Glass Fibre Glider Repair Manual

Slingsby Sailplanes

GLASS FIBRE GLIDER

REPAIR MANUAL

This manual complies with British Civil Airworthiness Requirements Chapter A6-2, the technical content of this manual has been verified and certified correct.

Signed: .....

S. Tucker
Chief Designer

Date: March 72

A.R.B. Design Approval No. AD/1124/47

Introduction

Glass fibre gliders have a load carrying, stressed skin method of construction. This means that any skin damage weakens the structure and must be repaired before further flying. Following any sort of an accident the glider structure should be systematically checked for damage before it is flown again.

Small holes in the wing or fuselage skin are easily repaired, and the techniques required are fully explained in this manual. If the damage is extensive and large areas of the structure are destroyed, then this manual will be of little value. In cases like this the glider should be returned to the manufacturer for professional attention.

The manual is divided into three parts.

1. An introductory section outlining some general topics to be noted when using glass fibre materials.
2. A repair section detailing repair techniques for the different glass fibre structure types.
3. A materials section giving details of the materials specified in the manual for repair work.

The manual is constructed from a number of data sheets. Each data sheet relates to a specific topic and cross referencing is used to relate topics of common interest.

All the materials specified in the manual are obtainable from the Company. Any materials supplied will have been inspected and passed as conforming to the standards required for aircraft work.

SLINGSBY SAILPLANES

GLASS FIBRE GLIDER REPAIR MANUAL

AMENDMENTS

Amendment No.	Amendment Date	Data Sheets Affected	Incorporated by
1	Feb. '73	31 Introduced 105 Issue 2 109 Introduced	
2	Mar. '73	109 Issue 2	
3	Nov. '74	Index Issue 2 17A Introduced 32 Introduced 33 Introduced	
4	Oct. '75	Index Issue 3 34 Introduced 35 Introduced	
5	Jan. '76	Index Issue 4 36 Introduced	

INDEX

INDEX (contd).

Data Sheet No.

MATERIALS SECTION

GENERAL SECTION

Introduction to Glass Fibre

Glass fibre composites have two basic constituents, the glass fibres and a surrounding plastic matrix. The fibres reinforce the plastic matrix and carry most of the applied load. The matrix gives the composite its rigidity and protects the fibres from moisture or chemical attack during service.

Glass fibres, are generally woven into a fabric, which gives a regular orientation to the fibres and enables them to be handled more easily.

To produce a glass fibre laminate, successive layers of the fabric are placed into position and impregnated with resin. The liquid resin solidifies within a few hours, and after post curing at elevated temperature, forms a strong matrix around the fibres.

Using this technique, intricate shapes can easily be formed with the load carrying filaments orientated in the best possible manner. Furthermore, because glass fibre is built up in layers it is possible to locally reinforce the laminate and mould in load bearing fittings, etc.

Types of Glass Reinforcement

After production of the basic glass fibres, numbers of continuous filaments are gathered together to form a collection of parallel fibres known as a roving.

Glass fabrics are made by weaving rovings together. Depending upon the closeness of the weave and the number of rovings in each weave of the fabric different weights per unit area may be woven.

There are two main types of bidirectional glass fabrics. Plain weave has an over one and under one configuration (Fig. 1) and is used for most flat surfaces. Twill weave has an over one under two configuration (Figs. 3 & 4) and is used where a good drapeability around compound curve shapes is required.

A unidirectional glass fibre fabric has the majority of the glass fibres lying parallel and in one direction with only enough transverse fibres to hold the fabric together (Fig. 2).

Rovings may also be used either individually or grouped together to give a fully unidirectional composite.

Chopped strand mat has random short fibres lightly held together with a binder. A laminate of this material is heavy and of low strength compared with one of woven fabrics. As a result it is little used in glass fibre gliders.

The Resin

Most laminating resins come in two liquid parts, a basic resin and a hardener.

Once hardener is mixed with the basic resin a chemical reaction begins and the mixture begins to solidify.

The proportion of hardener to resin is absolutely critical, since the cured strength depends upon it. An excess of hardener in the mixed resin is as damaging as a deficit. In both cases the cured resin will have an incomplete molecular structure and poor physical properties as a result.

The temperature of the resin mix affects the rate at which the curing reaction occurs. If the temperature is too low the resin will be too thick to work and will drain out of the laminate before solidification occurs. Ambient temperature and humidity requirements are specified by the resin manufacturer.

The length of time before a mix of activated resin begins to solidify (pot life) is dependant upon the temperature, and the quantity of resin. Once the resin becomes thick and stringy, the curing process is well on its way. Resin in this state should not be used since the cured strength properties will be seriously degraded.

Once the resin has hardened, post curing at elevated temperature is required for the resin to gain its full strength. If a large enough oven is not available, a hot air tent should be constructed around the repair with a thermometer measuring the average temperature inside the tent.

Liquid resin is soluble in Acetone and Methyl Ethyl Ketone (MEK). Either of these solvents may be used to clean wet brushes or remove clothing stains, etc., (Note: many man made fabrics are also soluble in Acetone or MEK). Once the resin has cured, it is absolutely neutral. It will not swell or shrink with changes in climate and is only attacked by a few chemicals.

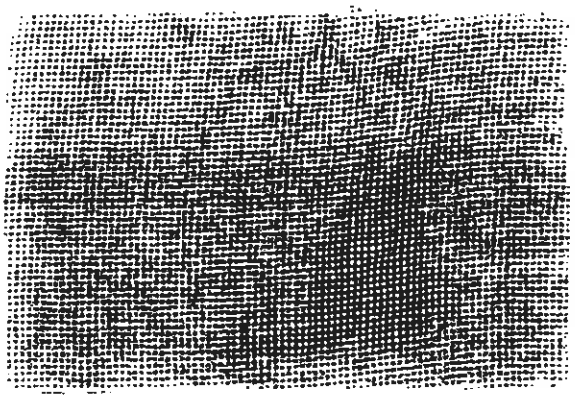
Gel Coats

The durability and appearance of a glass fibre moulding is dependant upon its exposed surface. The purpose of the gel coat is to provide a resin rich covering to the exposed surface of the laminate. This prevents the outermost glass fibres of the laminate from becoming exposed and liable to attack by moisture and sunlight. If the gel coat is pigmented a solid coloured surface is also given to the laminate.

Generally the gel coat surface is incorporated in the moulding process but it may also be used as a paint, and after curing, polished up to give a smooth glossy surface.

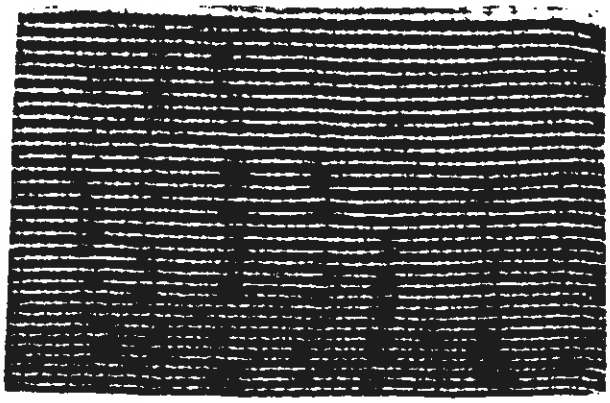
Fibre Glass Woven Reinforcements used on Slingsby Gliders

Fig. 1.



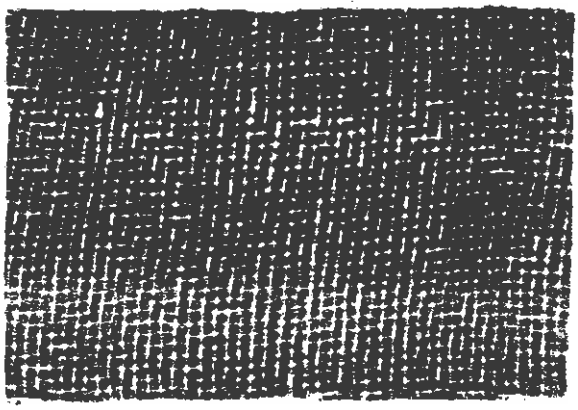
Interglas 90070
Plain Weave
78 gms/sq. metre

Fig. 2.



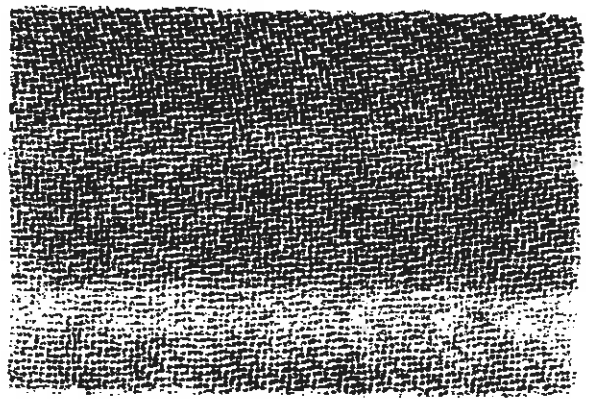
Interglas 92145
Unidirectional Plain Weave
210 gms/sq. metre

Fig. 3.



Interglas 92125
Twill Weave
280 gms/sq. metre

Fig. 4.



Interglas 92110
Twill Weave
160 gms/sq. metre

The pictures above show the cloth as seen when held up to a strong light. A cloth sample from the damaged area should be held to a strong light after the resin is burnt off for identification (Ref. Data sheet 14 Page 1).

Storing of Glass Fibre Materials

Storing Resin

Most laminating resins have a limited shelf life which is specified by the manufacturer. In general they should be stored in airtight tins at a cool temperature. The resin should be allowed to warm to workshop temperature well before use.

Storing Hardener

Hardeners generally react with oxygen in the air so must be stored in airtight containers. Some hardeners may crystalise if they become cold. To liquify the hardener it should be warmed and then allowed to cool to room temperature.

Storing Glass Fabric

Glass fabric should be stored in a warm dry atmosphere. In order to preserve the fibre surface treatment it must not get damp.

Before use it is recommended that the fabric is heated to 45°C in an oven to drive off any moisture that may be in the fabric.

Storing Acetone, MEK, etc.

Both Acetone and MEK are highly volatile and inflammable. Containers must therefore be tightly sealed and kept at a low temperature.

Useful Tools for Glass Fibre Work

1. Brushes of 1" width to 3" width.
2. Clean splints of wood for stirring, etc.
3. Scissors.
4. Number of tin cans to hold solvents for brush cleaning, etc.
5. Unwaxed paper cartons or tin cans to hold quantities of resin.
6. Sanding blocks of various sizes and shapes.
7. Sharp trimming knife.
8. Hacksaw blades wrapped with tape at one end to form a handle.
9. Selection of hand files.
10. Weighing scale which is accurate to within one gramme.

General Safety Precautions when Using Glass Fibre

Most resins are irritant to the skin. Many people are allergic to the resin and repeated skin contact can produce serious damage. If symptoms of an allergy appear when the resin is used, further contact should be avoided, and the symptoms will slowly fade away.

Direct skin contact with the resin should be avoided and rubber or plastic gloves worn when there is a possibility of the hands becoming severely contaminated.

The resins and solvents used in glass fibre are all poisonous so every precaution should be taken to keep them away from food. The face and especially the eyes should also be protected from resin and its solvents.

If a rotary grinder is used on a glass fibre laminate, much glass and resin dust will be produced and a respiratory mask should be worn for protection. The same dust is likely to cause an irritant skin rash to develop on the forearms, especially when glass fibre is being hand sanded. The arms should be washed in soapy water and the operator should avoid scratching, especially while dust is lying on the skin.

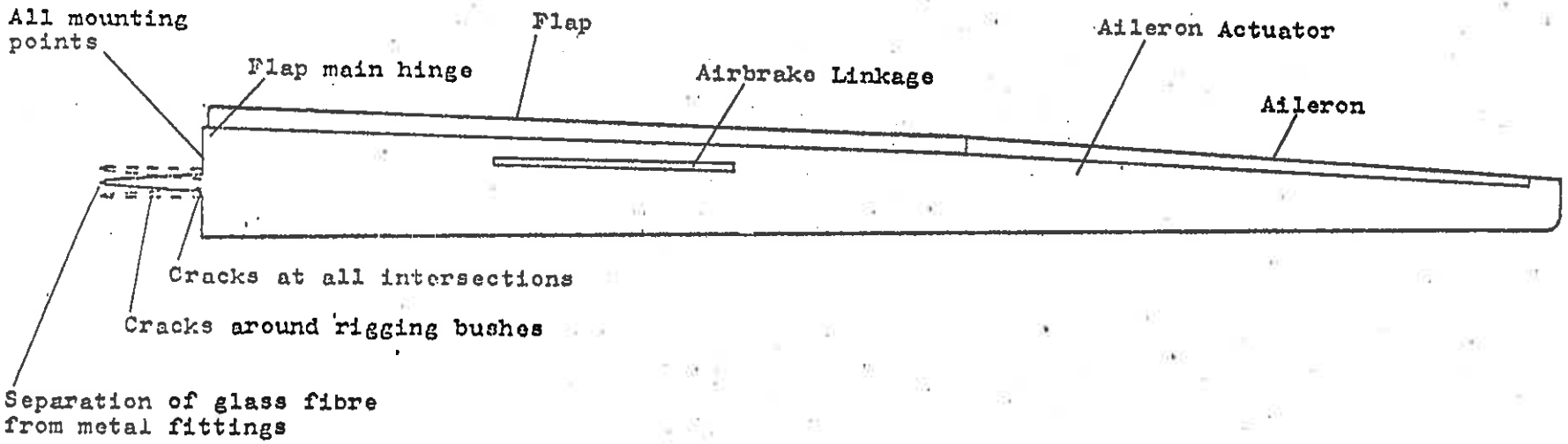
REPAIR SECTION

Wing Check Procedure

General

Look along the wing for dents, creases, etc. Fibreglass damage is mainly seen as cracked gel coat and white blushes in the glass cloth. White blushes will show as dark patches when a light is shone through single skin laminate. Check all hinges, pivots and attachment points for free play.

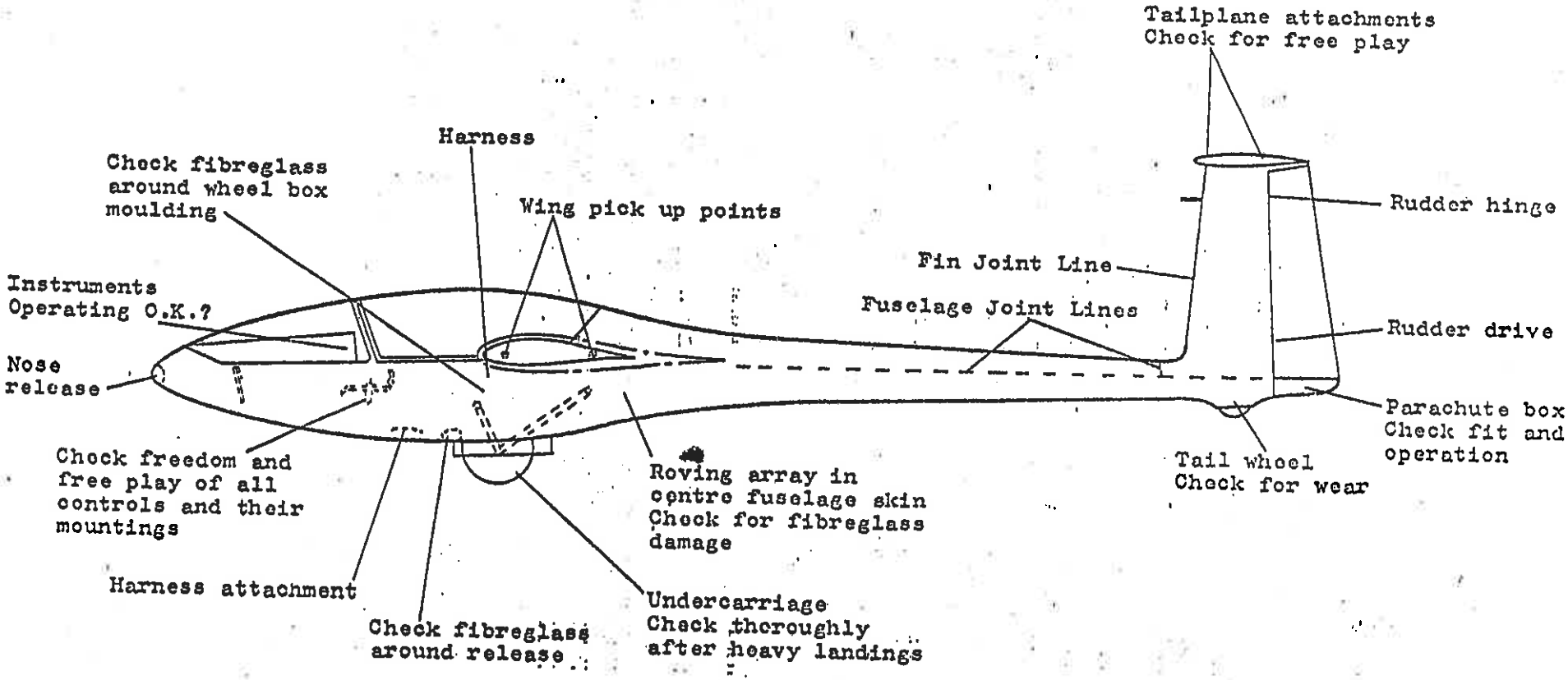
Note: Small hairline cracks may occur at places where filler putty has been used such as the leading edge and at the wing root joint. These are usually unimportant and only if such a crack suddenly grows should it be examined fully by removing the gel coat and looking for signs of damage in the fibreglass.



