
7. Ailerons

Overview.

The ailerons are made in much the same way as the rudder. The only difference being that the ends are not rounded but have close-out ribs instead and the aileron cores are supplied in 2 pieces each side, an inner and an outer. The aileron cores are supplied with the, by now, familiar end pieces with which to make the flanges for the close-outs. To achieve the correct tip and root angles small wedge shaped slivers are cut from each end. Bonded in the root end of each aileron is a plate and bolt with which to attach the actuating push-rod. Two hinges hold the aileron to the wing, pivoting on its lower surface. As usual, the construction of only one part is described so a simple doubling up of cloth pieces will enable both ailerons to be made together.

Step 1

Preparation.

The first thing to do is to discard the wedge shaped slivers of foam core, then temporarily attach the close out flange end pieces in their relevant positions with small dabs of rapid epoxy.

The inner and outer sections will next be joined together and aileron cores treated as one component. The cores are cut so that they mate correctly when they are put together with the upper surfaces on top - this way any small variations in the casing thickness will not have any effect. Set the two cores together in their lower casings and check that leading and trailing edges and washout are continuous from one core to the next. The washout is set when the cores are manufactured, but a double check is advisable - a method for checking this with a spirit level is given at the end of this chapter. Once you are happy with the mating faces remove the cores from the lower casings, apply rapid epoxy to their mating faces and reset them, in the lower casings. From now on they may be regarded as one single core.

The upper surface, which has the small trailing edge joggle in it, will be laid up first.

Saw away about 5 cm (2") from the leading edge of the lower casing (the one to accept the trailing edge support block) then lay it onto a flat bench, glued down if necessary to make it completely flat. Lay the aileron core into the casing and use *small* blobs of rapid epoxy, if necessary, to keep it flat too. Check that the washout is 1.1° before proceeding.

Being so long and slender the aileron cores will easily bow and if skin lay-ups are allowed to cure on them in this condition they will not fit your wing properly so take care to ensure, at all stages of their construction, that they don't get out of shape.

Cut lengths of 'uni' to the following dimensions for each aileron: 2 off 165 cm (65") long, and several strips of peel ply.

Mark lines on the core at $\pm 30^\circ$ to the leading edge to aid cloth orientation during laying up.

Attach a long strip of peel ply to the trailing edge joggle as in figure 1 using double sided tape. Peel ply also the tip and root flange cores.

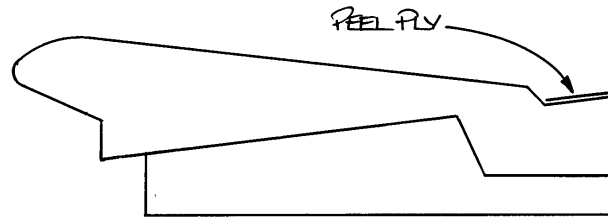


Fig 1. Aileron in trimmed lower jig block.

Step 2

First lay-up

Micro slurry the foam, keeping it off the peel ply, taking it around the leading edge and back about 2-3 cm (1").

Coat the foam now with epoxy then lay the first ply on at 30° to the leading edge, wrapping around the leading edge to within about 1 cm ($\frac{1}{2}$ ") of the corner. See figure 2.

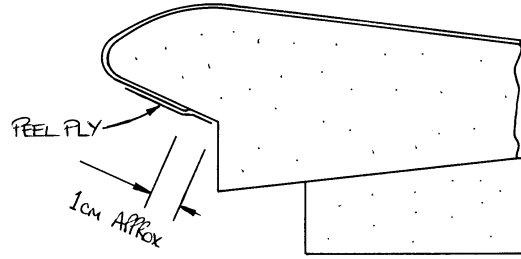


Fig 2. Extent of lay-up at leading edge.

Squeegee this layer thoroughly before scissor trimming the overhanging edges to within 1 cm of the foam then lightly apply a coat of epoxy and the next ply at 30° to the leading edge *the other way*.

Scissor trim this layer after squeegeeing then apply peel ply to the ends of the fibres at the leading edge and allow to cure. Knife trim the edges at the appropriate time, sanding them back after full cure.

1st lay-up summary.

1 ply 'uni' - 30° to leading edge.
1 ply 'uni' - 30° *other way* to L.E.

Step 3

Remove the aileron from its jig block, flip it over and set it flat in the other jig block. Cut away the trailing edge support block and sand the remainder down to blend the main foam surface with the glassfibre trailing edge, tearing off the peel ply when it becomes exposed. See figure 3.

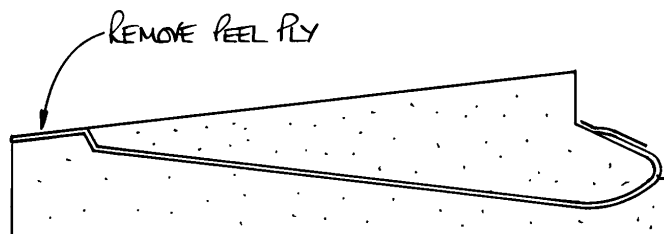


Fig 3. Aileron with trailing edge support block removed.

Cut pieces of 'uni' cloth as follows: 2 off 165 cm (65") long

Mark the foam of the aileron with lines at $\pm 30^\circ$ from the leading edge with which to orientate the cloth.

