

TOP NOTCH PRODUCTS

# SHOESTRING



## ASSEMBLY MANUAL

Top Notch Products Company  
PO Box 1051  
Goodlettsville, TN 37070  
Tel 615-866-4327  
Fax 615-523-1154  
Email - [tnproducts@cs.com](mailto:tnproducts@cs.com)  
[www.topnotchkits.com](http://www.topnotchkits.com)

# WING ASSEMBLY

- 1. Use a straight edge to align the false leading edge (FLE) with the plan. Glue a pinning tab to the front of each stand off as shown in the photo. Secure each tab to the building board with a couple of crossed pins. Assure that FLE is at 90° to the building board.
- 2. Assemble W7 and W7-A and W8 and W8-A. Note the correct orientation of the A components, they should be on the outside of the servo bay. A good way to avoid problems here is to assemble both sets at the same time. Just make sure you assemble two sets that are opposite each other. Then select the set for the wing half you are working on.



Pin tabs are used to secure FLE to the building board.

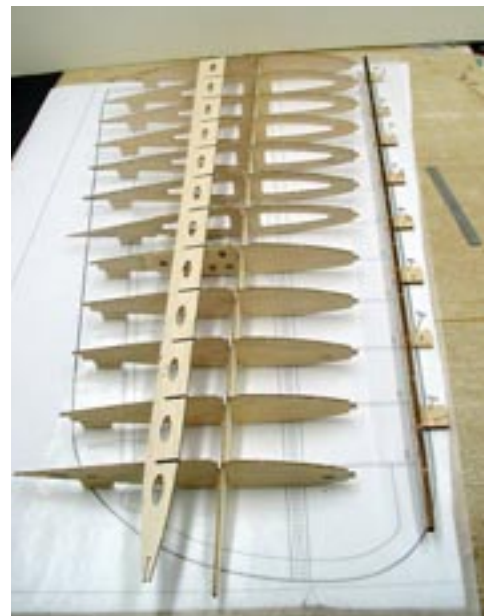
## Builders note:

When assembling laser cut components it is important to remember that the accuracy of the laser cut part may exceed that of the tolerances maintained by the material. This can be caused by milling tolerance issues, humidity and other factors in the manufacturing processes. When assembling these components make sure that all parts align exactly with their respective tabs and slots. If they don't seem to fit, go back and locate the problem. Do not force the parts. When they are correctly aligned they will practically fall together.

When assembling notch and tab parts you will be required to dry fit many parts before gluing them.

This is because many of the internal parts require some movement of other parts to get tabs and slots into position. Do not glue parts until directed to do so. In the event that a part is missed, you may have to remove the tab to get it into position. Lets build this puppy but put your glue away for now.

- 3. Place the bottom sheer web (SW-B) on the bench with the slots up. Slide each rib into its appropriate slot. Note that the first full slot will be for W2.
- 4. Now install the top sheer web (SW-T) onto this assembly until it will align with SW-B. Hold the top and bottom of the sheer webs in alignment at the root and tack glue them with a small amount of thin CA. Now do the same at the tip of the sheer web. You should now have all ribs except W-1 captive on the sheer web assembly.
- 5. Slide each rib tab into the appropriate notch in the false leading edge (FLE).
- 6. Install a wing gusset (WG) at the leading edge of rib W3, W7 and W11. Make sure the ribs are seated in the leading edge and the ribs are aligned with the gussets.
- 7. Chamfer the edges of the fore and aft wing tip braces (WT-F & WT-A) so they will seat at the intersection of the sheer web and W12.
- 8. Install the ply wing tip. It will fit into slots in the leading edge and sheer web tip and tabs will interface with W11.



All ribs have been installed into the bottom sheer web. Top sheer web is lying on top of the assembly and is ready to be installed next.

- 9. Install the 1/16" ply wing trailing edge. It must tip into the slot in W7 and then slide forward into the slots at the trailing edges of ribs W2, W3, W4, W5 and W6. Tabs will engage it into rib W1.



The 1/16" ply trailing edge keys into all wing ribs. It must tip into rib W-7, then slide forward into remaining ribs.

- 10. Install the aileron bay trailing edge (ABTE). A small amount of extra material has been provided to allow sanding the ends to parallel W7 and W12 for a flush fit. The end marked "R" is the root end. Use a piece of 1/8" music wire through the hinge holes to align the hinge blocks (HB) and glue them at this time. First tack glue them, then remove the piano wire pin and then complete gluing them with thin CA.