Fuselage Check Procedure

General

Fibreglass damage is mainly seen as cracked gel coat and white blushes in the glass cloth. White blushes will show as dark patches when a light is shone through single skin laminate. Check all hinges and attachments for free play and difficult movement or assembly.



Repairs Necessitating Manufacturer Liaison

This data sheet describes particular areas of damage where liaison with the manufacturer is required before a satisfactory repair can be made.

Non Repairable Areas

The non repairable areas relevant to a particular glider are illustrated on Page 2 onwards of this data sheet. In these areas only very minor repairs, e.g. small skin punctures, etc., may be made by a non approved repairer. Any other repairs must be referred to the manufacturer.

Extensive Skin Repair

If large areas of skin require repair, it will be difficult to reform the correct surface profile without proper rigid moulds. Also the structure may be weakened by the extensive removal and repair of load bearing skin.

Repairs Involving Fabricated Glass Fibre Components

In a repair of this nature, manufacturer's drawings of the area involved should be obtained.

Repairs Involving Glass Fibre Rovings

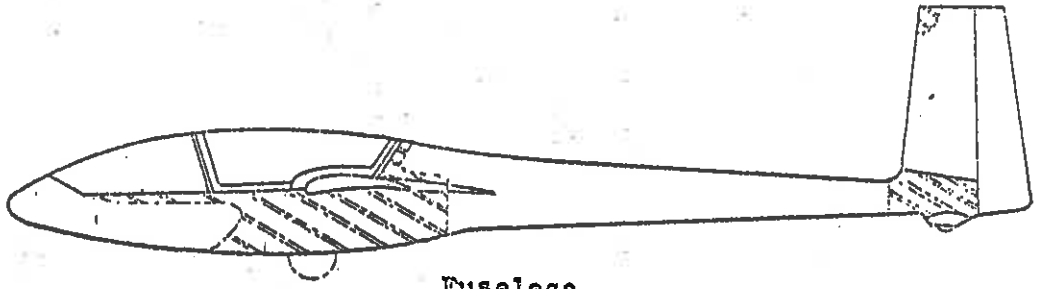
Generally these areas may be repaired by the manufacturer only. To determine the repairability and exact method of construction full details should be submitted to the maker.

Fittings requiring Jigging for Positional Location

Fittings that are torn from position may require special jigging to ensure they are correctly located relative to neighbouring components.

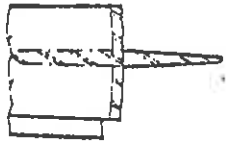
Non Repairable Areas T.59. Kestrel

Tailplane

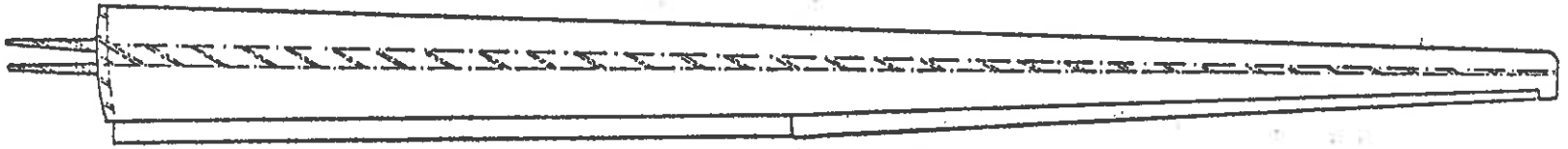


Fuselage

Non Repairable Areas



Port Wing



Starboard Wing

Strength Considerations of Glass Fibre Repairs

The strength of a glass fibre repair is generally dependant upon the bond strength of the repair to the original structure. Since the repair receives its working loads through this bond it is imperative that every effort is made to ensure a perfect connection.

Correct surface preparation of the bond area is vital. Data sheet 15 section A gives details of the necessary procedure.

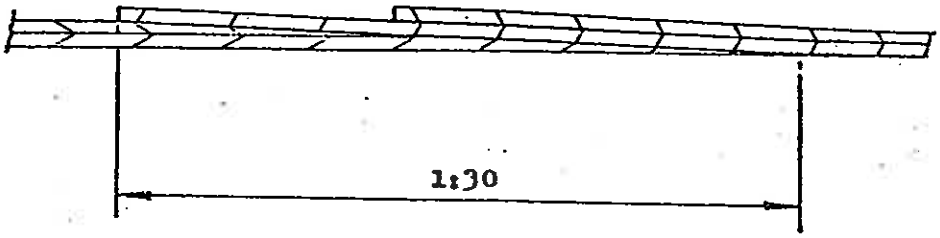
Local areas of poor bond strength within a larger bond area give rise to stress concentrations which can initiate failure of the bond. For this reason no air bubbles must be trapped between the adhering surfaces. If the first layer of a patch is oversize and no attempt is made to trim it down (ref. Data sheet 16, para. 6) a poor bond area may exist at its boundary. This can be serious, since the resulting stress concentration may initiate a peeling failure which would quickly propogate throughout the bond.

A patch repair that is much stiffer than the surrounding structure will also generate a peeling stress on its bond boundary. To minimise this effect the edges must be feathered off and the patch thickness built up gradually. Correct splicing and smoothing of the repair will ensure that this happens. Repairs to sandwich structures should have matching core materials between the replacement and the original in order to prevent any large differences in stiffness. For the same reason the number of cloth layers in a repair should be similar to the original.

Splicing of glass fibre joints is necessary to reduce stress concentrations and limit the bond tensile stress. The minimum splice angle is 1:30 (Fig. 1). At the corners of a spliced joint oversize patches can cause resin rich areas to occur (Fig. 2) which may inititate bond failure. A correctly trimmed patch does not have any tendency to form these resin rich areas (Fig. 3).

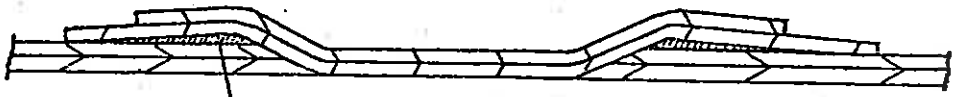
A study of the repair data sheets will show that one layer of cloth is recommended to finish most repairs. This extra layer of cloth is used to reinforce the edge joint and also provides allowance for any damage to the surface fibres when finish-sanding the surface. 90070 or similar thin cloth should preferably be used for this layer, so that when the repair is finished with gel coat, the slight hump due to the extra layer cannot be detected.

Joints between pieces of cloth in the same layer should be overlapped by at least 30 times the layer thickness. If laps of this type occur in successive layers, they should be staggered to prevent two occuring together.



Correctly Spliced Joint

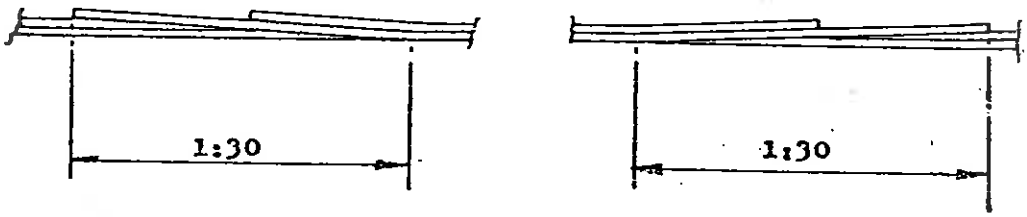
Fig.1



Bad Jointing Technique

A. Oversize patch.
B. Incorrect splice angle

Fig.2



Good Jointing Technique

A. Patch is no larger than chamfered area
B. Cloth edges correctly staggered
C. Correct splice angle

Fig.3

Not to scale

Preparation of Glass Fibre Repairs

This data sheet describes the preparatory steps which are common to most types of repair.

1. The location of the repairs should be noted and their relationship to non-repairable areas. If anything other than a minor repair is required in these areas the manufacturer should be consulted.
   Cracks in the gel coat finish indicate severe straining of the glass fibre structure at that point. To determine whether the glass fibre is damaged, it is necessary to remove the gel coat by grinding it away or carefully chiselling and peeling off. If the glass fibre shows signs of overstraining, (white cracks in the structure) the affected area should be cut out and the damage treated as a hole.
2. The structure type to be repaired, should be ascertained, also whether the area is accessible from both sides. The relevant data sheets describing the repair may now be selected.
3. Small samples of material from a known position on the damaged area are now analysed to determine the structure of the original laminate. The samples are fired on one edge with a match or cigarette lighter. This burns off the resin and allows the individual fabric layers to be separated. The weight and fibre direction of each layer may now be determined and related to the parent laminate. Notes should be taken so that the repair will be identical to the original laminate. If the structure utilises a core material, the type and thickness should be noted.

3. contd. If the core is balsa wood the grain direction of the replacement should match the original. If hessian has been used as a core material this will be detected as a brownish layer sandwiched between the inner and outer skins.

4. The damaged area should be cleaned and then cut back until sound material is reached. No evidence of whitening or cracking must be allowed to remain, and the hole to be repaired should have no sharp corners.

5. The presence of internal controls, fittings or structure in the damage area should now be noted. Any control linkages, bearings, etc., should be taped to keep out glass dust and surplus resin, etc.

6. The patch edges are now prepared according to the repair data sheet being followed. Any surface that will have glass fibre bonded to it must be prepared according to Data sheet 15 section A. When preparing a chamfered edge the sanding direction should be towards the tip. The prepared edges should be examined for any signs of delamination, which must be removed by further sanding.

7. The inside of the structure should now be cleaned out and any loose pieces of glass fibre or accumulations of dust removed.

8. The repair should now continue according to the particular repair data sheet being followed.

Surface Preparation for Glass Fibre Laminates

Surface preparation to ensure a good bond - Section A

Fibre Glass Surfaces

1. Degrease the area to be worked upon. Thoroughly abrade the area to remove any gel coat, paint, etc., and expose a fresh surface. The principle of this abrasion is to remove the top film of resin from the glass and slightly roughen the glass fabric such that it becomes whiskery. Care should be taken to ensure that too much of the glass reinforcement is not abraded away.
2. Remove any dust with a clean cloth.
3. Degrease the newly exposed surface to remove any possible traces of wax or grease. A clean cloth saturated with clean Acetone should be used to wipe the surface.
4. The Acetone must be allowed to evaporate off from the surface. Careful use of an hot air blower is recommended to drive off any traces of Acetone that may be trapped in the surface fibres.
5. Having cleaned the surface it should be used as soon as possible.

Metal Surfaces

1. Degrease the surfaces to be bonded.
2. Roughen the surface with a file or very coarse clean glass paper. The ideal is to grit blast just before bonding.
3. Degrease the surface with Acetone, just before bonding.

PRE-WETTING GLASS FIBRE UNIDIRECTIONAL ROVINGS

In a number of repairs glass fibre ropes are used where high loads are carried (e.g. around bearing housings and cut-outs).

Ropes are usually made up of a number of rovings. The number of individual rovings which go to make up the ropes will be called up on each individual repair.

1. The required number of rovings are cut to their correct lengths.

2. The rovings are laid up on a sheet of flat polythene or formica. Hold one end of one roving and stipple along the length of the roving with a resin impregnated brush. Take hold of an end of the next roving, keeping hold of the first roving. Stipple this second roving with a resin impregnated brush.

3. Pull the two rovings between the finger and thumb of the right hand to squeeze out any excess resin and to keep the fibres of the rovings together.

4. Add a further roving to the rope and impregnate it in the same way as before. Squeeze out the excess resin.

5. Repeat this process, adding rovings to the rope until the desired number has been reached.

Inspection of Glass Fibre Repairs

Whenever freshly laminated glass fibre has set hard it should be inspected for defects before any further work is done upon it. This data sheet describes the points to be checked.

1. The laminate must have cured hard in the correct period of time. If the laminate has not set, incorrect mixing proportions or too low an ambient temperature will be the cause.
2. There must be no air voids in the laminate, particularly at the bond between the original structure and the repair laminate.
3. The laminate must show no signs of insufficient wetting out, i.e. no white fibres visible in the laminate.
4. The resin cast samples associated with the repair should have cured hard in the correct period of time. After 8 hours post curing at 54°C the resin samples should be hard and brittle. If they are still rubbery the resin was mixed incorrectly.

If any of the above defects are present the laminate must be rejected and carefully stripped from the original structure ready for a fresh attempt at the repair.

6. The edges of the cloth must be trimmed to ensure that the patch only covers the correct area. To trim the patch, lift the edges and remove the excess with a sharp pair of scissors. Re-stipple the edges down again.
7. Each subsequent layer of cloth is then positioned and stippled into the preceding layers, (trimming if necessary) until the laminate is complete.
8. When laminating has finished, the repair must be allowed to cure without any further disturbance.

Pre-Wetting Glass Fibre

There are a few laminating jobs on glass fibre gliders where the use of pre-wetted cloth is expedient. Glass cloth is laminated on flat cellophane or plastic film (up to four layers may be laminated at once). The pre-wetted cloth is then transferred to the job and stippled in place, the plastic film being peeled off as stippling proceeds.

Pre-wetted cloth simplifies the job of laying cloth in awkward places, but it must be done with care and the following points noted.

1. Care must be taken to ensure that the pre-wetted cloth will have a good bond to the parent material. The bond area must be prepared according to Data sheet 15 section A, and just prior to laying up should be wet with resin.
2. The plastic backing film should be peeled off as the cloth is being laid, because with it in place the cloth laminations cannot assume a double curvature or irregular shape.
3. It is not easy to see if air bubbles are below a number of layers of cloth but it is important to ensure that none are trapped.
4. The edges of the cloth layers must be staggered so that there is not an abrupt end to a number of layers.

Wooden Surfaces

1. The wood should be clean and free from grease, paint, polish, etc., and should be abraded with coarse glass paper to leave a roughened surface.

Surface preparation to ensure a good release - Section B

1. The moulding surface should be undamaged and free from surface imperfections, chips, etc.
2. The surface should be polished with a non-silicone wax polish (see Data sheet 104).
3. Release agent is then carefully brushed or sponged on and allowed to dry.
4. If required, activated gel coat is now brushed onto the mould surface and allowed to become just dry.
5. The mould is now ready for laminating.

