

TUFF PLANES

visit us at <http://tuffplanes.com>

U-2 DRAGON LADY

60" EPP Slope Sailplane



Build Instructions (Rev 1)

Tuff Planes LLC
Copyright 2004
All rights reserved

Table of Contents

Description	Page
Table of Contents.....	2
Getting Started.....	3
Wing Buildup.....	4
Fuselage Buildup.....	9
Final Assembly.....	11
Balance and Flight Testing.....	14
Limits of Liability.....	15
Appendix A, Scale Details.....	16

Getting Started:

Read instruction manual completely prior to assembly of any parts.

Read and follow all manufacturer warnings.

Work in a well ventilated area.

Use a dust mask whenever sanding.

Wear your safety glasses whenever cutting sanding or spraying.

Visit <http://tuffplanes.com> for build pictures and the latest tips.

Check Kit Contents

- EPP Wing Cores (R&L)
- EPP Fuselage
- 3/16 X 6 X 35 Balsa Sheet for Tail Feathers
- ¼ x 1-1/2 in. Tapered Balsa Wood Ailerons (2x)
- ¼ x 1/8 x 36 Balsawood Spar Cap
- 3/8 x ½ x 36 Basswood Longeron (2x)
- 1/8 x ½ x 36 Basswood Wing Spar (4x)
- ¼ in. dia. X 36 in. Carbon Fiber Wing Rod
- ½ x 30ft. Fiberglass Tape
- Control Clevis (7x)
- Control Horns (4x)
- 12 in. x 2-56 Threaded Rod (2x)
- Detailed Instructions

Collect Additional Parts Required

- 5/8" Fiber Reinforced Strapping Tape
- 1-1/2" Fiber Reinforced Strapping Tape
- ½" plastic hinge tape (3M Plastic Tape works well)
- 3M 77 adhesive (read warning label)
- 20 Minute Epoxy (read warning label)
- Radio Gear: 4 Cell, 600mAh Battery (modified from square 1x4 pack to rectangular 2x2 pack), 2x Mini Servos, (1.3 x 0.7 x 1.3 or smaller), Radio Receiver, (max size, W x H including connectors < 1.6 x 0.8").
- Shoe Goop Adhesive (read warning label, Household and Marine Goop are OK too)
- Covering Material (solartex or equivalent)
- 1 Sheet 220 Grit Sand Paper
- Wax Paper (or plastic cling wrap)

Organize Tools Required

- Permanent Marker
- Foam Cutting Tools
- Utility Knife
- Sanding Block
- Dust Mask
- Safety Glasses

Wing Buildup:

Prepare Work Area

- ❑ Identify flat work surface that is at least 36" (wide) x 24" (deep) in size with both ends open for the wing to hang over. You can verify table flatness by using a straight metal ruler at least 36" long. Lay it on edge at various angles and positions on the table to see the warps and dips. Flatness greatly affects the performance of the wing.
- ❑ Clean the work surface thoroughly. Protect the work surface with a double layer of newspaper or sheet of plastic. Spread it out evenly to avoid introducing a warp in your wing.
- ❑ Collect several books to use as weights while assembling the wings. Optional, a flat board at least the size of the wing is helpful in spreading out the weight during assembly. It keeps the foam compression uniform holding the wing straight.
- ❑ Have your wax paper prepared to keep the wings from sticking to the wing beds.

Joining right and left cores.

- ❑ Remove plastic slag from wings. The slag is a byproduct of the hotwire process used to cut the airfoil into the EPP block. Use your 220 grit sandpaper to take off any hard to remove spots. You are just removing the slag for now.
- ❑ Dry-Fit the wings with the spars to get a feel for the size and fit of the assembly. The wings can be built up as a single assembly if you have a large enough work surface. These instructions will describe the method for a more typical size work area.
- ❑ Review figure 1. The first step will be to install the 1/2 inch wide fiberglass tape and the 1/2 x 1/8 basswood sticks.
- ❑ Trim basswood wing spars and cut the fiberglass tape to size. Dry fit them onto the wing. (The fiberglass tape should span the full length of the wing)
- ❑ Install top and bottom wing spars. Using 20 minute epoxy, sandwich 3 layers of 1/2" wide glass tape between the 1/2" wide basswood spar and the foam wing. Upper and Lower wing spars should be installed simultaneously. See Figure 1 (Use a 3/32 diameter bead of epoxy between each layer. You will need to mix up a very large batch) Work the first layer of epoxy into the foam to get some penetration.
- ❑ Place the wing into the wing bed before the epoxy starts to cure. Use cling wrap or wax paper to keep the wings from sticking to the wing beds. Make sure everything lays flat and is lined up perfectly before laying on the weights. (see figure 1)
- ❑ Lay your flat board and weights to put pressure on the sandwich assembly. Check it to make sure nothing shifted. This is a critical operation for flight performance.
- ❑ Allow to cure.
- ❑ Sand Basswood spar flush with airfoil using 220 grit sandpaper.
- ❑ The next steps are to join the wings, install the 1/4 diameter CF spar and install the balsa spar cap.
- ❑ Dry-Fit the CF spar and line up the wings perfectly. Tape the bottom wing beds to a flat surface in proper orientation. Allow a 1/2" gap between covers in the middle of the wing so the goop will not stick to it. The wing will be joined right side up so the wing-rod can be installed from the top
- ❑ Coat the root of both wing cores and lay them together in the wing beds.