Aileron bay trailing edge (ABTE) keys into all wing ribs. Note that in this photo the aileron servo mount rails have already been installed. You will get to those later.

- 11. Here comes the "G" word. At this point you have the entire superstructure of the wing dry fit assembled with a few minor exceptions. Get your glue out. One note here, when building like this it is easy to lose track of what has been glued and what has not. Best to be systematic about it. Start with the rib leading edges, at each step along the way check the assembly for square. Before beginning place some weight on the aft portion of the wing rib to be sure they are in contact with the building board. Yet another note, when gluing the sheer webs, make sure that they are perfectly flush top and bottom. Use some scrap 3/32" balsa to shim them up at every other bay. Once flush, apply thin CA into the glue ports cut into SW-T. Hold the two sheer webs in close contact and apply just enough CA to tack them at this time.

- 12. You are now ready to install the top spar flange. Note that the spar flange has a top and a bottom. Be sure to install it so that the root end aligns with W1, if it doesn't align, flip it over. Use aliphatic resin or slow CA to glue this. Keep the weight on the aft rib sections to assure the ribs are seated on the building board. Apply glue to the entire length of the spar web and to each rib flange notch. After installing, weight it with a straight edge until cured.

- 13. When the glue has cured, remove the weights and pins and remove the assembly from the building board. DO NOT remove the pinning tabs and stand off's at this time. Lay the assembly upside down and install the bottom spar flange in the same manner as you did the top one. Leave the leading and trailing edges float above the plan.

- 14. The next step is to apply the top wing sheeting. Before that can be done however we need to plane the false leading edge to contour with the wing ribs. Plane the aileron bay trailing edge to contour as well. Also sand the trailing edge ply and wing tip ply somewhat to contour to increase glue land along these edges. Each wing skin will require four 4" x 36" sheets of 1/16" balsa. Prepare four 1/16" x 15" x 36" wing skins.

- 15. Place the assembly back on the building board topside up and pin the pin tabs to the board. Trim one of the wing skins to about 1/2" oversize. You may have a preferred method but I will tell you what I did and you can decide. Using aliphatic resin glue, apply a liberal bead of glue to all ribs and on the top spar flange, leave the last two inches of the top spar flange at the root end without glue. This area will be glued later as part of the spar joiner. Leave the leading edge and trailing edges dry. Place the wing skin over the assembly and weigh it down with sand bags, shot bags, magazines or what ever you use to assure that the skin is kept in contact with all ribs until the glue has set. This will take about 20 minutes. After the aliphatic resin has set, remove the assembly from the building board, snap off all the stand off's and pinning tabs. Temporarily force the top sheeting into contact with the ply wing tip and mark the edge with a pencil line.



- 16. Place the assembly upside down on the bench and put pressure along the leading edge to force the sheeting into contact with the leading edge. Apply thin CA along the entire leading edge and let cure. Apply pressure along the trailing edge and apply CA there as well. Trim the sheeting to within about 1/4" of the ply wing tip, DO NOT glue the wing tip sheeting at this time.
- 17. Install the two 3/32" ply servo mount rails. Use the 1/16" ply servo mount to align the screw holes for a better fit. You can screw the rails to the cover and then glue assembly into position. Remove the screws and cover when cured.
- 18. Plain all bottom leading and trailing edges to contour in preparation for the bottom wing sheeting. A set of three jigs is supplied to support the wing while installing the bottom sheeting. Glue some 2" pieces of 1/4" x 1/2" balsa into the slots provided to support the jigs. Place these 1/4" balsa jigs at W2, W7 and W12. Apply a liberal bead of glue to the bottom of all ribs and the bottom spar flange except where noted. Once again do not glue the last two inches of the spar flange to accommodate adding the spar joiner. Also omit gluing around the servo bay, this will make it easier to remove material for the servo mount and will be glued with thin CA after the opening has been cut.
- 19. After curing, use the same technique to glue the leading and trailing edges with thin CA. Trim the tip as you did the top skin and then starting at the center in line with the spar web, use thin CA to glue both skins to the ply tip at the same time. This will help keep both sides even. Glue on the 1/4" leading edge's and plane and sand to shape.
- 20. Assembly of the wing halves is a two-step process. First install two 1/4" x 1" dowels into the holes provided in the 1/4" lite ply wing joiner rib. This rib will not only align the wing halves but also support the 1/4" wing mounting dowel. It's a good idea to use a piece of 1/4" carbon fiber rod for this component. Assemble the wing halves with the ply wing joiner rib. Prop one wing tip up 4" at W12 for correct dihedral.
- 21. Use one of the 1/64" ply spar joiners as a template to mark and remove the wing sheeting from the top and bottom spar flanges at the wing joint. Use slow setting Epoxy or finishing resin and lay in four of these 1/64" ply joiners with a liberal application of Epoxy between each one. Use plenty of pressure to keep the ply joiner flush with the top of the balsa sheeting. When cured, turn the wing over and repeat the process on the bottom spar flange.
- 22. Glue on the wing bolt plate.
- 23. Note that the aileron is laminated from three pieces. The bottom piece is 3/16" balsa, the center section is assembled from 3/32" balsa and 3/32" ply and the top is 1/4" balsa. The ply aileron horn is glued into the 3/32" balsa center section first. These parts are provided with a 1/8" pinning hole at each end. Use a piece of 1/8" music wire or the shank of a 1/8" drill bit in each hole to align the parts when laminating them together. Note the stack order of the parts and be sure to make a left and a right.
- 24. A great tool for marking and shaping the ailerons is three 2" sections of 1/8" music wire rounded at each end. Place these in the hinge holes in the aileron and then temporarily install onto the wing. These will hold the aileron ridged while you mark the edges of the aileron assembly for shaping.
- 25. Glue the two 1/64" ply aileron cable opening liners about 1" behind the main spar and about 1" out from the joiner rib. After gluing, remove the balsa from the center to allow access for your servo cables.