Step 4

Second lay-up

Micro slurry then epoxy paint the foam ensuring no micro gets onto the glass fibre trailing edge.

Lay the two plies of 'uni' on at $\pm 30^\circ$, squeegeeing and scissor trimming each in turn then leave to cure knife trimming as required.

2nd lay-up summary.

- 1 ply 'uni' - 30° to leading edge.
- 1 ply 'uni' - 30° other way to L.E.

Step 5

After full cure sand the edges to the foam and trailing edges. Using a hacksaw blade, run it against the leading edge angle as a guide and cut into the foam, up to the skin *but not into it*, to remove a triangular sectioned strip of foam from the entire aileron length. See figure 4. Check that sufficient foam is removed for the hinges to fit, allowing approximately 5 mm (3/16") for the radius of the close-out lay-up (refer to figure 6). Clean off any foam from the newly exposed skin in preparation for the leading edge lay-up.

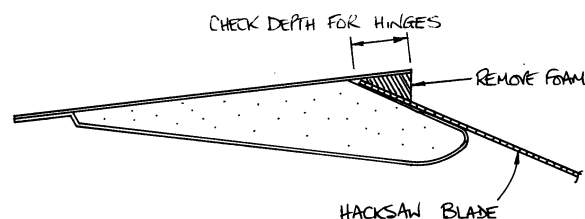


Fig 4. Removing foam under skin for hinge.

Cut strips of 'bid' cloth at $\pm 45^\circ$ to the following dimensions:

- 2 off full length x 10 cm (4") Leading edge.
- 4 off 20 cm x 10 cm (8" x 4") Hinge reinforcement.

Roll the long pieces up to help retain their dimensions as much as possible.

Set the ailerons up so that they have their leading edge upwards (figure 5) in blocks of foam with vees cut in them.

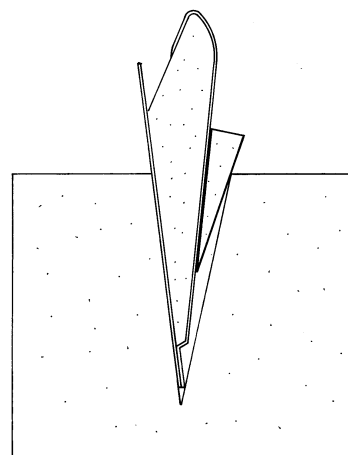


Fig 5. Aileron set in foam "V" blocks.

Step 6

Leading edge lay-up

Apply micro slurry to the foam making sure it's wiped off the glassfibre flange before lay-up. Using dry micro make a *small* radius at the bottom of the vee. If the radius here ends up too large you'll have problems fitting the hinges later. Its purpose is simply to eliminate air bubbles forming.

Paint all over the lay-up area with epoxy then roll the first layer of cloth out from one end progressively, stippling it into place as you go. See figure 6.

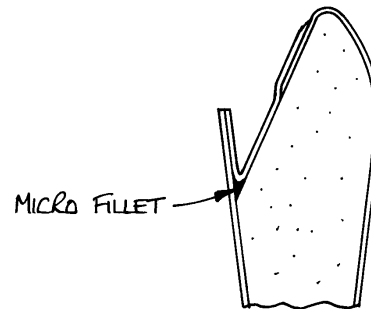


Fig 6. Leading edge lay-up.

Once thoroughly wetted out apply two hinge reinforcement plies in both of the locations shown in figure 7 then apply the next full ply in a similar manner to the first.

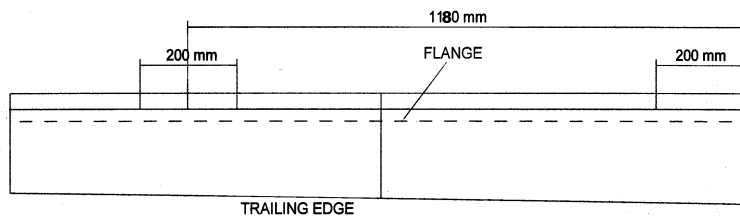


Fig 7. Hinge reinforcement ply locations

Apply peel ply on the fibre ends of the leading edge and on the flange over the hinge reinforcements. Leave to cure. After cure trim and sand the aileron's ends then crack out the foam end core pieces.

L.E. lay-up summary.

- 'Bid' at +/- 45°
- 1 ply - full length
- 2 plies - hinge positions
- 1 ply -full length.

Step 7

Close-out lay-ups

Clean the remnants of foam from the insides of the resulting glassfibre flanges in readiness for laying up, and on the root close-out only make a cut out on the leading edge only for a flox corner - see figures 8 and 9. This will be needed for strength, since in this area a large part of the leading edge will be removed later to provide clearance for the aileron push-rod.

Bonded in each aileron root will be an AN4-10A bolt through an XA2 plate with an EUR001 washer as in figure 8.

The tip close-out is a simple 2 ply lay-up.

Cut 5 pieces of 'bid' at +/- 45° to the following dimensions:
30 cm x 10 cm (12" x 4"). (3 off - Root close-out, 2 off - Tip close-out).