The Technique of Laminating Glass Fibre

This data sheet describes the best technique of laminating with glass fibre.

1. Using shaped paper templates all the requisite pieces of cloth are cut out.
2. The workshop temperature must be at least 23°C and relative humidity not more than 65%.
3. The bonding surface must be prepared according to Data sheet 15 section A.
4. The quantity of resin required should be estimated and the correct proportions (ref. Data sheet 100) of hardener and resin mixed together in a clean container. There must be no possibility of the container contaminating its contents. For this reason unwaxed paper cartons are recommended. Until experience is gained the maximum quantity of resin mixed at once should be limited to 150 gms. If the resin is for structural repair work a small sample (about 1cc) of the mixed resin is now cast into a container fashioned from aluminium foil. The sample should be labelled and placed aside to cure for inspection later (ref. data sheet 18).
5. Brush a coat of resin onto the prepared surface, place the first layer of cloth upon it and stipple the cloth into the resin, ensure that all air bubbles are worked out and that the cloth weave pattern is not disturbed. If the brush is very slightly wet with resin during these stippling actions it will be found that the cloth will wet out quickly, will not stick to the brush and the resulting slight surplus of resin will be enough for the next layer. Beware of using too much resin since this results in a heavy repair. Ideally there should be just enough resin in the laminate to wet out the cloth. When glass cloth is correctly wet out the glass fibres are almost invisible.

Single Skin Repair

This data sheet describes the repair techniques for single skin damage, where the damage is accessible from one side only.

1. Work through Data sheet No. 14.
   The edges around the hole to be repaired should be chamfered at an angle of 1:30 minimum.
2. To provide support for laminating the patch, the hole must have a backing piece attached to the non-accessible side. The backing piece is cut from thin plywood or rigid foam and if possible should be about 25-50mm. larger all round than the hole. It is passed through the hole and bonded with cotton flock to the "blind" side of the laminate as shown in Fig. 1.
   Plywood will not conform to any compound curve without treatment, so rigid foam sheet should be used for the backing piece if the area has compound curvature. In cases of severe compound curvature shaped balsa blocks or a preformed backing piece must be used. A preformed backing piece can be made from the glider by using the opposite symmetrical position as a mould. A single layer of cloth is laminated on the opposite symmetrical position to the damaged area and when this is released and turned inside out it becomes the required preformed backing piece. If the single layer is lacking in stiffness extra layers of cloth may be laminated onto the preform, but care must be taken not to distort it from the true shape.
3. When the cotton flock has cured the clamping wires and supports are removed.

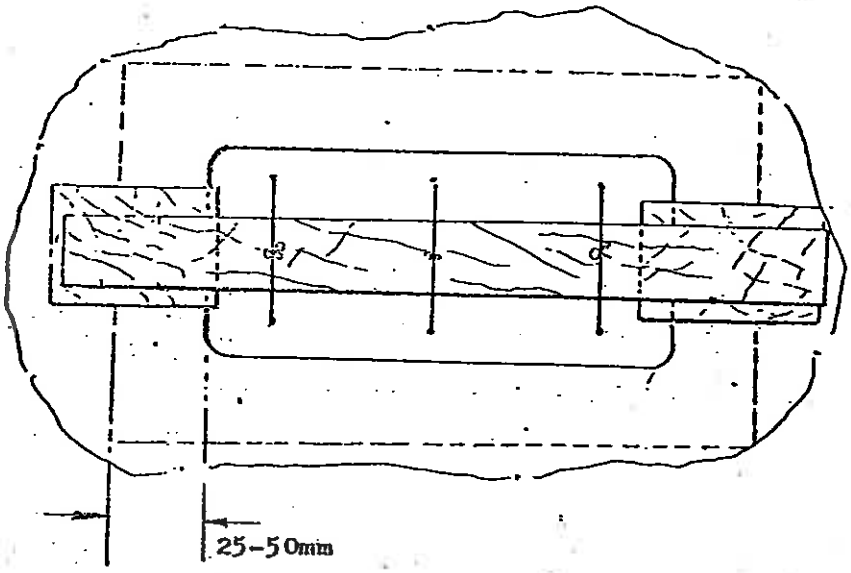
Finishing Glass Fibre Repairs

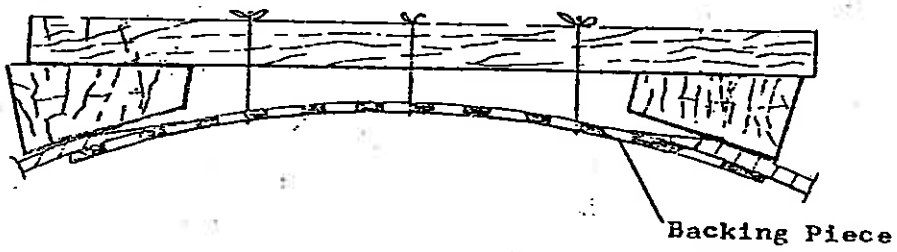
In general, most repairs will not have a moulded surface and require painting with gel coat and polishing to match the surrounding surface. This should be done as follows:

1. The rough edges of the repair should be sanded off and blended in with the surrounding surface.
2. The laminate surface is now abraded. Care must be taken not to damage too many of the surface fibres. Laminated glass cloth has a rough surface texture due to the fabric weave. To eliminate the weave texture, polythene film may be smoothed over the finishing laminate whilst it is still wet. When the laminate has hardened and the cellophane is removed it will be found that a smooth surface results which may be lightly abraded without damage to the surface fibres.

   If it is necessary to remove any humps caused by cloth creases, etc., then it is likely that the fibres will be completely cut through and in this case a further repair to the cloth damage is required.
3. A thin layer of activated gel coat is now painted over the abraded surfaces and allowed to just dry.
4. A second coat is now brushed on and allowed to cure hard.
5. The gel coat is now sanded smooth, and the surface should be free from imperfections and have a good depth of colour. If further coats are required paragraphs 3 and 4 should be repeated.

   Note - that if fresh gel is to be applied onto a cured gel coat the hard surface must first be lightly abraded to provide a key.
6. Preferably all repairs should now be post cured (ref. Data sheet 1 Page 2 and Data sheet 100). However if the repair is only of a minor nature post curing is unnecessary.





Bond Backing piece
Using Cotton Flock

Single Skin Repair

Fig.1

Not to scale

4. The repair is now laminated as described in Data sheet No. 16. Only the same number of layers as the original are laminated at this stage, (Fig. 2).

5. The repair is inspected according to Data sheet No. 18.

6. The patch is now prepared for the finishing layer as follows:-

   (i) Rough edges sanded flush.

   (ii) Surface abraded ready for further laminating.

   (iii) Surrounding 50mm. gel coat ground off.

7. The finishing layer of cloth is now laminated as shown in Fig. 3 and polythene smoothed over the wet surface. The finishing cloth should be 90070 or similar thin cloth. A heavier cloth will require more work to produce a smooth invisible repair.

8. When the finishing layer has hardened, remove the polythene and inspect according to Data sheet 18.

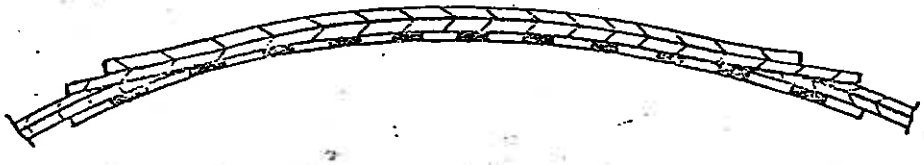
9. The repair is now finished according to Data sheet 19.

Single Skin Repair

This data sheet describes the repair of single skin damage when it is readily accessible from both sides.

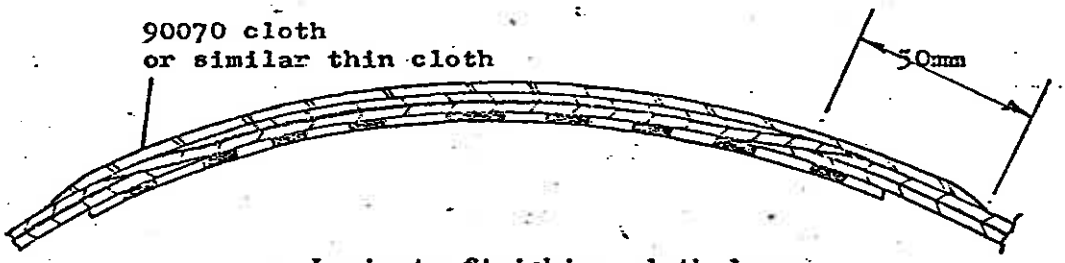
A satisfactory repair could be made exactly as described in Data sheet 20. However, because of the easy accessibility the repair may be laminated up from the inside against a backing piece that is removed after the repair has hardened. This method of repair can give a smooth moulded finish to the external surface.

1. Work through Data sheet No. 14.
   The edges around the hole to be repaired should be chamfered at an angle of 1:30 minimum. Note that in this repair the inside edges are chamfered since the repair is made from the inside, (see Fig. 1).
2. The repair backing piece is made directly from the glider by using the opposite symmetrical position as a mould. Two layers of 90070 cloth are laminated on the opposite symmetrical position to the damaged area, (Fig. 2) and before release the surface is sanded smooth and finished with fine carborundum paper. When the lamination is released and turned inside out it becomes the required backing piece.
3. The moulded backing piece is wax released, positioned over the damage hole and bonded to the surrounding area with impact adhesive, Fig. 3.
4. If the repair area is large, the backing piece may be gel coated before laminating any cloth. This means that only the edges of the repair will require final finishing with gel coat. Two gel coats should be brushed on, the first coat should be just dry before the second is applied, and this second coat must also be just dry before laminating begins. Each gel coat should stop approximately 10mm. from the hole edge to avoid any chance



Laminate cloth patches
Same number of layers as original

Fig.2



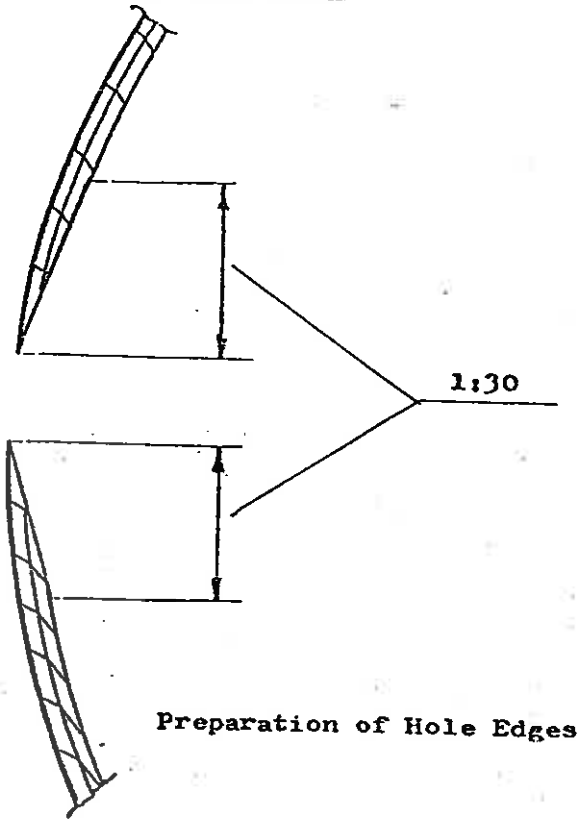
Laminate finishing cloth layer
smooth polythene over

Fig.3

Single Skin Repair

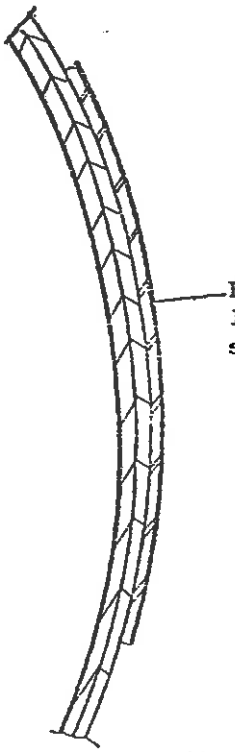
Not to scale

Single Skin Repair
Accessible from both sides



Preparation of Hole Edges

Fig.1



Backing piece made from the opposite
symmetrical position to the repair

Fig.2

Not to scale

4. con. of contaminating the edge chamfer.

5. Working from the inside, the repair is now laminated as described in Data sheet 16. Only the same number of layers as the original are laminated at this stage.

6. When cured the repair is inspected according to Data sheet 18.

7. The repair edges are now sanded flush, and the patch surface and surrounding 50mm. abraded ready for laminating.

8. A final layer of cloth (92110 or similar) is now laminated as shown in Fig. 4, and allowed to cure.

9. Inspect the final cloth layer according the Data sheet 18.

10. The backing piece is now released and the repair finished according to Data sheet 19.

Sandwich Structure Repair

Damage to outer skin only

This data sheet covers the repair of damage to the outer skin of a sandwich structure (Fig. 1).

1. Work through Data sheet No. 14.

   The damaged glass fibre should be cut back and also all core damage cut out (Fig. 2).

2. The damaged core is replaced with microballoon filler as shown in Fig. 3. Note that this filler will be heavier than the core it is replacing. If the core damage is extensive, a plug of similar material should be carved to fit the damage hole and padded with microballoons when it is set in position.

3. The core plug is now sanded flush and the skin edges chamfered to an angle of 1:30 minimum using a sanding block as shown in Fig. 4. Care should be taken not to sand the core material substantially below its original depth.

4. Glass cloth is now laminated over the core and chamfered edges according to Data sheet 16. Only the same number of layers as the surrounding skin should be laminated at this stage (Fig. 5).

5. When hard the repair is inspected according to Data sheet 18.

6. The patch is now prepared for the finishing layer as follows:-

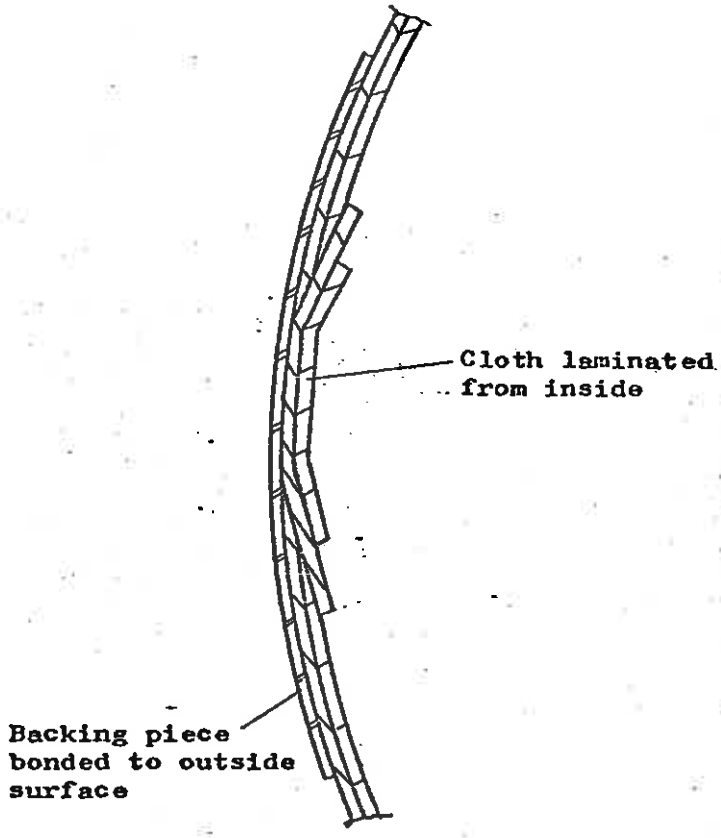
   (i) Rough edges sanded flush.

   (ii) Surface abraded ready for further laminating.

   (iii) Surrounding 50mm. gel coat ground off.