Wing assembly suspended on the rib jigs at W2, W7 and W12. These jigs will support the wing assembly while the bottom sheeting is being installed.

This concludes assembly of the wing.

## Stabilizer assembly

- 1. Assemble the elevator core (EC) from two parts. This and the following steps are best done over a sheet of parchment paper. This material is available in your local grocery store in the baking department. Hey, if chocolate chip cookies won't stick to it, glue doesn't stand a chance. I digress.
- 2. With the core sheet flat on the bench, install all split ribs starting from S1. Hold the core sheet flat while applying thin CA.
- 3. When all ribs have been installed, install the trailing edge. Hold the trailing edge in place with the straight edge of a ruler or other straight edge while applying CA as shown in the photo at the right. This will keep the assembly straight.
- 4. Turn the assembly over and install all ribs on the opposite side. Apply finger pressure to the ribs to keep the assembly flat and make good contact with the parts.
- 5. Assemble both stabilizer skins and sand out any irregularities. For the next step you will need some spring type cloths pins or other means of providing even pressure along both leading edge halves. Cloths pins work best.
- 6. Use a straight edge or a straight board on the bench to butt the stabilizer skin up against for the next step. If you can just butt the assembly up against the straight edge and then bring it into contact with the skins the next step is much easier to do. Place one of the skins on the bench with the trailing edge butted up against the straight edge. Now apply aliphatic resin glue to all the ribs on one side of the stab assembly. Next apply a liberal bead of thick CA along the trailing edge. Flip the assembly over and but it up against the straight edge and then bring one half down into contact with the skin. Apply pressure until the CA sets and then rock the assembly over and apply pressure to the other half.
- 7. Turn the assembly over immediately and repeat the process for the opposite side.
- 8. Now apply a cloths pin about every inch along the leading edge check the assembly for straightness before the next step.
- 9. Hold the assembly on end and apply thin CA to the leading edge at the tip. Allow it to run down the leading edge between the sheeting until it reaches the center. Now flip the assembly over and repeat the process for the other half. You can now glue the tip sections by just squeezing them together and applying CA. This concludes the assembly of the stab section. Trim and sand to finish.
- 13. Assemble the elevator sections. Note that one elevator core also contains a ply plate to attach the horn to. Keep this in mind when hinging to get it on the desired side.



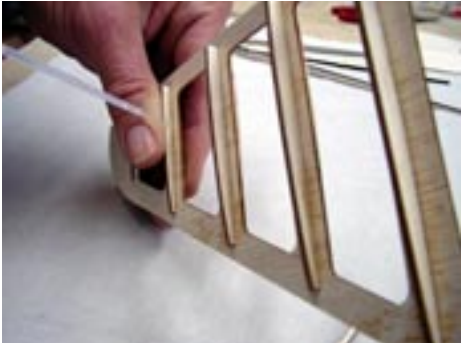
## Fin Assembly

- 1. Use the same technique as the stabilizer, lay the core sheet flat on the bench and install all the split ribs on one side. Install the trailing edge with a straight edge as before. Trim the corners off of the leading edge of each rib to align with the leading edge and install the leading edge.



