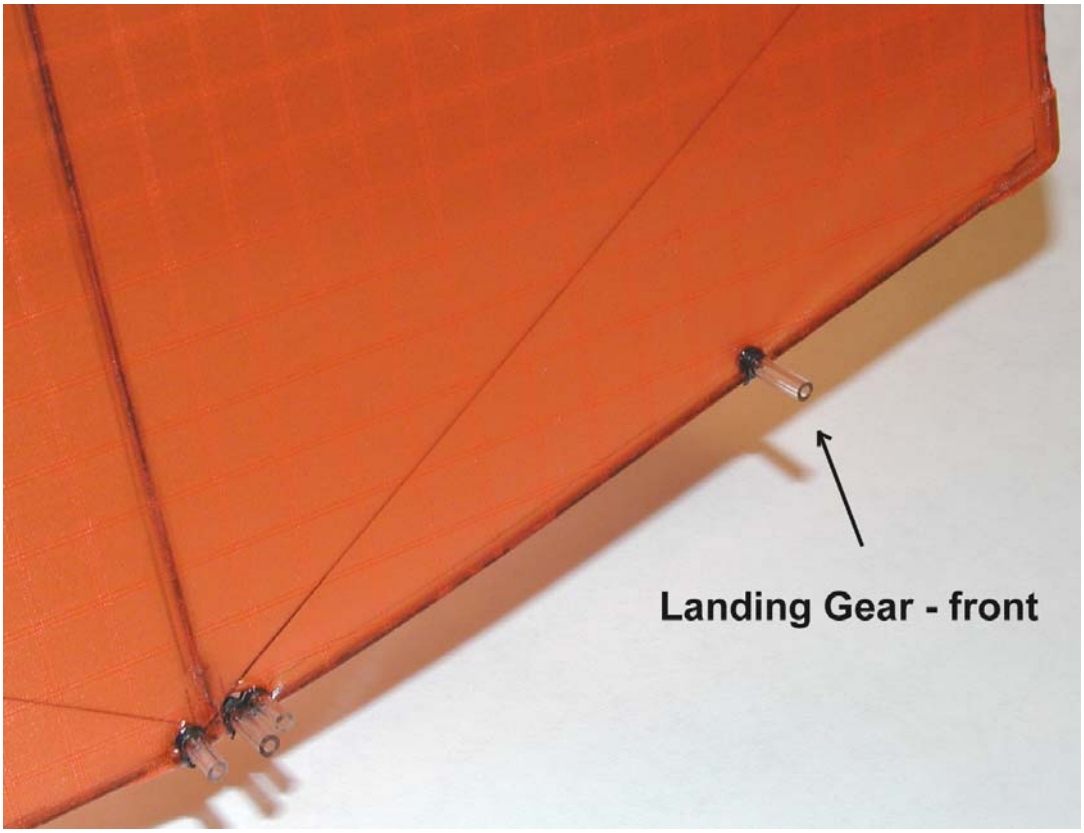
That's three fittings on the bottom and two on the top.



At the bottom rear corner of the fuselage, add a 3/4 inch fitting for the fuselage diagonals connection.

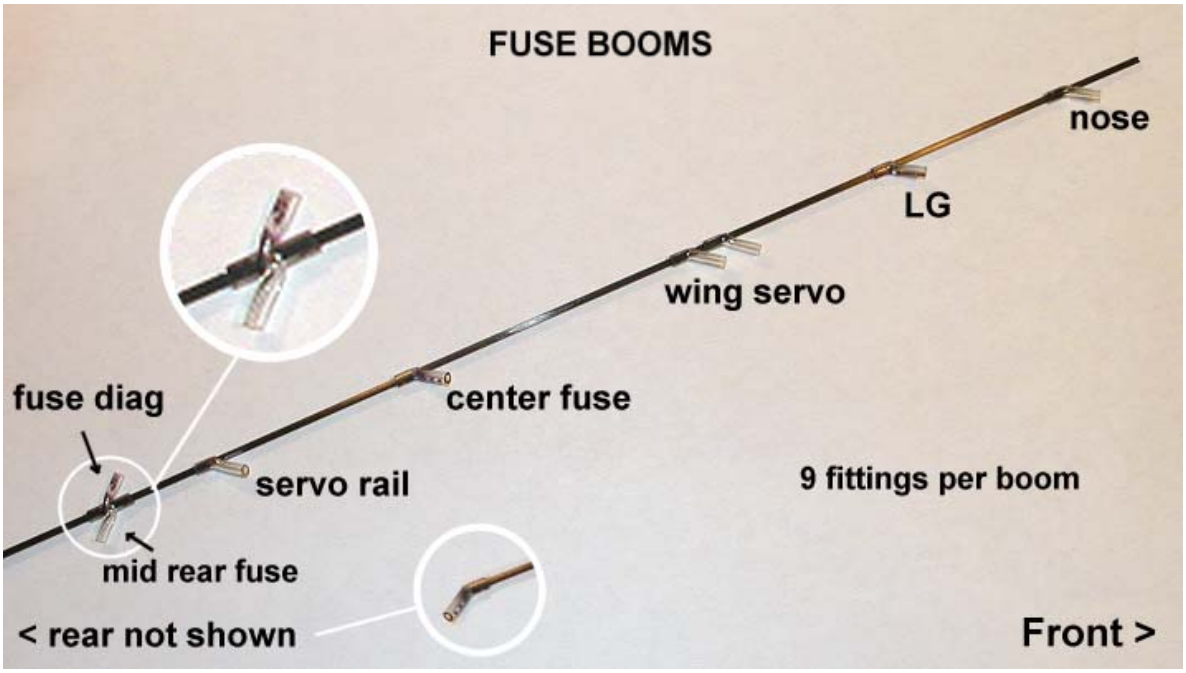


Finally add a 1 inch fitting located 2.5 inches back from the nose on the bottom of the front of the fuselage for the landing gear front struts.



6.3 Prepare booms

You will insert 9 T-fittings onto each boom. All go the same direction except the rear servo rail connector at the mid-rear vertical junction. Behind them and butted against them are the fuselage diagonal fittings.



Push the fittings on from the front with 6 per boom going from the elevator/rudder front servo rail forward. Add one backward per boom from the rear for the rear servo rail/mid-rear vertical connection

and another one started through its hole from the rear and pushed up against the rear rail fittings for the diagonal brace. Finally, add one on the rear ends of the booms stopping when the fitting hole reaches just past the boom ends.

Straighten and locate the fittings on the boom held up against the fuselage connectors for reference. Start from the rear for correct spacing. Match both booms together to fine-tune the fittings locations and alignment.

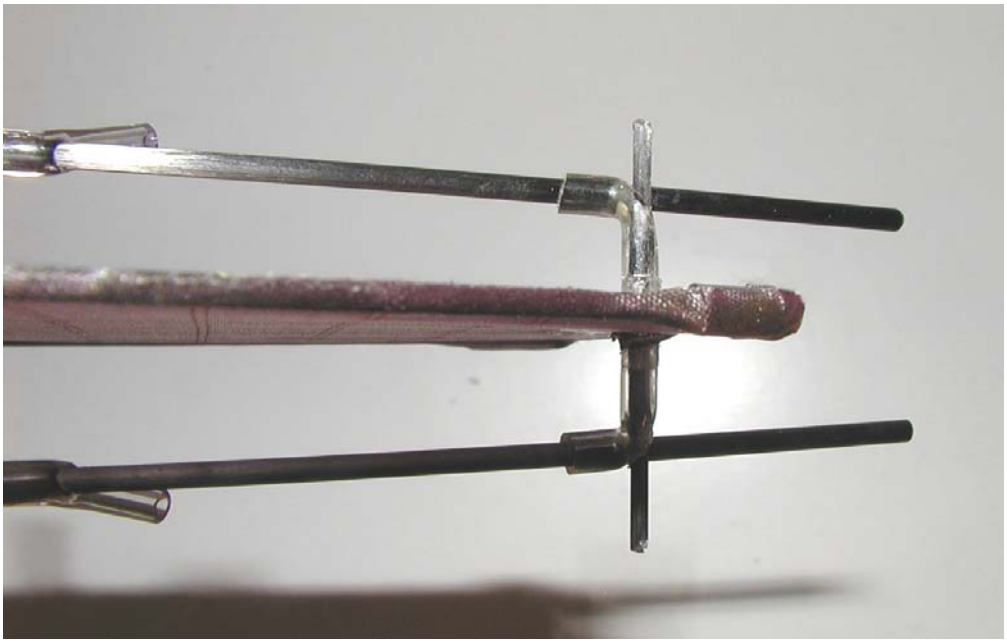
6.4 Install booms

Insert and center the connector rods into the fuselage boom fittings if not done previously.

NOTE: The four servo rail locations need to use the 1 1/2 inch long connector rods so they extend enough out past the center booms for the bands to attach. The remainder can use 1 1/4 inch rods that end up closer to being flush with the frame.

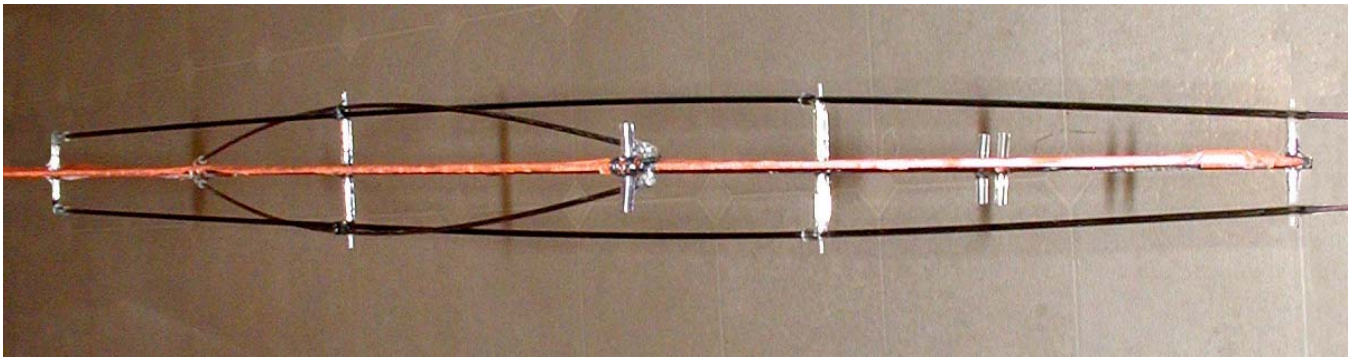
To install the booms on the fuselage, locate them below the connector rods. You will need to work at getting the connector rods out through the holes in the T fittings. The fittings do stretch if you help them along and will hold snugly once inserted.

Start with the rear connectors and then the fronts then add the middle and mid-rear ones. As you go you'll see when the fittings need to be shifted slightly forward or back on the booms to not only keep the fuselage and connector rods straight and square but also prevent the panel from twisting and puckering.



This step will take some time to tweak and get correct. Some twist may be inevitable at this point but once the diagonals are installed, they will take care of it. Keep checking that the panel is straight and that the booms are staying matched with each other and not skewed off to one side.

Also be sure that no one panel internal section is being stretched too tight from the fittings being too far apart, or too loose from being too close together. When viewed from the end, you want the fuselage straight with no curving to the left or right. I find I have to work with it quite awhile before it suddenly lines up and looks correct.

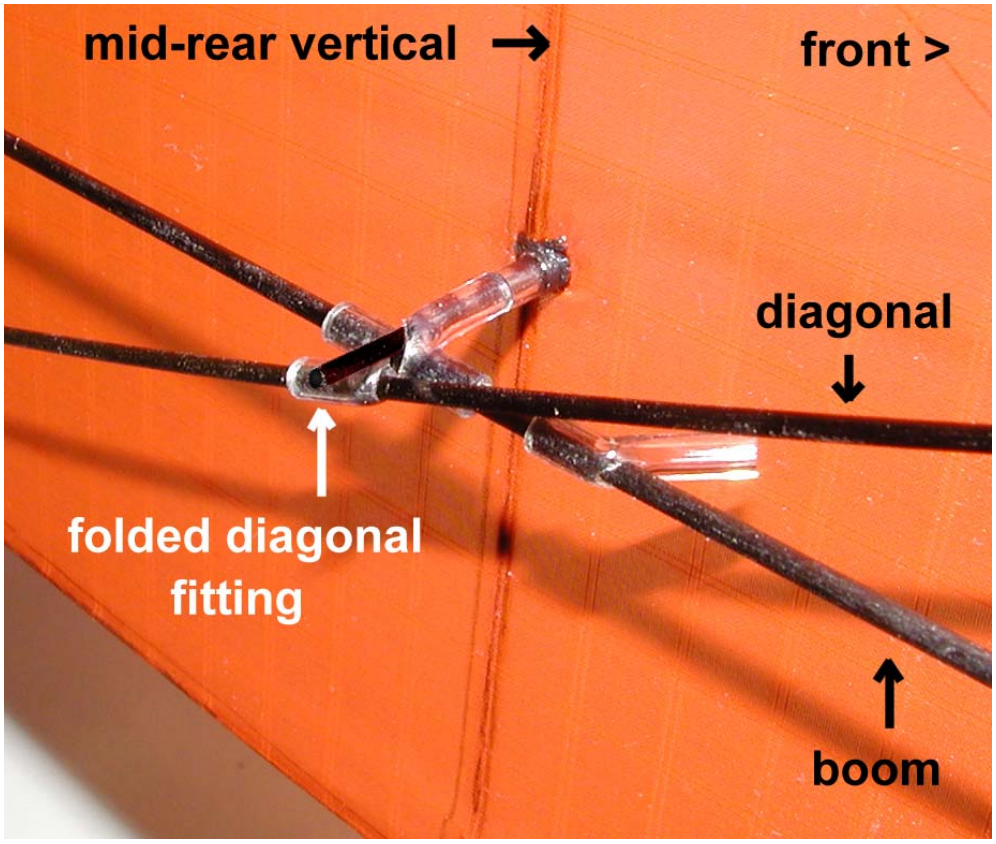


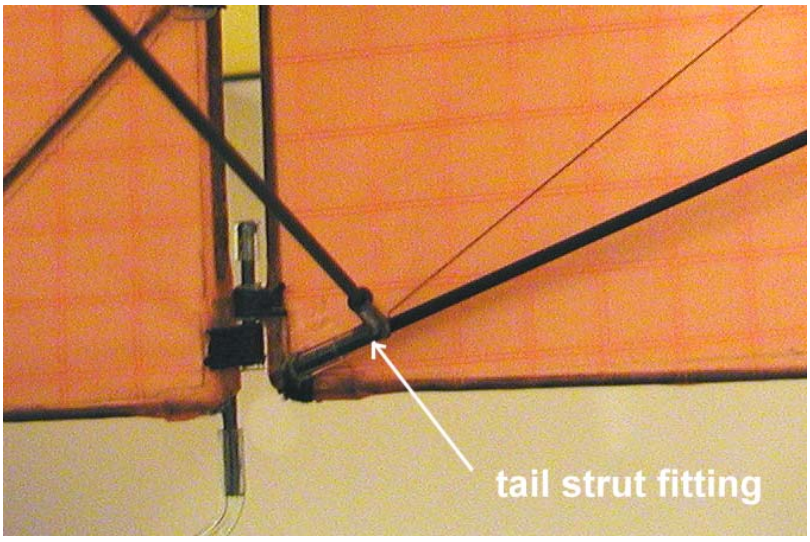
At this point you can tack all the fittings on the booms with a small amount of CA at the ends of the fittings if you want so they can't shift later.

6.5 Diagonal braces

Add two T fittings to the diagonal rods and slide them almost all the way to the other end of the rod. These will be used for the tail struts later.

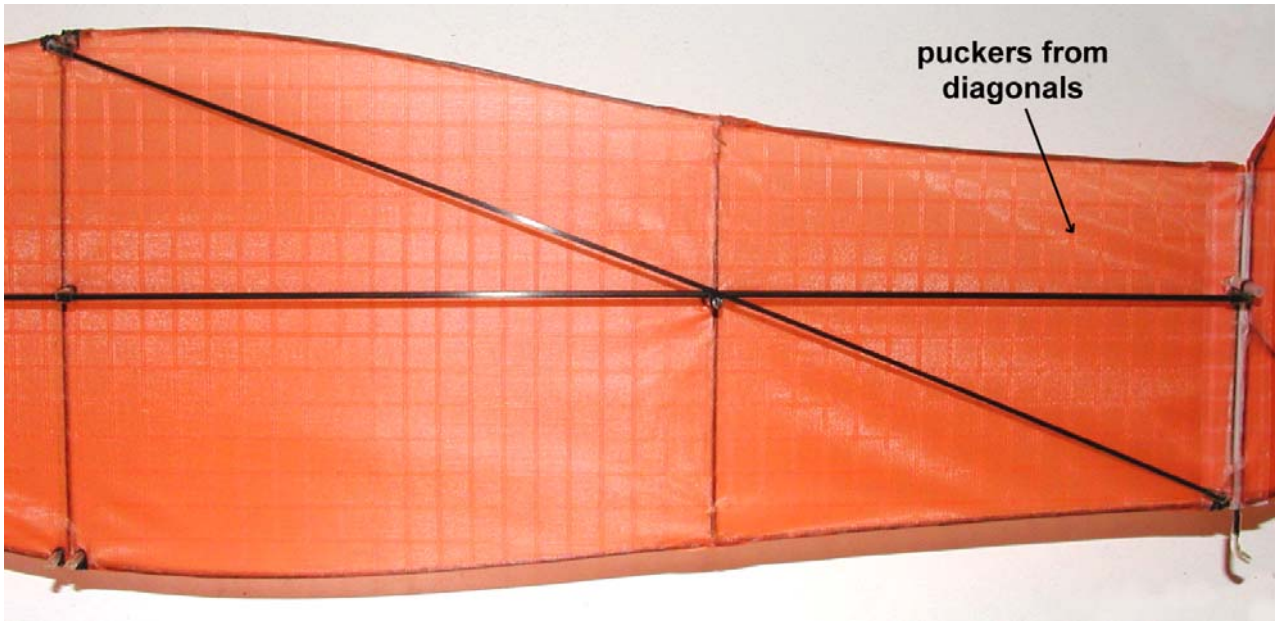
Install the fuselage diagonal braces first through their boom fittings by folding the fittings back on themselves and working the diagonals through. Space them on the rods so the front ends align with their front-top fittings and insert fully. (See first picture in 6.4 above)





Finally connect the fuselage diagonals into their bottom rear fittings, making sure that the tail strut fittings are pushed up the rods far enough to allow the ends to be fully inserted. Once seated, slide the tail strut fittings down next to the diagonals fittings and rotate if needed into their proper position for later.

At this point recheck the fuselage for straightness. If things are twisted or otherwise crooked, DON'T mess with the boom fittings again, only adjust the diagonals in their fittings until even.



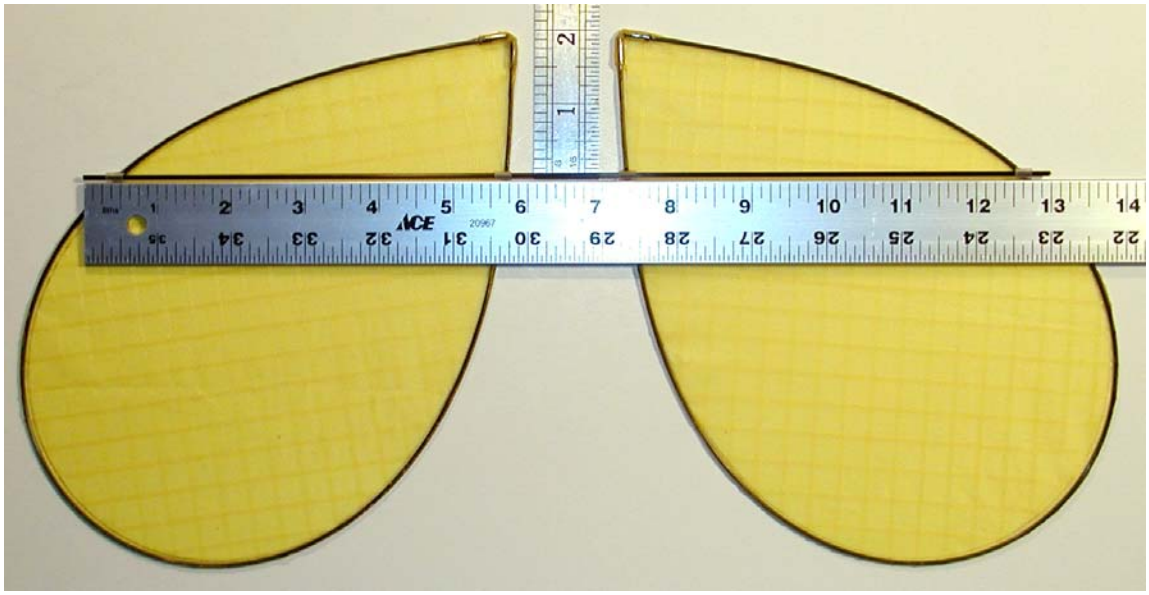
If you find bad puckering of the rear fuselage panel section from excess pressure from the diagonals, make sure they are fully seated in their fittings or if so you may want to trim just the slightest amount off the ends of them to relieve the excess pressure. Usually sanding or filing them slightly is enough.