- ❑ Lay a bead of Shoe Goop over the length of the narrow, 1/4 inch wide, spar channel and press the CF wing rod in.
- ❑ Add additional Shoe Goop (if required) and then press the balsa spar cap on top of the wing rod. (The 1/8 balsa rod cap may not be flush with the surface of the airfoil. It will be sanded later.)
- ❑ Wipe off any excess Shoe Goop.
- ❑ Keep the wing straight by using wood boards to hold the wing flat against the core covers. Check it to make sure nothing shifted. This is one of the most critical operations for flight performance.
- ❑ Adjust wing roots so they line up perfectly. Allow Goop to cure.

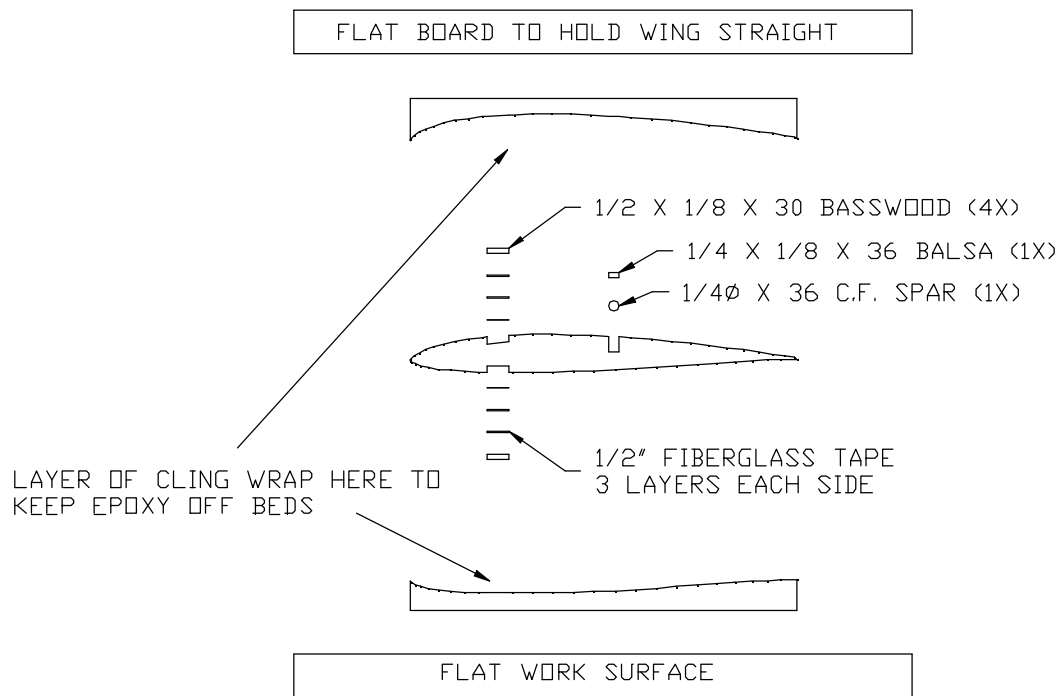


Figure 1

- ❑ Sand Balsa spar cap flush to airfoil with 220 grit sandpaper being careful to keep the airfoil true.
- ❑ Reinforce the center section of the basswood spars. Remove enough additional basswood from the center section to apply an additional 4 layers of glass tape to each side. (longest strip should be 1.5") See Figure 2.
- ❑ Allow to cure and sand flush.

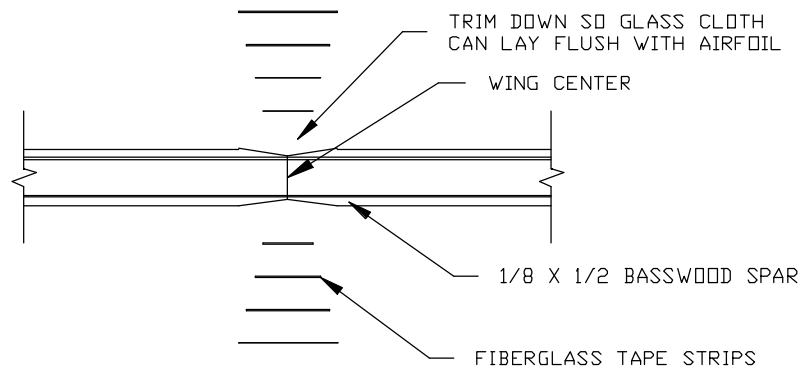


Figure 2

- ❑ Goop in the aileron stock in the center and tip of the wing trailing edge as shown in figure 2. See figure 3 for cross section view. Goop should be applied to the EPP and the CF longeron.
- ❑ Allow to cure. Once cured, light weight glass cloth (not included) is optional and can be used to reinforce the trailing edge joint.
- ❑ The wing is constructed slightly oversize. Trim the wing to 60" length (or maximum allowed in your area) if the aircraft's intended use is competition.

