6. Flaps

Overview

Each flap comprises two main cores which are joined together sandwiching a laminate made up from 5 mm thick brown PVC foam (part no. FCFL) with 2 plies of glass fibre each side of it. The flap has a total washout of 1.4°. The flap's skins will be applied, then after cure, the FL1, FL2, and FL3 hinge plates installed, the mid one (FL2) being located in the 5 mm foam sandwich piece. Three small plates (FL7) will also be laminated into the root to provide a hard point for the flap drive pin.

The longer outboard core has a 25 mm piece pre-cut at its tip to make a flange with, as does the inboard core. The inboard core also has an extra piece pre-cut at its root end which is to be used to extend the flap to conform with the fuselage shape at a later stage. Put this piece in a safe place for now.

Step 1

Joining cores together

Firstly, the supplied 5 mm foam (FCFL) needs to be made into a laminate. Cut four pieces of 'bid' cloth from your scraps slightly larger than the size of the foam piece orientated ± 45° to the edges.

Apply two plies of the cloth to each side of the foam and wet it out having micro slurried the foam's surface first. Cover both sides with peel ply, then sheets of plastic to prevent epoxy getting everywhere, before weighting it down on a flat surface just enough to keep it flat.

After cure remove the plastic and peel ply, trim the edges to get rid of sharp pieces of glass fibre, then lay the laminate up against the end of one of the flap cores at the joint position, i.e. not the root or tip. Mark the section shape onto the laminate and cut this piece out remembering you'll need two of these, one for each flap. See figure 1.

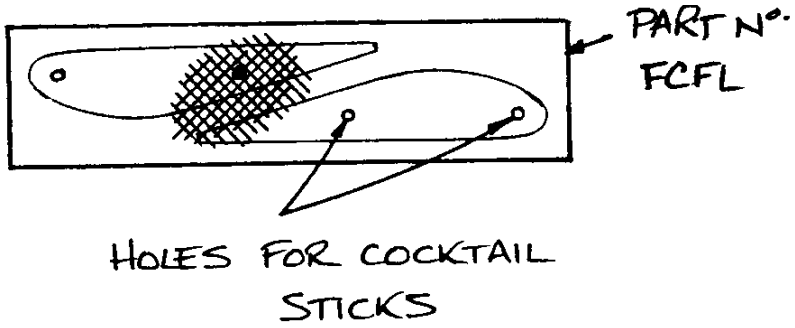

Fig 1. Positions of profiles cut from laminate.

The trailing edge support block shape need not be included, in fact you may cut the last centimetre (½") of trailing edge off completely. The gap left here upon joining the flap cores together can be filled with a piece of scrap foam later.

Sand the profiled sandwich lay-up so it's just smaller than the foam core's profile. What you want to avoid is a lump in the flap's surface at the joint which will need blending out with filler later. A dip in the surface, although best avoided, is less costly weight wise.

Drill two holes through the profiled laminate, one at the leading edge the other at the trailing edge, to allow short lengths of cocktail stick through, then with the profile in position on one of the core ends, stab the sticks through it into the foam to make locating holes. Do this with the other core also so the profile can be held positively in position.

Set the two flap cores, in their jig blocks to maintain the 1.4° washout, on a flat surface and in position to be joined together, having first placed a strip of plastic down at the join line to act as a release. Sighting along the leading and trailing edges will tell you if they are aligned correctly. Use a long straight edge to confirm absolute straightness of the two cores in relation to each other.

When you are happy with the cores' alignment mix some wet flox and apply to both sides of the sandwich profile piece. Separate the cores enough to place the sandwich in position, locate it using the cocktail sticks then press the cores back together and carefully weight them down so they don't move then allow the whole assembly to fully cure undisturbed.

Although the washout is set during core manufacture, a double check prior to layup is advisable. A method for checking washout with a spirit level is given at the end of this chapter.

Step 2

Bottom skin lay-up

Preparation

Cut a triangular shaped channel out of the foam each side of the 5mm rib to a depth of 5-6 mm for a flox joint to be made between the rib and skin.