On the other hand, if they seem too loose and can't be fully seated in their fittings, you can add some tension by trimming the mid-rear boom connector fittings slightly to narrow the booms at that location thus in effect lengthening the bowed diagonals. Just don't narrow the location so much that your servos won't fit between the booms. ☺

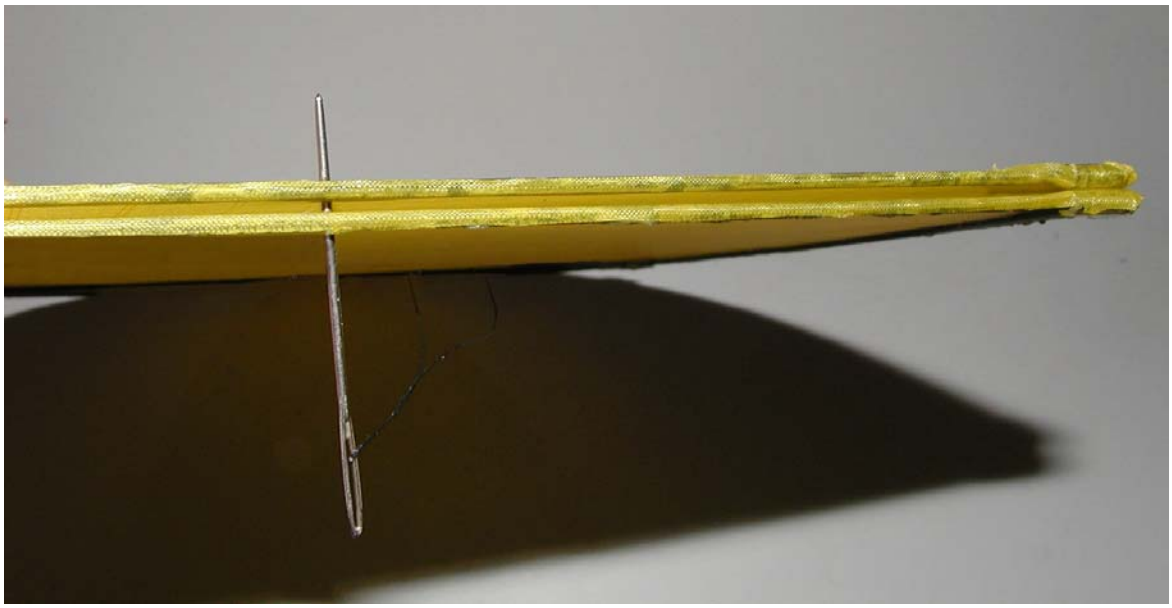
7. Elevator Construction

7.1 Install bushings

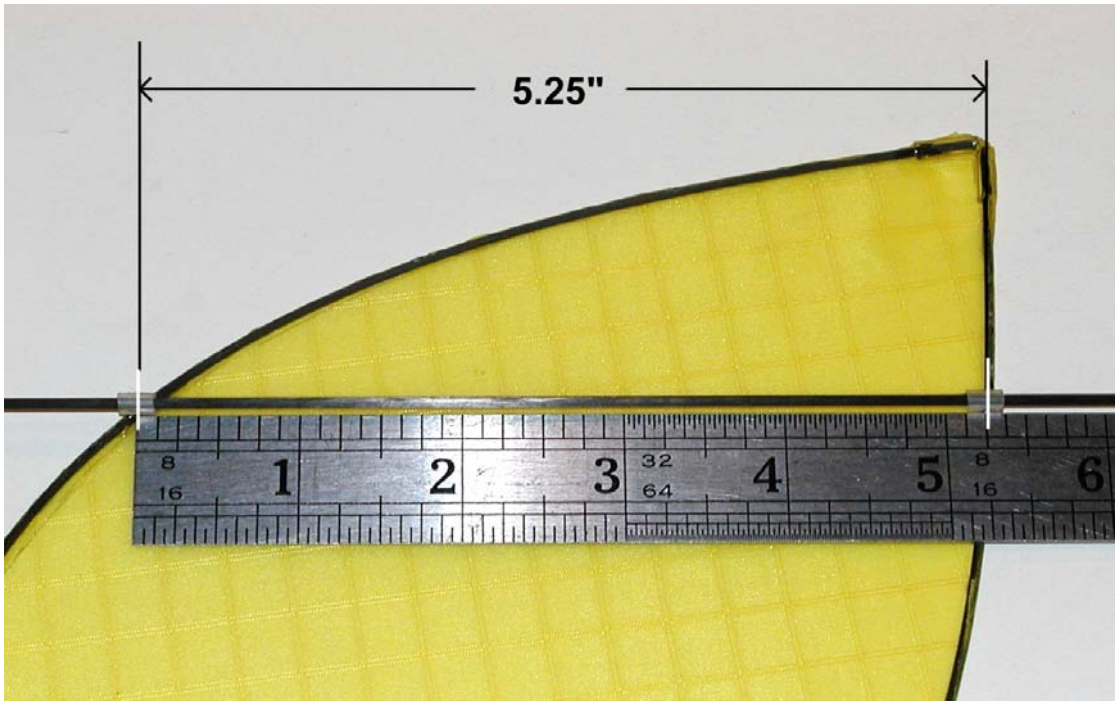
Position the elevator panels as shown with the frame sides up. The inboard bushings should be located 2 inches back from the root LE at the elbow fitting point. On one panel only, make a pair of small pencil marks 1/8” apart on the fabric next to the inboard rod. The two marks should be centered, one on each side of the 2 inch location.



After one panel is marked, pick up the other, and place them together, fabric sides facing and matching each other. Find the marks you made, and with your sewing needle, poke holes in the fabric at both marks adjacent to the inboard rods and through both panels. Be sure to keep the panels aligned, as it's critical that the two bushings are located in the same places on each elevator half. (Think “mirror images”.)



By poking holes this way to mark bushing locations, once lashing has started the bushing can't move. Lay the elevator halves back down with the frame side up. From the inboard bushing center, measure across each elevator panel approximately 5-1/4 inches to where the outboard bushings will mount.

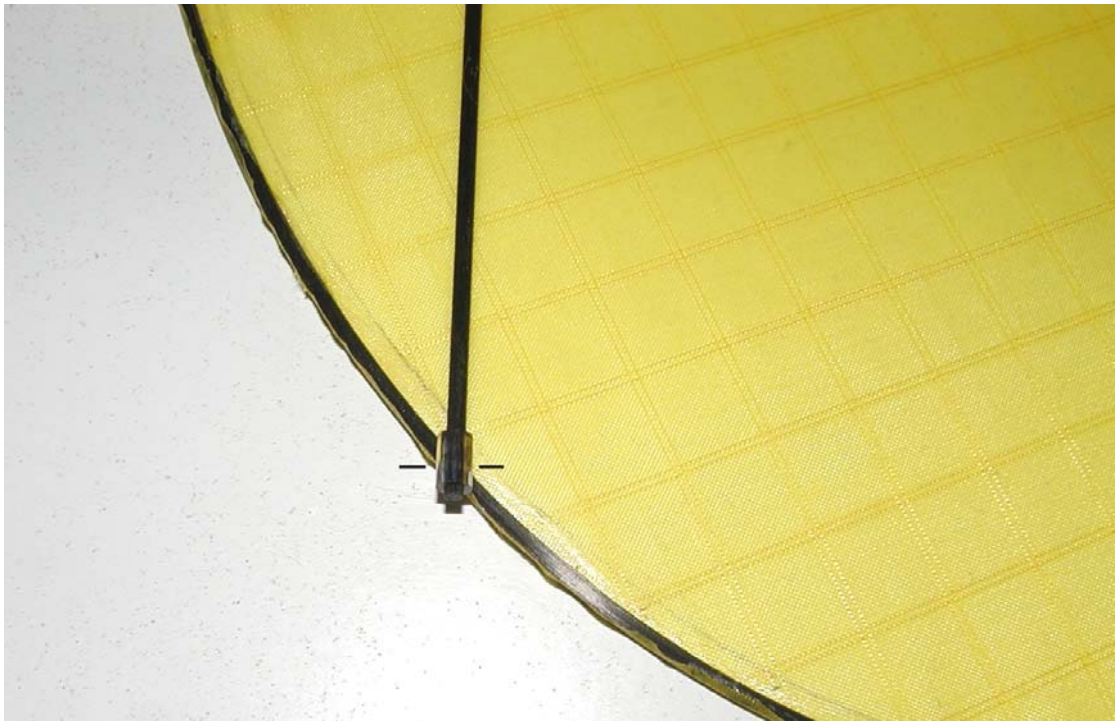


Next take the 13 inch, 0.07 diameter rod and lay it across both panels. Arrange the panels so that the rod crosses the inboard bushing locations and outboard marks. There should be at least 3/8 inch overhang of the rod ends beyond the outside edge of each panel. If not, adjust panel spacing until there is. (See first picture this section)

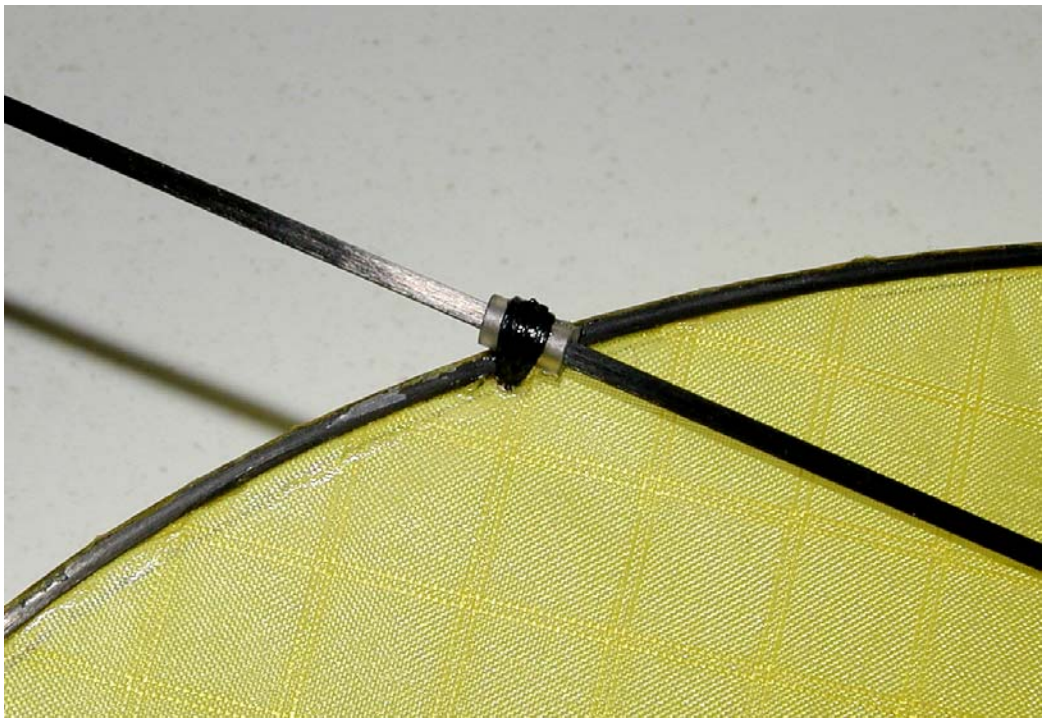
When finished, there should be about 1-1/2 to1-3/4 inch space between elevator halves at the inboard bushing locations. The actual measurements aren't as important as getting both halves symmetrical and mirrored and that the panels don't come in contact with the fuselage booms during operation.

The distance between the front inboard elevator panel corners should be approximately the same as the distance between the inboard bushings at their center. If not, adjust the angle of each elevator panel equally, keeping the rod over each inboard bushing location and changing the outboard locations if needed. When everything is placed correctly, mark the outboard bushing location on each panel.

Once again, place the panels together, fabric sides next to each other. If the outboard bushing marks do not line up, split the difference, poking a hole through the fabric in that spot. A single hole per panel is sufficient, as the outboard bushings are single-wrapped.

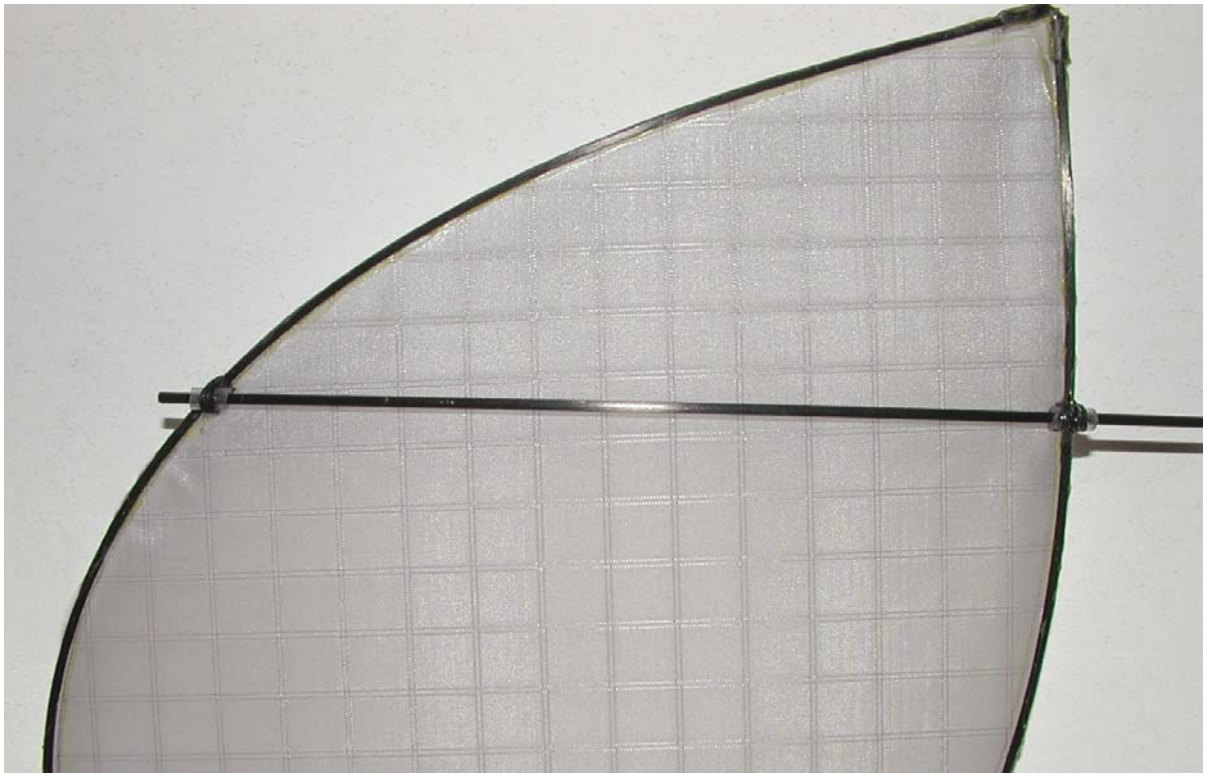


Slip 4 small bushings onto the rod. Position the rod onto the panels, with the inboard bushing between the inboard holes, and the outboard bushing over the outboard hole.



Tape the rod to the fabric to hold in position and tack the bushings with CA to the elevator frames, before lashing them in place. Tie the bushings to the frame as directed in the Lashing section (Section 4).

Insert a 3/4 inch elbow fitting 1/4 inch over each end of the pivot rod. These elbows will connect to the elevator struts later.



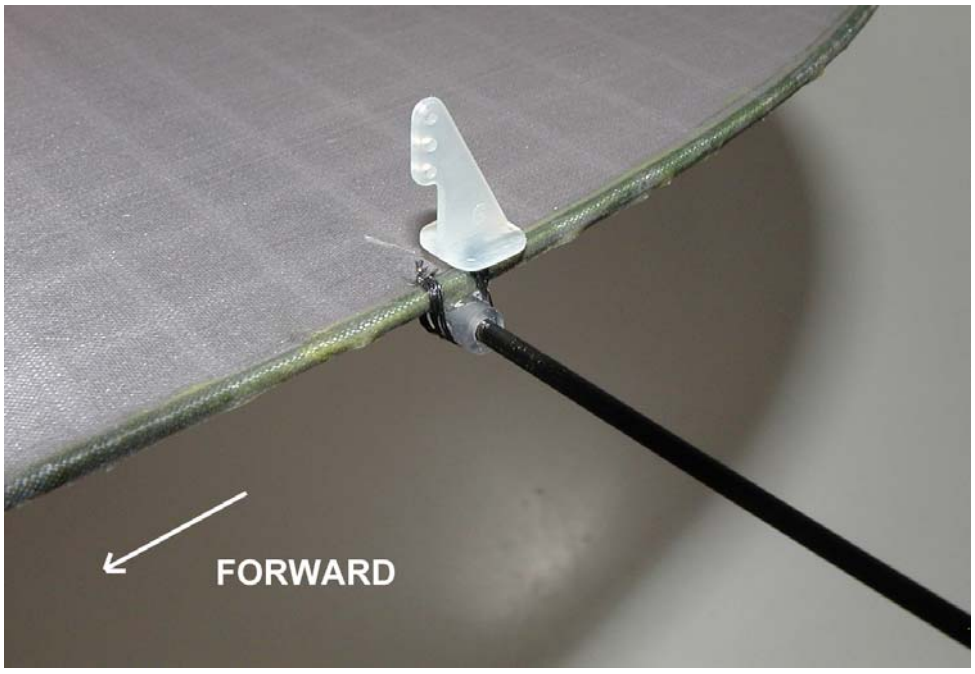
7.2 Center bushing

With the rod inserted in both elevator panels and the end elbows inserted 1/4 inch on the rod ends, check the distance between the inside edges of the root bushings. It should be approximately 1-1/2 to 1-3/4 inches. This measurement is the final length needed for the long center bushing that will be attached to the fuselage later.

Using a single edge razor blade over a hard surface cut this length from the long bushing material keeping the ends square. Slip the long bushing over the center of the rod. Ideally, with both end elbows inserted on the rod ends about 1/4-inch, the elevator should move freely with very little side-to-side movement.

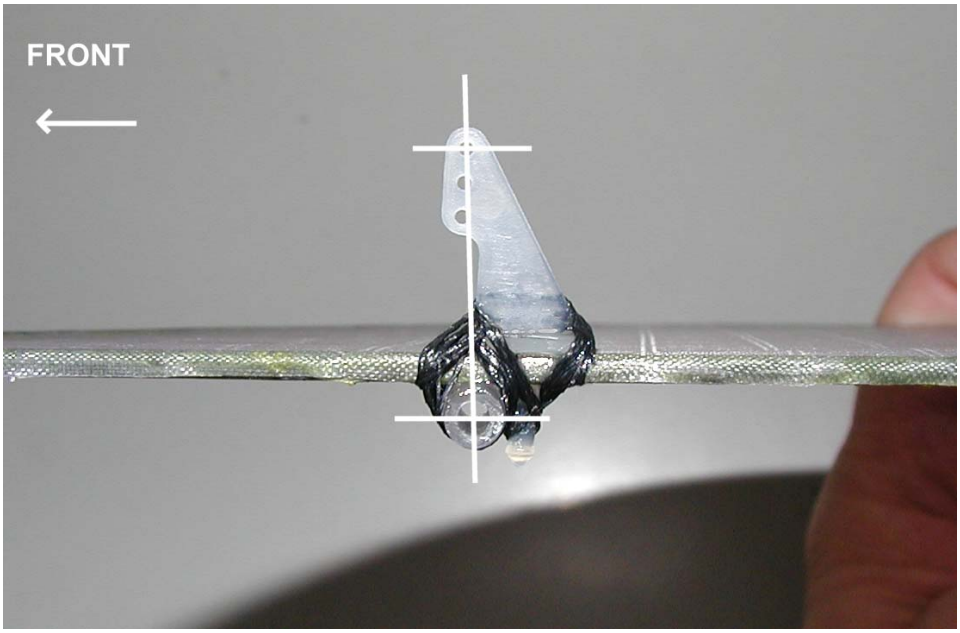
7.3 Install control horns

The control horns are positioned on the fabric side just behind the inboard bushing on each panel. The horn base should be positioned in the corner formed by the rear of the inboard bushing, and the external frame.

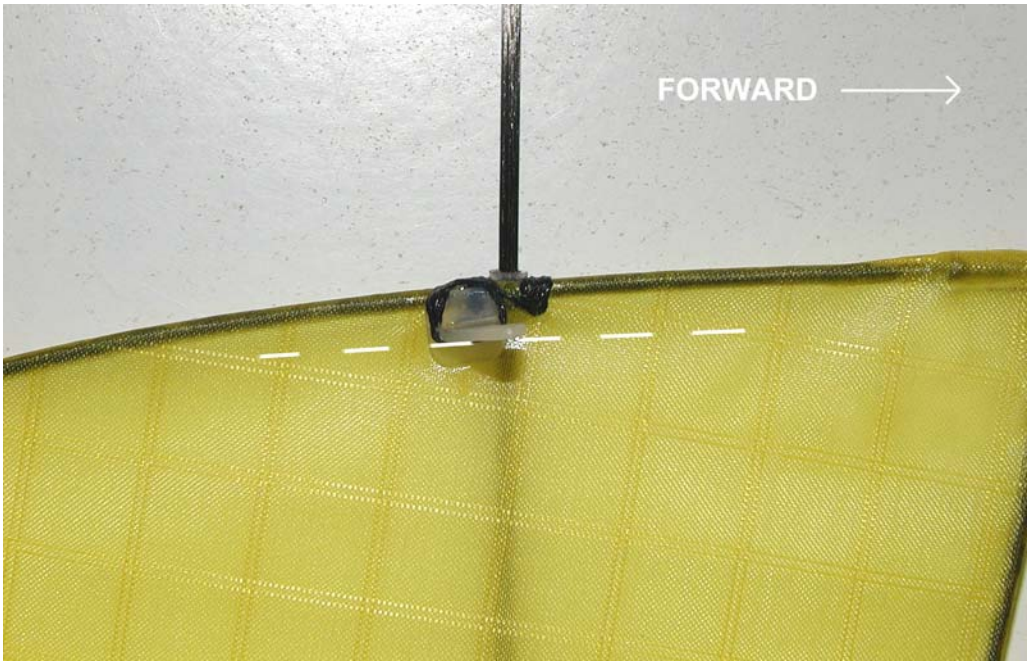


It is important that the control horns be mounted in the precise corresponding places on each panel. (Again, think “mirror images”.) Also, the outer linkage holes must be in line with the center of the rod.

Note: the lashing for the bushing tilts the horn a little to the rear. This tilt will not cause any problems as long as the outer linkage hole is in line with the rod center on both panels.