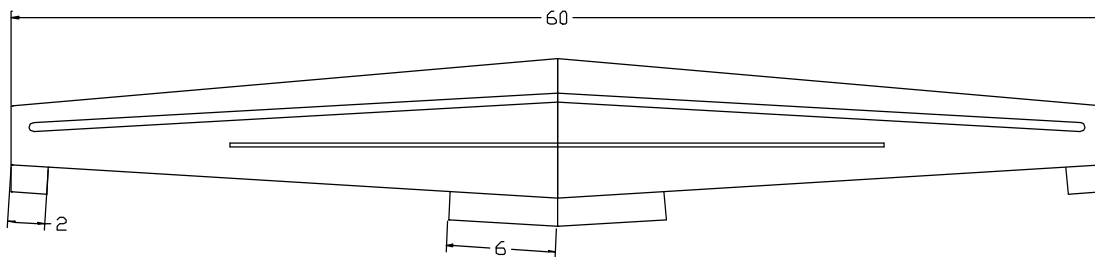


Figure 3

Wing Gear Installation

- ❑ Lay the wings right side up in the wing covers.
- ❑ Outline the servo locations using a permanent marker. (see figure 4)
- ❑ Note, servos larger than 1.3" x 0.67" x 1.3" (mini) will need to be moved inboard to keep them from protruding above the airfoil or interfering with the spar matrix. Screw mounting tabs will generally need to be removed to fit servos into the wing.
- ❑ Cut out servo location and dry-fit servo. Servo should be snug but not so tight as to distort the airfoil.
- ❑ Create channels in the wing to allow the servo wires to reach the fuselage. Wire extensions may be required. Wires must be accessible at the center of the wing so they can be plugged into the fuse later.

- ❑ Check servo-arm orientation prior to installation. Servo arms should be perpendicular to the body, oriented towards the outside of the wing and oriented towards the aileron control surfaces. Make sure you apply power to the servos and your trims are neutral.
- ❑ Install servo using a dab shoe goop on each corner.
- ❑ Cut out a small dime size cavity on upper wing cover to accept the servo horn when lying wings upside down.

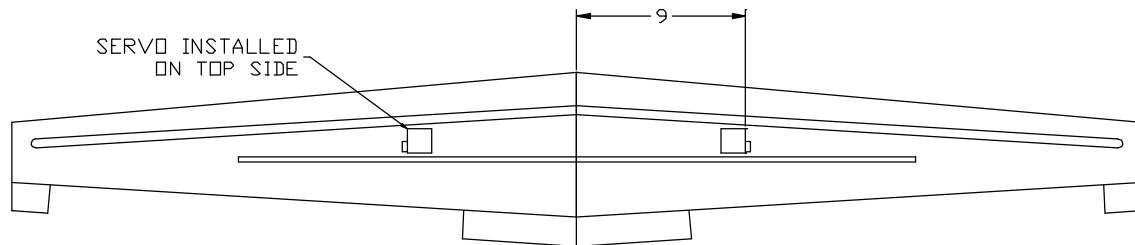


Figure 4

Tape Wing:

Final Wing Preparation:

- ❑ Inspect wing for low spots. Fill in low spots with a light-weight wallboard compound. Pay special attention to the basswood spar areas. Finish sand with 220 grit sandpaper. Low spots, especially in the basswood spars become very obvious in the final covering so take care to make them perfect now. However, take care not to change the airfoil.
- ❑ Inspect wing for high spots. Sand down high spots with 220 grit compound. One exception is in the center portion of the basswood sing spars. This area is covered by the fuselage.

Apply 3M “77” Adhesive to Bottom Side of Wing:

- ❑ Lay down top wing covers on your flat work area. Orient them and tape them down so the wing lays in them flat and level.
- ❑ Lightly sand top and bottom cores with 220 grit sandpaper and a sanding block to remove any molten EPP from core cutting process. Be careful not to change the airfoil as this will impact the performance of the plane.
- ❑ Spray adhesive on wing bottom surface only. Take proper precautions to avoid over-spray on unwanted areas.