Step 8

Root close-out

Before you start this lay-up you'll need to get together the following;

XA2 plate, AN4-10A bolt, EUR001 washer, AN960-416L washer, AN316-4R nut, and FL13 spacer.

File the flat sides and the large radius of the XA2 plate as necessary so that it sits in the position shown in figure 9. Scuff sand the XA2 plate on both sides with 60 grit paper and also sand the bolt head. XA2 should have its two straight edges rounded off on one side slightly to allow cloth to run around it without snagging or cutting it. While you have the sand paper in your hand, roughen up one side only of an EUR001 washer and keep it handy.

With the bolt through the hole in the XA2 plate mask its shank and thread to keep epoxy off. Position the XA2 plate and bolt in the end of the aileron's root, as in figure 9, with the bolt 45 mm from the leading edge and 35 mm from the end of the leading edge flange, and hollow out the foam locally to allow good clearance around the bolt's head (which will be potted in with flox later) allowing the plate to sit flat on the foam. Double check that the distance from the bolt hole centre to the end of the leading edge flange is the same on both ailerons.

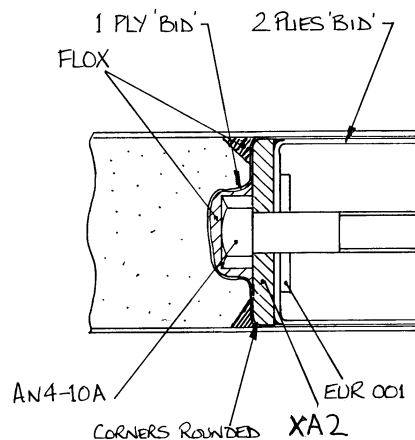


Fig 8. Section through aileron root.

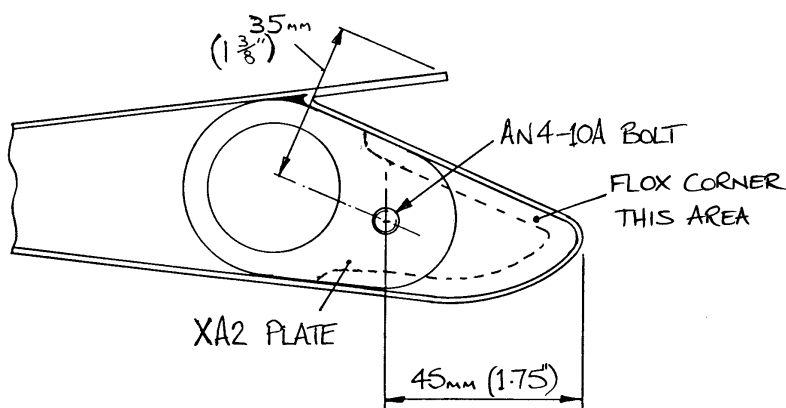


Fig 9. Section through XA2 plate in root end.



Micro slurry the foam in the aileron close-out, wiping off any that gets on the glassfibre flanges, then apply flox into the leading edge groove you made earlier. Next, lay in a ply of 'bid' with the fibres at 45° to the chord line and wet it out with a brush, stippling the cloth into the cavity for the bolt head and onto the flanges. Scissor trim the edges.

Lay the XA2 plate on a work surface covered with plastic, with the bolt sticking up and lay on a ply of dry 'bid', parting the fibres to allow the bolt through in a place that will allow complete coverage of the aileron close-out when laid in place, something similar to that in figure 10.

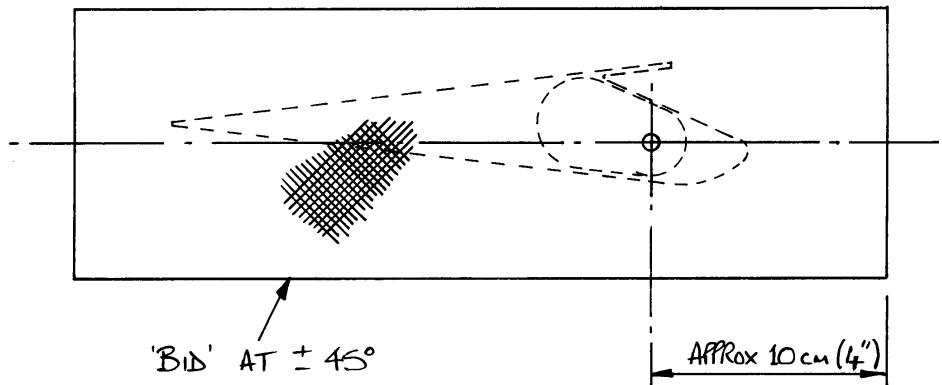


Fig 10. Where to poke the bolt through the cloth.

Wet this ply out with a brush then apply another ply as you did the first. Carefully remove the masking tape from the bolt then place the EUR001 washer over it and down onto the wet glasscloth, rough side down of course. Temporarily install the lightly greased FL13 spacer, washer and AN316-4R nut, tightening them up so as not to squeeze all the resin out but just to ensure the large washer is down flat. See figure 11.