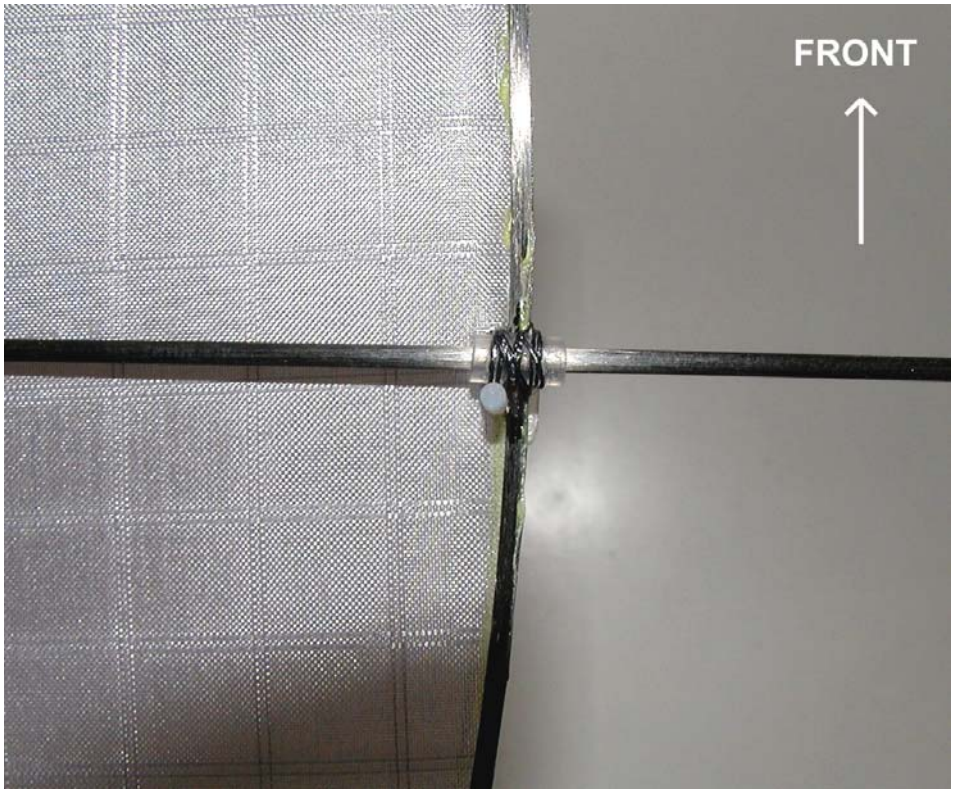


Tack one horn in position keeping the horn aligned with the inboard frame rod.

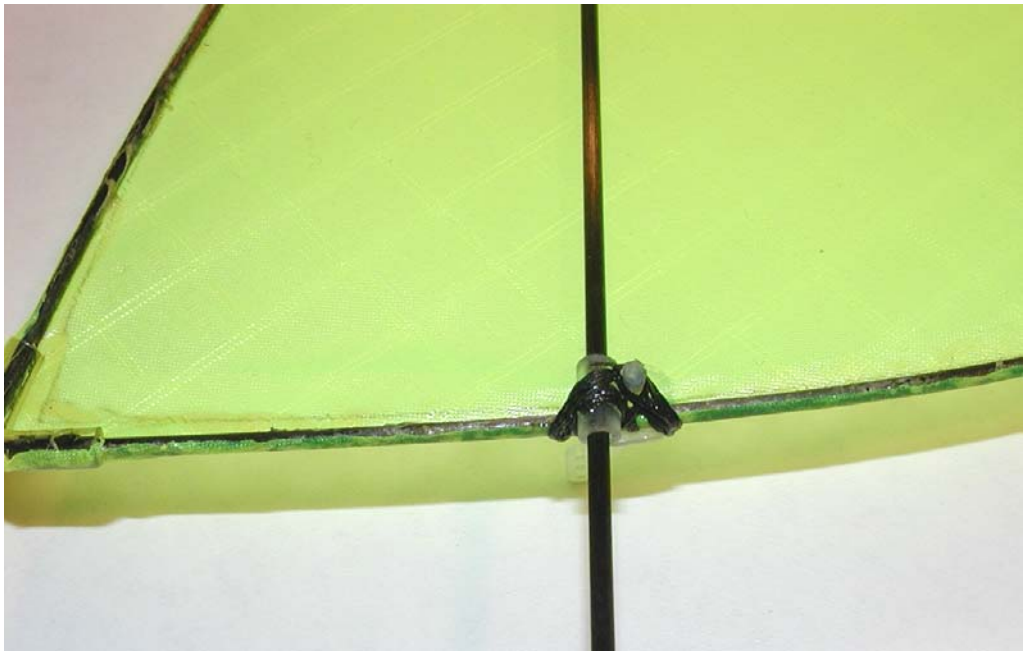


Lash it in a figure 8 around the horn base on top and its post underneath keeping it vertical if it wants to tilt on you.

Finally, coat all thread with CA and trim excess thread.


FRONT


FRONT



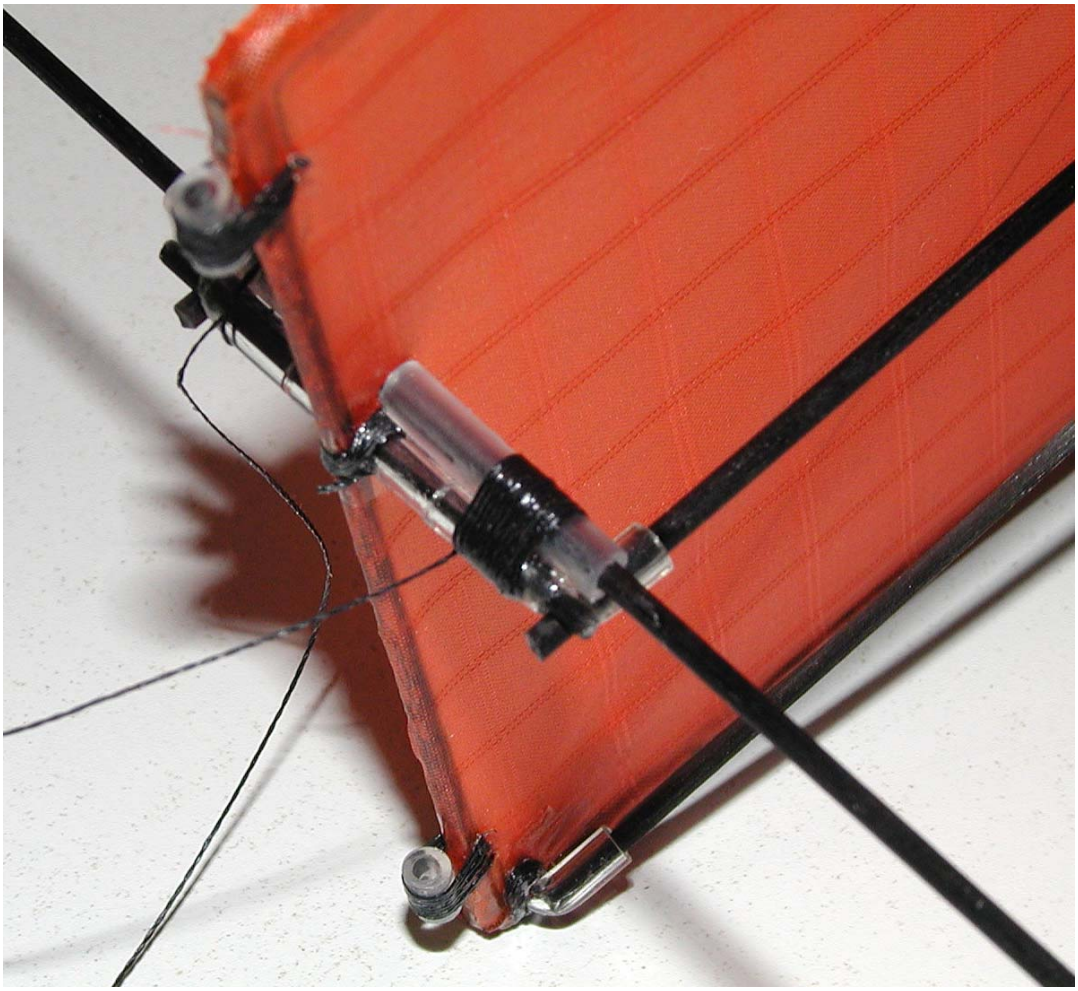
Repeat the above two steps for the opposite control horn installation.

Note: It's very easy to get the two horns misaligned. After the first horn is fastened, butt the elevator halves together at the bushings with the rod inserted prior to tacking the second horn to its panel.

7.4 Attach to fuselage

The center booms on the fuselage can be removed if the panel ever needs service. To allow for this we want to split the middle elevator pivot bushing in the center and attach the two halves to either side of the fuselage at the rear. These get lashed to the two rear center boom elbows only and lay just in front of and above the fuselage rear connecting rod. (see section 7.2 picture above)

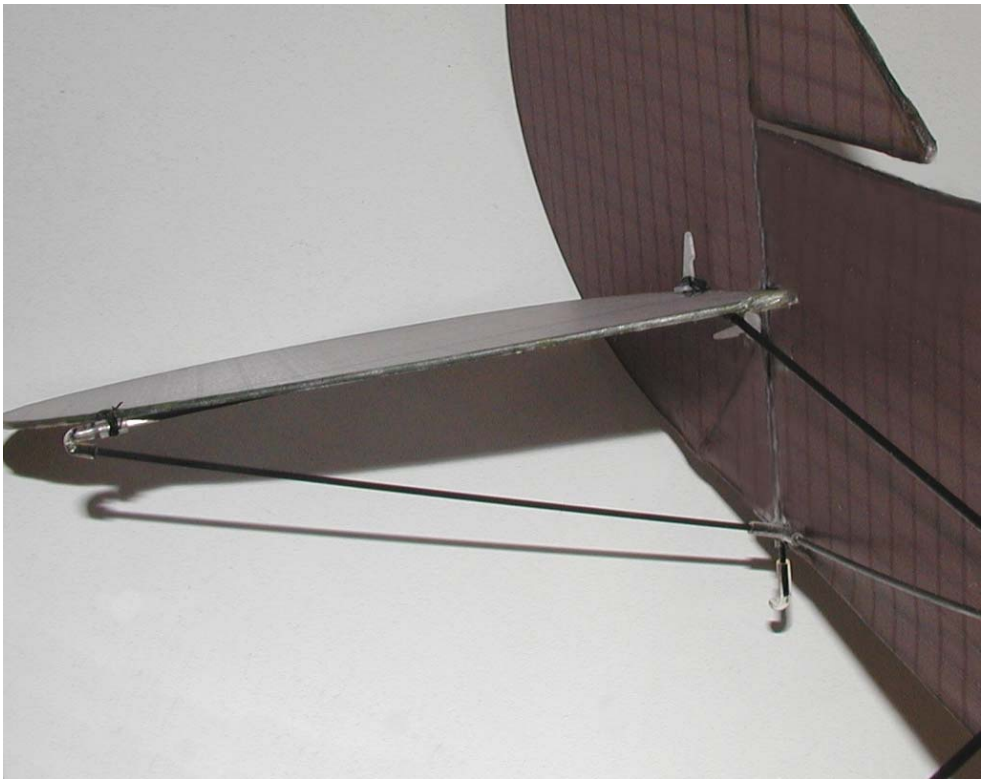
A hole large enough for the rod to pass through is needed where the bushing meets the fabric and should be located just in front of the fuselage rear vertical rod.



7.5 Assemble

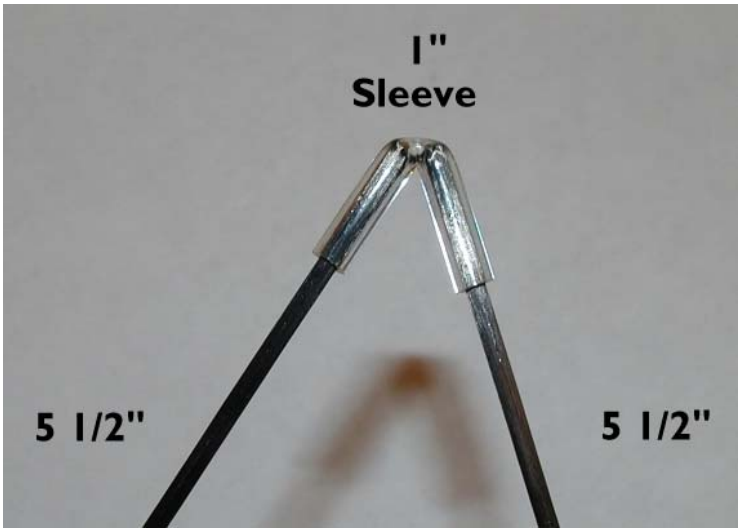
Insert the rod through the bushings and slip the elevator halves on the rod with the control horns facing up. Add the elbow fittings on the ends and adjust for freedom of movement but very little side play.

Add the elevator diagonal struts to the elbows and attach to the fittings at the bottom of the fuselage diagonal support rods.

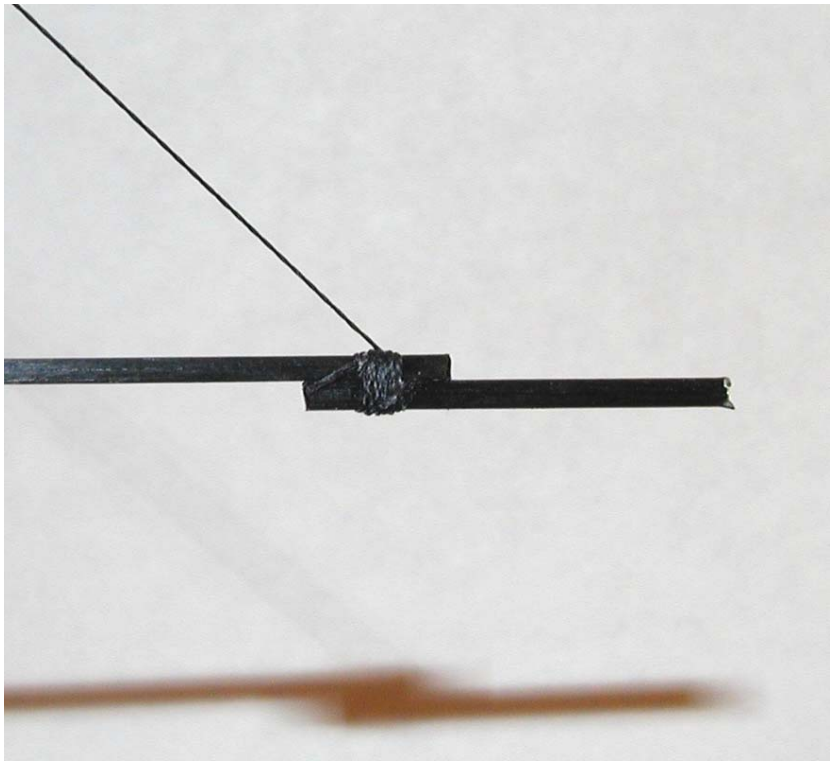


8. Landing Gear

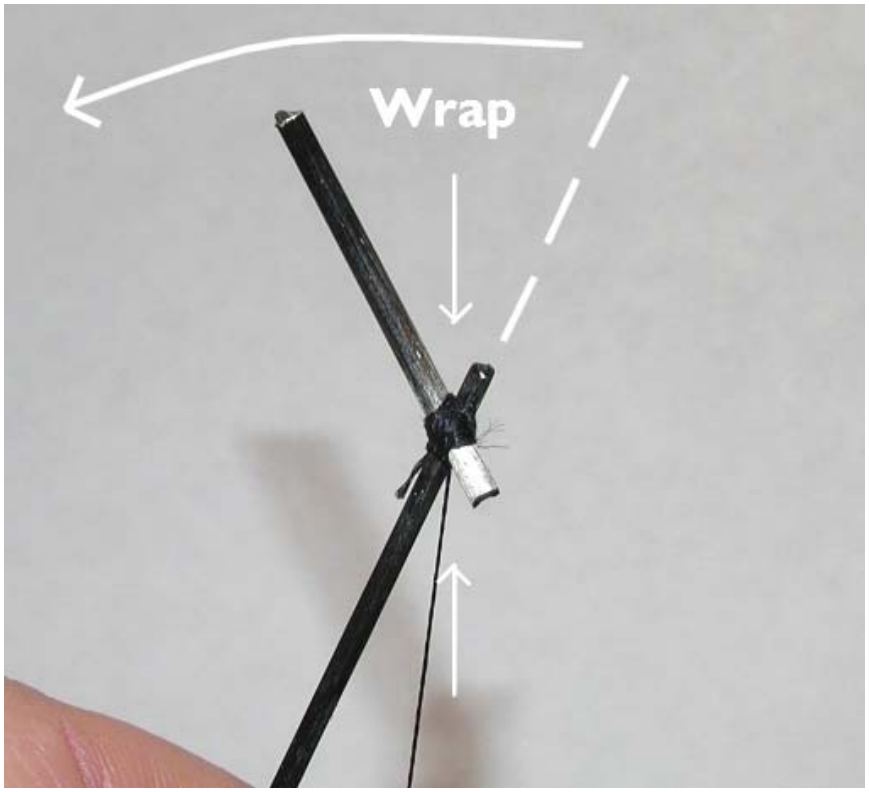
Insert the 5 1/2" front and rear landing gear struts into a 1" long fitting.



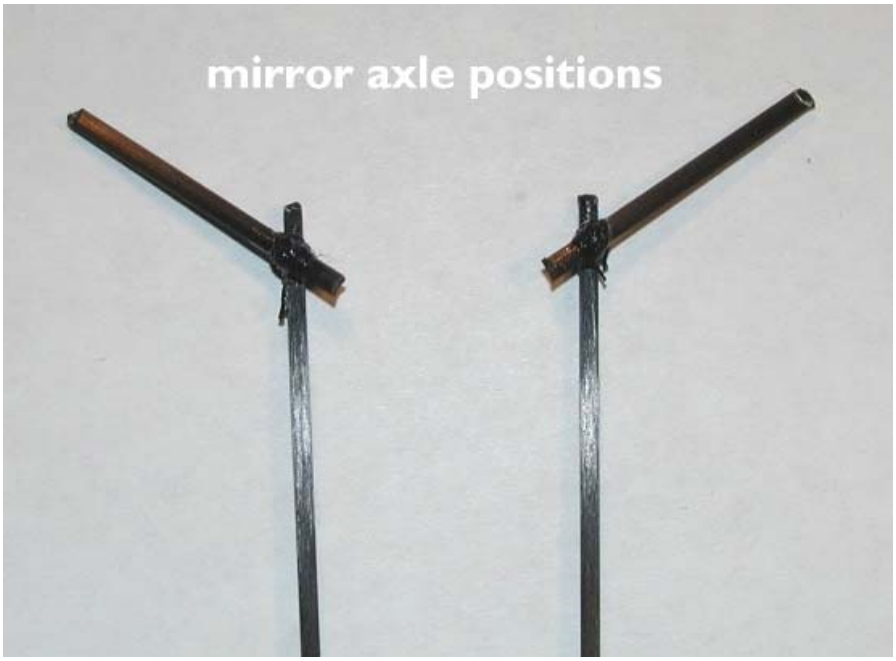
Take the wheel axle and lash it to the 7" long struts but do not glue yet. Space the lash location so the wheel clears the end of the axle by at least 1/8" for the hub fitting used to hold the wheel on.



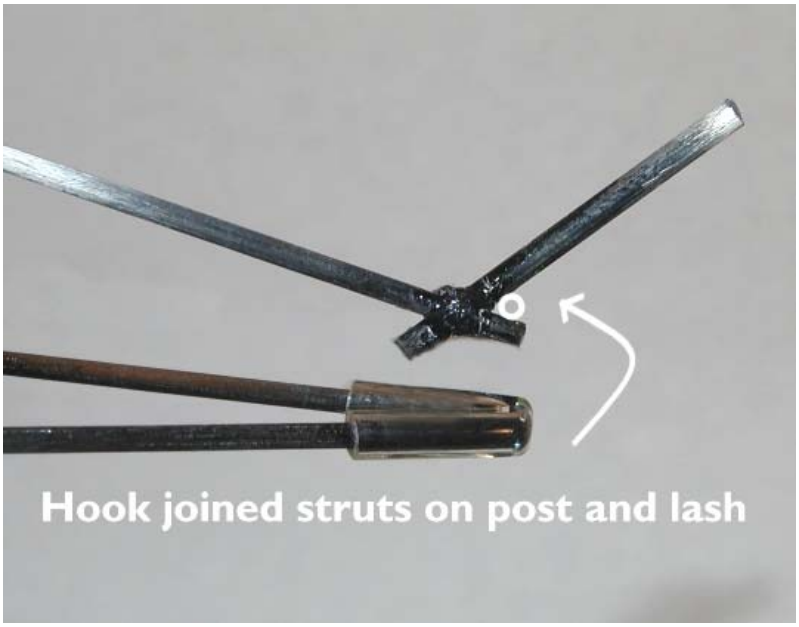
Now twist the axle out to about a 45-degree angle and lash the other direction around the posts and glue.



Be sure to mirror the two sides.



Next hook the front/rear struts over the hook formed under the axle and lash tightly. Keep the lashing alternating between post and strut in a figure eight pattern and tight toward the center. You want to be able to easily fold the struts flat together for transport once removed.



Locate the axle behind the center strut for proper alignment. You'll have a specific left and right hand gear. Insert the rear struts into the fuselage lower center and front struts into the lower forward fittings. The longer center landing gear strut connects at the center boom fitting and can be adjusted along the boom for gear alignment. Note also that by inserting the center strut into the fitting twisted slightly you can adjust toe-in alignment to some degree.