The first skin to be laid up is the bottom skin so set the jointed cores in their jig blocks with the trailing edge support block downwards, as in figure 2, having cut the jig block back along the leading edge about 7 or 8 cm thus giving access underneath.

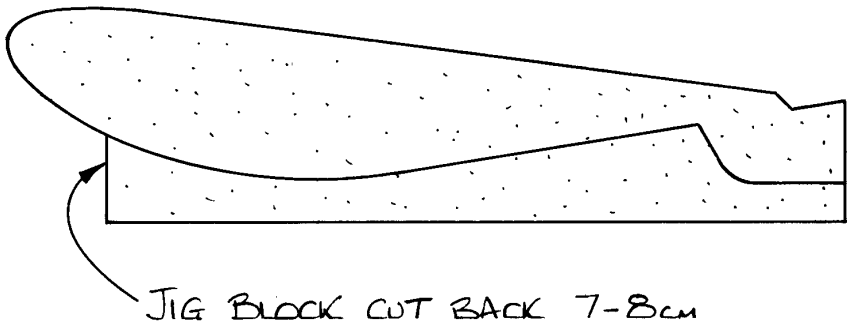

Fig 2. Flap core in jig block.

Bond the jig blocks to the bench with rapid epoxy to keep them flat and do likewise with the core to the jig blocks, remembering to use small blobs. Attach also the 25 mm pieces to the main cores in their relevant locations. Remove the foam flashing around the leading edge to make it nicely rounded, brushing any bits off the core afterwards.

Mark the core's foam surface with lines at 30° each way to the leading edge for ply orientation during lay-up.

Attach peel ply to the trailing edge joggle, as in figure 3, with thin double sided tape. Peel ply also the 25mm root and tip pieces.

Cut a piece of 'uni' to the following length:

1 off 2.5 m (98") x full width,
and several pieces of peel ply for the leading edge.

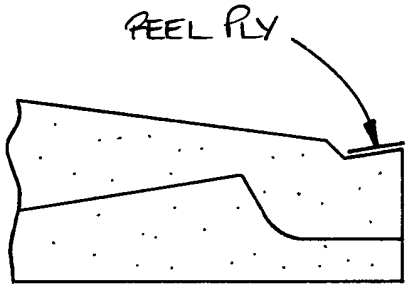

Fig 3. Flap core trailing edge detail.

Step 3

Skin lay-up

Fill the grooves each side of the rib with flox and underneath about 5cm back from the leading edge. Micro slurry the foam, keeping it off the peel ply then, having painted the foam surface and peel ply with epoxy, lay on the first ply at 30° to the leading edge

Figure 4 shows a method of laying on the cloth, using the 'off-cut' to provide the second ply.