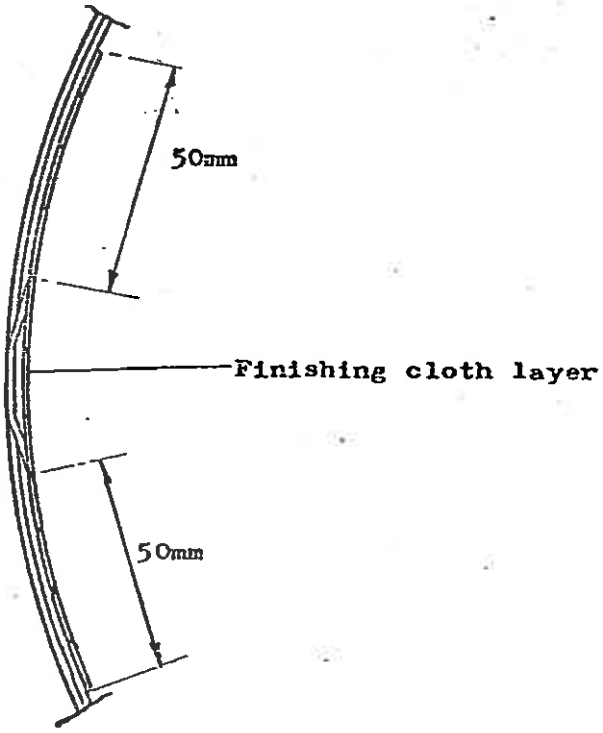
7. The finishing layer of cloth is now laminated over the repair and if required polythene smoothed and fastened over the wet laminate (Fig. 6). The cloth should be 90070 or similar thin cloth. A heavier cloth will require more work to produce a smooth invisible repair.

Single Skin Repair
Accessible from both sides



Laminate cloth layers
Same number as original

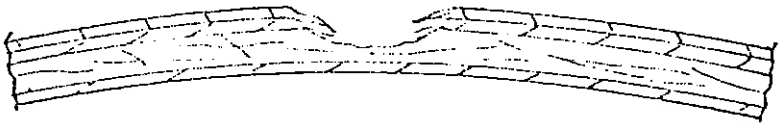
Fig.3



Laminate finishing cloth layer

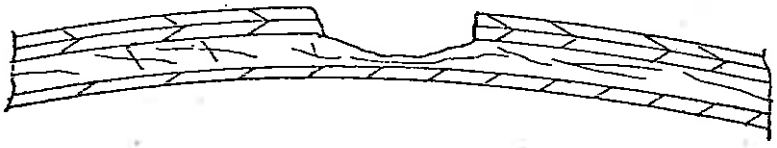
Not to scale

Fig.4



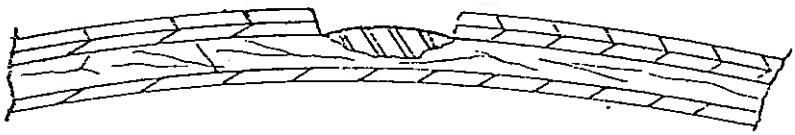
Typical damage to outer skin

Fig.1



Damaged glass fibre cut back

Fig.2



Damaged core replaced with filler

Fig.3

Sandwich structure repair
Damage to outer skin

Not to scale

8. When the finishing layer has hardened, remove the polythene and inspect according to Data sheet No. 18.

9. The repair is now finished according to Data sheet No. 19.

Sandwich Structure Repair

Minor damage to both skins

This data sheet describes the method of repair to a sandwich structure when both skins have only minor damage, (Fig. 1).

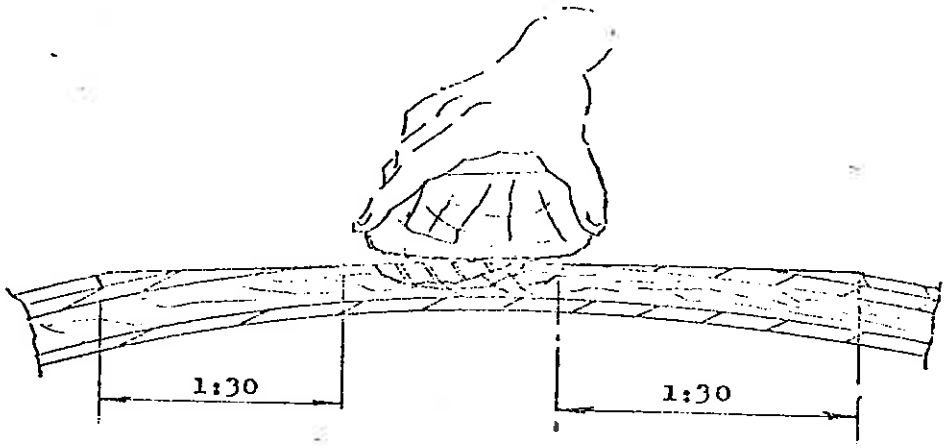
1. Work through Data sheet No. 14.

   The damage to both skins must be cut away until sound material is reached. The hole edges should be chamfered at 1:30 minimum (see Fig. 2) and the core cavity prepared as shown in Fig. 3. Note that although the cavity is regular and straight sided, the hole in the inner skin has radiused corners. If the inner skin is very thin a 1:30 chamfer will be impossible to achieve. In this case a reduced chamfer is acceptable but the cavity must be made large enough to expose a portion of the inner skin surrounding its hole so that there is an overlap of not less than 30:1.

2. The core replacement plug should now be carved to fit the cavity. The plug should be fractionally smaller to allow the inner skin patch to lay between the plug and surrounding core.

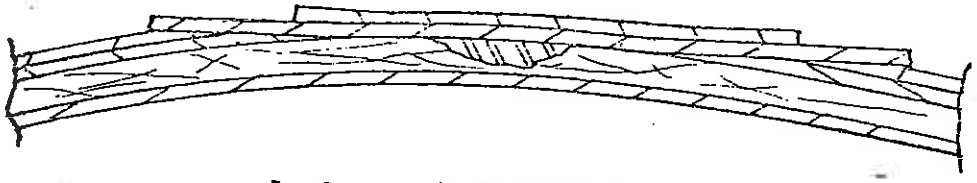
3. The required pieces of cloth are now cut to shape. Note that the inner layers must be large enough to reach up the cavity walls.

4. The sides of the plug are now painted with resin and a ½mm. layer of cotton flock spread over its bottom face. The requisite pieces of cloth for the inner skin are pre-wet out on polythene sheet and then gently positioned over the cotton flock and plug sides. The polythene is now peeled off, (Fig. 4).



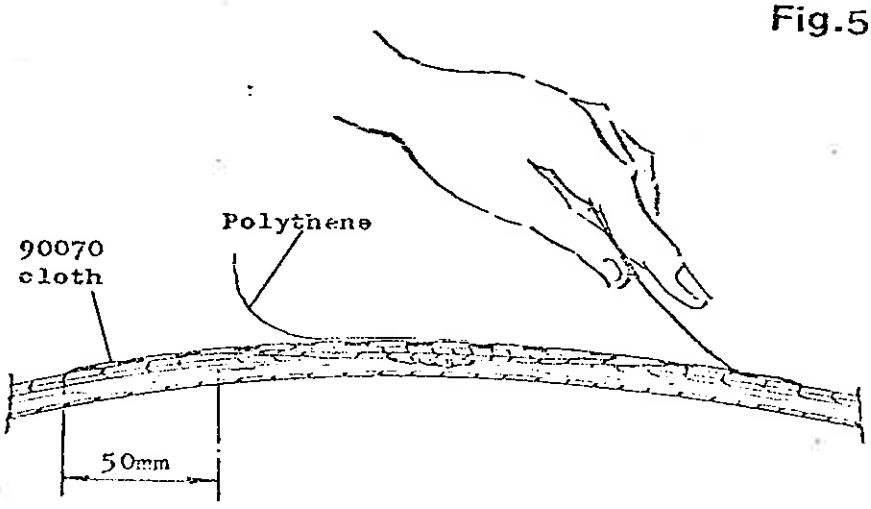
Core filler sanded flush and
Skin edges prepared

Fig.4



Laminate cloth patches
Same number of layers as original

Fig.5

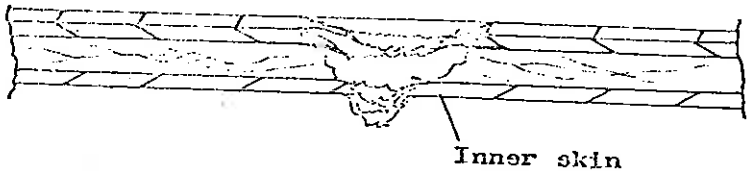


Laminate finishing cloth layer

Fig.6

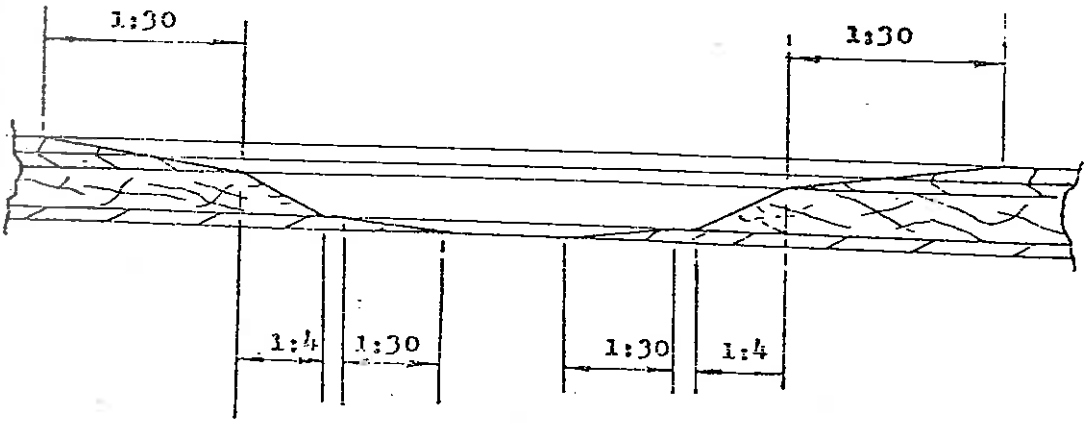
Sandwich Structure Repair
Damage to outer skin

Not to scale



Typical Damage

Fig.1



Preparation of Hole Edges

Scottish Structure Repair
Minor damage to both skins

Fig.2

Not to scale

5. The inner skin and core cavity is painted with resin, the plug positioned, and then pushed firmly home. This will make the cotton flock layer on the plug squeeze up and push the wet cloth into the hole to form a good bond, (Fig. 5). The plug should be held down with weights until the resin has hardened.

6. The plug surface is now sanded flush with the surrounding core surface and outer skin glass fibre edges chamfered to 1:30 minimum.

7. The outer skin layers are now laminated as described in Data sheet No. 16. Only the same number of layers as the surrounding skin should be laminated at this stage, (Fig. 6).

8. The repair is inspected according to Data sheet 18.

9. The patch is now prepared for the finishing layer as follows:

   (i) Rough edges sanded flush.

   (ii) Surface abraded ready for further laminating.

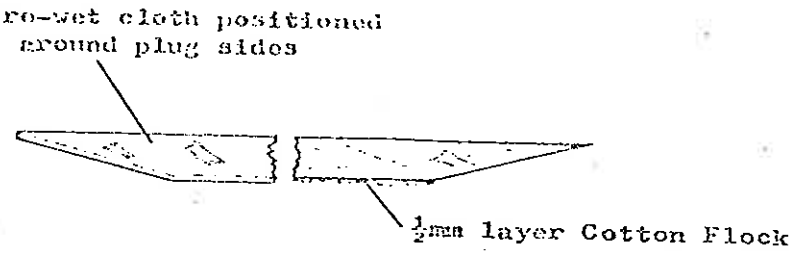
   (iii) Surrounding 50mm. of gel coat sanded off.

10. The finishing layer of cloth is now laminated over the repair and polythene smoothed over the wet laminate, (Fig. 7).

    The cloth should be 90070 or similar thin cloth. A heavier cloth will require more work to produce a smooth invisible repair.

11. When the finishing layer has hardened, remove the polythene and inspect according to Data sheet 18.

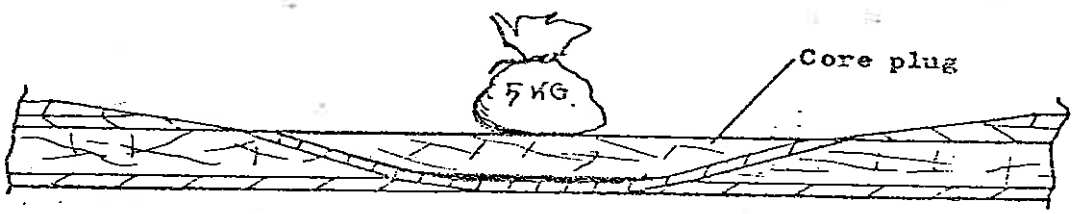
12. The repair is now finished according to Data sheet 19.



Positioning of cloth around plug

L/H side shows an external view
R/H side shows a section through the centre line

Fig.4

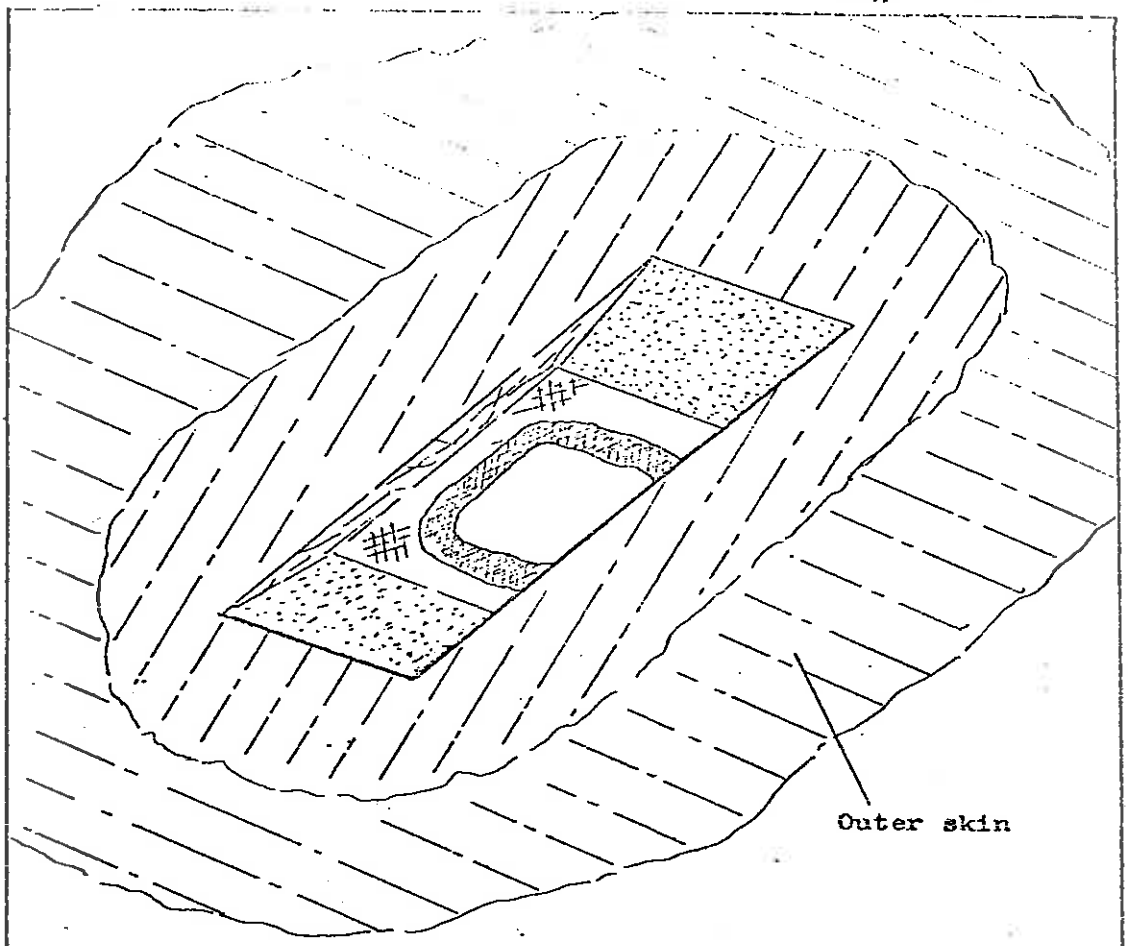


Plug inserted in core cavity

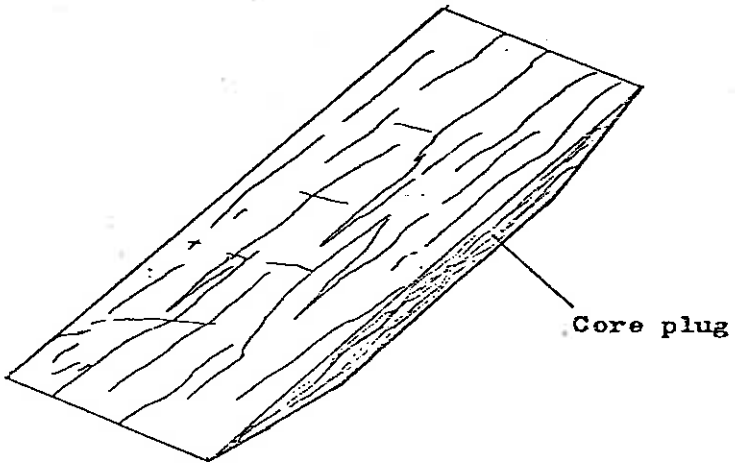
Fig.5

Sandwich Structure Repair
Minor damage to both skins

Not to scale



Cavity runs parallel to core grain (if Balsa)