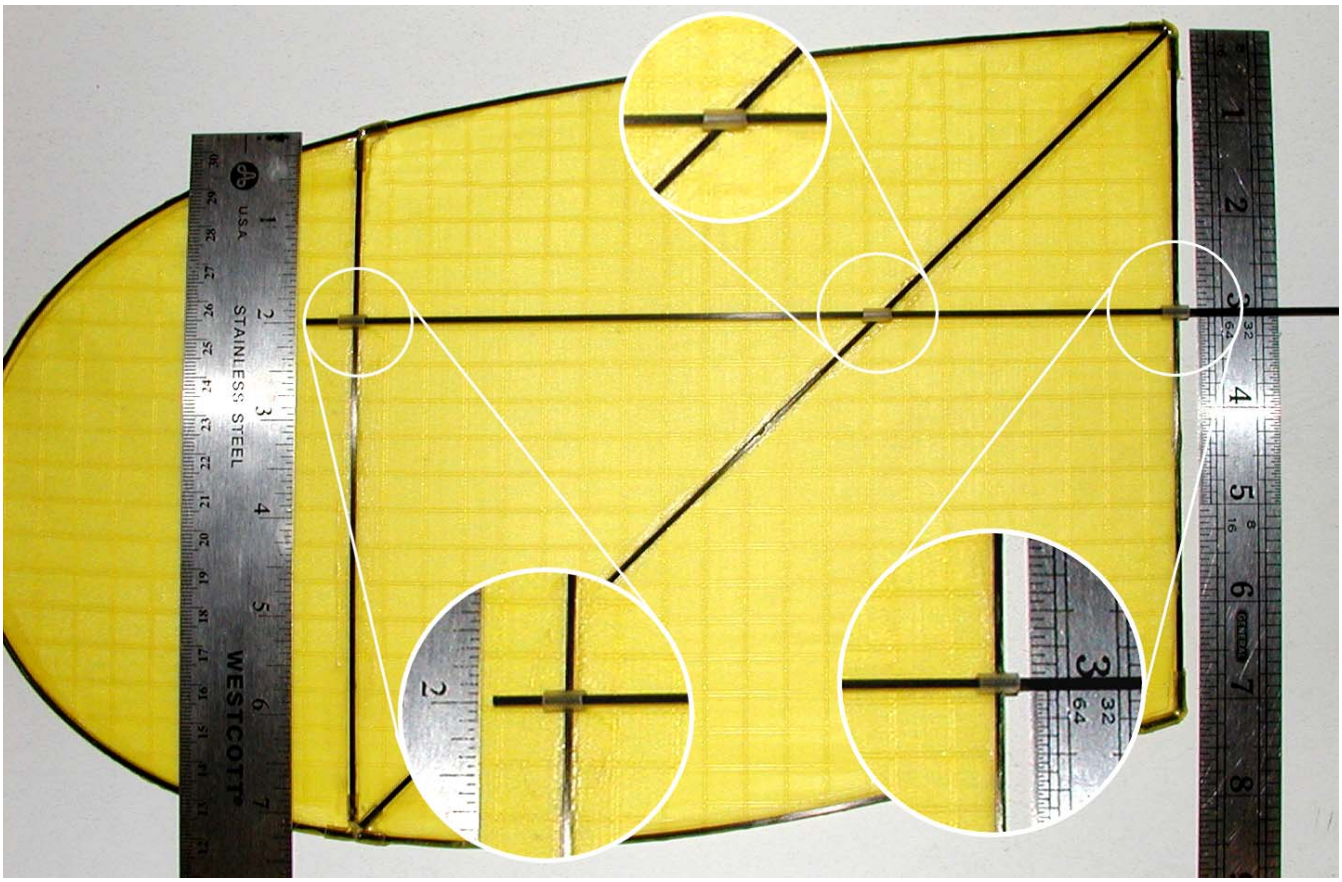

axle located to rear
of center strut

9. Wing construction

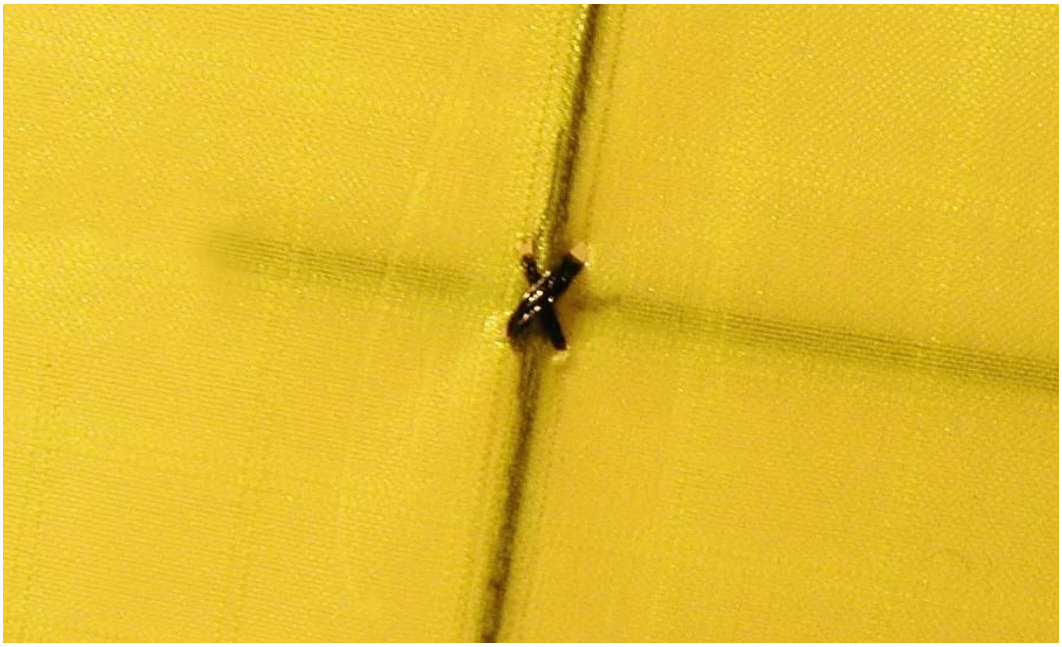
TIP: prior to starting the wings, match up pairs of opposite panels placed fabric-to-fabric sides together and check that the frames line up well. I always seem to find that when sorted in the two possible orders, one order matches better than the other so use these together as a left and right. Add a piece of masking tape to each notating left upper and right upper pair as well as left bottom and right bottom pair.

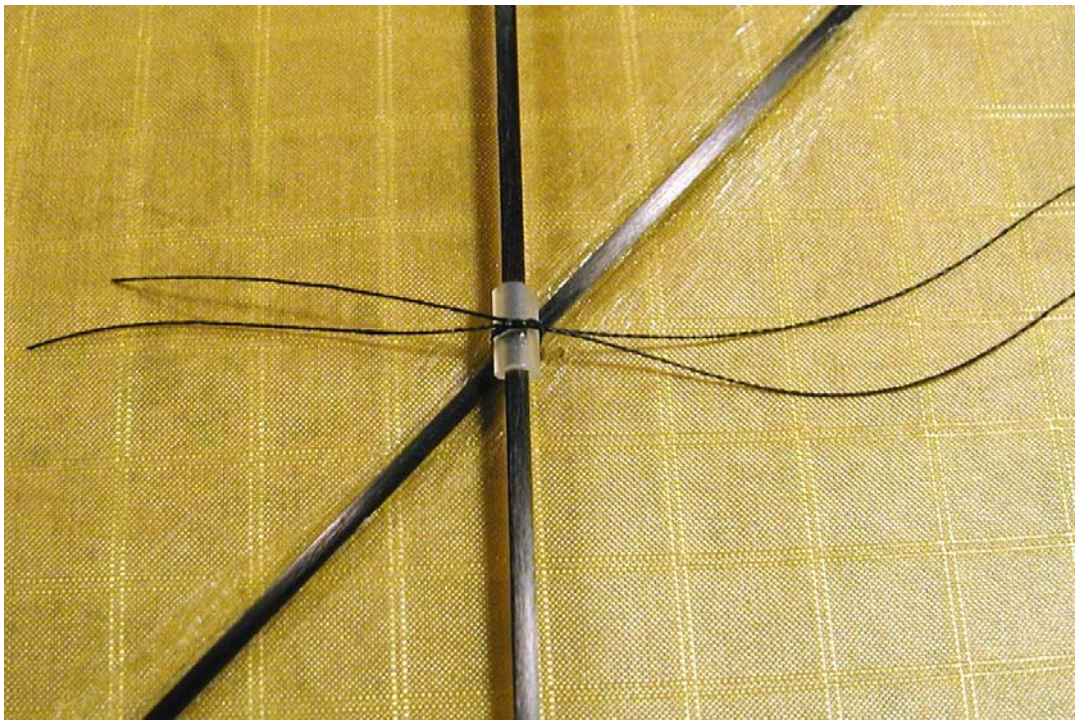
9.1 Install bushings

Install three bushings to each wing panel. Layout the locations on one panel first. The root bushing gets placed centered 3 inches back from the front corner. Next locate the outboard bushing centered 2 inches back from the leading edge on the spreader. With a wing pivot rod inserted in the inner and outer bushings, the location of the third middle bushing can be positioned. Use the needle hole method to mark their locations and lash with the rod in place being careful not to let glue get in the bushing. Center all bushings over their respective rods.



The middle bushing is angled to the diagonal rod it attaches to but when lashed with the rod inserted through all the bushings it aligns just fine.



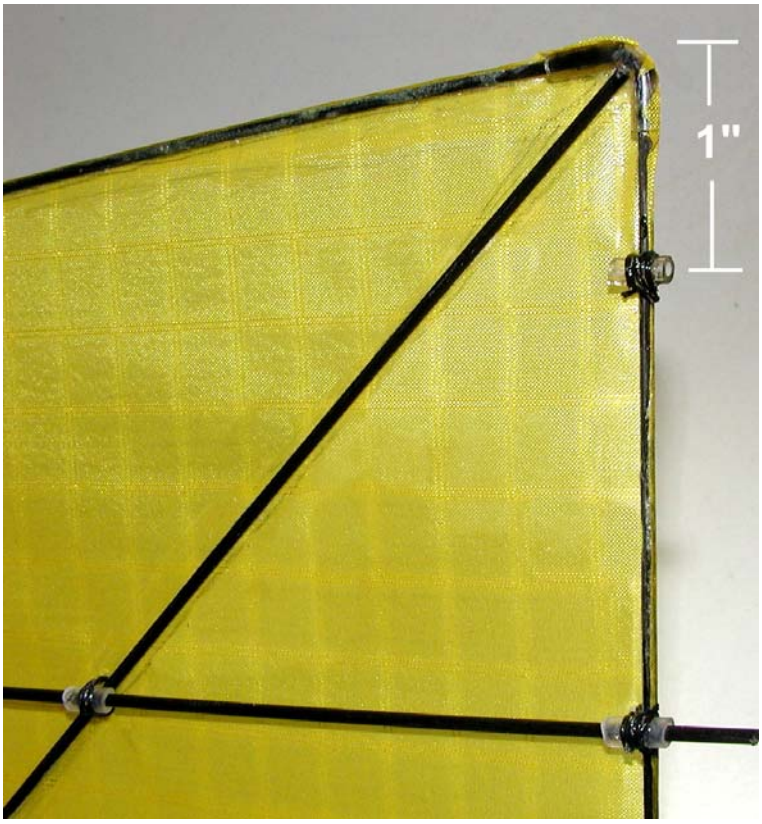


Once one wing panel is complete, match it up fabric-to-fabric to its mirrored mate and again use the needle to accurately locate the next panel bushing locations. It is not as important that the exact measurements are perfect as it is that the opposite wing matches the first as close as possible. Using the needle method to mark them assures they end up very close to equal.

Finish the remaining wing pairs the same way.

9.2 Install linkage fittings

The 1/4 inch long linkage fittings used to attach the wings together to operate as "wingerons" is attached the same as the root bushing only locate it 1 inch back from the front corner. Center it over the root rod and match it's location accurately to the mirrored matching wing panel as before. Lash these fairly tightly but not fully collapsed as only a thin linkage wire will be inserted later and if they collapse some, this will aid in keeping the connection tight.

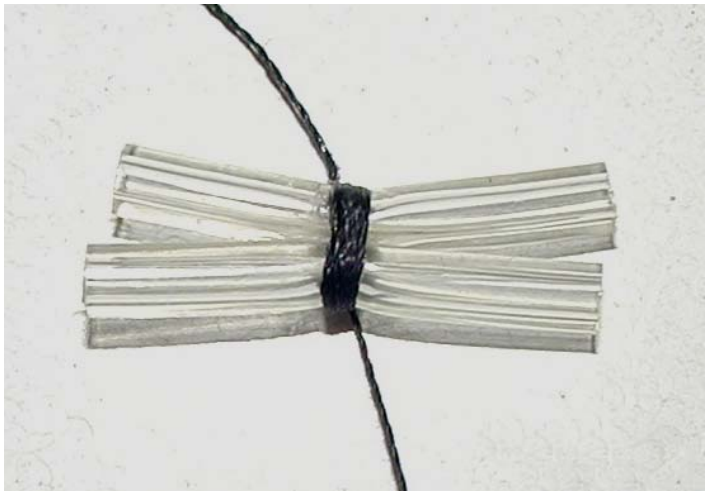


9.3 Wing spar stops

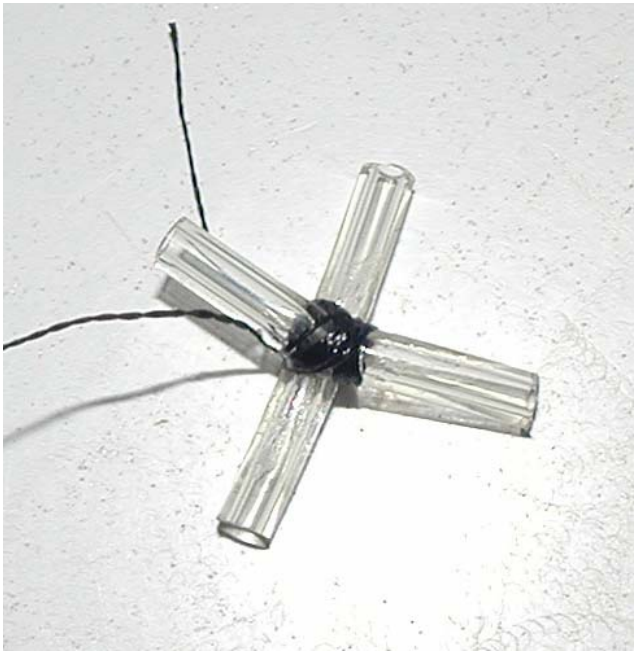
With your wing pivot spar rods inserted in the wings, add a 1/8" wide piece of fitting material as a stop sleeve over the root ends of the rods, leaving about 3/8" rod exposed past the sleeve. These keep the wing panels from sliding off the rods when disassembled and reduce the side play of the wing pivots. Test their location by inserting the spar ends into the fuselage wing fitting connectors and adjust slightly if necessary to allow the spars to be fully seated.

9.4 Wing support frame

Make four X connectors from 3/4" long fittings lashed together in the center.

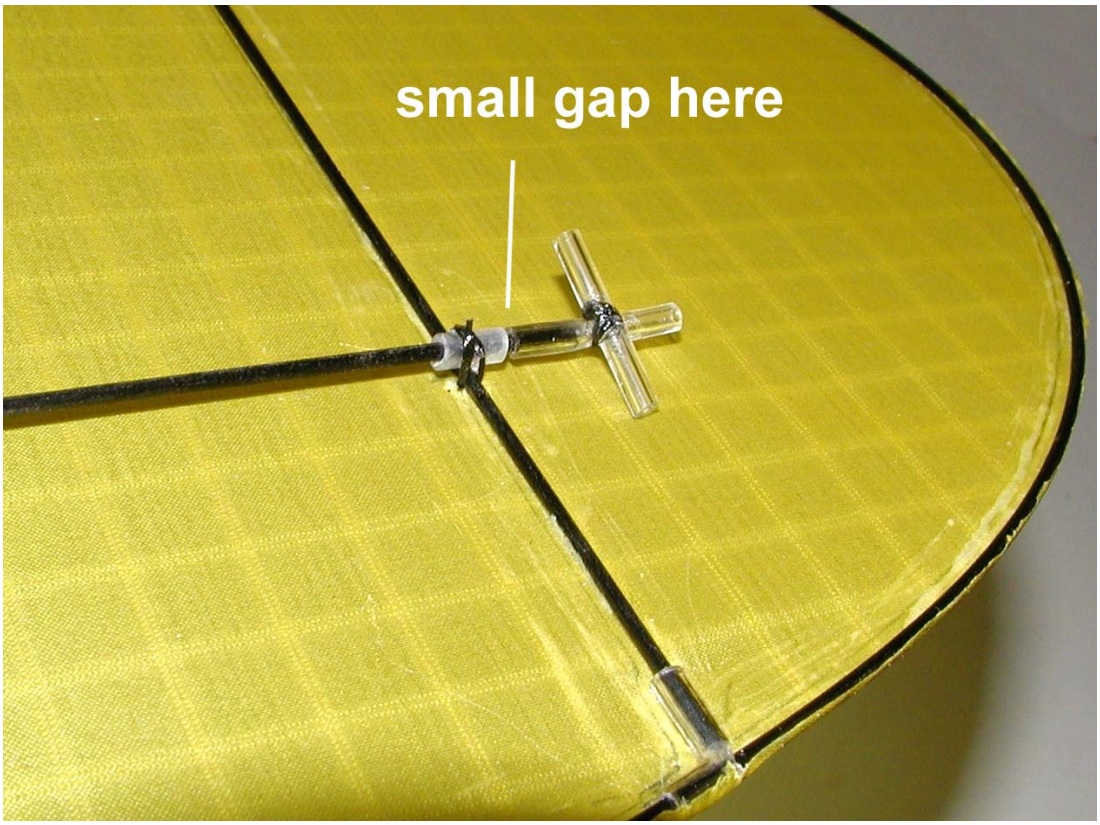


Before gluing the lashing, twist the fittings into a cross and lash the other direction to hold the shape.

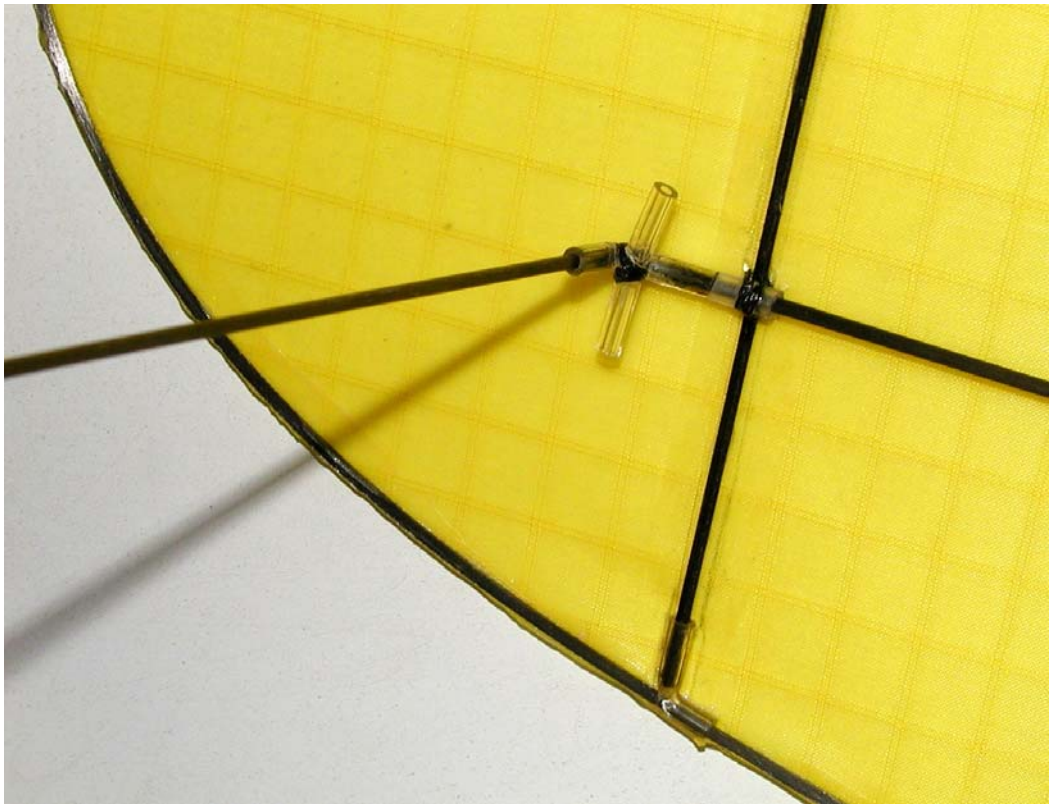


Keep the lashing tight and glue well. These will be trimmed as needed depending on location and fit.

Insert one leg of each X connector over the outboard end of the wing panel struts. If you can't get it far enough on to have it tight and still have a little side play between it and the inboard stop sleeve, remove and trim until it complies.