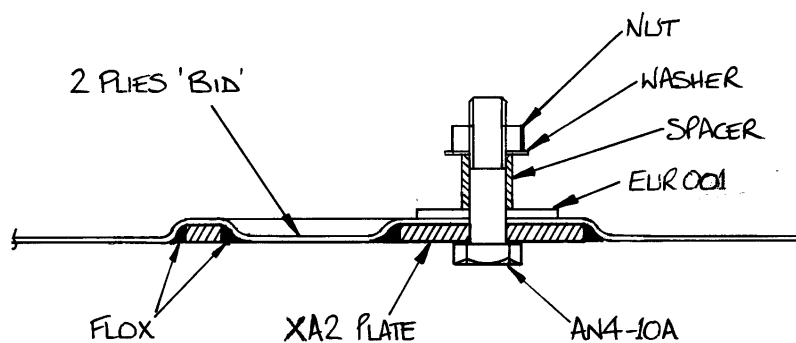


Fig 11. Section through XA2 plate ready for installation.

Apply a generous amount of flox to cover the bolt head and scrape some into XA2's large hole and all around the edge to form a fillet for the cloth to run down when in place in the aileron. Place the XA2 assembly into the aileron's close-out, stippling the plies into place then, having double checked the dimensions in figure 9 and made sure nothing will move. Stand the aileron on its tip end and allow to cure before trimming and sanding.

Root close-out lay-up summary.

1 ply 'bid' +/- 45° in root
XA2 plate
2 plies 'bid' +/- 45° over XA2 plate.

Step 9

Tip close-out

Apply micro slurry as usual to the foam in the aileron's tip then make a small fillet radius in the corners cleaning any excess from the glassfibre flanges before laying on 2 plies of 'bid' at +/-45° to the chord line, wetting out and scissor trimming each in turn.

Tip close-out lay-up summary.

2 plies 'bid' +/- 45°

Step 10

Attaching the hinges

The attachment of the hinges follows the same principle as that of the rudder and anti-servo tabs. Two MS20001-5 hinges, one 5" and the other 6" long, are attached to the inside of each aileron flange with floc and pop-rivets. See figure 12.

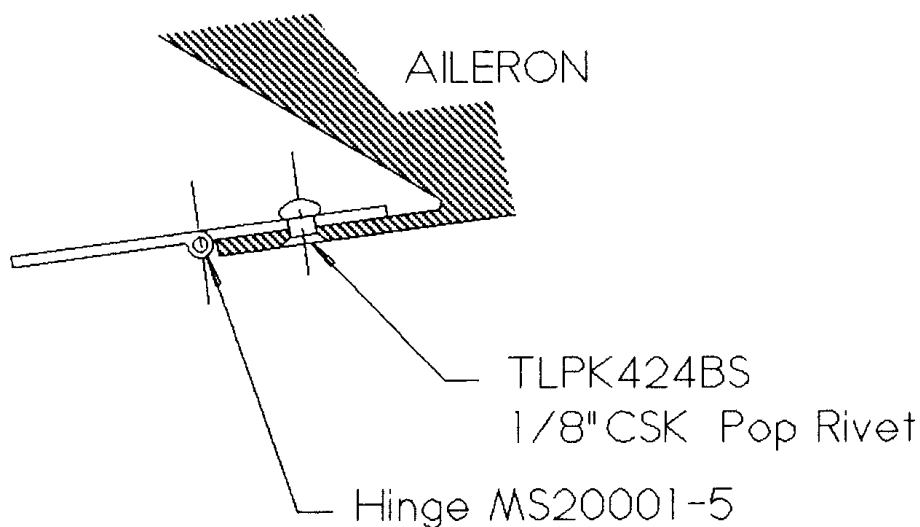


Fig 12. Typical section through aileron hinge.

File the hinges' edges to smooth off any roughness then cut pieces of hinge wire to be about 1 cm (1/2") longer than the hinge itself to allow for a bend at each end for safetying. See figure 13.

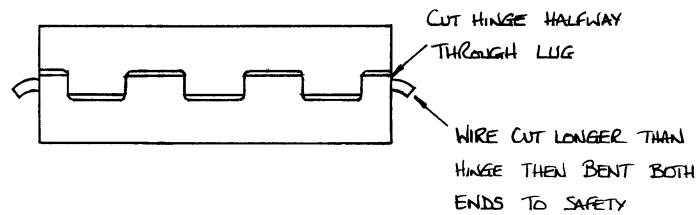


Fig 13. Typical method for safetying hinges.

Mark the areas where the hinges will go onto the aileron flange as in figure 14.

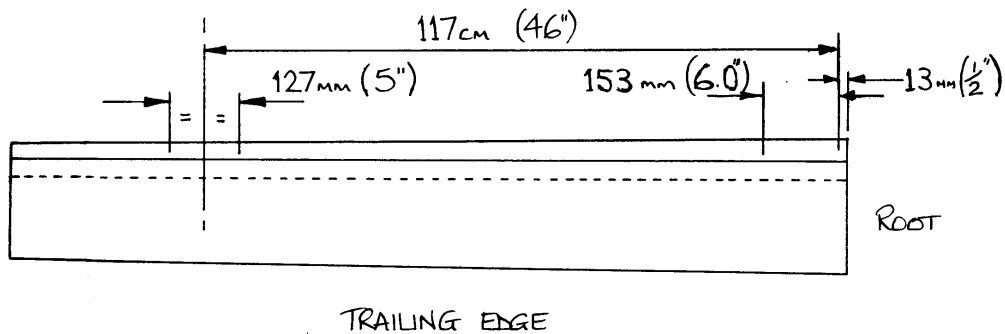


Fig 14. Hinge positions to be marked on aileron flange.