Preparation of core cavity

Fig.3

Sandwich Structure Repair
Minor damage to both skins

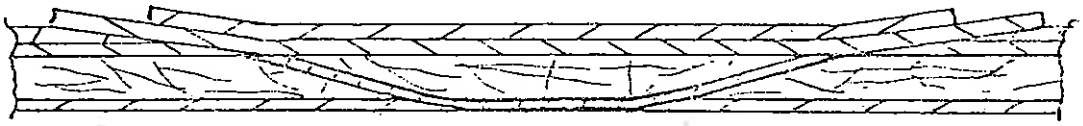
Not to scale

Sandwich Structure Repair

Major damage to both skins

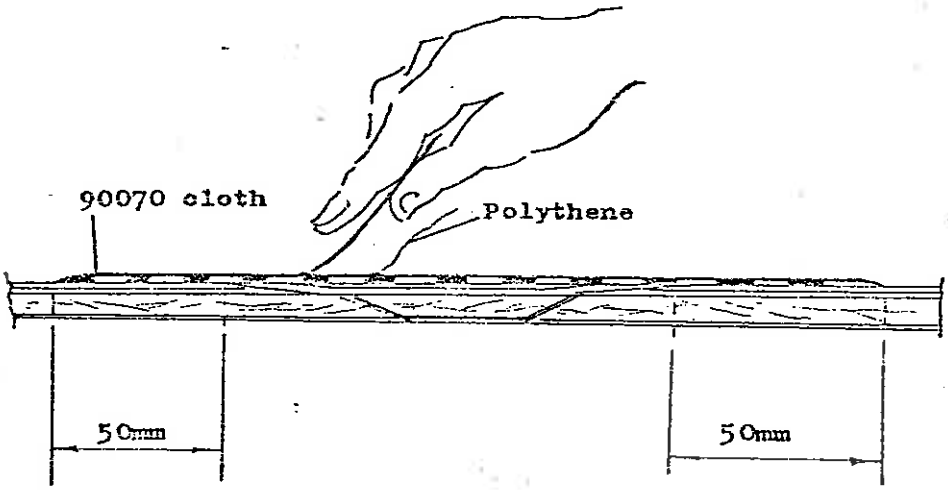
This data sheet describes the method of repair to a sandwich structure when both skins have major damage.

1. Work through Data sheet No. 14.
   The damage to both skins must be cut away until sound material is reached. The hole should be prepared as shown in Fig. 1, and the core cavity prepared as described in Data sheet No. 23, paragraph 1.
2. A backing piece must be used to enable a repair to be made that conforms to the original structure curvature. The backing piece is cut from thin plywood, rigid foam, or similar and if possible should be about 25-50mm. larger all round than the inner skin hole. It is passed through the hole and bonded with cotton flock to the "blind" side of the inner skin as shown in Fig. 2.
3. When the cotton flock has cured the clamping wires and supports are removed.
4. The core replacement plug should now be carved to fit the cavity. The plug should be fractionally smaller to allow the inner skin patch to lay between the plug and surrounding core.
5. The required pieces of cloth are now cut to shape. Note that the inner layers must be large enough to reach up the cavity walls.
6. The inner skin layers are now laminated in place according to Data sheet 16. A thin layer of approx. $\frac{1}{2}$mm. of cotton flock is smeared over the plug bottom and chamfered faces, and resin is painted on the vertical faces. The plug is now pushed firmly down into the cavity, Fig. 3, and held to the curvature with weights until the resin has cured.
7. (See Fig. 4 & 5). The repair is now completed as described in Data sheet No. 23 sections 6 - 10.



Laminate cloth patches
Same number of layers as original

Fig.6

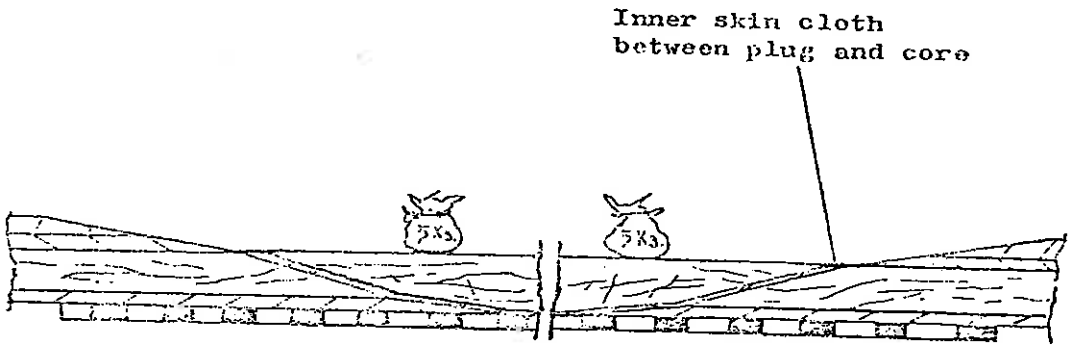


Laminate finishing cloth layer

Fig.7

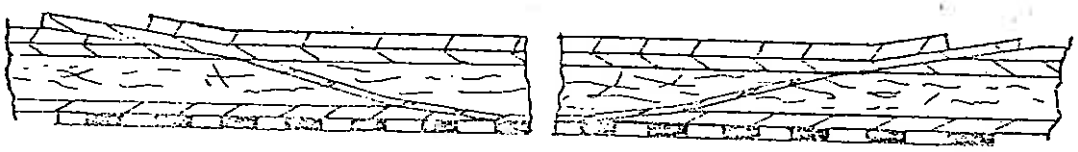
Sandwich Structure Repair
Minor damage to both skins

Not to scale



Core replacement plug inserted in cavity

Fig.3

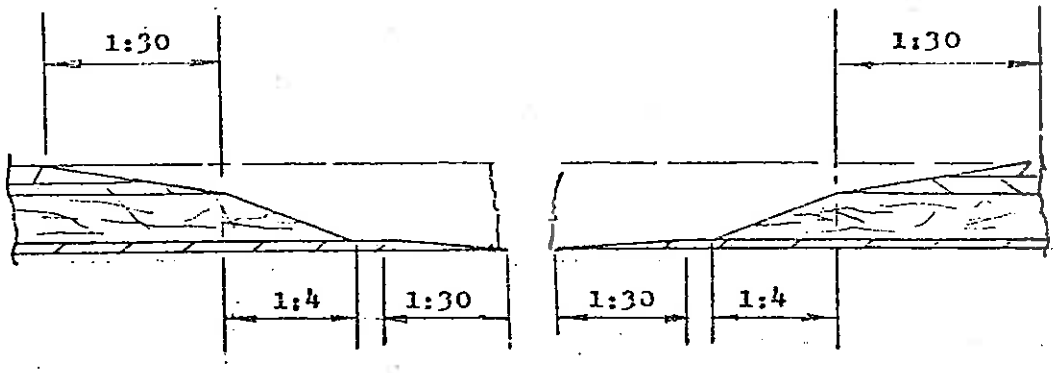


Laminate Outer skin layers
Same number of layers as original

Fig.4

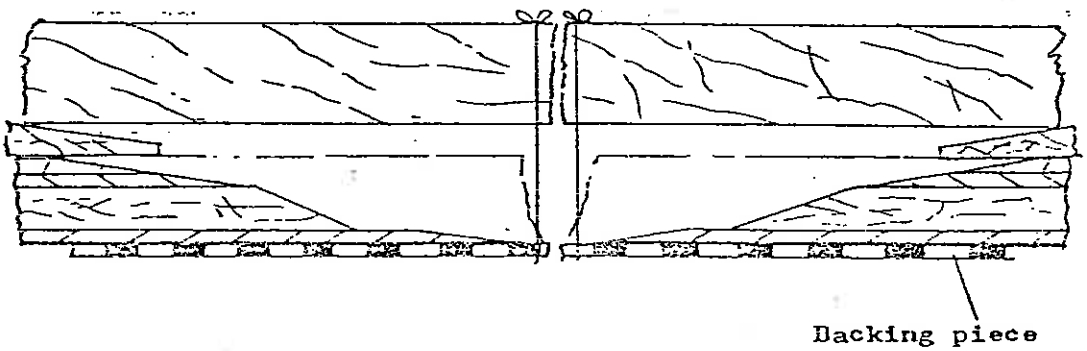
Sandwich Structure Repair
Major damage to both skins

Not to scale



Preparation of hole edges

Fig.1



Bond backing piece
Using Cotton Flock

Fig.2

Sandwich Structure Repair
Major damage to both skins

Not to scale

Sandwich Structure Repair

Major damage to both skins - Alternative to Data sheet 23.

1. Work through Data sheet 14.

   The damage to both skins must be cut away until sound material is reached. The hole should be prepared as shown in Fig. 1. The edges should be chamfered at 1:30 minimum and 25mm. of the inner skin inner surface around the hole lightly abraded. A 1:30 chamfer will be impossible to achieve if the inner skin consists of only one layer of cloth. In this case a reduced chamfer is acceptable but the overlap must not be less than 30:1.

2. A backing piece of thin plywood or rigid foam is cut to the inner hole size plus 25mm. all round.

3. The inner skin patch pieces are now cut to shape and should be the same size or slightly smaller than the backing piece (weave direction matching the original).

4. The patch pieces are now laminated, (according to Data sheet No. 16) onto one side of the backing piece.

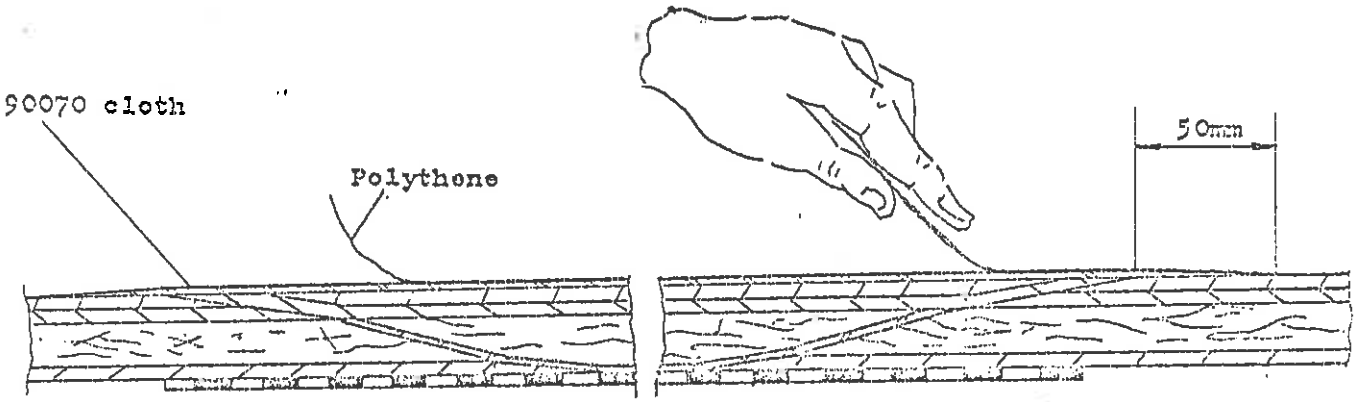
5. Using a small brush through the hole, resin is painted on the prepared surfaces of the inner skin. The backing piece complete with laminated wet cloth is passed through the hole and pulled up to the skin as shown in Fig. 2.

6. When the inner patch has cured the clamping wires and supports are removed. The joint between the replacement cloth and the original skin should be inspected. If any gaps are apparent the patch is unsatisfactory and should be carefully stripped off before a fresh attempt is made.

7. A core replacement plug is now carved to fit the cavity, and the new inner skin surface lightly abraded.

8. The plug is now fitted into the cavity using microballoon bonding paste as a padding material. Weights are used to hold the plug down until the microballoon mix has set.

9. The repair is now completed as described in Data sheet No. 23 sections 6 - 10.



Laminate finishing cloth layer

Fig.5

Sandwich Structure Repair
Major damage to both skins

Not to scale

Repair of Worn Bushes

Worn bushes may be rebuilt using a resin based filler material which has good bearing properties.

If the bush carries a moving part its material will have a white colour and probably have a P.T.F.E. constituent. The filler mixture required is as specified on Data sheet 107.

If the bush carries a non moving part its material will have a neutral glass fibre colour and the filler mixture required is as specified on Data sheet 108.

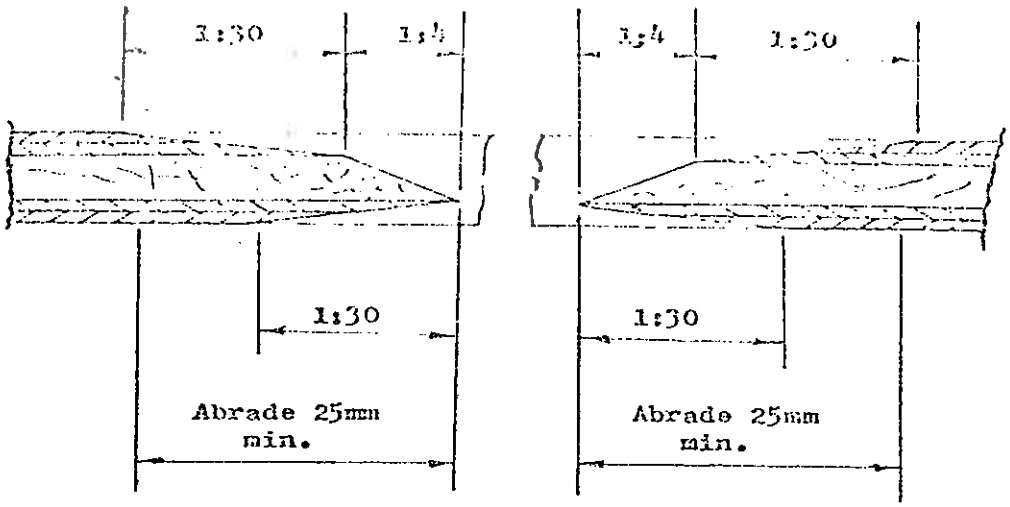
Depending upon the degree of wear there are two alternative repair methods as follows:

A. The bush is rebuilt around an undersize mandrel which is removed after the resin has set. The resulting hole is then reamered out to size. This method is used when the amount of wear is slight and only a very thin layer of filler is required to bring the bush back to size.