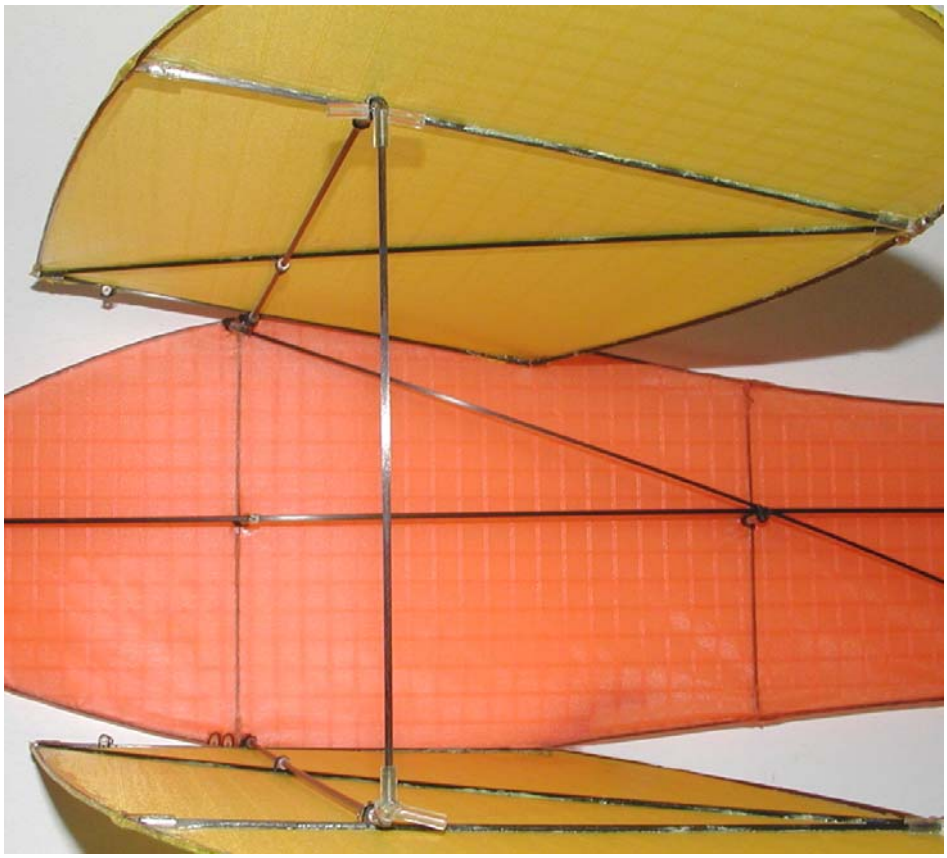


Add the wing connecting upright struts to the X connectors opposite the spar.

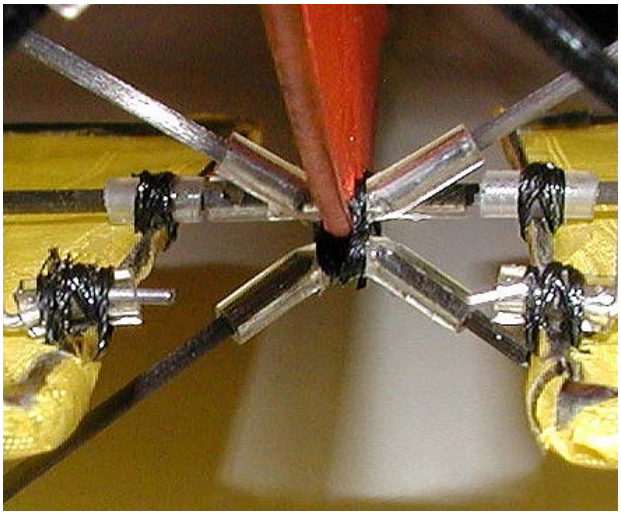


Connect the other end to the other wing panel on the same side of the plane. The lower wings are positioned fabric down and the uppers are fabric up.

All four wing connectors on the fuselage are located just behind the center vertical.



Add the wings diagonal struts from the top, front, outboard wing fittings to the lower fuselage fitting just in front of the longer landing gear fitting. This will form a rectangle framework.

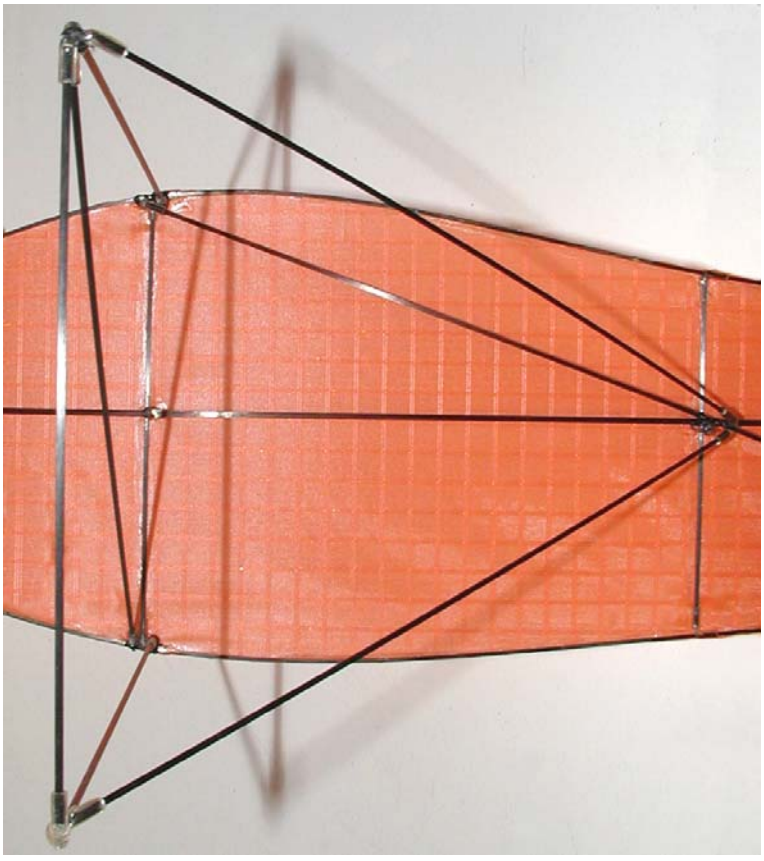


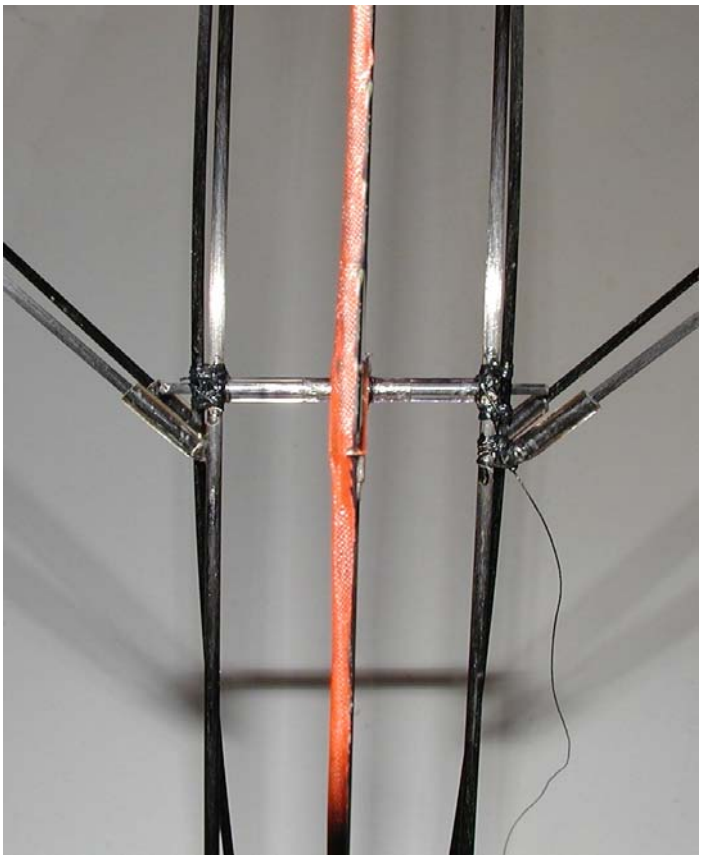
9.5 Rear diagonal struts

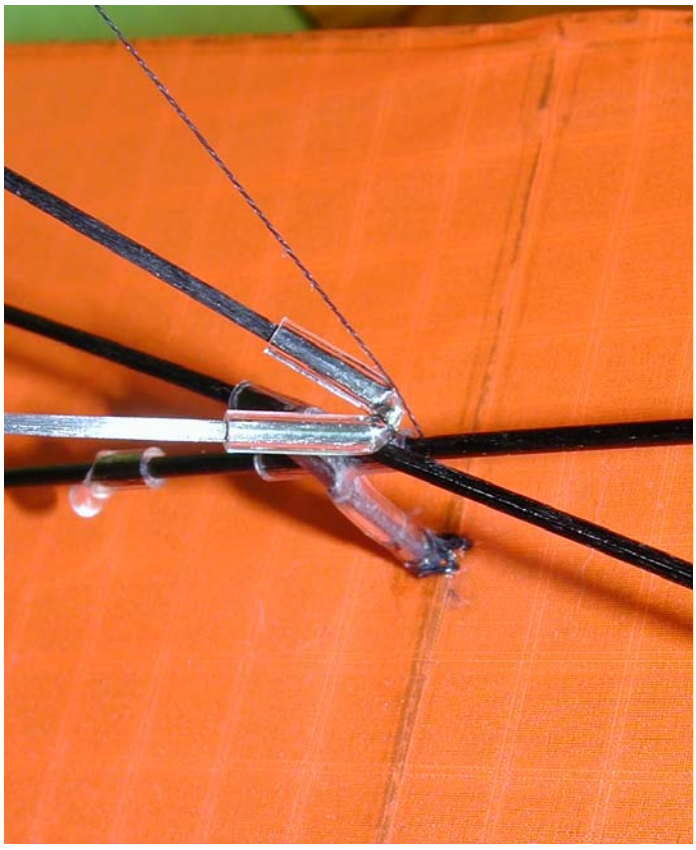
Connect the four wing rear diagonal struts into the backs of all four outboard wing X fittings. Note the lower front fitting isn't used and can be trimmed if desired.

Add a 3/4 inch fitting sleeve over the rear ends of the strut pairs on each side connecting them together the same as you did with the landing gear struts previously.

These elbows get lashed just behind the rear mid connector junction on the fuselage. By eye, locate them to find the best position to square the wing spars. Where positioned vertically will determine if the upper spar matches the lower. In general tend to error with the spars slightly swept back if both can't be aligned straight across.







You may find it best to locate the lashing with the elbow on the fuselage diagonal, above or below the center booms or on the center booms themselves behind the connecting rod for best wing alignment. You can start the lashing with the thread tied around the elbow center and laced around the rod to be joined. Pull tight and keep wrapping it tightly as you go. Try to zig-zag the wrap around both sides of the rod and fitting for best attachment. Be sure to match up the lashing on the other side with the location of the first.

NOTE: If the wings are not ending up quite parallel or have a little too much or not enough dihedral, try flipping over the connecting X fittings to slightly change the rigging distances. Due to the offset from the tubes crossing each other this can make the diagonals longer or shorter or the outer uprights longer or shorter letting you fine tune the wing alignment. A flat upper wing with very slight dihedral in the lower is ideal or both flat but you shouldn't end up with any anhedral (or drooping) between the wing sides.

10.0 Mounting Gear

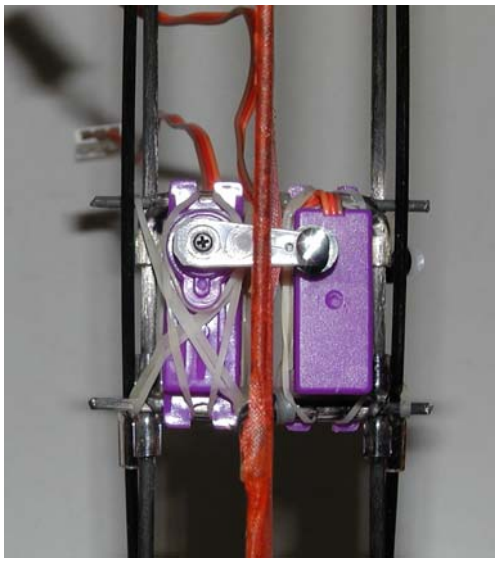
10.1 Servos - Rudder and Elevator

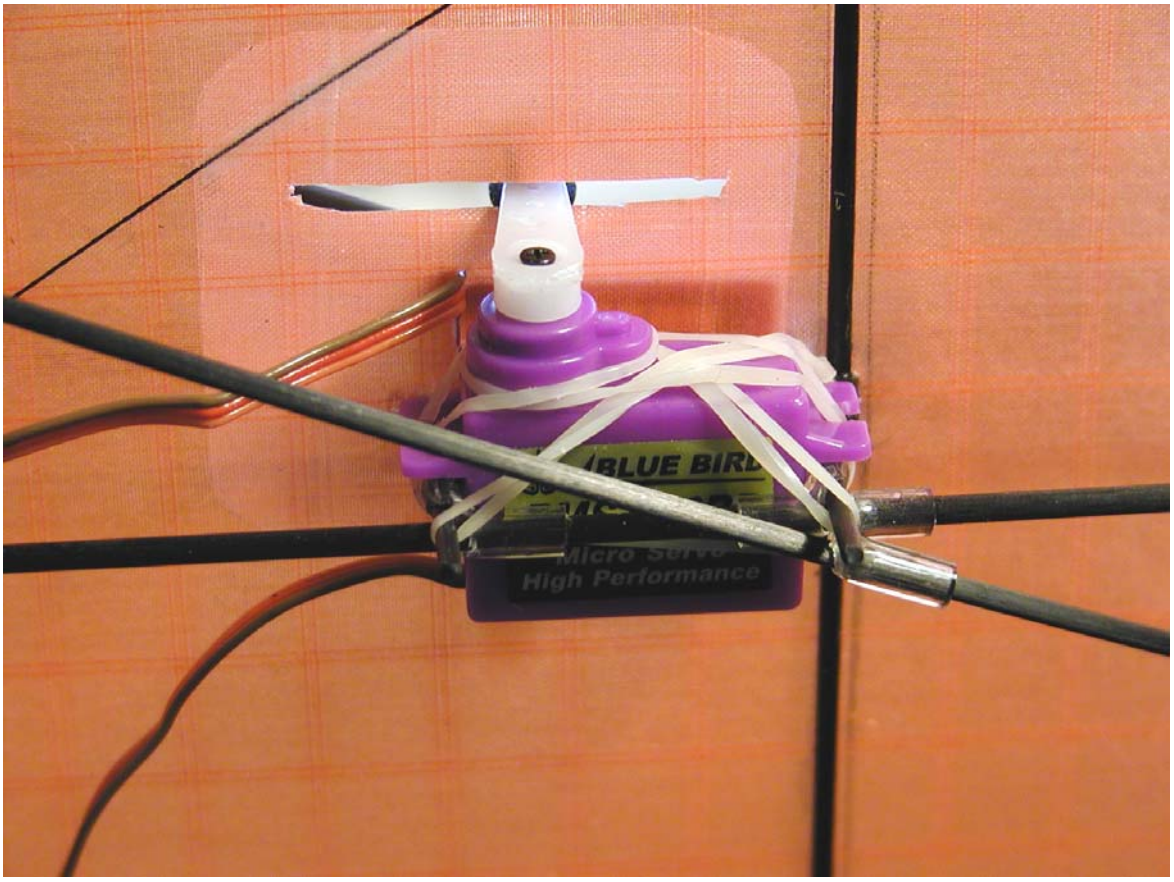
Use the same kind of servos for the rudder and elevator or at least ones that are the same length to fit between the servo rails equally. Hitec HS-55s or GWS-picos are typical here. We like the Blue-Bird BMS-306 or 306 BB servos for their long servo arms and that their mounting tab locations are lower on the case than other brands. This is handy for the elevator installation option below you may want to use.

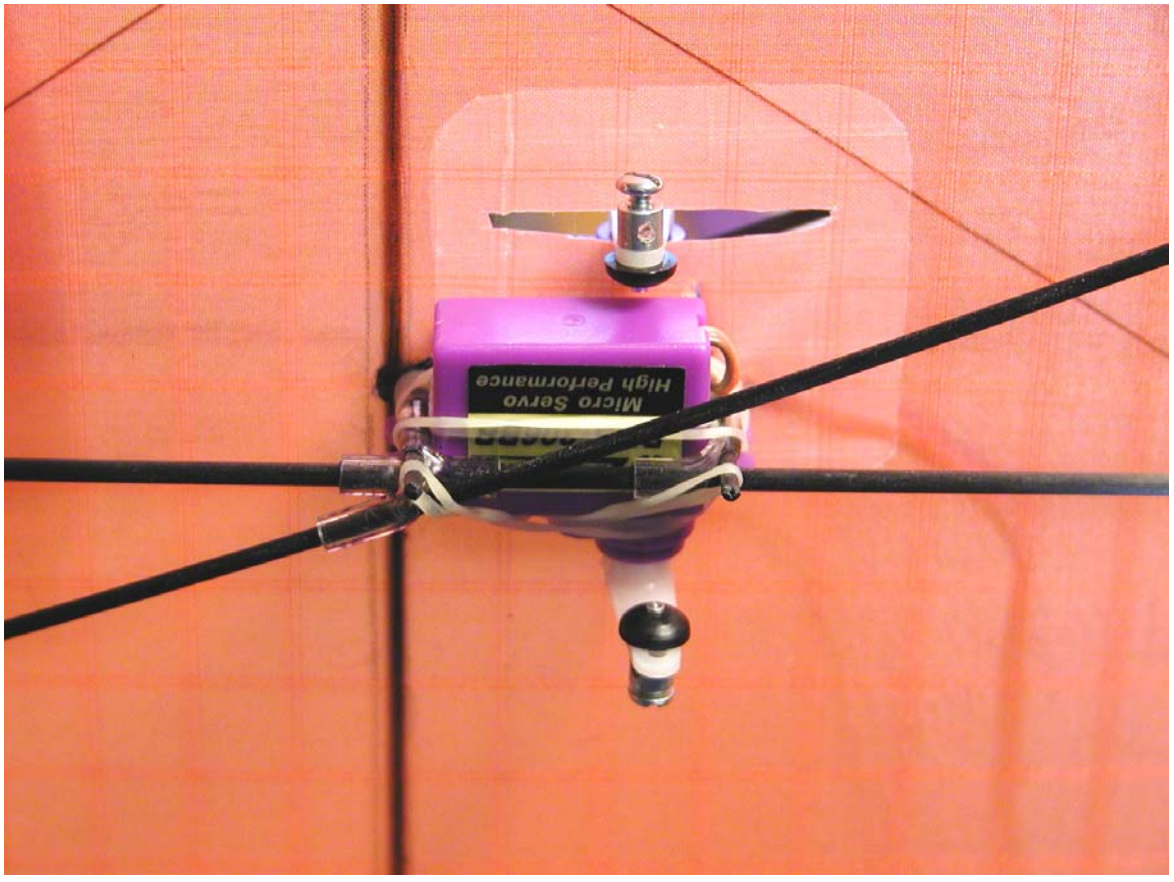
The R/E servos get located in front of the mid rear fuselage vertical junction connector which becomes the servos rear support rail. The front rail gets positioned where it is snug up against the servos and uses the existing fittings already on the center booms. The rudder servo is mounted inverted on the right side with its arm pointed outward. The elevator servo goes upright on the left. Position both servos with their drive posts forward for best linkage clearance.

10.2 Elevator Option

OPTION (1): If your servo type will allow for it (or can be shimmed to work) and has an arm long enough, the elevator servo arm can be passed through the fuselage fabric over the bottom of the rudder servo case on other side. This makes the arm more centered between the two elevator halves for a symmetrical action.

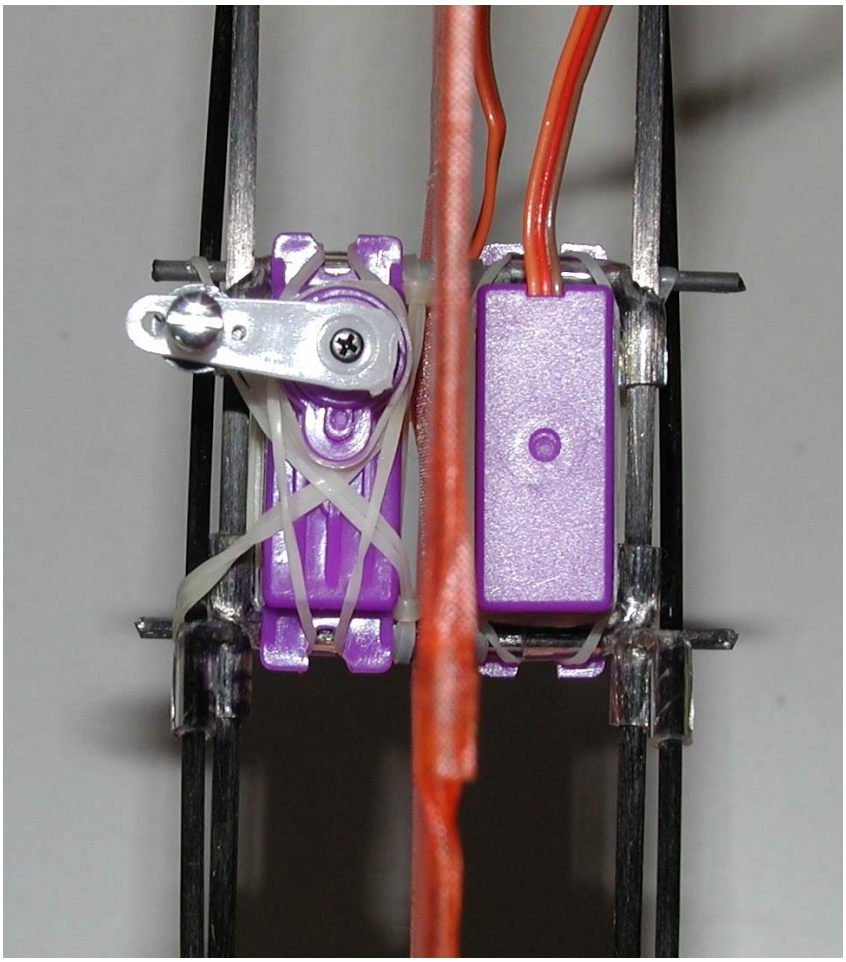



BLUE BIRD
High Performance


Micro Servo
High Performance

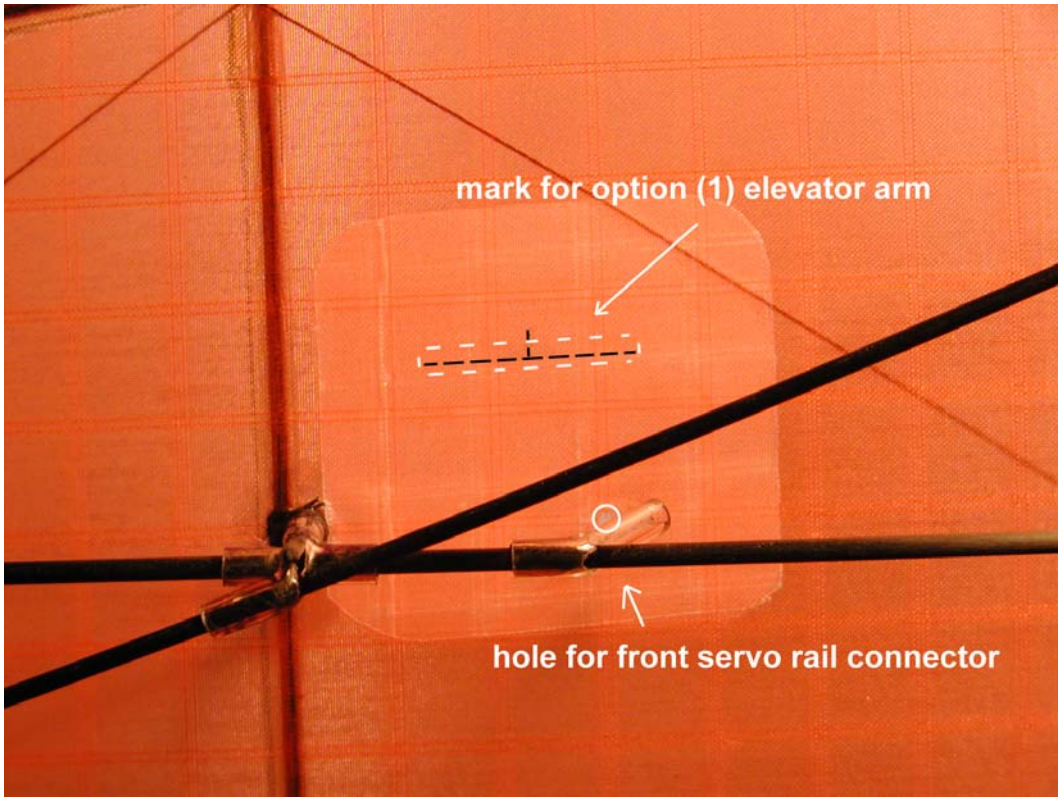
OPTION (2): If your servos cannot be offset vertically as in option (1) you can just point the elevator arm outward. In practice, this typical mount with both arms directed outward still works fine. For the purest however, note that one elevator half gets more of a direct activation than the other offset half so this method tends to vary the elevator deflection slightly at extreme control travels. This doesn't really affect flight but is worth noting.