Cut away the flange of the aileron locally to accept the hinge pivot and sand the corners at an angle thus giving clearance for the bent hinge pin ends. See figure 15.

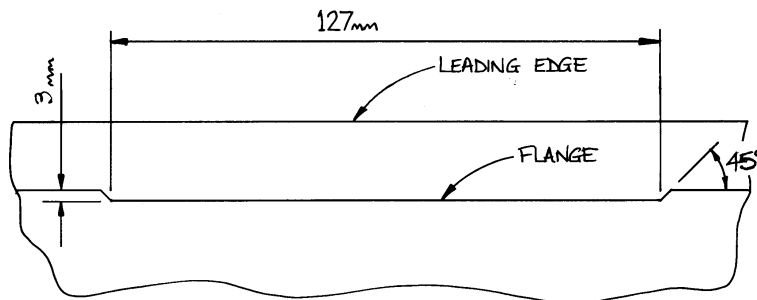


Fig 15. Flange cut back locally for hinge (outboard shown).

Adjust the cut-outs until the hinges fit correctly.

Clamp the two hinges for one aileron onto a straight edge (see figure 16) in their relevant positions placing them against the aileron as a double check.

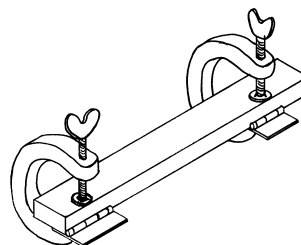


Fig 16. Hinges held in line on straight edge.

Mark the rivet hole centres onto the aileron as laid out in figure 17 then, holding the hinges in place, drill through with a 3.3 mm drill placing a cleco in the first few holes to maintain their positions whilst drilling the remaining holes. Ensure when doing this operation that the distance from the hinge pin to the AN4-10A bolt is exactly the same for each aileron.