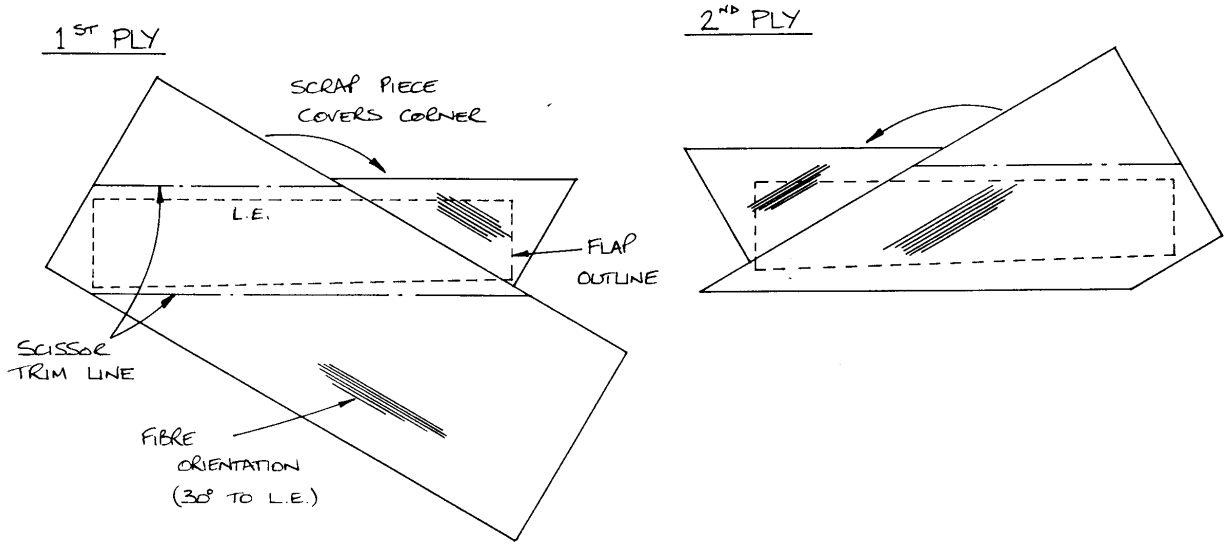

Fig 4. Positioning 'uni' cloth for skin lay-up.

The first ply wraps around the leading edge and back approximately 3-4 cm. See figure 5.

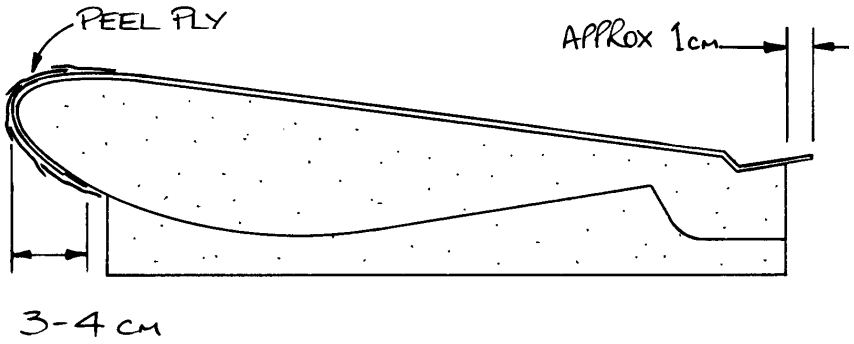

Fig 5. Bottom skin lay-up.

Squeegee the first ply, wetting it out properly and scissor trimming the edges to within 1 cm (½") of the core before laying on the second one at 30° the other way to the leading edge. This ply should be trimmed to be about 1cm shorter than the first ply at the leading edge to feather it down to the foam.

Apply peel ply over the fibre ends at the leading edge and all around the leading edge as shown in figure 5 then leave to cure, knife trimming at the appropriate time.

First lay-up summary.

1 ply 30° to leading edge
1 ply 30° *other way* to leading edge.

Step 4

Top skin lay-up

Preparation

Retrieve the top surface jig blocks, cut the leading edge back as you did the others and set them in line on your flat bench. Remove the flap from its jig blocks, flip it over and set it up as before in the other jig blocks, making sure everything is straight.

Remove the peel ply and saw off the trailing edge support block, sanding the foam to blend the top surface with the trailing edge flange.

Carefully sand the glass fibre at the leading edge to remove any bumps and to help feather the glass to the foam core. Take special care not to sand into the foam, of course. See figure 6.

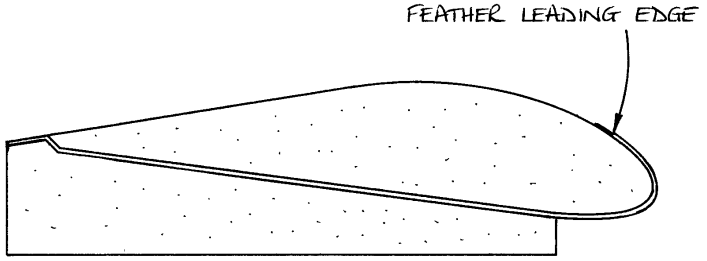

Fig 6. Flap core ready for top skin lay-up.

Continue the groove each side of the rib for flox where the trailing edge support block was and mark the core's surface with orientation lines at 30° each way to the leading edge. Apply peel ply as usual, to the 25mm core pieces. Don't overlap onto the existing glass fibre.

Cut a piece of 'uni' to the following length:

1 off 2.5 m (98") x full width,
and several strips of peel ply.