Note: This picture is actually the rudder servo viewed from below but it will look the same for the elevator viewed from above since the rudder servo is inverted and the elevator servo is right side up.



10.3 Rear servo installation

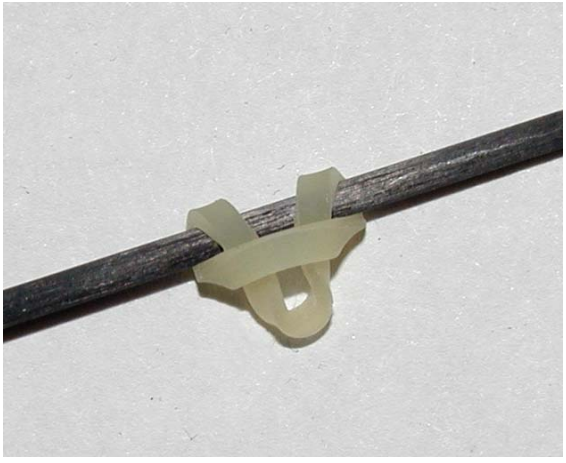
Start by applying a 2 inch square of repair tape for reinforcement to both sides of the fuselage fabric. Center it where the elevator servo arm cutout will pass through the fuselage fabric for option (1). Keep it low enough so that the front servo rail connector rod hole will pass through the tape also.



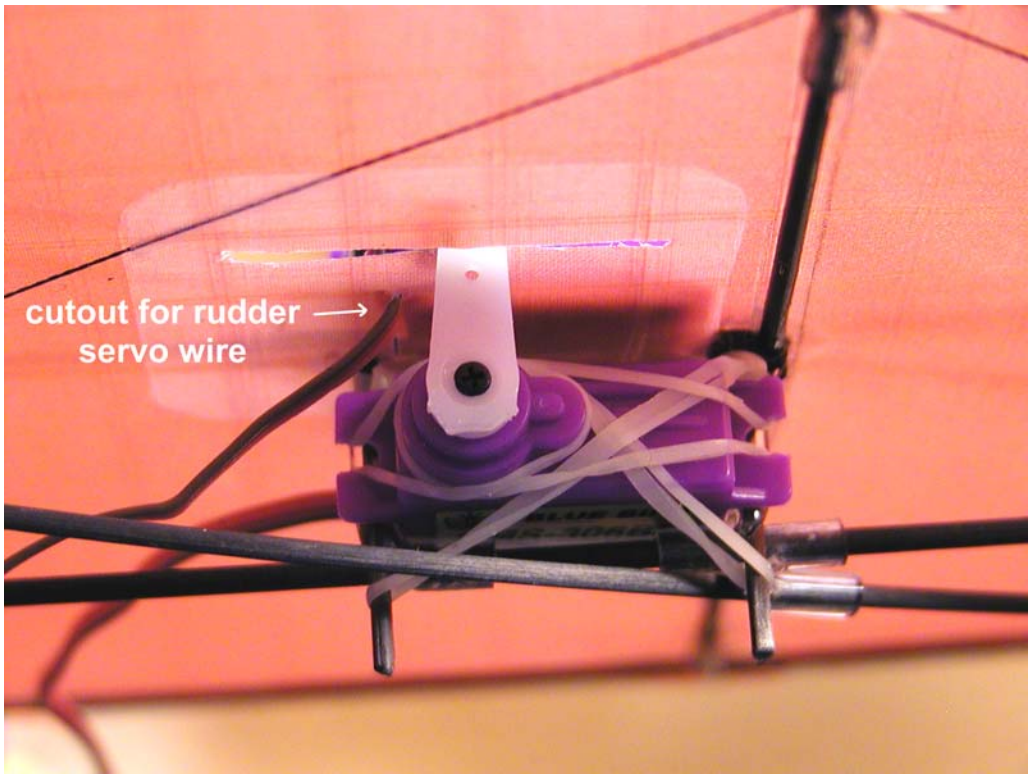
Position the front rail fittings along the center booms to the proper distance for your servos and insert a connector rod through the fittings. Poke a hole in the fuselage fabric for it to pass through. You can test install the servos now and hopefully they will have a nice snug fit between the rails. If not, move the front rail back until they do.

The servos get secured with rubber bands to the frame with enough of them used that the servos won't move under flight loads. If provoked enough however, they will dislodge from the frame to prevent stripping servo gears or worse. This has been tested with hard tail bounces where the elevator servo came completely out of the fuselage and was left hanging undamaged on the end of the linkage wire. Not recommended to try, but it's good to know it works.

You can use slip knots with the bands at the center of the connecting rails on each side of the fabric to attach them. Stretch them out over the tops of each servo mount tab and case to an opposite connecting rod end.



The slip knots can also be started between the ears on the servo mount tab. The more locations you apply the bands, the more secure the servos will be.



This is where a spring hook or bent end on a piece of wire is handy to fish the bands around the servos and hook them.

To test that you have enough bands installed, you can press up on the servos to see how tight they are held down. Check to see that they don't want to rock up on the ends either.

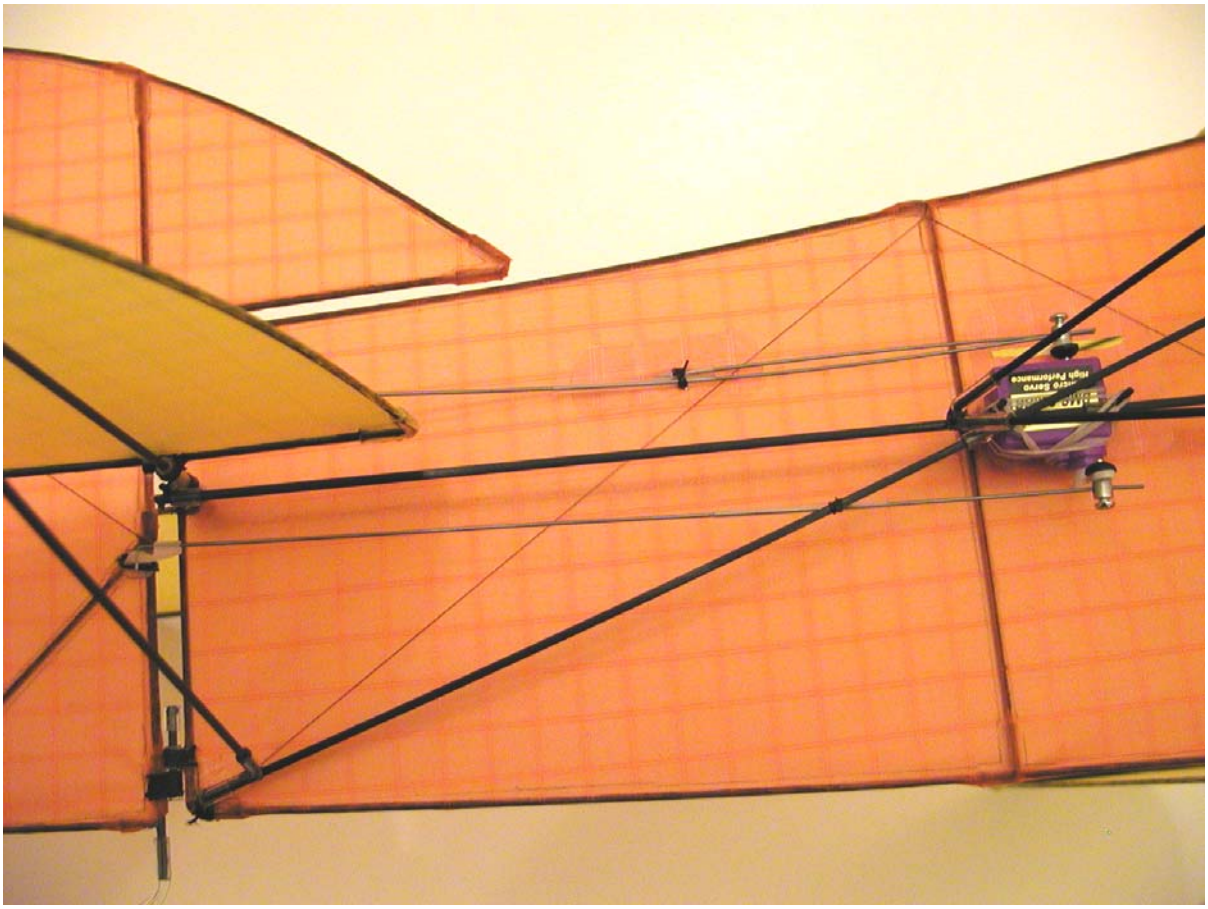
10.4 Rudder linkage install

For the linkage, use the longest servo arm you have and install the Dubro connector in the outer hole temporarily without the securing washer or arm screw for now.

You may need to enlarge the servo arm hole with a 1/16 inch drill bit to fit the connector post. Note that some servo arms holes are too big for the post and cause it to have excess play in the joint.

Start with the rudder servo positioned on the right side mounted up-side-down. Check ahead to see that the servo arm and connector doesn't come in contact with any frame part when positioned at both travel extremes.

Ideally you want the linkage to be a straight line from the connector to the rudder horn with the wire crossing the diagonal fuselage support closely where you will lash a guide sleeve for it to slide in. It doesn't matter if this sleeve is on the inside or outside of the diagonal but one side should allow it to be a straighter line depending on the servo width and arm length.



Install the servo arm connector allowing it to freely rotate in the arm without any excess play. I find it easier to do this with the arm off the servo and the retainer resting curved side down on a block of wood. Use a flat metal tool to apply firm, straight down pressure on the metal connector through the servo arm and into the plastic retainer. Do not hammer on it. Rocking it slightly as you begin pressure makes it easier to get it started.

Slide a short sleeve onto the linkage wire. Insert one end of the wire in the arm connector and make a 1/4" L bend on the other end. Connect the L bend to the outer hole on the rudder horn and secure it with an EZ link provided.

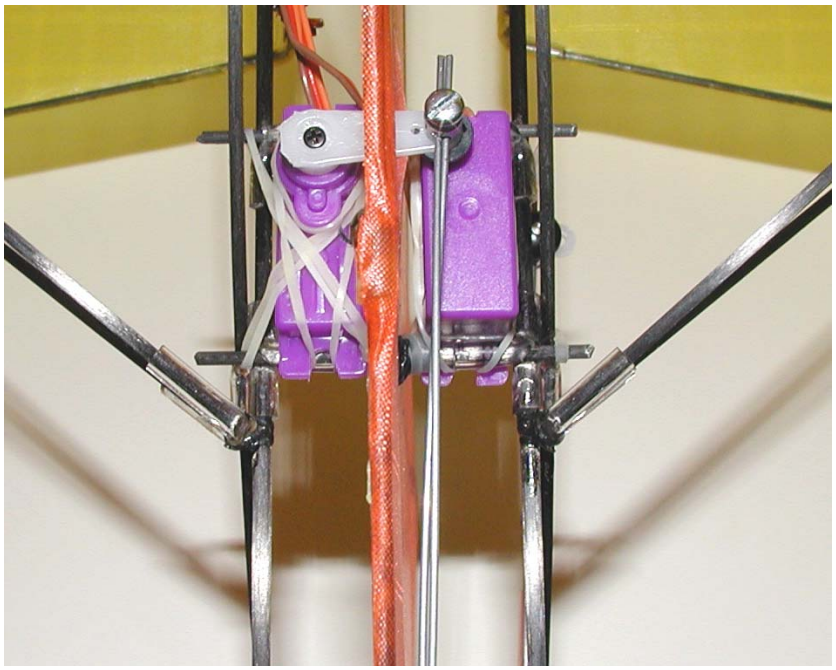
With the arm centered on the servo, center the rudder and tighten the linkage connector screw. Cut the wire a little long past the servo connector to allow for future adjustment. Lash the sleeve on the diagonal rod at the path of least resistance to the control motion range.

Later once you have the radio connected, you can find the zero trim servo center, position the arm as close to center as possible on the servo and secure the servo arm screw. Then you can readjust the linkage connector screw to re-center the rudder if needed.

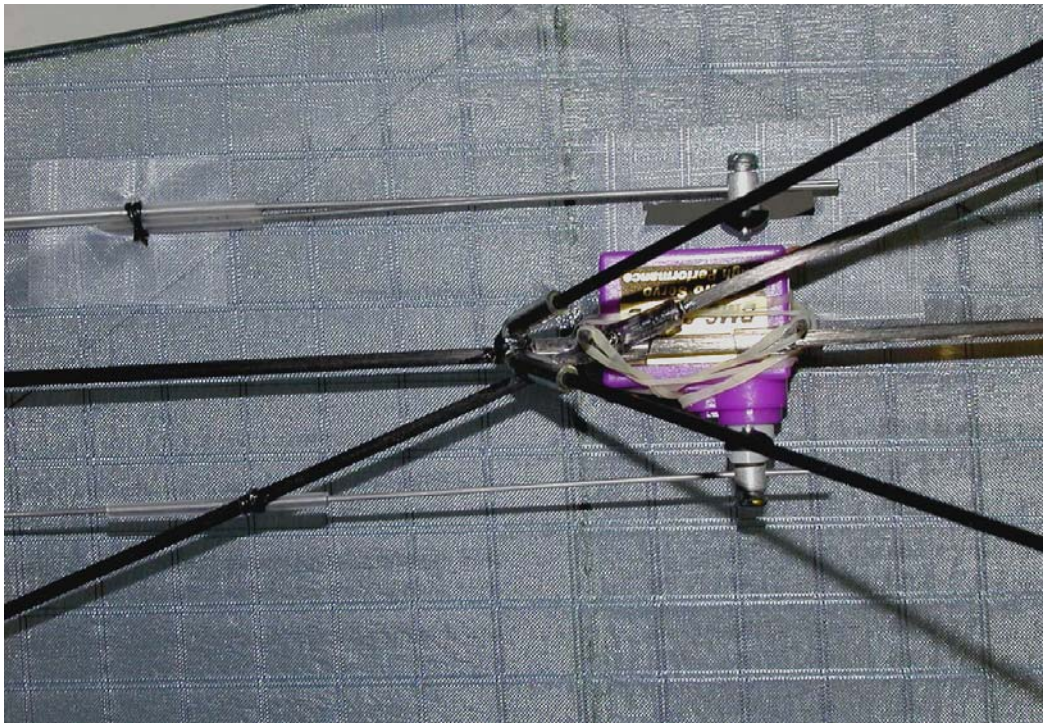
You'll also need to cut a small slit through the fabric to pass the rudder servo wire to the left side of the fuselage to access the receiver as shown above.

10.5 Elevator linkage install

The elevator linkage needs to connect together at or near the servo. Some may want to lash the two wires together but we find that by drilling out the servo connector hole with a 1/16" bit that both wires can be fed through and tightened together. This allows easy adjustment of both elevator halves individually as well as together. If you lash them together, you'll need to bend the linkage wire to align the elevators evenly.

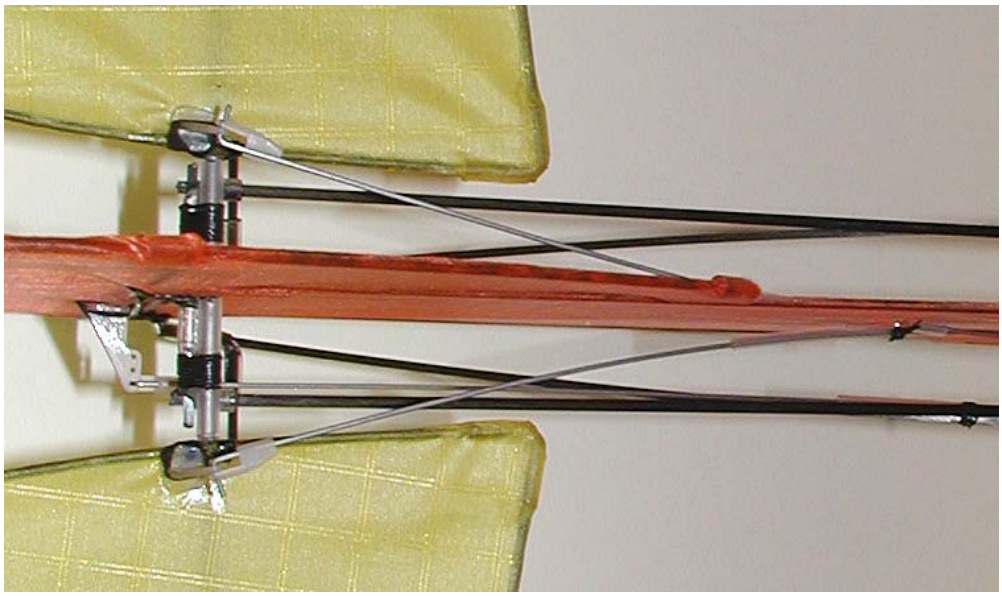


The elevator linkage installation is the same as for the rudder except you'll need to pass one of the elevator half wires through the fabric to reach the servo. Add a piece of reinforcing tape on both sides of the fuselage where the wire logically crosses keeping in mind the servo travel range.



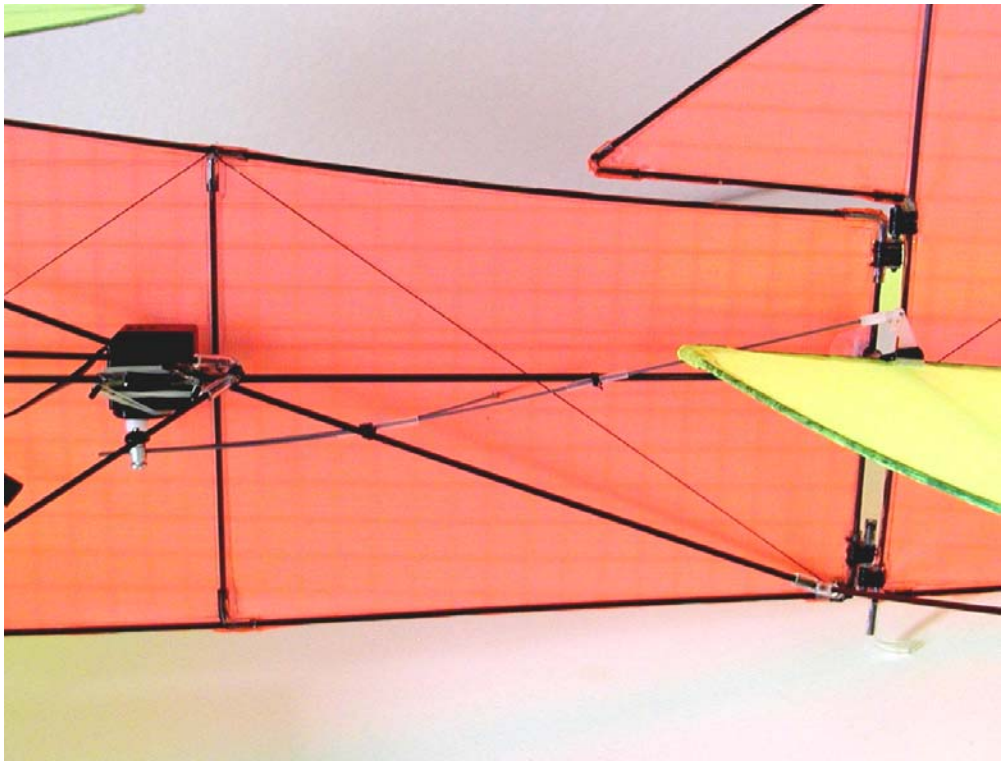
You want a sleeve on both wires with one going through the fuselage fabric and the other laying next to it. Lash these together at the hole.