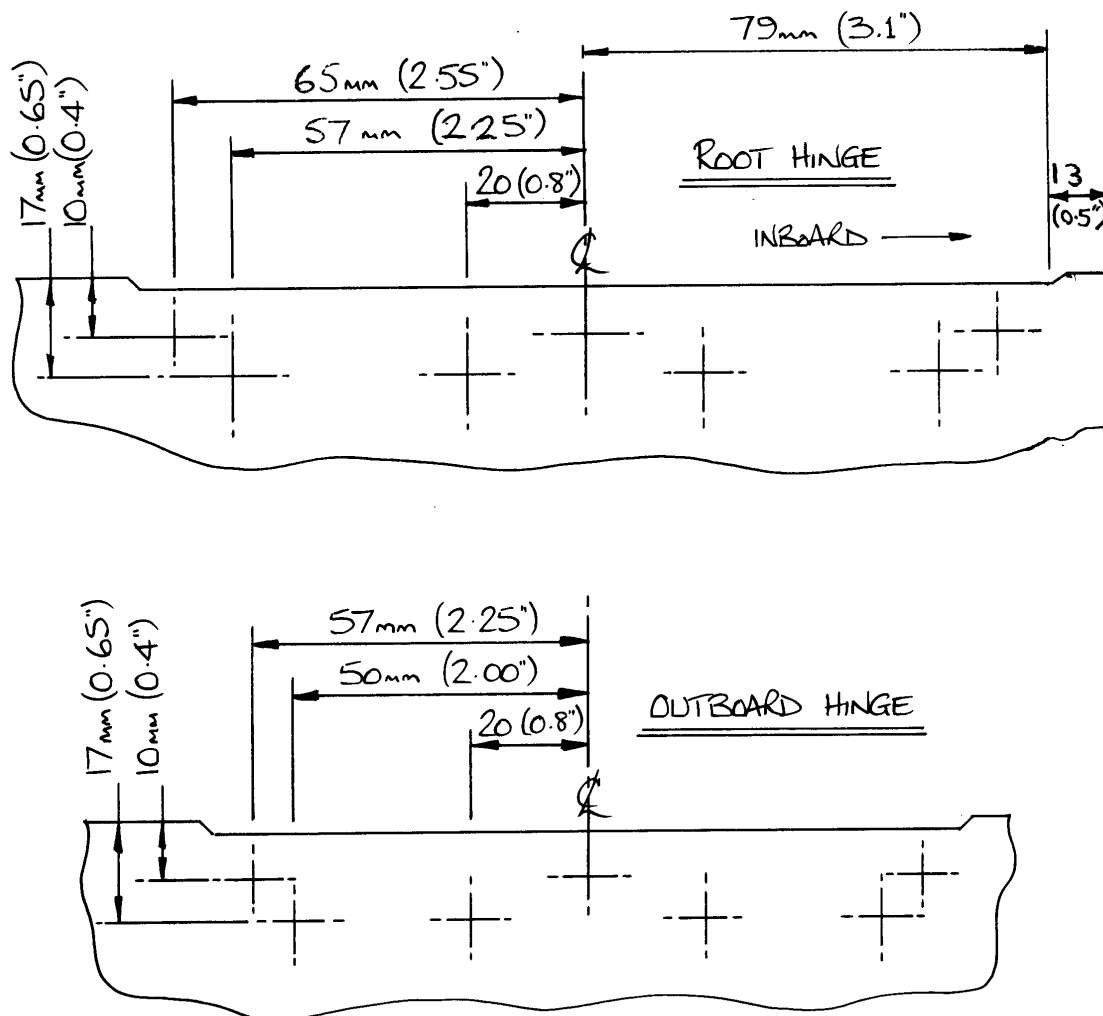


Fig 17 Rivet hole centres in flange - aileron L.E. not shown

With all holes drilled remove the clecos and deburr each hole, removing all remaining swarf, then scuff sand the hinge flange in preparation for bonding to the aileron. Countersink the flange's holes with a drill bit for the rivets.

Strip off the peel ply from the aileron flange, if you haven't already, then mix up a small quantity of wet flox. Carefully apply a skim of flox to the correct side of the hinge flange to be riveted, making sure not to get any in the joints, (*otherwise your Europa will have a very poor roll rate!*) then offer them up in place with the aileron. Rivet them up, using TLPK424BS rivets, wiping the excess flox off as it oozes out then leave to cure.

Aileron mass balancing

The ailerons are next statically balanced, the purpose of which is to resist an aerodynamic resonance causing the aileron to flutter and result in its catastrophic failure. Lead weights on arms attached to the aileron's leading edge are used to achieve balance.

The lead weights supplied are slightly heavier than required so you can drill holes in them for fine tuning after painting.

Step 13

Preparation

The arms onto which the lead weights are mounted are made from scrap foam and the full size templates, shown at the end of the chapter in figure 29, will need making from card to get their profiles.

Using the templates, make the two 38 mm (1.5") wide arms from styrofoam scraps left over from making the flying surfaces. They may need slight adjustment to fit your aileron's leading edge snugly. Trim the lead as necessary to fit the end of the arm as indicated in figure 21.

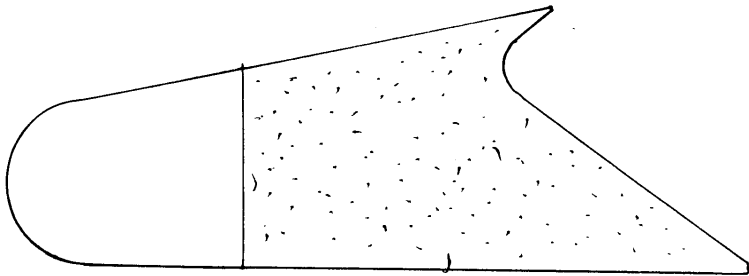


Fig 21. Lead fitted to match arm.

Step 14

Arm and weight attachment

Now lay the aileron on a flat bench with the hinge flange side on the table.

If the hinge is touching the table and lifting the aileron's skin from the surface just support the aileron between the hinges on the corner of the table leaving the hinges overhanging.

The foam arms are to be attached to the aileron's leading edge 20 mm (3/4") from the inside edge of the hinges. See figure 22.

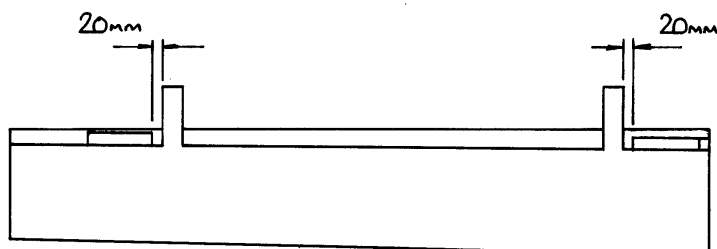


Fig 22. Position of mass balance arms.

Scuff sand the areas of the aileron that will be covered by the foam arm, mix up some rapid epoxy and bond them in place flat to the table as in figure 23.

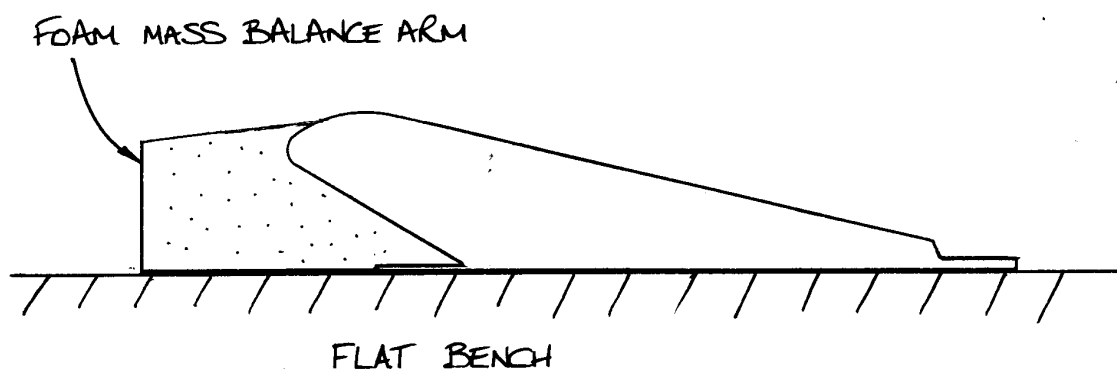


Fig 23. Bonding arm to aileron on a flat surface.