Apply Tape Reinforcement to Bottom Side of Wing:

- ❑ Apply the 5/8” fiber reinforced strapping tape as shown if figure 5. Stretch tape firmly while applying it so it lays up flat. A third hand may come in handy here.
- ❑ Apply the 1-1/2” fiber reinforced strapping tape as shown in figure 6.
- ❑ Flip wing over and repeat process for top side

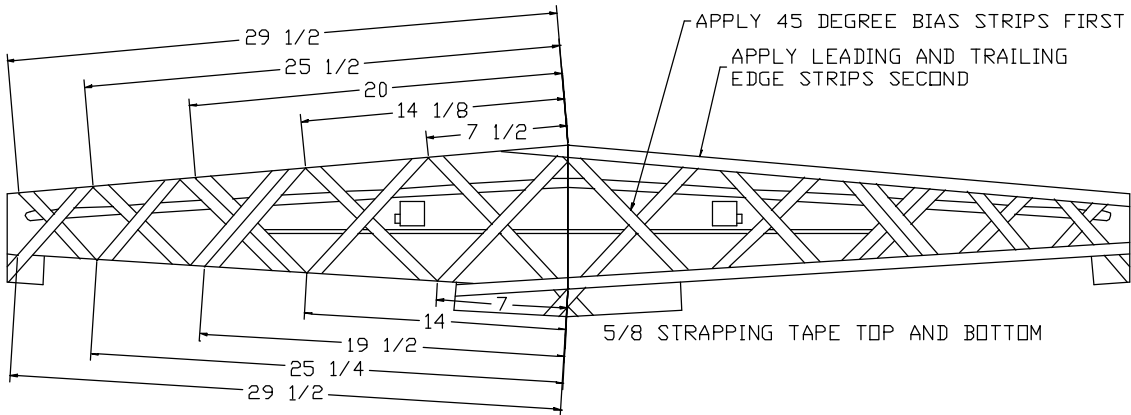


Figure 5

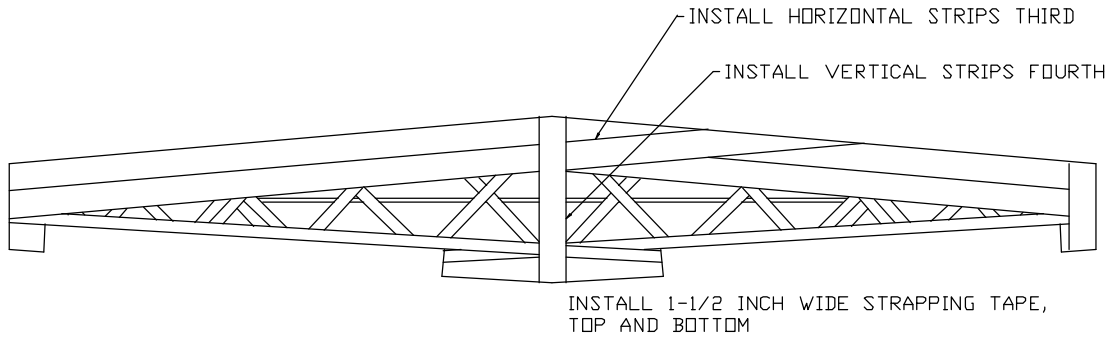


Figure 6

Fuselage Buildup

Install Top Longeron

- ❑ Dry fit and trim the top basswood longeron into the fuselage. Make sure you have at least 10-1/4 inch piece remaining for use later.
- ❑ Using Shoe Goop, install the top basswood longeron into the fuselage.
- ❑ Straighten out any fuselage twist and allow to cure for 24 hours.

Sand to Shape

- ❑ This is the most painstaking activity but also the most critical for appearance as well as performance. Keep an eye on the foam while your sanding. If kernels of foam are coming loose lighten the sanding force or go to a finer grit sandpaper.
- ❑ Reference Appendix A for line diagrams and templates.
- ❑ Remove the section of fuselage below the wing. It will be sanded separately and glued to the wing later.
- ❑ Use templates to mark the areas where material is to be removed. Be careful to keep the tail feather and wing mounting areas square. These will need to be filled if you round them over
- ❑ First step is to round over the fuselage from the jet engine intake back.
- ❑ Second step is to round over the fuselage in front of the jet engine intake
- ❑ Final step is to blend the front to rear section and shape the jet intake.

Install Radio Gear

- ❑ Care should be given to removal of foam in radio gear areas. The foam removed will be trimmed and used to fill in any voids resulting from the radio gear installation. The radio gear should be mounted deep enough to allow approximately 1/4 foam between it and the fuselage skin surface.
- ❑ The battery should be set as far forward as possible to avoid unnecessary nose weight. Cut out the section shown in figure 6 and fit the battery in.
- ❑ Fit the servo behind the battery in the approximate location shown in figure 7. Be sure the servo is deep so the control horn does not protrude above fuselage skin.
- ❑ Cut out the location of the elevator push rods using a utility knife or razor saw. Use the elevator control horn to set the height of the control rod at the tail section. (See Figure 8)
- ❑ Using shoe goop, install the outer sleeve of the elevator control rods leaving 4 inch gap from the servo and 3 inches at the tail.
- ❑ Install the inner control rod using the supplied clevis and threaded rod to the elevator servo. Do not trim the rear end until after the "Y" joints are prepared.
- ❑ The receiver should be placed behind the servo and below the elevator control rods. Cut out the area and dry fit the receiver. Let the antenna hang out for now. It will be taped to the outside of the fuselage later.
- ❑ Cut hole in fuselage for wing servo connectors to reach receiver
- ❑ Install power switch. Locate switch above wing where a miss placed finger cannot turn it off during launch. Create a cavity next to the switch to house the charging adapter. This can be covered with a piece of colored tape during flying.