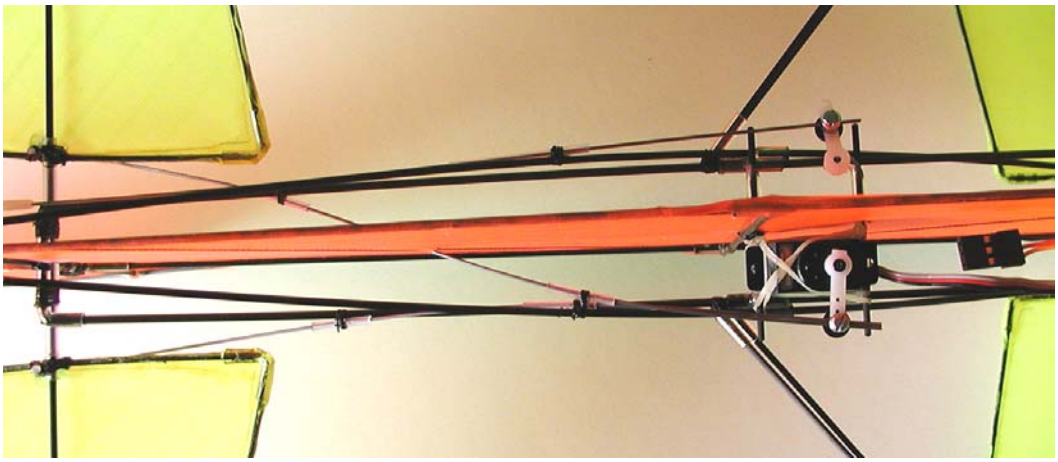
Very little forming is needed for the linkage if using option (1) but having the ends straighten out slightly prior to connecting to the control horns makes for a better alignment.



If using option (2) then you will need to form more of a dog-leg in the crossover wire between where it exits the fabric and the servo connector.

Here is an option (2) installation with the elevator servo mounted inverted using different locations for the guide sleeves.





One issue with mounting the elevator servo inverted is that the linkage angle to the control horns are not square anymore causing some built-in differential travel. Adding vertical dog-legs in the wires can fix this. Again, unless you are a purest looking for the perfect 3D plane, you may never notice it. We've found that shaping the linkage with smooth curves is more efficient than using hard Z bends.

Many builders have there own favorite methods and material preferences for linkage such as using CF rods etc. While these may be slightly more precise in control, they might not be as forgiving in the case of a serious crash and require more work to repair. Whichever method you use, be sure you have full range of travel, low linkage resistance, and as direct a connection as possible.

10.6 Wing servo installation

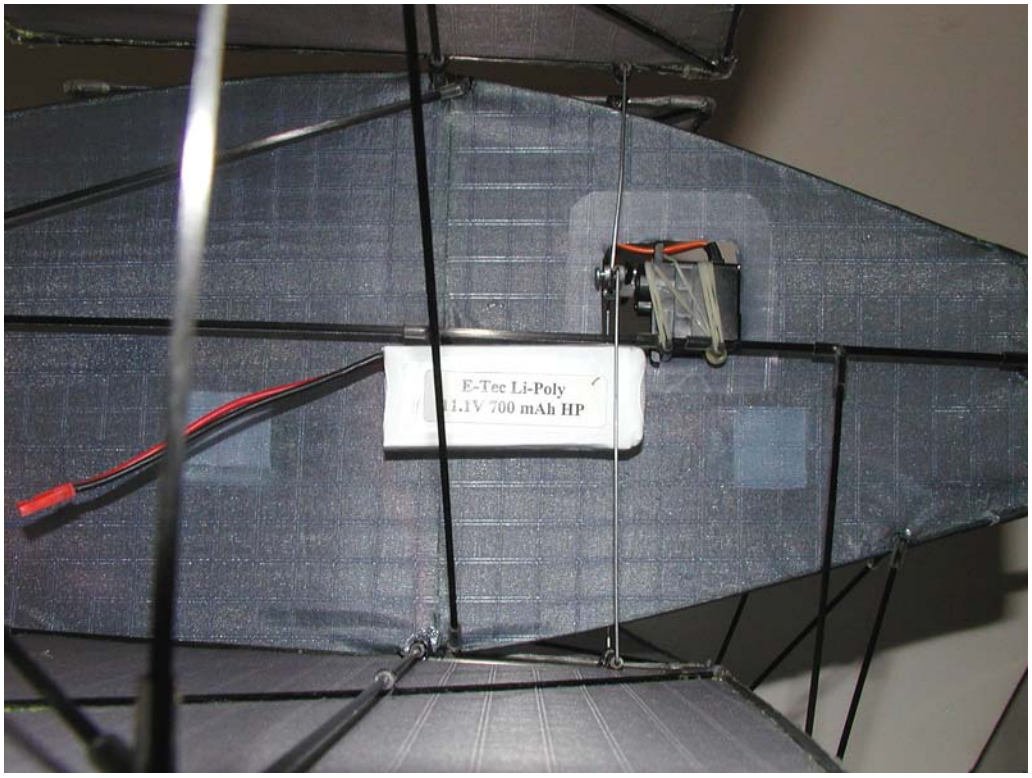
The wingeron system used for roll control is nothing more than all four wing halves moving together like giant 100% ailerons. To do this you want to use a fair sized servo like at least a Hitec HS-55. The GWS Naro HP will work as well as the Blue Bird BMS-371 and many others. We prefer the Blue Bird due to its oversized dual servo arm and good torque. A dual arm is required but if the one supplied with your servo isn't very long then consider using another brand or find an oversized arm that will fit it.
There are actually four possible locations for the wing servo; above or below the center booms, and facing forward or backward in each location.

Each has minor advantages and disadvantages. All will work fine but pack placement for precise knife edge static balance for the purist may not be perfect for some locations depending on pack and motor weight.

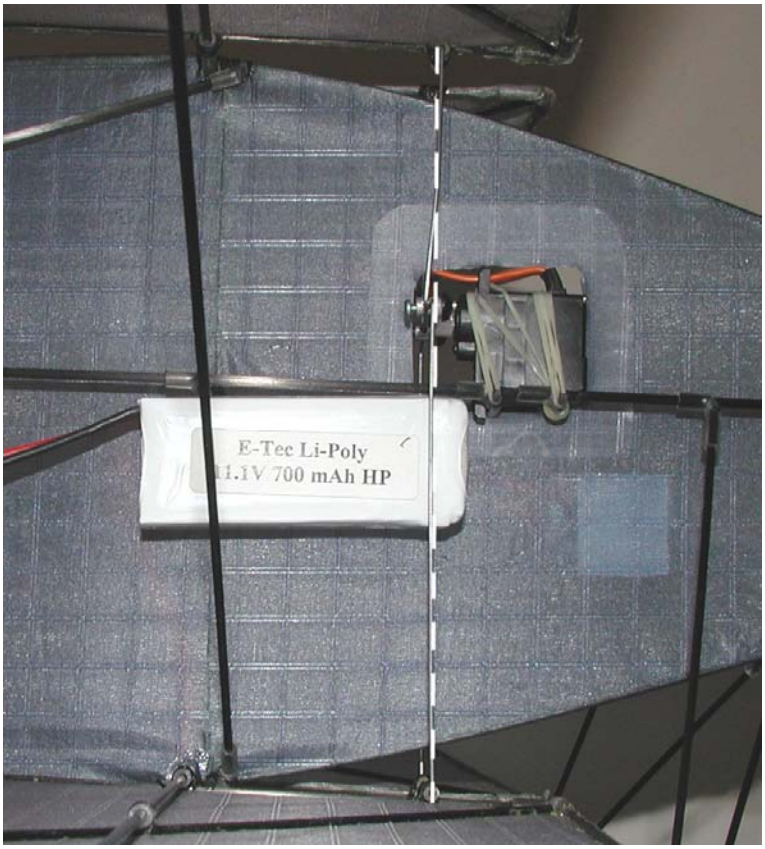
After testing all possibilities, I favor the low pack and high forward mounted servo placement. This is also the best location if you want to use different size and weight packs on occasion as well as having the pack free of obstructions if released from a nose-in.

Depending on motor/pack type, it might be a good idea to now lay out the gear on its side and find the rough placement based on a CG at the fuselage main vertical or slightly forward of it. If nose heavy due to a heavy motor, you can get a little help by flipping the servo backward. Installation is the same either way.

Here is the finished installation with the servo mounted above and forward.

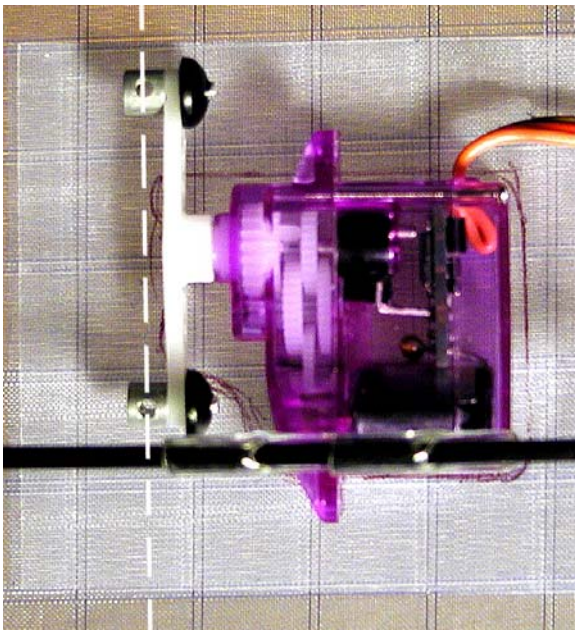


With the wings installed, start by finding the vertical line running between the upper and lower wing linkage connectors. Do this with both wings parallel to the center booms.



Next install the connectors on the servo arm and position the servo with the arm pressed on vertically temporarily, instead of horizontally as it will be used. Have the servo positioned with the post facing back and up. Lay it flat on the fuselage side in position lining up the connecter linkage holes with the vertical reference line.

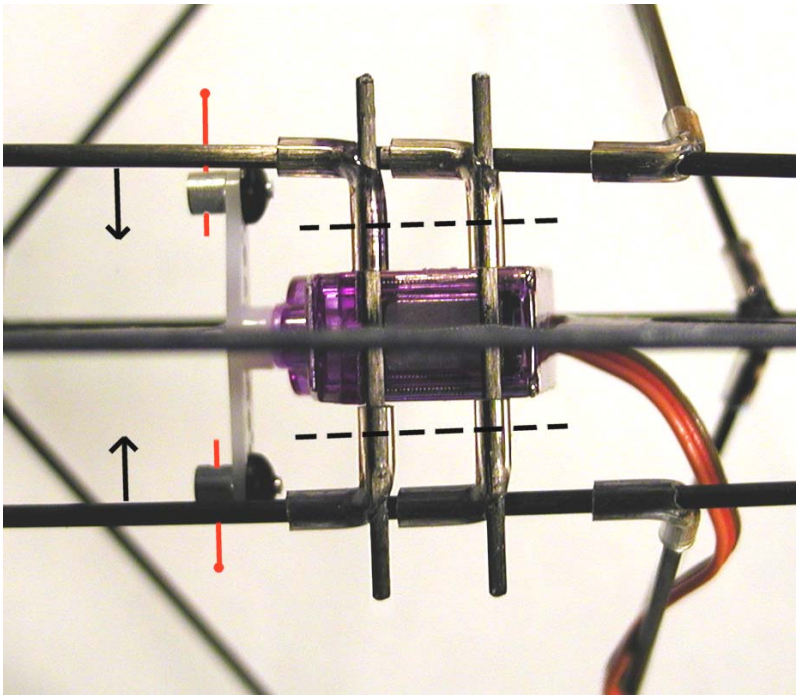
Mark around the servo and allow room for the servo arm at the post location and extend the outline slightly below the center booms for the servo rails. Apply a 2 inch square of reinforcing tape centered over the outline on both sides of the fuselage.



Trim the outline with sharp pointed scissors.

Move the servo rail fittings along the center boom until in position under the servo. Install the rail rods under the center booms through the fittings. The rear rod needs to rest up under the servo mount tab with the front rod well forward but not so far that it risks missing the front edge of the servo case.

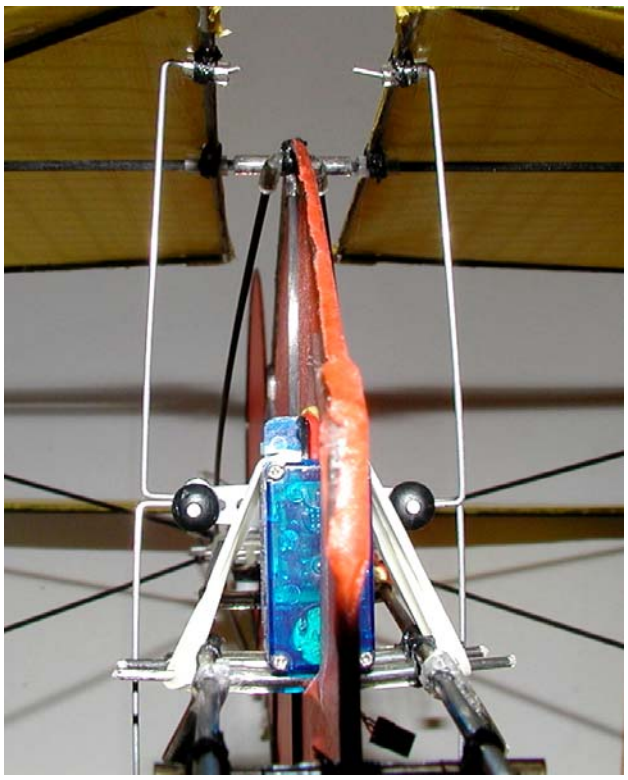
Check the seating of the servo on the rails. You want the center booms brought in far enough that when the servo is moved to maximum control travel the linkage wire doesn't hit the center booms. This requires trimming of the servo rail fittings as well as the fuselage main vertical connector fittings nearby. This also will keep the servo "seated" flat on the rails between the rail fittings and not let it move sideways.



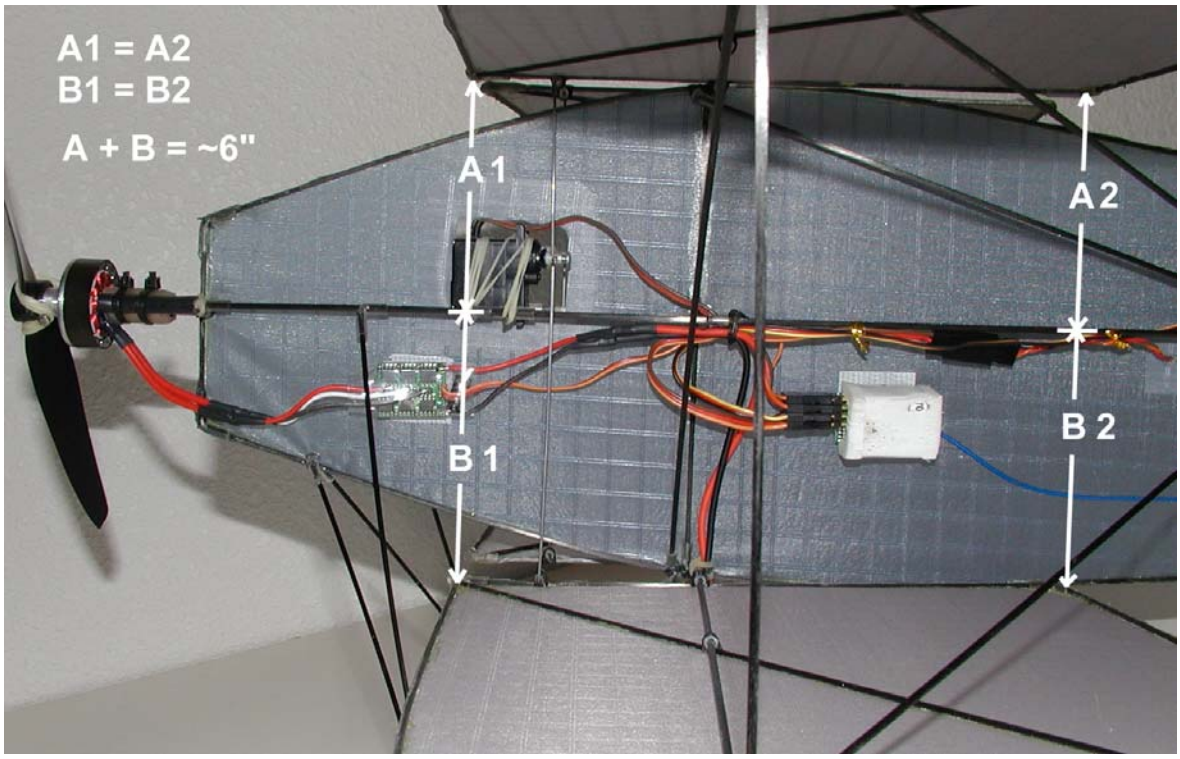
Band the servo generously over the case top front and rear and around the top mount tab down to the servo rails.

10.7 Wing servo linkage

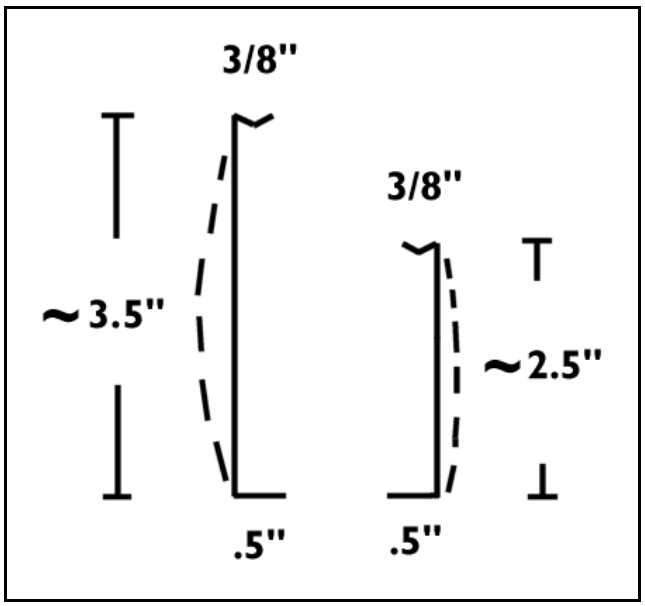
If you drill out the servo connectors with a 1/16 inch bit, two linkage wires can be inserted in the attachment holes. This allows separate upper and lower wing linkage to be formed for easier alignment. This also has the advantage of creating a longer servo arm that is adjustable.

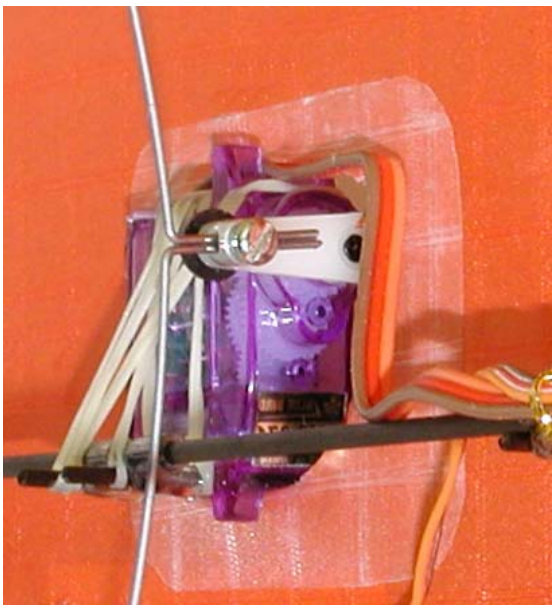


The linkage is formed based on the distance between the upper and lower wing linkage fittings and the servo arm connectors when the wings are all parallel to the center booms. Due to differences in servo heights and wing alignment variances, no exact measurements are available but the overall distance between the upper and lower wing should be close to 6 inches.



The diagram gives the rough idea but you need to measure the distances yourself to be safe. It's best to error on the long side as shown by the dashed lines so a slight outward bow can be added later to easily adjust them shorter to the exact alignment needed.





Start at the end of the wire and bend about 3/16" up some then another 3/16" back down to form the approximate 3/8" wide wing fitting ends. These angles can be fine tuned later for a snug pop-in fit connection that is still free floating and can release if you crash hard on a wing.

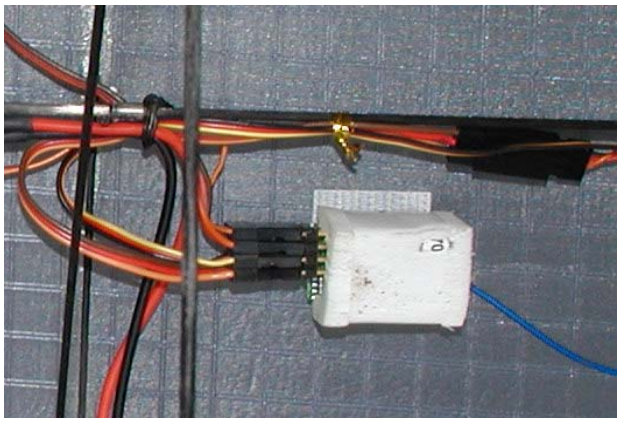
Measure your lengths and bend the 90 degree 1/2 inch long "L" for the servo arm connectors.

Once all are inserted into the connectors you can adjust them in or out equally to line up the linkage vertically. Tighten the connector screws and check the LE to LE and TE to TE measurements for the approximate 6 inch distance and form the bows as needed to achieve equal dimensions between the LEs and TEs. Finally check that the top wing LE to center boom equals the top wing TE to center boom so you didn't add any angle of attack to the rigging when you made the adjustment.

Note the routing of the servo lead back to the receiver around the servo arm. You can use the top servo mount tab as a holder for the wire to help keep it out of the way.