File off any rough edges and scuff sand the flat bonding face of the lead weights then, with the aileron set on edge, leading edge up, temporarily attach one to the end of each foam arm with tape as shown in figure 24.



Fig 24. Lead weight temporarily fixed to arm with tape.

Step 15

Preparation

Prior to laying up the mass balance horn securing straps it would be prudent to check that full aileron deflection can be achieved first. A chamfer at the end of the lead weight may be necessary. Check aileron deflections on the completed wings before coming back to this chapter to permanently attach the mass balance horns.

Bond the lead weights to the foam horns with rapid Araldite.

For each mass balance weight, cut pieces of 'uni' to the following dimensions:-

3 off 5 cm x 38 cm (2" x 15") with the fibres running lengthwise.

These fibres will run from about 5 cm (2") back from the edge of the foam onto the aileron, all the way around the lead weight and back onto the other surface of the aileron, again about 5 cm (2") beyond the foam.

Scuff sand with 60 grit paper the areas of aileron which the lay-up will bond to.



Step 16

Mass balance lay-up

Lay a piece of plastic sheeting onto a flat surface and paint an area of it with epoxy the size of one of the plies of cloth.

Lay the first ply onto the plastic, which should stay in place on the wet epoxy, then wet it out. Lay on subsequent plies, orientated in the same direction, wetting them out one at a time until the laminate is three plies thick.

The laminate can be easily trimmed with scissors to a width slightly greater than the horn itself and at least 36cm (14") long.

Micro slurry the foam upper and lower surfaces only.

Now lay the wet laminate onto the mass balance horn, remove the plastic and ensure it's properly attached by using a brush or squeegee.

There should be a minimum of 5 cm (2") overlap onto the aileron's skin on both upper and lower surfaces as shown in figure 25.

The edges should be left overhanging enough to enable trimming back to the foam and lead after cure and so ensuring a good square edge.

Cover the whole of the wet laminate with peel ply and allow to cure trimming the edges at the knife trim stage.

Remove the peel ply after full cure and sand the edges as required to make them straight and flush with the horn's sides.

Step 17

Side lay-ups

The sides are next laid up with two plies of 'bid' with a floc corner binding them to the 'uni' lay-up previously made.

Cut the usual 5-6 mm (1/4") triangular channel around the complete periphery of the exposed foam on each side.

Cut 2 pieces of 'bid' at +/-45° to be of sufficient size to cover each side of the mass balance horn and to overlap onto the aileron leading edge by at least 1 cm (1/2"). These side lay-ups can either be made laying on individual plies or laying up the two plies on plastic sheeting and applying them together.

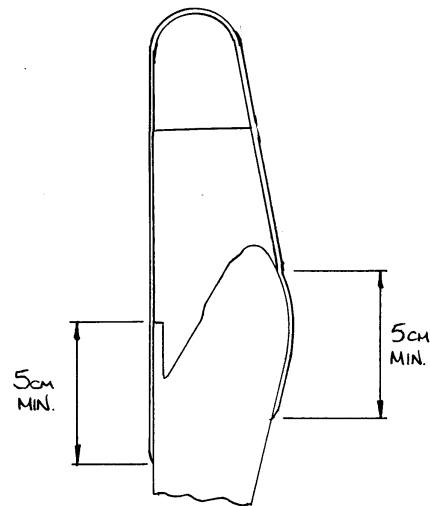


Fig 25. Extent of 'uni' plies onto aileron skins.

Apply the micro and floc corners to the horns then lay-up the sides wrapping the plies onto the leading edge of the aileron by a minimum of 1 cm (1/2"). See figure 26.

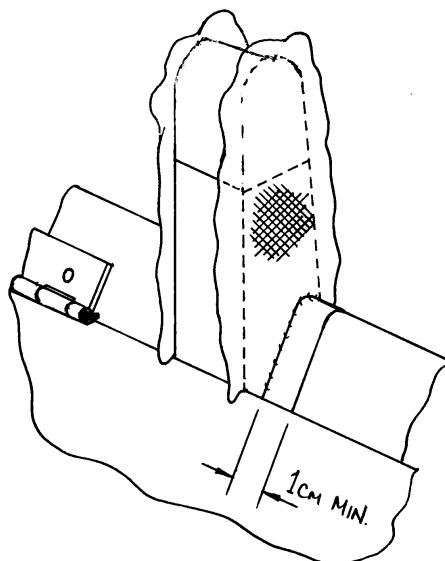


Fig 26. Side lay-ups to lap onto aileron by 1 cm minimum.

Step 18

Checking for balance

The final aim is that the aileron, when suspended from the hinges, will lie horizontal through its centreline. This can only be accurately checked after the final paint has been applied. Before painting, however, to get an idea of balance, suspend the aileron by its hinges. It should hang with the nose of the mass balance horns pointing down at about 45° as in figure 27. In other words the aileron should be over balanced.