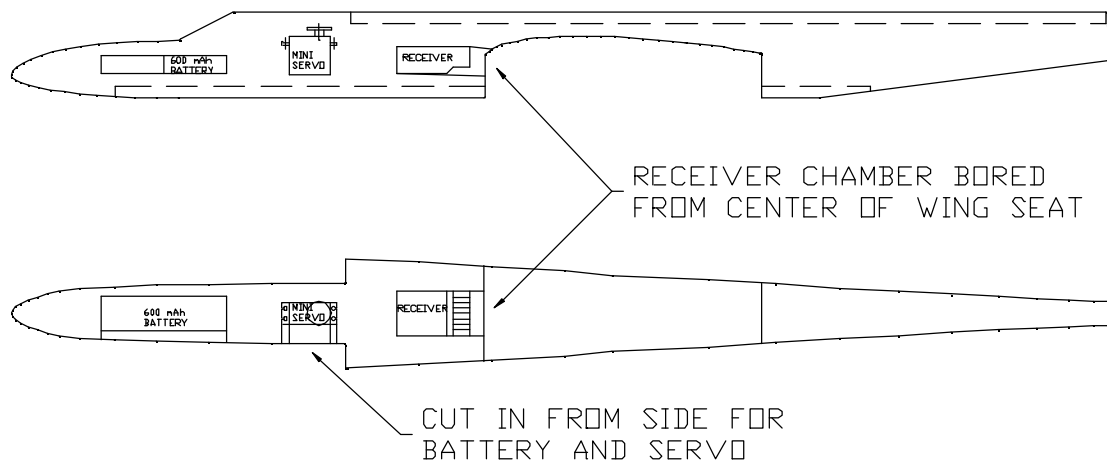


Figure 7

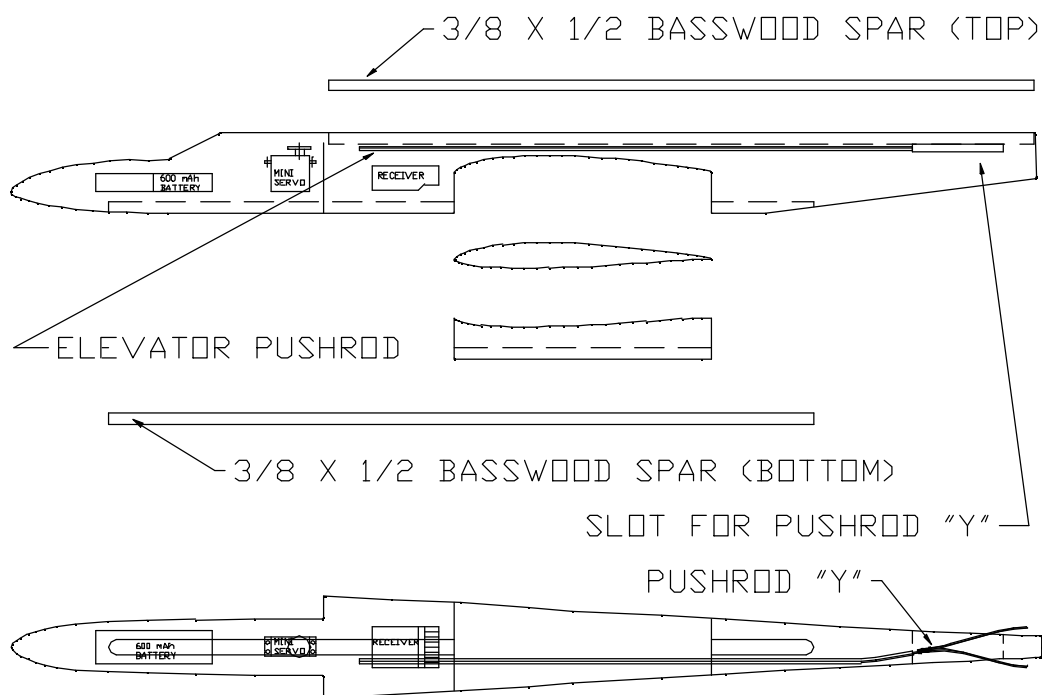


Figure 8

- ❑ Create push rod "Y" by gluing and reinforcing 2 pieces of the 2-56 threaded rod stock together. Reinforce the joint using high strength thread. Rod can be welded or brazed too. Leave the exposed section long so that it can be trimmed later
- ❑ Cut the channel the "Y" will be sliding in.
- ❑ Install the Y and check that it slides forward and backwards freely.
- ❑ Using goop, backfill all the radio gear voids with the foam chunks previously removed.