Photo at right shows all fin components .

- 2. Turn the assembly over and repeat the process on the reverse side.
- 3. Glue on the 1/8" ply trailing edge taking care to align it with the balsa trailing edge.
- 4. Assemble the two-piece fin skins and install.
- 5. Use some scrap 1/16" balsa and glue two laminations to the bottom of the skins to stiffen the sheeting at the bottom.
- 6. Carve and sand to shape. Assemble the rudder from three 1/4" laminations. Note that the center lamination also contains a ply horn mount, as did the elevator.



Here the second half of the split ribs are being added to the stabilizer core sheet. Note that this part of the construction is done in the air.



Here the laser cut fin sheeting is being assembled over parchment paper with thin CA.



Here the fin sheeting is being installed. Note the tab on the rudder post will provide exact positioning.



After assembly add two layers of scrap 1/16" balsa to the bottom of the assembly as shown in this before and after example.

## Fuselage

A couple of notes on the fuselage construction

The firewall has 3.5° of right thrust built in. This will require that the motor be mounted offset to the left side of the airplane so the spinner will center. This requires that the fuselage sides be slightly different and so are marked left and right. Be sure to note this.

- 1. Assemble the three laminations that will comprise the firewall. If you have your motor mount, now is a good time to locate and drill the mounting holes and install the blind nuts. The centerline and the offset thrust line are indicated on the firewall front for this purpose.



Some fuselage subassemblies. Note the addition of 1/4 X 1/8 hardwood behind the screws on the servo tray. Pinning holes in the wing bolt plate provide perfect alignment when laminating the two parts. Note that the #1/4-20 blind nuts have been trimmed.



Again the use of pinning holes provided in the parts make accurate alignment of the fuselage doublers fool proof. The holes in the 1/32" doubler are for applying glue as well as lightening.



Here the fuselage construction has begun, showing the laminated firewall, laminated F2& F2-A as well as the tank floor. These components will set the angle of the firewall at 3-1/2° of right thrust. Add triangle stock for additional strength.

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- 2. Assemble the two fuselage sides with the former notches in the sides. Note that there are two sets of fuselage sides. One set has all the notches to accept the formers in it and the other set is marked skins. Put the set marked skins aside for use later. Also note that the sides are marked Left and Right. The two sides are slightly different and must be used in their appropriately marked locations. They will set the thrust offset in the firewall. Glue on the aft section of each fuselage side. Next, using the pinning holes at the front and back of the 1/32" ply doublers, glue on the doublers using the following method. Place the fuselage side on the pins and test fit the doublers by sliding it down the pins. Remove the doublers and flip it over. Apply a liberal bead of thick CA to the following areas. All areas of the forward solid area (the area without the glue port holes cut into it), along the wing saddle, at each former and all of the aft solid area. The area with the holes cut in it will be glued later with thin CA. Now slide the doubler down the pins and press into contact with the fuselage side. As soon as the two parts have fixed, remove the pins and apply pressure along the entire doubler. Use a straight edge to apply pressure to the doubler and liberally apply thin CA through all the glue portholes.
  - 3. Lay one fuselage side on the building board and using Epoxy, glue in F4-A. Use a square to assure it is at 90° to the side.
  - 4. Cut a piece of scrap stock 3-1/2" long to be used as a tail spreader in the next step. Apply Epoxy to the remaining side of F4-A and install the second fuselage side. Use the spreader stick in the tail section to keep the fuselage sides parallel until the Epoxy has cured. Also use a square to assure that both fuselage sides are parallel at the elevator saddle.
  - 5. Assemble the laminated wing bolt plate from one 1/4" lite ply and one 1/16" AC ply part. Press in the #1/4-20 blind nuts, the nut flanges will require trimming.
  - 6. Now install Former F-5, the wing bolt plate assembly and the servo tray with Epoxy. Note that all these parts interface with each other.
  - 7. Install F-6, F-7 & F-8 and the tail post (TP); note that the tail post is recessed 1/8" to leave room for the vertical fin post.
  - 8. Install F-4 with Epoxy.
  - 9. Install the F-3 assembly with Epoxy.
  - 10. Install the firewall assembly and the tank floor with Epoxy. After curing, add 3/8" triangle stock along both sides and the firewall as well as along the tank floor and firewall.
  - 11. Assemble and install the hatch hold down block (HH) and glue to F-5A.