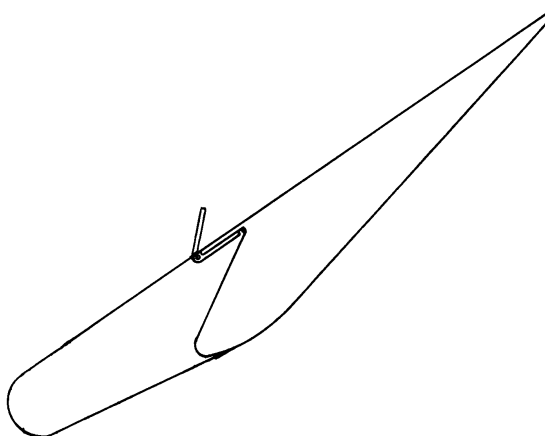


Fig 27. Aileron before finishing and balancing.



After final paint has been applied, to bring the aileron into balance, simply drill into the side of the lead with a 1/4" drill to remove sufficient material. Fill the hole(s) with a foam plug and dry micro. The final balanced state is shown in figure 28.

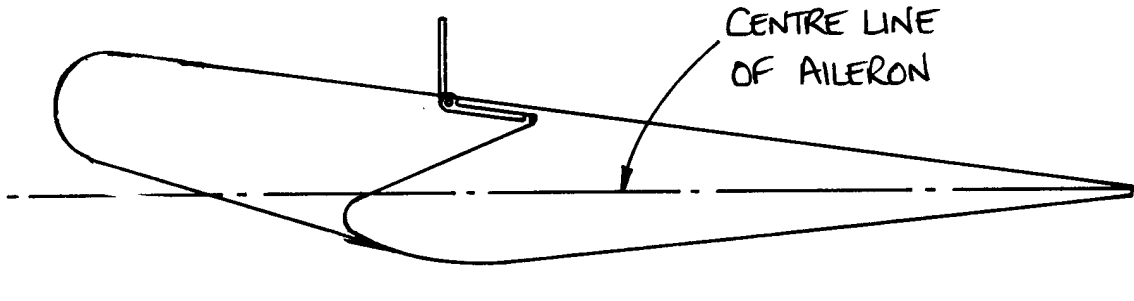


Fig 28. Aileron properly balanced after final painting.

Method of checking washout.

Introduction

As the aileron cores are very flexible, and easily deflected from the intended washout angle, the following procedure, using a spirit level, will enable accurate checking and setting up of the cores before lay-up.

Method

The following set-up should be carried out on a flat and level bench, however slight anomalies will be automatically catered for.

You will need to make a wedge shaped block about 15 cm (6") long for your spirit level to stand on so that the bubble reads level at the aileron root.

1. After gluing the two cores together set the combined core on the bench whilst correctly positioned in the lower casing.
2. With the spirit level on its wedge shaped block positioned at the aileron root check the position of the bubble carefully. It need not be perfectly level but you must be able to get the bubble back to exactly the same place later.
3. Move the wedge and level to the aileron tip **without turning it round** and shim the tip leading edge under the lower casing until the bubble is in exactly the same position as when it was at the root. Make sure that the shim is only pushed under the casing by 10-15 mm (1/2"). It would be useful to have one of the pieces of shim 4.0 mm (5/32") thick. This effectively removes all built in washout, and is our starting point.
4. Now remove 4.0 mm (5/32") of the shim and leave the remaining shim in place.

5. Sighting along the leading edge, add shims under the casing along the span as required until it is straight.
6. The aileron core should now be set up with 1.1° of washout, and is ready for the first lay-up.

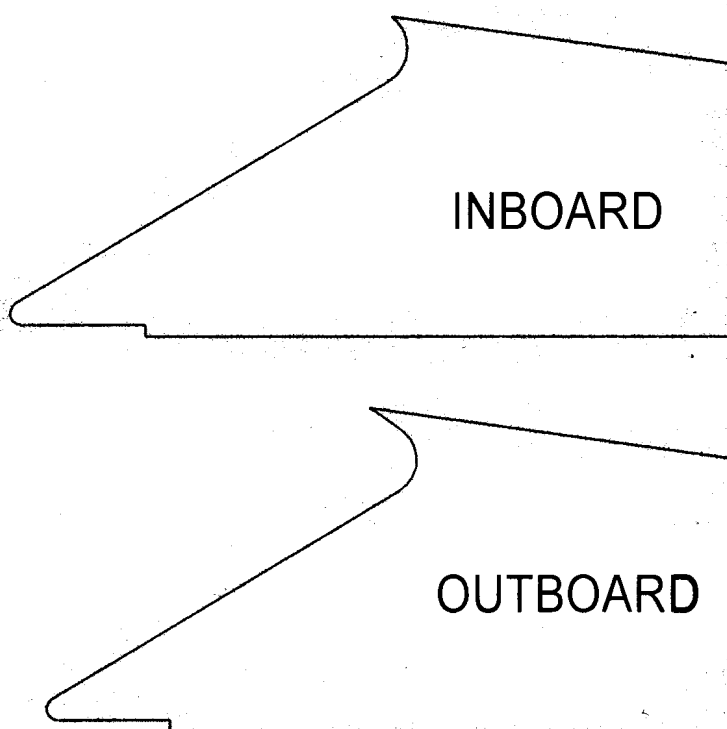


Fig 29. Full size templates for mass balance horn arms.



INTENTIONALLY BLANK