Mount Wing

- ❑ Connect the radio to all controls and check out functionality. Double check that all controls function properly. Make sure wing servos are attached and determine if you need extensions for these devices.
- ❑ Mark the shape of the fuselage on the lower wing bed and sand to shape.
- ❑ Dry fit the bottom basswood longeron into the channel provided. Trim off the excess and put aside for use later. Trimmed off section should be minimum 10-1/4 inch long.
- ❑ Glue the basswood longeron to the bottom wing bed with the basswood longeron positioned accurately with respect to the fuselage channel.
- ❑ Use 12 pieces per side (right and left) of 5/8 inch wide strapping tape biased 45 degrees to reinforce the wing mounting area of the fuselage on top. Tape should overlap 1/2 inch over the basswood longeron and wrap around wing seat by another 1/2 inch.
- ❑ Repeat taping for the bottom wing seat.

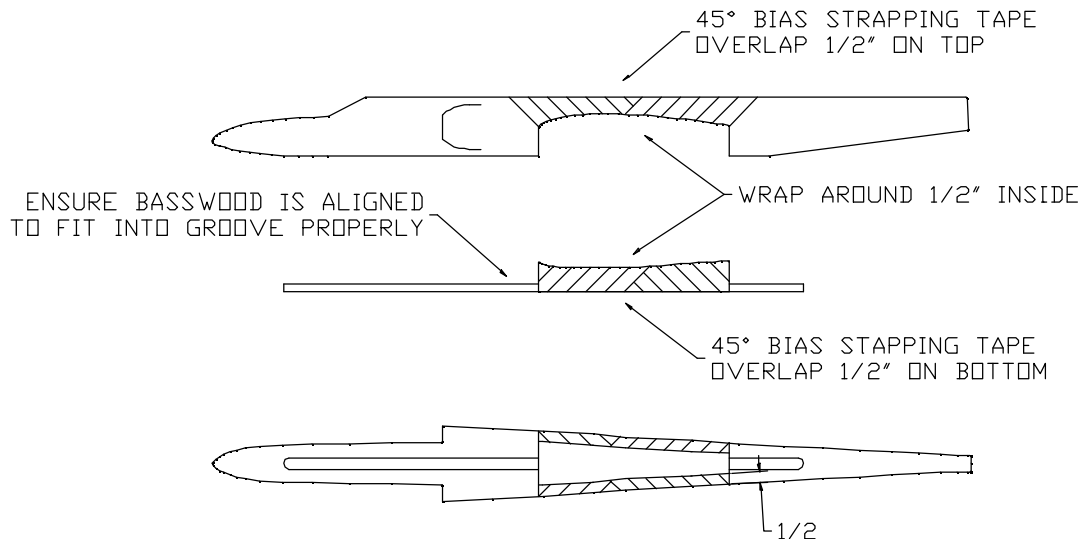


Figure 9

- ❑ For the best finish, cover the fuselage using a light wallboard compound. This will fill in any voids and provide an extra smooth surface to continue the building process.
- ❑ Plug the wing servos into the receiver and verify function and direction
- ❑ Lightly sand mounting surfaces. Follow with an alcohol wipe to remove any contamination.
- ❑ Glue wing into place using Goop adhesive. A generous coating along the tape lines and EPP surface should be applied. Use weights and tape to hold everything in position while the glue cures. Allow 24 hours to cure
- ❑ Apply a 1/8" bead of Goop adhesive to the joint around the wing and allow another 24 hours to cure.

Final Assembly

- ❑ Tape fuselage nose with a minimum of 3 layers of 45 degree bias tape. (see figure 11)
- ❑ Tape fuse lengthwise with an additional 2-3 layers of strapping tape. Do not cover the mounting surface for the horizontal stabilizer.
- ❑ Cut the horizontal and vertical stabilizers from the 3/16 thick balsa sheet provided.
- ❑ Cut out the scale feature / reinforcement. It should be rounded over, and tapered in several locations. Be sure to make a right and a left.
- ❑ Glue horizontal stabilizer on first with 5-minute epoxy and allow to cure. Make sure it is level with wing.
- ❑ Glue vertical stabilizer on first with 5-minute epoxy and allow to cure. Make sure it is perpendicular to horizontal stabilizer.
- ❑ Glue scale feature/reinforcement with 5-minute epoxy and allow to cure.
- ❑ Using lightweight wallboard compound, fill gaps seams and voids.
- ❑ Allow to cure and finish sand.
- ❑ Pre-balance plane before finishing. See figure 12