B. The bush is rebuilt exactly to size around the actual bearing member (or a mandrel of identical size).
This method is used when the thickness of filler required is fairly large.

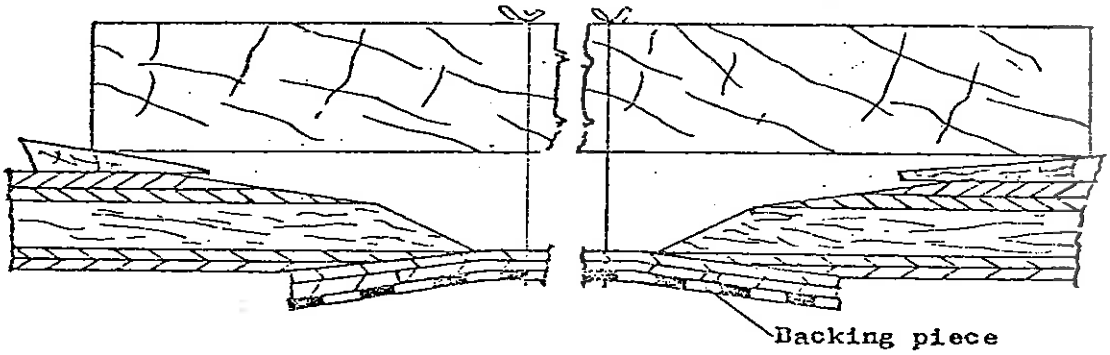
The general repair technique is as follows:-

1. Set bush axis vertical.
2. Degrease and abrade the bore as described in Data sheet 15 section A.
3. Blank off the lower end of the bush with a backing piece (Fig. 1.).
4. If the mandrel is tubular, blank off one end.
5. Wax release the mandrel surface.
6. Estimate the quantity of filler required. Mix it gently to avoid stirring in air, if possible leave to stand for 10 mins., and then pour it into the bush hole (Fig. 2).



Preparation of hole edges

Fig.1

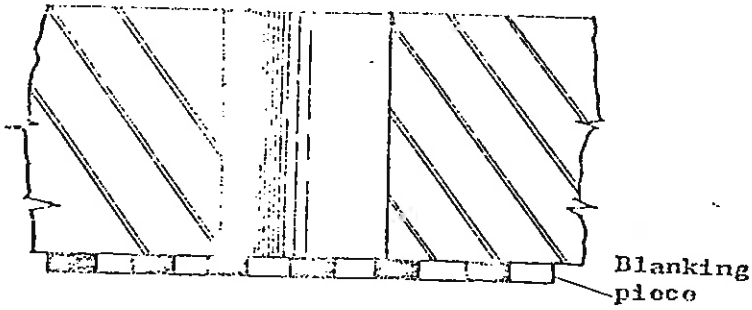


Backing piece and inner skin
Patches secured in place

Fig.2

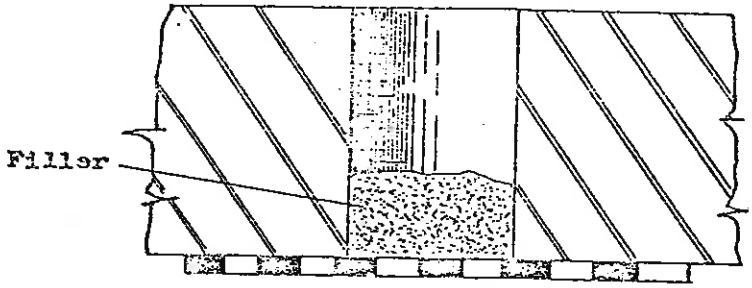
Sandwich Structure Repair
Major damage to both skins

Not to scale



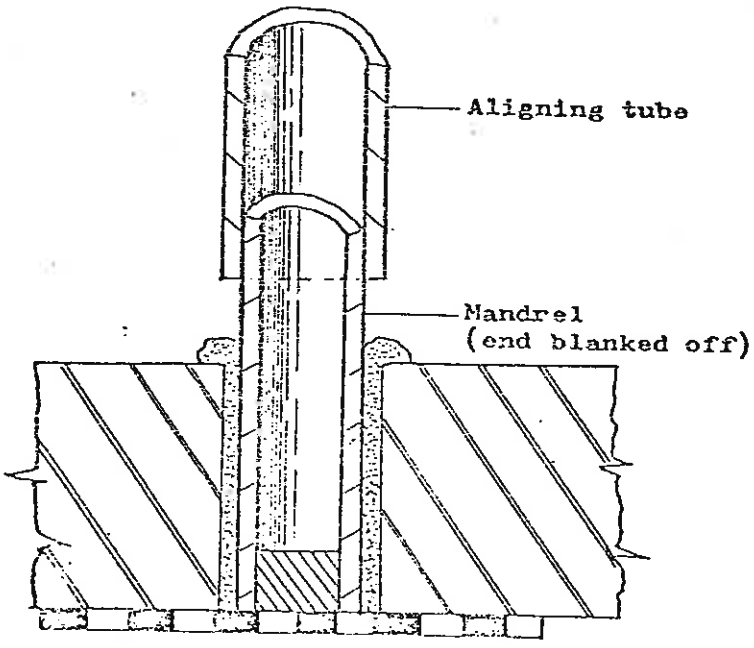
Lower end of bush blanked off

Fig.1



Filler poured into bush hole

Fig.2



Mandrel pushed into bush bore and aligned with opposite mating bush

Fig.3

Repair of Worm Bushes

Not to scale

7. Gently push the mandrel to the bottom of the bush. This forces the filler up the annulus and any surplus out of the top.

8. If the bush has an opposite mate, the mandrel must be aligned with it and secured until the filler has set (Fig. 3).

9. The mandrel is now removed, and if required, the bush is reamered to size.

10. The bush surface should be examined and must be found void free. If any voids are present the effective bearing area is reduced and the filler strength lowered. In this case, the filler must be completely removed and a fresh attempt made.

If the curvature is different, the sides of the preform should be snipped to allow it to bend easily (Fig. 2). Cotton flock is smeared along the edges and the rib held in position under pressure until secure.

4. The skin on both sides of the stiffener is now abraded, also the first 30mm. of the neighbouring undamaged stiffener ends.

5. The load bearing cloth for the stiffener is pre-laminated on polythene or cellophane film, (Data sheet 17). To do this the outside layers of the stiffener are laminated first (note fibre directions). Glass rovings are laid along the centre and then the final (innermost) layer of cloth is laminated, see Fig. 4. The layers must be well consolidated and the roving ends should protrude by a few millimetres.

6. The stiffener and prepared surfaces are painted with resin and the pre-wet laminate positioned over the stiffener. The rovings must lie along the stiffener ridge and the wet laminate should overlap by 30mm. onto the neighbouring stiffener ends. The cellophane is slowly peeled off and the exposed cloth stippled into place. Air bubbles between the stiffener former and the wet laminate are unimportant but none must exist in the joint between the wet laminate and the skin. When the laminate is in place the roving ends are snipped off and the repair allowed to harden.

7. The repair is now inspected and post cured.

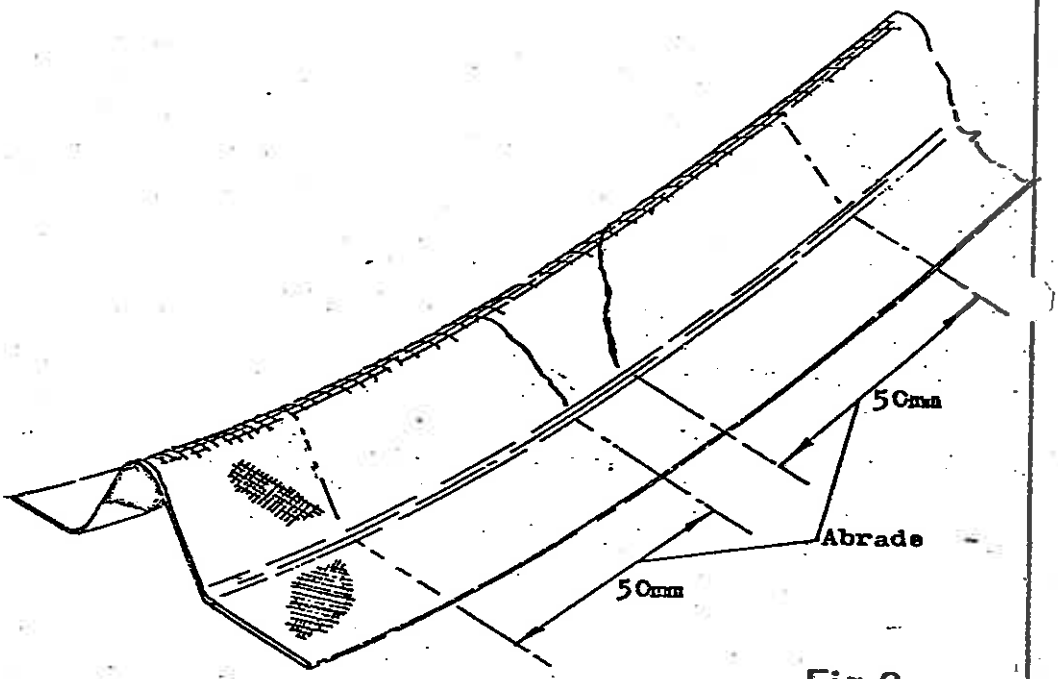
Repairs of Stiffeners

Triangular section

This data sheet describes the repair of triangular section stiffeners.

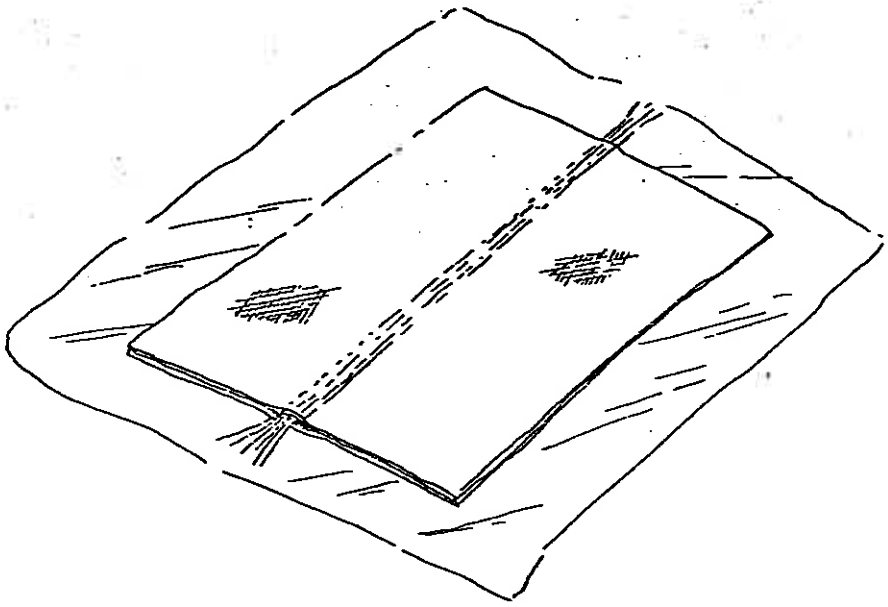
Triangular stiffeners have unidirectional rovings along their apices. If necessary the number of rovings can be ascertained from the manufacturers before the stiffener is repaired.

1. An internal stiffener can only be satisfactorily repaired from the inside and the skin to which the stiffener attaches must previously have been repaired.
2. If the stiffener is slightly cracked a satisfactory repair can be made directly on top of the damage. (This is the only case when a repair may be made directly over existing crack damage). The stiffener is prepared for repair by abrading 50mm. either side of the damage and also the skin either side of the stiffener (Fig. 3). The repair is then made following section 5 onwards.
3. If the damaged has resulted in the loss of the stiffener form, a shaped former must be made to provide a backing for the structural cloth during laminating.
   There are two different methods of creating this former, as follows:
   (i) A core is carved out of polyurethane foam or expanded polystyrene.
   (ii) A light glass fibre preform is made using the opposite symmetrical stiffener as a mould (Fig. 1). Cellotape is stuck along the rib as a release agent, and a single layer of cloth laminated over. When this is released (and the cellotape stripped from the moulding area) surplus laminate is trimmed back to the stiffener base and it is tried against the skin in the repair position.



Slightly cracked stiffener

Fig.3

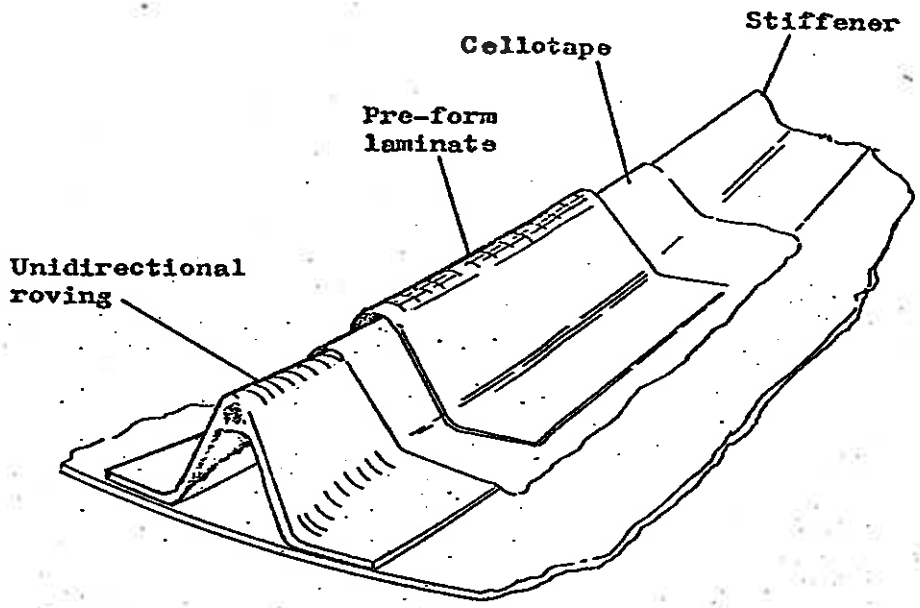


Pre-laminated Stiffener cloth

Fig.4

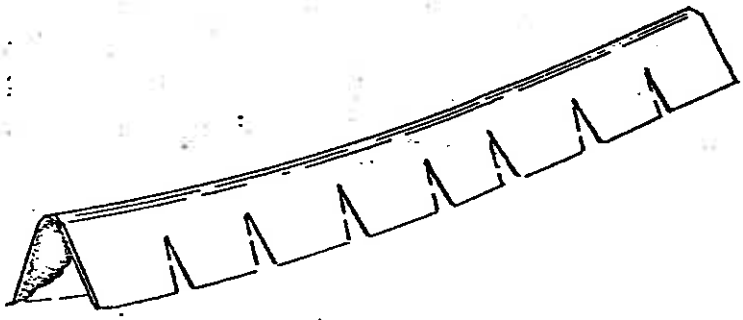
Triangular Section Stiffener Repair

Not to scale



Moulding a stiffener pre-form from an opposite symmetrical stiffener

Fig.1



Pre-form sides snipped to allow it to bend

Fig.2

Triangular Section Stiffener Repair

Not to scale

5. The finishing layer of cloth is now laminated over the repair and polythene smoothed and fastened over the wet laminate.

6. When the final layer has hardened, remove the polythene and inspect according to Data sheet No. 18.

7. The repair is now finished according to Data sheet No. 19.

If the trailing edge damage extends beyond the bond line and the structure has single skin surfaces the skin repair is made in a similar manner to that described in Data sheet 20.