Step 5

Skin lay-up

Fill the rib's grooves with flox then micro slurry the foam, keeping it off the glass fibre at the leading and trailing edges then paint the surface with epoxy.

Lay on the first ply at 30° to the leading edge in a similar fashion to the bottom skin, wet out and squeegee it then scissor trim 2-3 cm back from the leading edge underside and about 1 cm beyond the trailing edge and at each end. Lay on the second ply at 30° the other way to the leading edge trimming this one about 1cm short of the first at the leading edge. See figure 7.

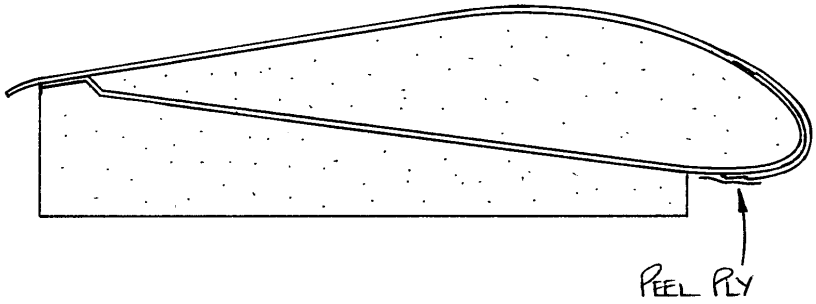

Fig 7. Top skin lay-up completed.

Peel ply the fibre ends at the leading edge then leave to cure, knife trimming as required.

Second Layup Summary

1 ply 30° to leading edge
1 ply 30° *other way* to leading edge

Step 6

Installing hinge plates

Preparation

Two jigs are required to position one each of the FL1 and FL3 hinge plates which are to be bonded onto the root and tip of the flap close-outs respectively. The centre hinge plate, FL2 will be positioned separately relative to FL1 and FL3.

Make the jigs from 12 mm (½") plywood or similar according to the drawings in figure 8. Later illustrations show how these jigs are used.

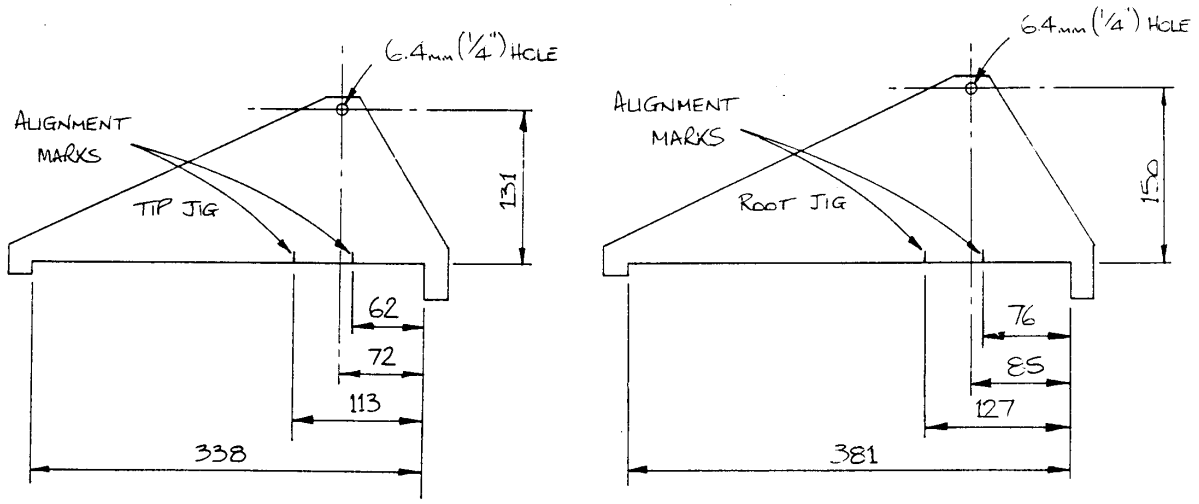

Fig 8. Flap plate positioning jigs (dims in mm).