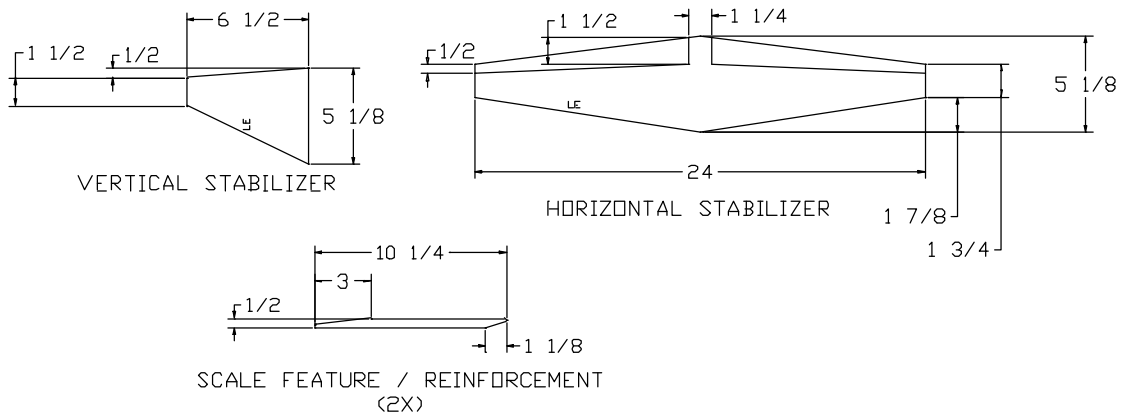


Figure 10

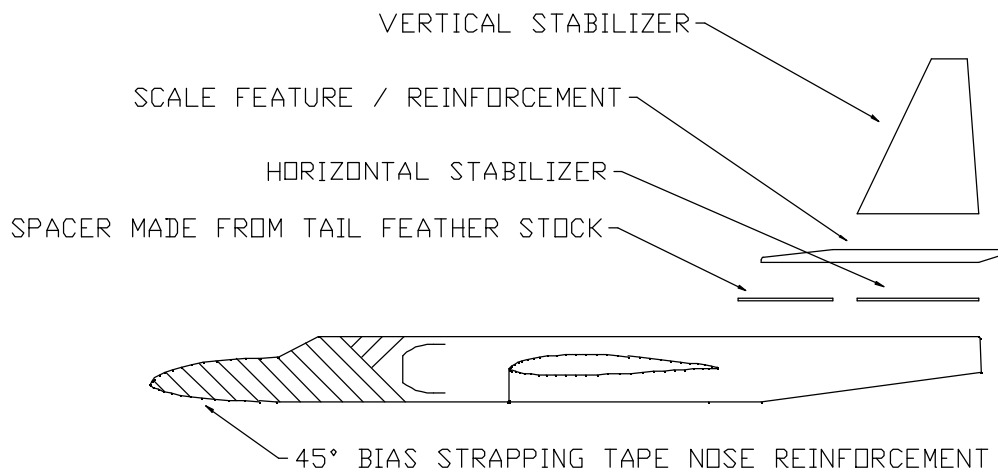


Figure 11

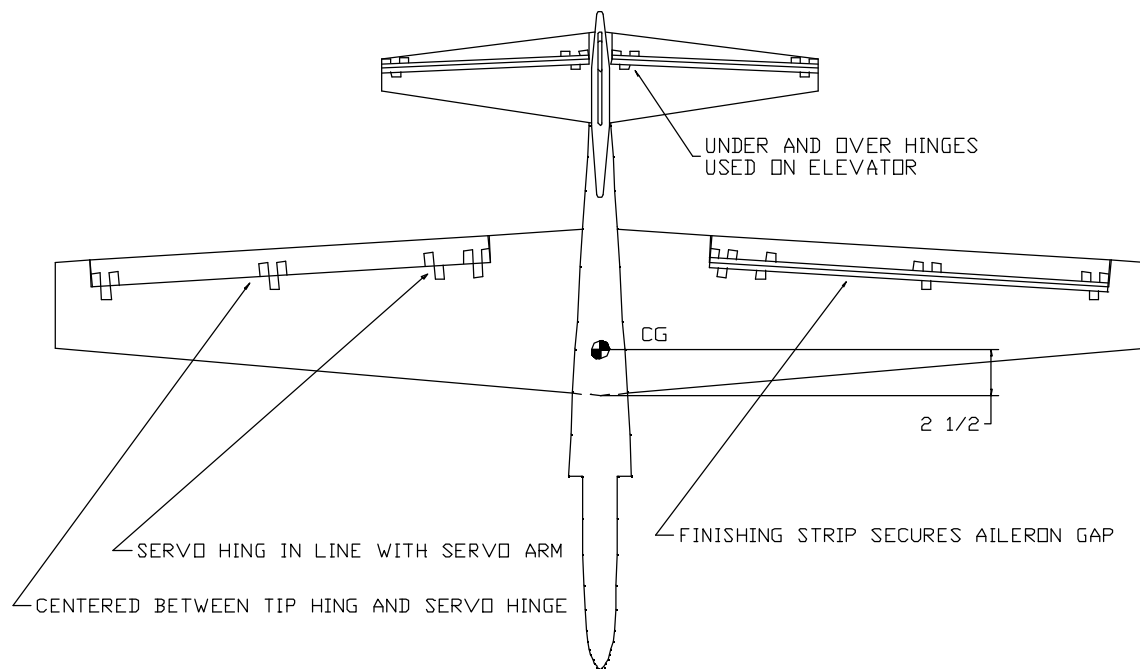


Figure 12

Finishing

- ❑ Preferred method of finishing is with a iron on plastic fabric.
- ❑ Note: EPP melts easily and you must keep your iron at a temperature that will not melt it. Constantly moving the iron while applying the covering material greatly reduces the risk of melting the cores.
- ❑ Entire plane should be coated with 3M 77 adhesive or equivalent
- ❑ For the wings, fabric should be pulled over surfaces to minimize wrinkles. Tack a 1/2 inch wide seam around the perimeter of the fabric. Shrink the material using a heat gun and then plant it with the iron. This allows you to shrink the material evenly over the surface of the wing and prevents film induced warps.
- ❑ 1 piece of plastic fabric for each wing (1x right, 1x left). The seam should be at the bottom of the wing along the trailing edge. There should a 1/2 inch overlap at the seam and 1/4 inch overhang onto the fuse.
- ❑ Each ailerons should be covered with a single piece of fabric with the seam along the bottom trailing edge. Overlap should be 3/8 inch.
- ❑ Tail feathers should be covered in the same method as the wings
- ❑ Fuselage should be covered with 4 pieces. 2 bottom, 2 top split at the jet engine intake. Cover rear to front and bottom to top.
- ❑ Install elevator using under and over hinges. (see figure 13)
- ❑ Install ailerons using under and over hinges.
- ❑ Install control horns on elevator and ailerons
- ❑ Turn on radio gear and allow all servos to center. Turn off radio making sure the servos do not move from their centered locations.

- ❑ Cut the second 2-56 threaded rod stock to length for the ailerons and install with clevises provided.
- ❑ Trim the elevator 2-56 threaded rod to length and with clevises provided

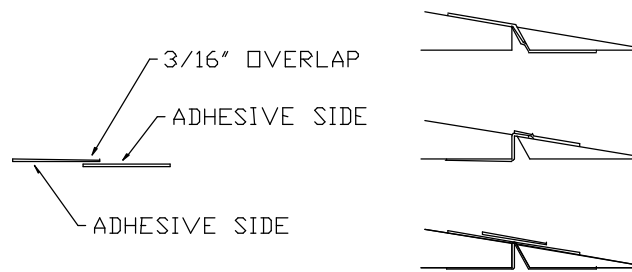


Figure 13

Balance and Flight Testing

- ❑ Verify the plane is still in balance. Reference figure 12 for location. Use 1/8 diameter lead or solder on nose or tail depending on the adjustment required.
- ❑ Balance the plane along it's length-wise axis. Add weight to light side wing tip to balance the plane right to left.
- ❑ Take weights with you for fine tuning while at the flight site.