Control surfaces with sandwich structure skins which have damage extending beyond the bond line into the skins are repaired in a similar manner to Data sheet 24.

Note that the balance of control surfaces may be disturbed if too much extra weight is added to their trailing edges.

Repair of Damaged Trailing Edges

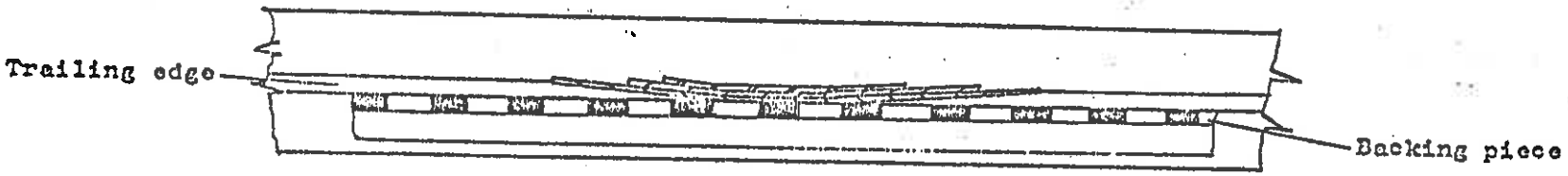
This data sheet outlines the repair of damaged trailing edges on ailerons or flaps.

The trailing edge may split cleanly open. If the split is less than 15mm. the two halves should be prised apart a little and resin squeezed into the gap. The two sides are then clipped together until the resin has set.

If the split is greater than 15mm. the two halves are opened and the mating surfaces abraded. Resin is painted on both surfaces and a thin layer of cotton flock spread on one surface. The joint is then clipped together until the resin has set.

If a piece of the edge is missing but the two halves are still jointed together (Fig. 1) then the edge must be rebuilt with cloth as follows:

1. Cut back all damaged glass fibres from the edge.
2. Grind away the gel coat and chamfer the surrounding skin towards the damage (Fig. 2). Grind the damage to a feathered edge if possible but do not remove any more material than is absolutely necessary.
3. Fix a backing piece across the trailing edge gap, and laminate cloth over the damage. Laminate extra cloth layers over the trailing edge so that the missing portion of the trailing edge is nicely built up level and leave to cure, (Fig. 3).
4. The backing piece is now removed and the repair inspected according to Data sheet 18.
5. The repair is now prepared for the finishing layer as follows:
   (i) Rough edges sanded flush.
   (ii) Surface abraded ready for further laminating.
   (iii) Surrounding 30mm. of gel coat sanded off.

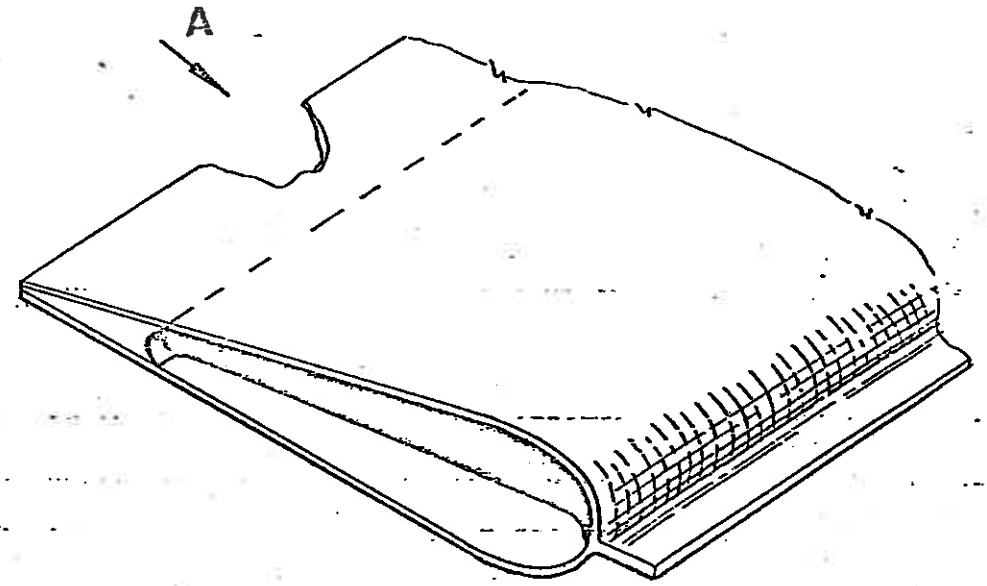


Lamination of patch layers
(View on Arrow A Fig. 1)

Fig.3

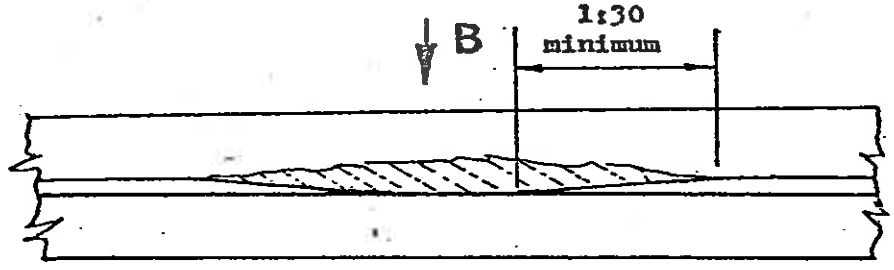
Trailing Edge Repair

Not to scale



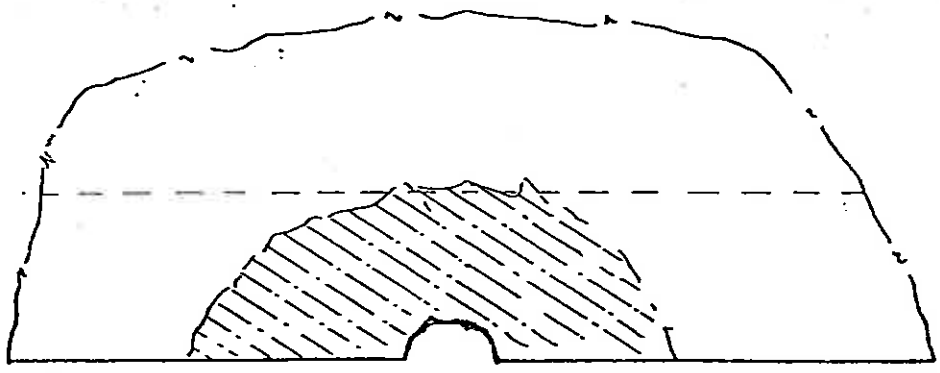
Trailing edge damage

Fig.1



Preparation of damage
View on Arrow A

Fig.2



Preparation of damage
View on Arrow B

Fig.2[a]

Trailing Edge Repair

Not to scale

8. When hardened, rough edges of cloth are sanded off and the repair is gel coated.

9. Post cure for 8 hours at 54°C before use.

Latch Pin Repair

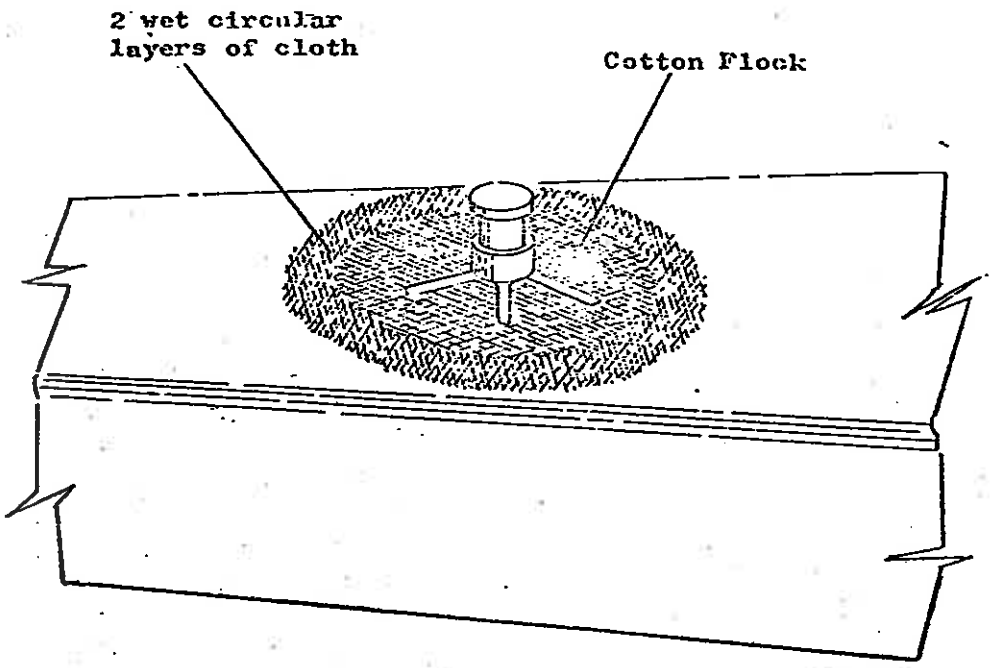
This data sheet describes the repair of broken latch pins on the wing roots. The strength of the latch pins is deliberately limited to prevent undue force being applied to the wing roots when rigging the glider.

1. Grind away the remnants of the pin barrel until it is flush with the surrounding surface. Do not remove any glass fibre that belongs to the root stump.
2. Degrease the latch pin area.
3. Abrade a circular area approximately 75mm. diameter around the old latch pin centre. (Remove all the gel coat).
4. Degrease the feet of the new latch pin.
5. Cut out 8 circles of 92125 cloth, each circle reducing in approximately 4mm. steps from 75mm. down to 47mm. diameter.
6. Laminate the 71mm. circle onto the centre of the prepared area, followed by the 67mm. circle.
7. Before the layers of paragraph 6. are cured the new latch pin is positioned in the same spot as the previous one and cotton flock spread around the feet, (Fig. 1).
8. The remaining cloth circles are now laminated over the latch pin. The circles are laminated in order of decreasing diameter, starting with the 63mm. circle and working through to 47mm. diameter. Finally the 75mm. circle is laminated over the whole lot. The fibres in the circle centres should be displaced sideways to pass around the pin barrel (Fig. 2), and the fabric direction of each layer staggered from the preceding one.

Repair of Damaged Fittings

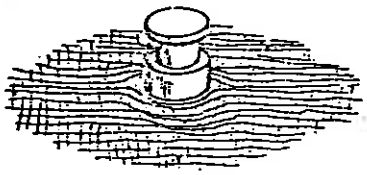
Load bearing fittings which are damaged or torn from their location are generally reset only after the surrounding structure has been repaired. Unidirectional rovings are often used to secure fittings. On any repair, care must be taken to ensure that the fitting is secured in exactly the same manner to that before damage. Jigging of the fixture to ensure correct position may be required.

Most fittings will be irrepairably damaged if torn from their mountings. New parts should be obtained from the manufacturer, who will also prepare a possible repair scheme if requested.



Latch pin positioned with Cotton flock

Fig.1



Glass fibres displaced to
pass around latch pin

Fig.2

Latch Pin Repair

Not to scale

Replacement of Canopy Transparencies

1. Carefully remove the wing root fairing from the aft portion of the canopy by peeling it off. These are required later to fix to the new moulding; take care not to damage them.
2. Remove the damaged canopy moulding by removing all the screws holding the perspex to the frame.
3. The new transparency will fit the existing frames if it is placed in the correct position. This can be found by constructing the jig shown in Fig. 1. This is not essential but if this system is not adopted it may be necessary to remove or add large amounts of G.R.P. at the centre frame.
4. Having ascertained the position of the bubble fit the aft portion to the frame as follows.
5. Attach the bubble to the canopy frame using one screw at the front of the frame and one at the back, both on centre line. Fit the frame to the aircraft making cut-outs where necessary. Mark all the trim lines with masking tape, remove the bubble and trim the canopy.
6. Proceed in a similar way as 5. for the front canopy but here the trimming should be carried out in stages.
7. Refit the transparencies to the frames with the centre screws. Proceed around the moulding drilling alternate holes in the transparency and fitting a screw as each hole is drilled.
8. Drill and countersink the intermediate holes.
9. Fit screws in the holes drilled at 8.
   Remove the screws from the holes not countersunk and countersink these.
10. Check that the transparencies are seated well. Put a strip of masking tape on the inside of the transparencies to protect them during bonding and remove the transparencies.

Abrade the contact area of the frame and transparency and degrease the areas using detergent solution. Leave to dry.

11. Cover the canopy surround on the fuselage with sellotape to prevent the canopy becoming bonded to the fuselage at operation 12., and mask off the transparency.

12. Fix the canopy frame to the aircraft and spread a thin layer of microballoon mix onto the frames and screw the transparencies on. Leave to cure (12 hours at 20°C).

13. Replace the fairing section removed at 1. by first abrading and degreasing the bonding surfaces as at 10. and then bonding with epoxy resin mix. Allow to cure (8 hours at 20°C).

14. Make good any edges using glass flock resin mix and fill screw holes using cataloy filler or similar.

15. Finally finish with gel coat as on the previous canopy.

Repair of damaged rigging bushes

This Data Sheet describes the method of replacing badly damaged rigging bushes in Kestrel wing forks. This repair is concerned entirely with primary structure, the utmost care must therefore be exercised at all stages. If during the repair any further damage is caused to the main wing spar member or to the root rib, the manufacturer should be contacted before proceeding.

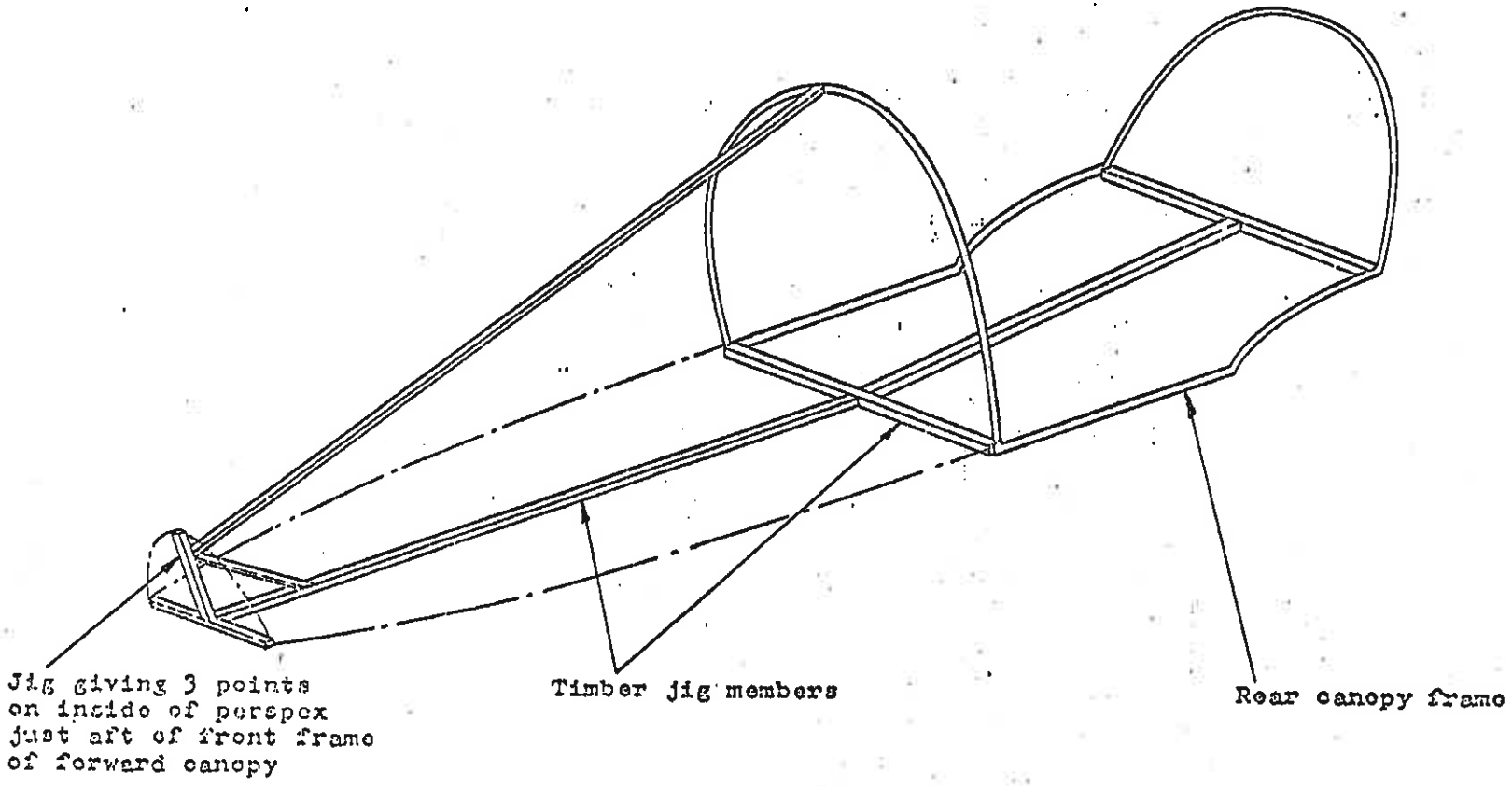
If the bushes are damaged on the inside face only, with no damage to the surrounding cloth, or if the damage to the surrounding cloth affects only the top few layers of cloth, the repairs may be effected by using Data Sheets 13, 20 or 26.