Crack out the 25 mm foam end pieces and remove any peel ply from the flanges then position the jigs as shown in figure 9 to transfer the alignment marks from the jig to the glass fibre flange. These mark the length of the slots which need to be cut into the flange to allow the flap plates through. The slot itself should be made to allow the hinge plate to sit flat on the foam core end, allowing a little extra for two plies of 'bid' behind it.

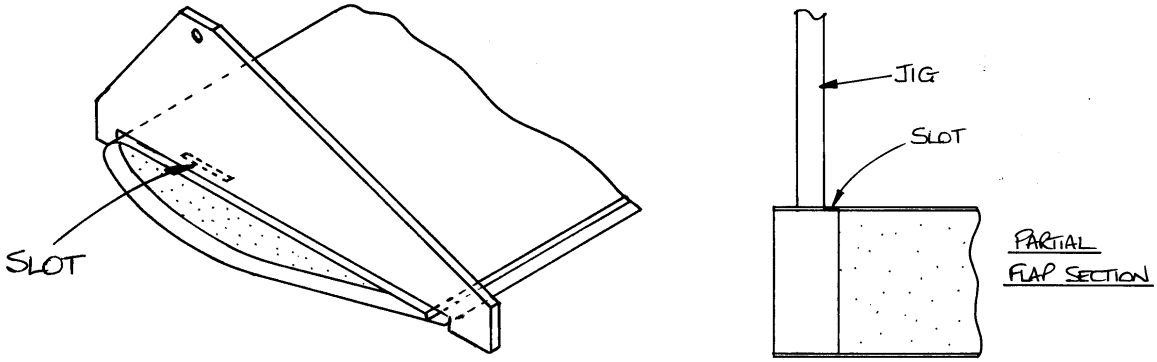

Fig 9. Typical jig position.

Mark the position for the 'middle' hinge plate, which will be situated in the rib, by using a straight edge to join the fore and aft alignment marks, respectively, from the flap's root and tip. Cut away the skin with a sharp knife first then, using a drill, rout the 5 mm foam out full depth until you touch the top skin. See figure 10. Take care when making this slot that you don't cut through the glass fibre skin of the 5 mm laminate or, more importantly, the top skin.

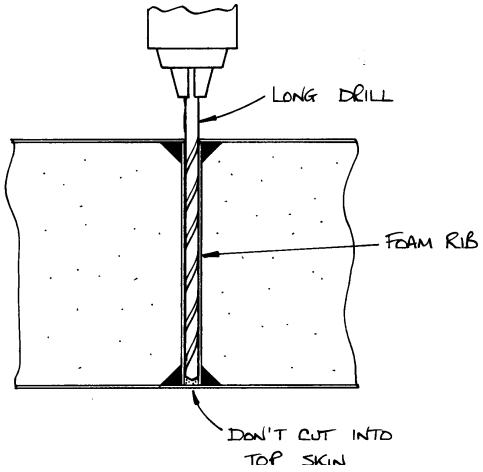

Fig 10. Section through flap at rib area.

Try the flap hinges in their relevant slots to check that they fit.

Step 7

Close-out layups

Preparation

Cut pieces of 'bid' cloth at +/-45° to the following dimensions:

6 off 50 cm x 12 cm (20" x 5") - 3 each root and tip.
4 off 25 cm x 12 cm (10" x 5") - 3 local plies root, 1 local ply tip.

Mask the FL1 and FL3 plates with tape to cover the area that will protrude from the wing to keep it clean leaving the pivot hole uncovered. Bond an FL9 bush into each of the hinge plates using Loctite 638 bearing retainer, then scuff sand the area of the plates to be bonded with 60 grit paper.

Abrade also three of the FL7 plates in preparation for bonding. These plates provide a mounting pad for the flap operating pin.

Attach the jigs to the underside of the flap with hot glue or bondo ensuring they are at 90° to the skin and 90° to the leading edge. See figure 11.