- ❑ Before flying, review the local model safety code. In the USA, review the AMA web site at: <http://www.modelaircraft.org> Following it will help keep you and the people around you safer.
- ❑ Conditions must provide enough lift to sustain plane flight.
- ❑ Gross balance test. If plane dives straight into ground, remove nose weight. Add nose weight if plane sustains flight for a short period but is nearly impossible to fly.
- ❑ Trim plane for level flight at low to medium speed. If the plane pulls up at higher speeds take weight away from the nose. In extreme nose heavy condition the plane will nose down straight into the ground... take weight away from nose. In extreme tail heavy condition plane will stall immediately and flight will be uncontrollable.
- ❑ Dive the plane down and see how it responds at higher speeds. If plane needs up elevator at higher speeds, add weight to nose. If the plane pulls up on it's own, remove weight.
- ❑ Final verification should be completed by diving the plane straight down. Let go of the stick. The plane should continue to flying straight down. If it does, your good!
- ❑ Adjust control surface throws. 3/8" up and 1/4" down is a good starting point.
- ❑ From a high speed dive, pull full up elevator. If the plane loses control reduce the throw until it does not. The throw may be increased incrementally as familiarity with the model increases.
- ❑ High speed dive test: Trim the plane for level flight. Allow the plane to climb several hundred feet up. Dive the plane for a high speed pass. The attitude of the aircraft should remain constant. Adjust nose weight as required.
- ❑ Wing twist test: Gain several hundred feet of altitude just in case you've got a problem. Get the aircraft in straight and level flight. Slowly pull up on the elevator and get the plane to continue in a gentle upward angle of attack. Keep pulling back on the stick to maintain angle and until the plane stalls. It will stall straight forward if your wing is straight.

Limits of Liability

In the use of this product, Tuffplanes only obligation shall be to replace such quantity of the product proven to be defective. User shall determine the suitability of the product for his intended use and shall assume all risk and liability in connection therewith.

Appendix A
Scale Details