- 12. Install F-5A. Use some 1/4" triangle stock behind F5-A for added strength.
- 13. Add the 3/8" triangle stock to the top from F5-A to F8.
- 14. Laminate GMA and GMB, once again using the pins for alignment. Drill and install the blind nuts for the landing gear and then install into the fuselage using Epoxy, add 3/8" triangle stock on all four sides of the GM assembly.
- 15. Install 3/8" triangle stock along the fuselage bottom from F4 to F8.
- 16. Install the 3/16" stabilizer saddle doublers (SD).
- 17. Install the five 1/4" square stringers, top and bottom between the firewall and F3.
- 18. Install the outer formers, FO-3, FO-4, FO-4A, FO-5A, FO-5B, FO-6, FO-7 and FO-8.
- 19. Install the wing saddle doubler (WSD). Note that WSD has two sections to it; there is a second layer to it at the aft end. Plain this second layer of WSD to taper flush with FO-5 to flush feather at FO-4A.
- 20. Assemble the outer fuselage skins. Once again there is a left and a right. The outer fuselage skins are assembled from three pieces.
- 21. Before adding the fuselage skins, check your fuselage assembly. You may want to sand or plain the edges of the assembly to provide more glue land for the skins at the edges. A couple passes with 120 grit sandpaper should do the job.
- 22. It's a good idea to sand the out sides of the fuselage skins before installing. It's a lot easier to do this while they can be laid flat on the bench.
- 23. When installing the fuselage skins it is helpful to have a piece of 5/16" square stock to insert into the pushrod exit to help keep things aligned at the aft end. There is a notch at the front that will engage a tab on the firewall assembly to align the front. Apply a liberal bead of aliphatic resin glue to all FO formers except the top portion of FO-3 from the wing saddle to the top. This section will be glued in a later step. Apply a liberal bead of thick CA to the firewall and along the wing saddle. Apply a second application to the firewall to make sure there is plenty of adhesive. Place the fuselage skin into position using the tab at the front and the push rod exit slot at the aft end. Align the wing saddle and press into contact until the thick CA cures. Do the same with the firewall area. Now using finger pressure, move along the top of the fuselage and apply thin CA to the remaining fuselage skin. Move to the bottom of the fuselage skin and repeat this process along the bottom. When completed, trim away the section of FO-8 that crosses the push rod exit slot.
- 24. Use a sheet of 3/32" balsa to sheet the aft bottom section from the landing gear to the tail post. Run this material cross grain.
- 25. Use a sheet of 1/4" x 4" balsa to sheet the top fuselage section from F5-A to the stabilizer saddle.
- 26. The hatch is constructed on the fuselage with the wing in position. Bolt the wing on and then place a piece of waxed paper at F-3 and F5-A to prevent adhesive from making the hatch permanent. Install two 1/8" dowels into FH-1. Round the ends so they will easily enter the holes in F-3. You will need to remove some material from the bottom of FH-1 to get a good fit.
- 27. Pin FH-5 in position over F5-A with the waxed paper in between them, install
- 28. Measure back from F3, 3-1/2" and 9-1/4" and place a mark on top of the wing at these locations. FH-2 and FH-3 will go at these locations.
- 29. Test fit HA-1 on both sides of the fuselage. You may need to trim or sand a slight angle at the bottom to accommodate the wing dihedral. When satisfied with the fit, glue HA-1 to FH-1 and FH-5.
- 30. Install FH-2 and FH-3 at the locations marked earlier.