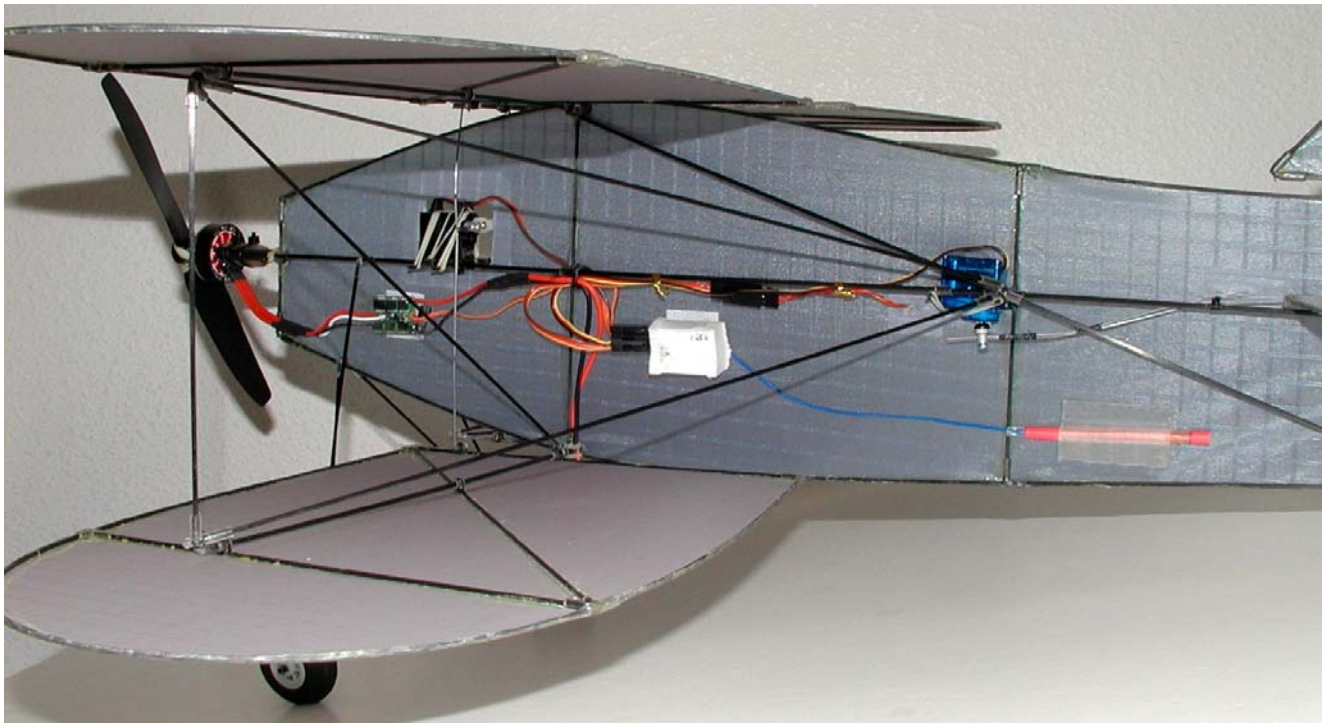
10.8 Receiver

You'll need to locate your receiver where it can be reached by all the servo wires. Except for servos with extra long leads, I found that one short extension was needed from the wing servo to the receiver. Mount the receiver on the left side of the fuselage. Tape the crystal in tight, and add some Velcro to the fuselage panel and back of receiver. I cut a small foam frame from the packing foam that came with the receiver just for some added protection.



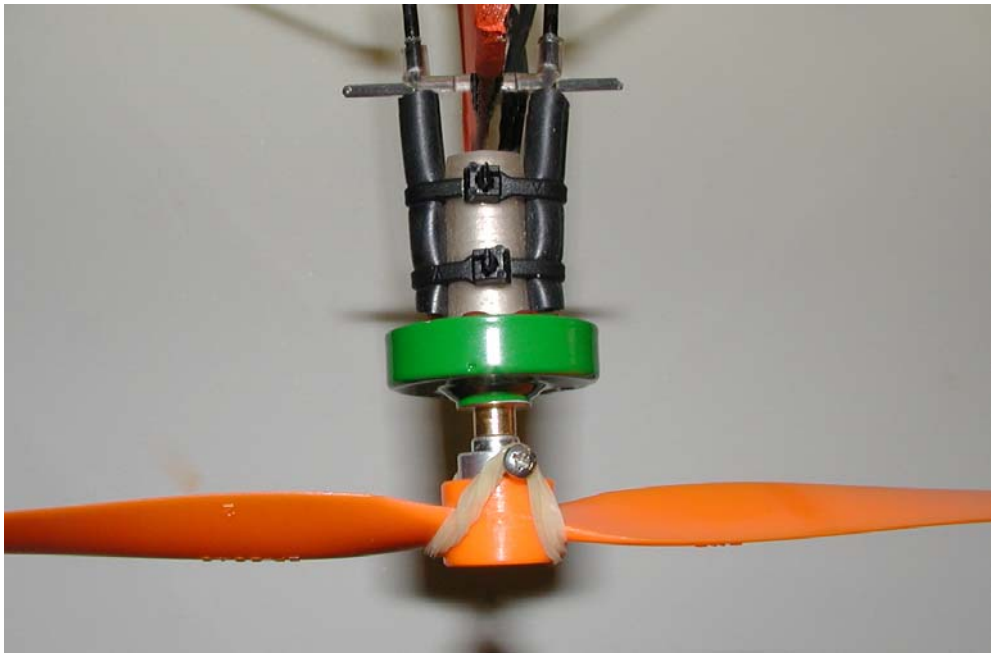
For the antenna, the small, coiled types work well or the stock full length wire can just be laced out the wing strut or fuselage bottom and left hanging. Some coil the wire around a straw, length of card-stock, etc. but don't let the wire cross itself anywhere or range will be reduced. Be sure to do a range check to be safe for all methods on installation.

NOTE: Do not allow the exposed wire end of the antenna to come in contact with the carbon fiber framework as it will cause instant glitching of the system. Best to add a little heat shrink over it to be extra safe.



10.9 Motor

This plane was designed around the 22.7mm diameter CD-Rom, post-mount type brushless outrunner motors. Many are available and the post mount type is easy to install and allow a zero centered thrustline. The post is also able to move in the mount to withstand direct impacts as well as be easy to adjust the up/down thrustline for best hover balance.



The motor post gets soft mounted between the extended center booms with wire ties. Add either some heat shrink or a length of surgical tubing over the motor post to prevent slipping. The boom ends get

some heat shrink over them and then a length of vacuum hose over that. Two tight wire-ties finish the installation.

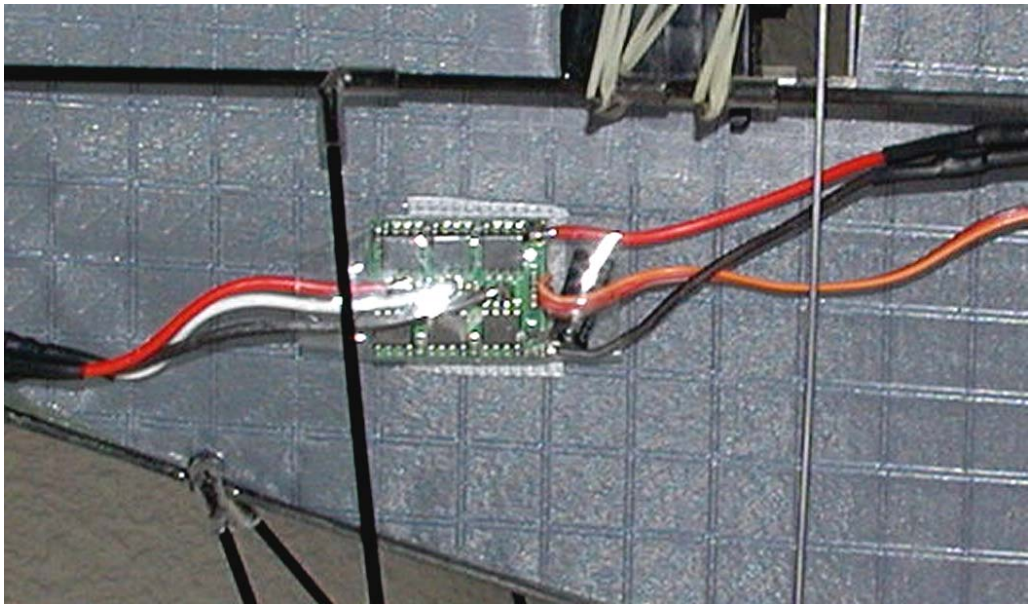
You'll have to trim the fuselage front vertical boom connector fittings as you did for the wing servo rails to further narrow the booms together at the nose for the motor post diameter. They can compress in a bit but you want them to be as parallel as possible at the mount for good contact with the motor.

In an impact, the motor will jam either up some or down some in the frame. Don't be tempted to add extra ties or other restrictive attachments. You want it flexible enough to prevent the fuse frame from breaking. The motor will not move in flight so there is no reason to attach it more robustly.

10.10 ESC

Locate the speed control between the motor and receiver also on the left fuselage side. Add Velcro to hold it in place. Program it with soft cutoff if available for the LVC so you know when to land without it shutting off the motor all at once. I like full brake also so if I know I'm about to crash I can kill power and get the prop stopped before it hits the ground if I'm lucky.

Run the ESC battery wire down and under the bottom of the fuselage to the left side and add a twist tie or band it at the wing pivot junction. This way you can connect the pack from the right side and have the connector available on the bottom out of the way.



10.11 Battery

For best 3D, mount the battery pack with Velcro to the right side of the fuse panel, just below the center boom. Have the packs center just slightly forward or centered over the vertical post at the wing pivots location depending on weight of the motor used. The vertical center post is close to the knife-edge neutral balance location with a 2 oz, 3S 700 pack and typical CD-Rom motor but with other weight packs and motors or for training and sport flying you can locate it slightly forward for more normal flight stability. At this neutral location, you can set the elevator parallel to the center booms and not need much if any forward stick to hold the nose up inverted. With the pack more forward, you'll need a little up trim for hands off level flight and a touch of forward stick for inverted.

11.0 CTC Owners Manual

You now own possibly the most versatile and resilient plane ever made. There are dozens of structural tricks used in its design to prevent frame breakage. With this durability a little responsibility is required to maintain the solid flight characteristics we pilots demand, so please read on.

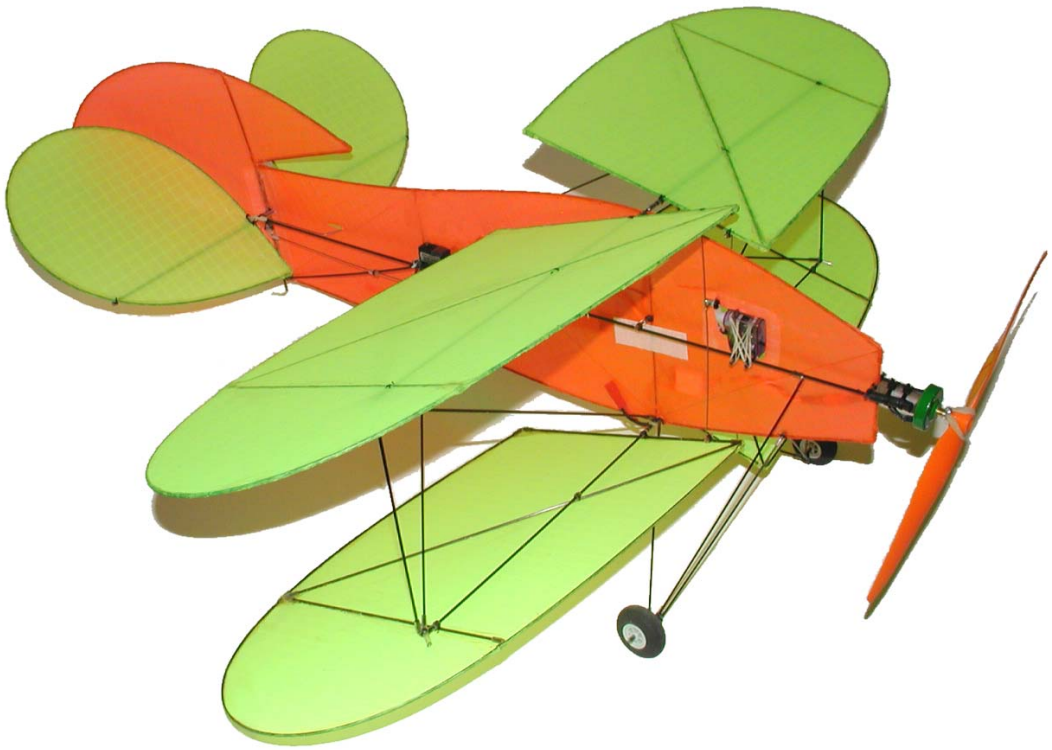
11.1 Final Adjustments

With radio on and trims centered, check that the wings are level, elevator parallel with the fuse booms, and rudder centered. Note that in most cases servo horns do not attach exactly 90 degrees to the servo case at center trim and need a little programmed offset or trim adjustment for a square center. This is most apparent with the wingeron servo since it aligns the wings and needs to be straight to do so.

Adjust travel of the rudder so you have the most possible but that it doesn't hit the elevator halves at full deflection plus full trim. Check that full down elevator doesn't allow the rudder balance tab to hit the elevator when moved. You can set so much down travel that the elevators hit the ground at rest. If you want that much throw, just don't use that much down stick when on the ground or add a tall tailwheel! ☺

Do a range check and you should be ready to fly.

WARNING: DO NOT ALLOW YOUR PLANE TO SIT IN THE SUN IN A HOT CAR OR NEAR ANY HEAT SOURCE OR YOU RISK HAVING THE PANELS TIGHTEN AND BREAK THE FRAME BOWS!



11.2 Pre-Flight Check List

Before flight and after ANY crash or hard landing, here's what to check for

* Prop straight on hub - straighten
* Motor straight on frame - push back into position
* Battery pack in proper location - never leave a crash site without checking as it may have been thrown loose and you won't want to lose it as I did once… ☹
* Landing gear is not knocked loose - replace back in fittings
* Elevator halves straight with each other - manually align and tweak linkage if needed to secure
* Servos snug in their seats and wingeron servo centered - manually straighten wingeron servo to realign wings
* Wingeron links snug in wing fittings - push back in if loose
* Tail square with wings - grab entire tail while holding fuse at servos and twist to straighten
* Fuse booms pressed snug together and in their fittings - if popped loose, re-install in fittings
* Wing struts all connected and seated - replace fully back in fittings

You can determine the order of priority of need of the above list based on your flight habits and experience level with the plane. You'll quickly find out the difference in "damage" between a minor nose in and a blown high-speed inverted pullout!

Most will be obvious with a quick glance but if the plane seems to fly at all differently then land and give it a closer examination.

For example, if your aileron trim is centered but the wings are visually not aligned anymore, either a link has popped loose or the wing servo is out of place. If the servo is crooked or raised out of its seat, just grab it and center it up between the fuse booms and be sure the lip is down against the rail. If raised out

of its seat, the wings suddenly now have a higher or lower than normal angle of attack causing a substantial pitch trim change in flight.

You may be tempted to add more bands or reinforce it somehow but don't! On our first prototype I kept breaking wingeron servo horns on bad crashes so developed this method of having the servo move instead. Every time you have to reposition it, think to yourself how easy it is to do instead of needing to repair the horn assembly or replacing stripped servo gears or worse.

11.3 Rigging Tricks

As a 3D plane, you don't want any stability. Ideally you want everything neutral so any position you put the plane in it will want to stay there (or so I hear).

The standard rigging of the wings are parallel in both chord angles and dihedral (or lack of). The wing chord lines should be parallel to the fuse booms with the booms centered nearly equally between the upper and lower wings. The horizontal all-flying elevator should also be parallel with the booms at center trim for a neutral CG. This position is located about on the main fuse vertical where the wings pivot and is good for 3D. (However, some pros testing it prefer it more forward, and others more to the rear.)

For R/E use or just a more conservative sport setup you can add dihedral by simply adding T fittings near the tops of the outboard wing uprights and relocate the wing diagonals there.

Or, with the dihedral added you can also shorten the outboard wing uprights to leave in the bottom wing dihedral and bring the top wing back flat or even with a little anhedral for some roll stability both upright and inverted. Knife-edge stability may suffer some with this setup however if you add too much.

Note: ANY change to any of the triangle lengths can have a profound difference in the rigging angles. This is true not only in the wing span axis but with the upper and lower rear diagonal wing braces as well. For example, even 1/8" shorter or longer will make the wings sweep back or forward a noticeable amount.

11.4 Power Gear Options

Lightweight (1-2oz) 2-3S (number of cells) LiPo (Lithium Polymer) packs are the battery of choice to keep the weight low. These and the current breed of CDRom style based brushless outrunner motors allow very good power to weight ratio flying.

Using a typical 20 turn GoBrushless, Westport or other CD Rom based 22.7mm diameter motor with a GWS 9x5 Direct Drive prop and small Etec 700 mAh 10C rated 2S pack, the motor & battery weight is about 2.25oz.

The plane weights about 3 oz stripped of gear. Plan on 1.5 to 2 oz for radio gear including a robust servo for the wingeron torque requirements and expect around 7 oz RTF with 2S pack. With more than 10 oz thrust available you can realize about a 1.5:1 power to weight ratio.

Running with a 3S 700mAh pack and a CustomCDR "mild" wind motor or GBX-single with 8x4 direct drive prop gets the AUW weight up to about 8 oz with up to about 18 oz thrust!

Both the 2S and 3S setups can push some motors at full throttle so try to limit full power to short bursts during punchouts and vertical up lines etc. allowing the motor to cool afterward with some cruise.

This will greatly increase duration as well and I routinely get over 10 minute flights with a mix of flight styles on the small 700 mAh packs. With the 3S pack you can expect slow harriers at about 1/3 throttle with full hovering at less than 1/2 and good vertical at about 3/4 stick.

11.5 It's all about wing loading

As a stock biplane with 700 mAh 2S pack at about 7 oz with 2.6 sq ft of wing area the wing loading comes out to 2.7 oz per sq ft. At 7.75 oz with 3S pack you're up to 3 oz/sq ft. Up to about 4 oz/sq ft is fine for best slow speed performance.

If you only fly sport and don't need the high power to weight ratio, running with heavier packs up to 900s or so will work for extra long duration fun-flying at the park.

The CTC even flies fine as a sport high-wing plane with the lower wing removed. This doubles the wing loading however so up goes the stall speed. It's good in a breeze and where you have some room to spread out a little.

Watch your speed when running heavy or as a monoplane because flight loads increase exponentially the faster you go. Again, manage your throttle. This is the most important pilot discipline in my opinion for learning advanced maneuvers. I've found that way too many pilots (including myself for a very long time) feel the need to keep it floored no matter how much power they have or what they are doing with it.

Also, if you want slamming 3D performance at higher loadings than 3 oz/sq foot, I recommend using 9 gram servos for the rudder and elevator channel and a 20 oz or so torque servo (IE: GWS Naro HP or MAX) for the wingerons.

11.6 Flight Notes

CG: Start with the CG just forward of the wing pivot fittings. You'll need a slight amount of up trim to keep the nose level and you'll need a little down stick in the inverted to hold the nose up. Ideally for 3D, I like to have the CG where with zero trim on the elevator (straight with fuse booms) I can fly upright or inverted with no back stick input needed.

The CG range is very forgiving so play with it for best location for how you want to fly. At the aft position it will fly fine here but tends to want to do automatic harriers unless you add a little down trim for straight and level and pitch will get twitchy. Some expo programmed in will help here.

Just hold the fuse right behind the upper wing pivot with your fingers as close to it as you can for an easy way to balance it and locate the pack where the plane is level for the rearward 3D position.

With the right CG, inverted as well as upright flight will require no elevator input to maintain level at a given speed. In fact, the plane will auto harrier with this setup once the tail sags and you add some power. Even knife-edge flight will require little or no rudder input to hold position.

Controls: Start with mild control travel settings until you get the feel for it. 1/2" deflection up and down for the wingerons and 1" on the elevator should give you the idea. Extreme deflections can be set later but the fact that this plane is only between 2.5 and 3 oz per sq ft loaded puts it in a different flight regime than most pilots are used to. Stall speed is very slow and at the slow end control normally suffers. With sufficient travel and prop wash over the tail, full control can be maintained. The oversized elevators and

rudders allow less deflection to do the same work as smaller ones deflected more. This helps prevent excessive control deflection drag to be created as well.

There are some differences you'll notice from the slow flight speeds and wingeron controls. An advantage is the extra roll control area available. You can't get more than 100% ailerons! On the downside, adverse yaw is the biggest culprit. Lots of rudder in the direction of the turn is required. About as much rudder is needed as the other controls are used. What happens is that when a wingeron (or aileron for that matter) goes down at the rear it creates lots more drag than the side going up.

Mostly at high angles of attack and slow speeds this causes much more drag on the side of the plane outside of the turn, opposite of where you want it. So you roll left for example and the drag wants to yaw the plane right at the same time if left rudder isn't added. Suddenly you end up flying knife-edge on the left wing. For extreme stunts this can be used for some very dynamic maneuvers ONCE you get used to it but you have to really fly the plane to do even normal coordinated turns. If you are coming from typical bank and crank A/E models, you'll be in for a wake-up call. REAL planes don't fly that way! ☺

Until you do get used to the handling, you may feel there is something wrong with the plane but stay with it and at the very least you'll become a much better pilot for the effort no matter what you fly.

In a hover you should try to control the plane with R/E only as much as possible. Adding wingerons to get the plane "turned" is tempting and can sometimes-even work correctly but depending on the conditions you just might experience control reversal and things can get fun real fast. For a nice hover without the tendency for the plane to pull toward the canopy, add a slight amount of up-thrust to the motor (front of motor tilted up a little).

If you are trying to learn ailerons with this plane, keep your control travel adjusted low at first. Adding aileron to rudder mix will help if not used to using the left stick for rudder also.

Since the plane is so light, in calm conditions you may notice other oddities as well from torque, P-factor and gyroscopic precession when flying slow enough. Even your own prop wash and tip vortices become big turbulence when doing power spins, etc. These are not shortcomings of the design, just effects of the low Reynolds number flight realm we're working in and actually add to the fun and learning process!