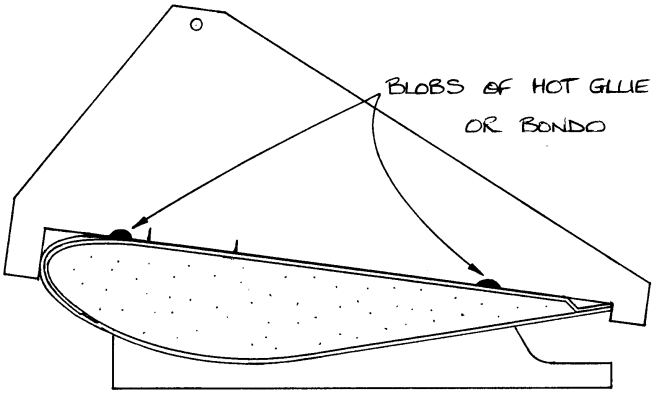

Fig 11. Jig temporarily attached to flap.

Step 8

Root close-out lay-up

Micro slurry the foam of the close-out, wiping off any stray micro from the glass fibre flanges. Lay in two plies of 'bid' at ± 45° to the chord line wetting each out in turn and scissor trimming to within 1 cm (½") of the flanges. Slit the cloth where the slot is to allow the hinge plate through.

Trowel on some flox to the hinge plate's unmasked end, then insert it through the slot and lay it against the wet plies in the close-out. Make flox fillets around all the edges and the hole to stop bubbles forming underneath the subsequent plies. See figure 12.

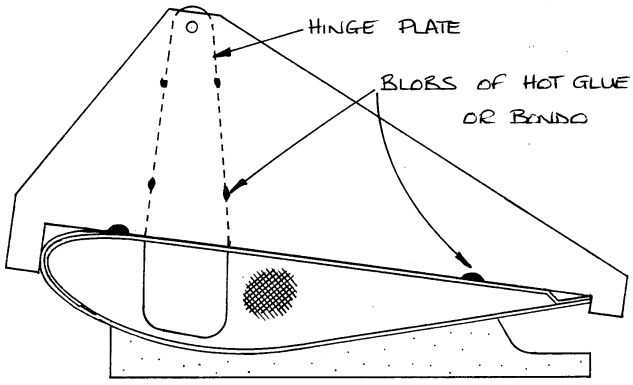

Fig 12. Flap hinge plate temporarily attached to jig.

Position the hinge plate to align with the marks on the jig and push a 1/4" bolt through the holes in the jig and hinge plate to locate the other end. Ensure that the hinge plate is at 90° to the leading edge and square to the bottom surface before fastening it in position with hot glue or bondo. Coat with flox one of the FL7 plates and position it 1 cm (½")away from the FL1 plate as shown in figure 13.

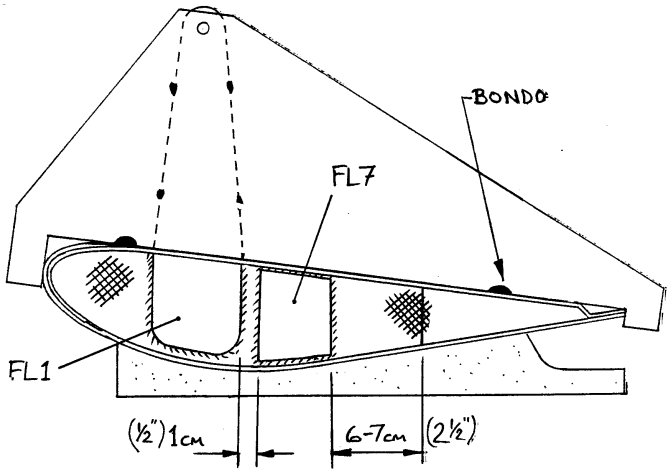

Fig 13. Position of FL7 plates.

Coat the metal of both FL1 and FL7 with flox then lay on a shorter, local ply running from the leading edge to at least 6-7cm (2½") aft of the FL7 plate.

Lay another flox coated FL7 plate directly over the first. Flox the exposed surface of the plate and form a fillet around its edges then lay on and wet out another local ply trimming it about 1 cm (½") shorter than the previous one.

Do the same with the last FL7 (3 in all) then finally add the last full length ply, scissor trim and allow to cure, knife trimming as required. Before walking away, double check that the FL7 plates have not moved from their intended position.