- 31. Install the 3/8" triangle stock on both sides.
- 32. Remove the hatch assembly from the fuselage and plain and sand the sides (FH-1's) and the triangle stock flat to receive the 1/4" hatch top for a good glue joint.
- 33. The hatch is retained by the two 1/8" balsa dowels at the front and a single #6-32 x 1" bolt at the aft end. You will have to attach the hold down blocks and drill and tap these at this time. You can mark the location of the hatch hold down bolt in the bottom of the 1/4" top by backing the bolt out and then pressing the top down on top of it to leave a mark.
- 34. Use the aft end of the hatch assembly as a guide to angle trim the end of a piece of 1/4" x 4" balsa, then glue in place on the hatch top.
- 35. Bolt the hatch assembly back in place and plain and sand to shape. A good method for getting a nice joint between the hatch and the fuselage is to take a piece of waxed paper and cut pieces to fit against F-3 and F-5 and about 1/4" oversized. Next mix a batch of Sig Epoxo-Lite and butter both ends of the hatch around and the edges so that when the hatch is bolted in place the Epoxo Lite will squeeze out to form a tight fit. Now bolt the hatch in place until the Epoxo-Lite cures and then remove and sand to shape.
- 36. The cheek cowls are composed of five parts and will later be cut to allow part of them to be fixed to the hatch while the major part of them will be attached to the fuselage. Note that CCL designated parts are for the left cheek cowl and those marked CCR are for the right cowl, I will describe the assembly of the left cowl. Start by gluing CCL-1 to CCL-3. Next add CCL-2 to the bottom of this assembly. Now add CCL-4. Trim this assembly until you get a reasonably good fit to the fuselage. With this assembly in place on the fuselage, add CCL-5 to the top of this assembly. Trim it for a good fit and then glue CC-5 to the cheek cowl assembly. Repeat this for the right cheek cowl.
- 37. Place the cowl ring on the firewall with two 1/8" dowels in the holes supplied in the cowl ring. NOTE: for a good fit you may want to use short sections of 1/8" brass tubing instead of wood doweling. With the cowl ring in place on the firewall, drill holes for the retaining screws, then remove the cowl ring. Trim the fiberglass cowl about 3/16" to provide a straight clean edge. Place the cowl ring on the bench with the labeled side up and place the glass cowl over it until the ring is nested inside the glass cowl. If the fit is irregular, sand the inside of the cowl until it is achieved, then Epoxy the cowl ring to the cowl.
- 38. Place the cowl onto the firewall and screw into place. Bolt the wing and the hatch to the fuselage and then place the two cheek cowls in position and mark the outline of the cowl on the front of the cheek cowl assemblies. Now trim and sand the cheek cowl assemblies to shape. Draw a line on both cheek cowls in line with the front of the firewall. Also draw a line from the front of the wing leading edge to intersect with this line. This will be the parting line for the cheek cowls and the smaller portion will be glued to the hatch assembly while the main portion will be glued to the fuselage. Cut the two sections apart and then glue to their respective locations. Use the same technique with a sheet of waxed paper to mate the two sections of cheek cowl.

## STAB INSTALLATION

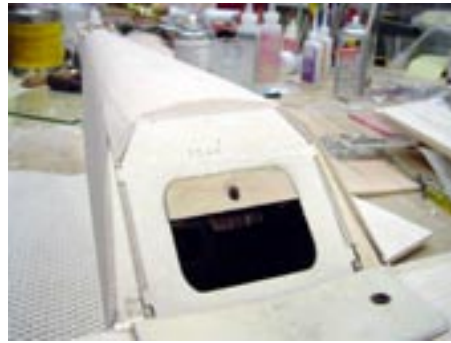
- 1. Place the stabilizer in the stabilizer cradle and check the fit and incidence angle. The stabilizer should fit snugly in the saddle. Locate and mark the exact center of the trailing edge and align that with the center of the tail post.
- 2. Square the stabilizer by measuring from the exact top center of the firewall to the trailing edge at both sides of the elevator tips.
- 3. Next check that the stabilizer is at 90° to the fuselage sides.
- 4. Glue the stabilizer to the fuselage with Epoxy. The elevator sections will be added after covering.

## VERTICAL FIN INSTALLATION

- 1. The vertical fin ply trailing edge is tabbed to fit into notches provided in the fuselage. It should rest snugly on the top of the stabilizer. If it does not add or remove some balsa from the bottom of the fin.
- 2. When satisfied with the fit, check the fin for square (90° to the stabilizer) and correct alignment (directly on and aligned with the fuselage center line).
- 3. When satisfied with this, Epoxy into position. The rudder will be added after finishing.



The wing bolt plate assembly and the servo tray will square the entire fuselage assembly when the tabs engage the notches provided in the fuselage sides.



The hatch hold down block (HH) has been installed and is visible through the lightening hole in F5-A. Use a #6-32 tap in the plywood block and then harden it with thin CA.



The outer formers have been added to the fuselage sides and the skins are about to be added. Both the top and bottom forward sections are sheeted with 3/32" balsa over the 1/4" sq. stringers.



The hatch is constructed on the wing with the wing in position on the fuselage. Note the 1/64" ply wing joiner. Next the cheek cowls will be added and shaped to match the fiberglass cowl.