Root close-out lay-up summary

2 overall plies 'bid' ± 45°
FL1 and FL7 plates with flox
1 local ply 'bid' ± 45°
FL7 plate with flox
1 local ply 'bid' ± 45°
FL7 plate with flox
1 local ply ± 45°
1 overall ply 'bid' ± 45°

Step 9

Tip close-out lay-up

Having micro slurried the foam at the tip, lay in and wet out 2 plies of 'bid' at +/- 45° to the chord line running them onto the flanges as in the root and scissor trim them to approximately 1 cm (½") overhang.

Slit the cloth where the slot is to allow the hinge plate through.

Trowel on some flox to the FL3 hinge plate's exposed end then insert it through the slot and lay it against the wet plies in the close-out. Make flox fillets around all the edges and the hole to stop bubbles forming underneath the subsequent plies.

Position the hinge plate to align with the marks on the jig and push a 1/4" bolt through the holes in the jig and hinge plate to locate the other end. Ensure that the hinge plate is at 90° to the leading edge and square to the bottom surface before fastening it in position with hot glue or bondo.

Coat the metal of the FL3 with flox making a fillet around its edges then lay on a shorter, local ply running from the leading edge to at least 7-8 cm (3") aft of the hinge plate's aft edge. Wet out and trim this ply then lay on a final full length ply to finish with. Leave to cure.

Tip close-out lay-up summary

2 plies 'bid' overall +/-45°.
FL3 plate
1 local ply 'bid' +/-45°
1 ply 'bid' overall +/-45°

Step 10

With both FL1 and FL3 installed and fully cured remove the jigs with a sharp tap.

Try the FL2 hinge plate in its slot and thread a piece of string through all the hinge plates' pivot holes. Place shims (e.g. pieces of mixing stick) in the holes of the two end hinge plates and under the string to position it in the hole's centre then pull the string tight. Check that the FL2 hinge plate will position such that it lines up with the other two and that the string runs through the centre of its hole. See figure 14.

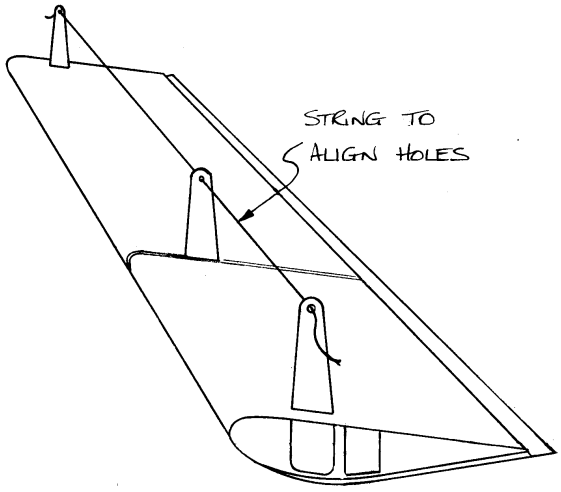

Fig 14. Aligning FL2 hinge plate with FL1 and FL3.

When you are happy that the FL2 can be positioned properly, squeeze some flox into the slot first of all, coat the plate, then pot it in place lining it up with the FL1 and FL3 plates by eye and checking again that all the holes line up by means of the string.

Support the FL2 plate with pieces of wood hot glued to it then allow to cure undisturbed ensuring nothing can move when it's left alone.

The flap structure is now complete and is ready for installation onto the wing.

Method of checking washout

Introduction

As the flap cores are 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 flap root.

1. After gluing the two cores together set the combined core on the bench whilst correctly positioned in the upper casing.

2. With the spirit level on its wedge shaped block positioned at the flap 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 flap tip **without turning it round** and shim the tip trailing edge under the upper 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 (½"). It would be useful to have one of the pieces of shim 8.4 mm (21/64") thick. This effectively removes all built in washout, and is our starting point.

4. Now remove 8.4 mm (21/64") 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 flap core should now be set up with 1.4^{o} of washout, and is ready for the first lay-up.

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