This repair should not be attempted by any person who is not fully conversant with glass fibre glider repairs.

1. With a sharp chisel carefully remove the glass fibre bandaging (Figs.1 and 2) from all the wing forks and also the side cloths from each side of the wing forks (6 layers each side of the Port forks, 11 layers each side of the Starboard forks, as shown in Fig.3). A note should be kept of how many layers have been removed and care should be taken to ensure that no more than the specified number are removed. If more are removed, then further repair work cannot be carried out on the wing.

   Drill out the damaged bushes and abrade the forks with aluminium oxide paper ready to receive the lay-up as described in Data Sheet 15 - A.

2. The cloth used throughout the repair is Interglas 92125, as described in Data Sheet 102. Before laying up, cut the cloth to the correct size to fit along the sides of the forks. Care should be taken when cutting cloth not



Manufacture jig similar to that shown above with rear removable canopy in position on aircraft. Construct forward part of jig to give 3 points of contact on the inside face of perspex just aft of front frame of forward fixed canopy.

Perspex can then be fitted over jig in correct position and frame positions marked for cutting lines.

Fig. 1.

2. (Contd) to stretch the material or distort the weave of the fabric. To obtain the correct size of glass cloth, the best method is to make paper templates of the area which is to be covered, lay them on to the roll of cloth and cut round them leaving about half an inch extra to allow for any stretching of the cloth when laying up. The cloth lay-up should always be at 45° to a free edge as shown in Fig.4, therefore, special care should be taken to ensure the correct fibre direction at the cloth cutting stage.

Note: Under certain lighting conditions there will appear to be a definite grain in the cloth; this does not follow the direction of the fibres and should be ignored.

3. Lay-up the side cloths as shown in Fig.3 as described in Data Sheet 16. The resin mix used is Epikote 162 (Date Sheet 100). Special care must be taken to ensure that the fibres of material are layed up at 45° to the edges of the forks as described above. The finished lay-up should be cured at room temperature for 24 hours and the lay-up inspected with reference to Data Sheet 18. The excess cloth can then be trimmed off using a rotary grinder and the sharp edges rounded off using a sanding block.

4. New bushes can be obtained from the manufacturers (1 off Part No.59C-20-23, starboard bush, 2 off Part No.59C-20-22, port bushes). The correct position for the bushes can be obtained by rigging the aircraft and marking the position of the rigging pin on the forks.

Note: Great care must be taken to ensure that the wings are fully rigged, i.e. all the locating pins at the ends of the forks are fully home in their sockets.

Carefully drill a 20 mm clearance hole through the forks using a stand drill. The new bushes should be

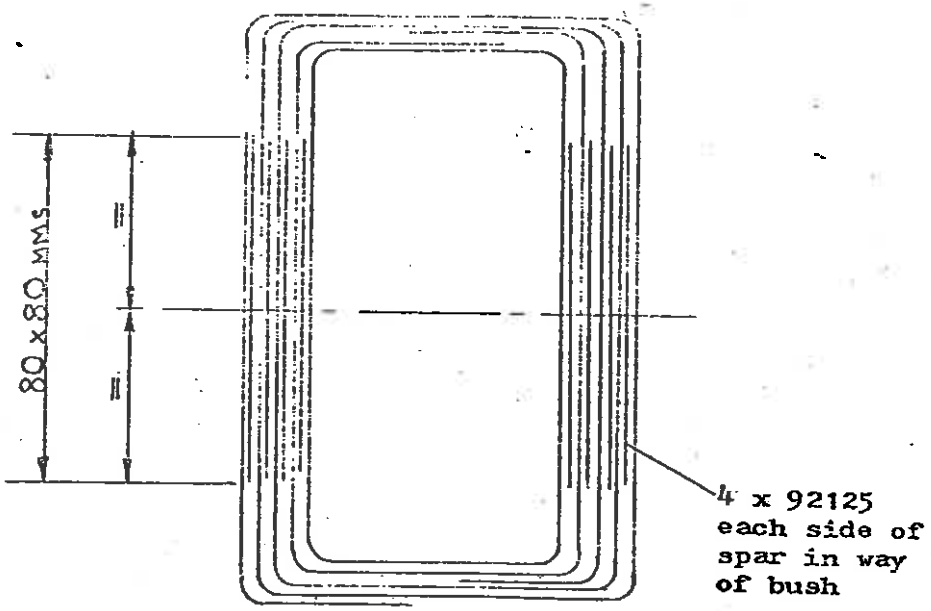
4. contd. degreased and abraded as described in Data Sheet 15A and then glued into position with a cotton flock mix (Data Sheet 106). To ensure that the bushes are aligned correctly the wings should be rigged together with the rigging pin (Part No.59A-00-10) until the cotton flock has cured for 24 hours at room temperature.

5. The surface of the forks can now be abraded prior to the bandaging lay-up. The lay-up of the bandaging and intermediate squares is shown in Figs.1 and 2. The best method for cutting these cloths to the correct size is to cut strips of cloth 660 mm wide from the roll (Fig.2). These strips can then be cut to the correct length during the laying up procedure. These cloths must also be laid up with the cloth fibres at 45° to the edges of the forks as shown in Fig.4. The resin used for the lay-up is Epikote 162 (Date Sheet 100) and the glass fibre cloth is Interglas 92125 as described in Data Sheet 102. The cloth is layed up around the forks as shown in Fig.1(Port lay-up) and Fig.2(Starboard lay-up) with 80 x 80mms square cloths layed up around the bushes after each bandaging layer. A sharp implement, such as the point of a pair of scissors is used to carefully displace the fibres of the cloth around the bush and rigging fixtures. (An example of this type of process is shown in Fig.2, Data Sheet 29). All the layers, bandaging and intermediate squares are arranged around the bushes as described above. When the lay-up has been cured (24 hours at room temperature) all the sharp edges are removed with a sanding block and the lay-up is inspected as described in Data Sheet 18.

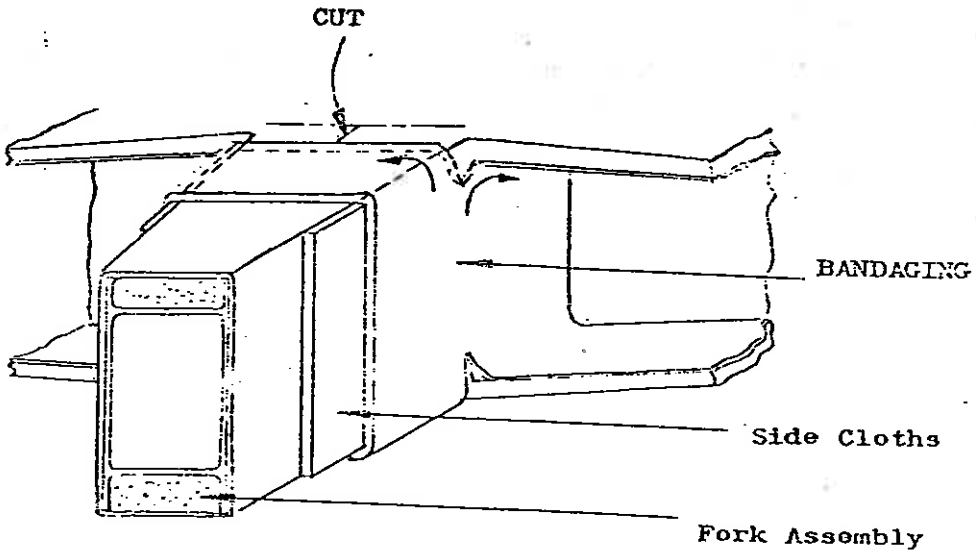
6. The repair can then be finished according to Data Sheet 19 if required.

7. The whole repair scheme should then be post-cured for eight hours at 54°C.

Fig.1 (PORT LAYUP)

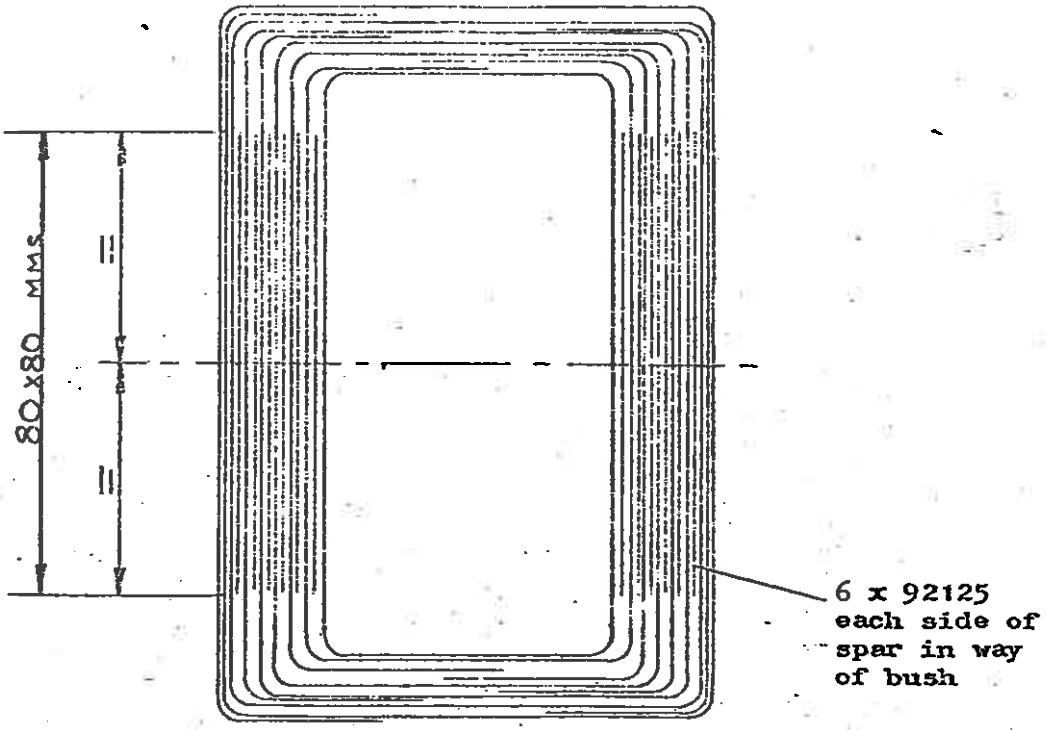


DIAGRAMMATIC METHOD OF BANDAGING BOTH FORKS OF PORT SPAR



ROOT FORK SHOWING METHOD OF CUTTING AND FOLDING BANDAGE (ALL FOUR LAYERS) UNDER ROOT RIB FLANGE

Fig.2(STBD.LAYUP)



DIAGRAMMATIC METHOD OF BANDAGING STARBOARD SPAR

(Bandage cut and folded under root rib flange as for port lay-up)

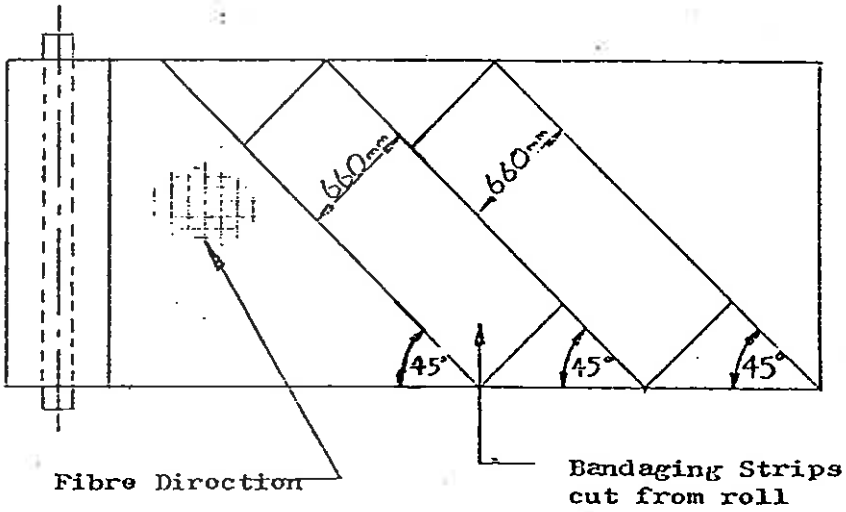
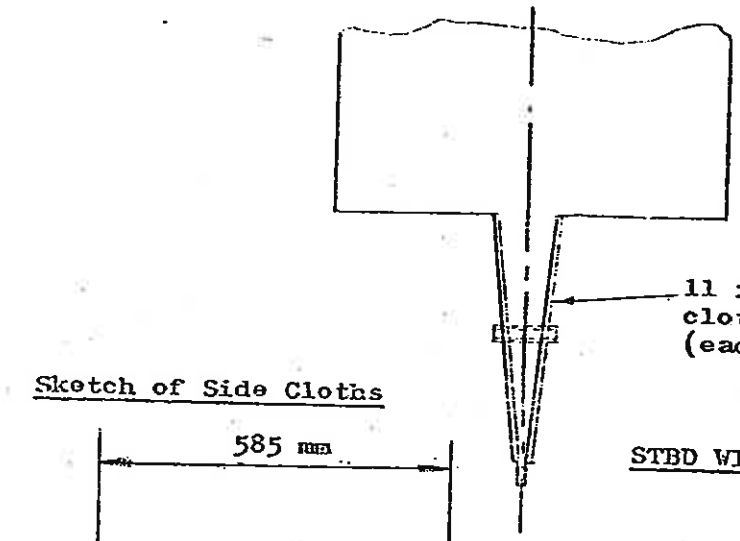
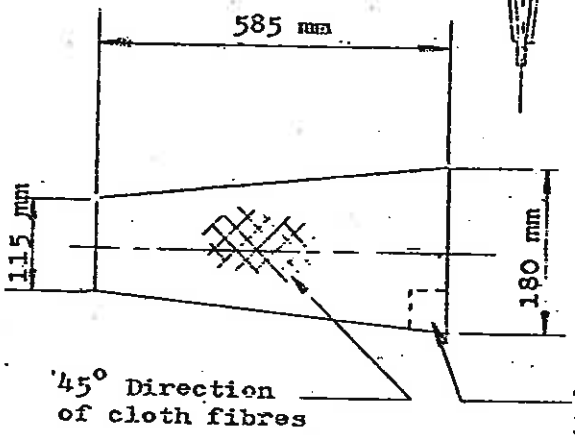


Fig.3



Sketch of Side Cloths



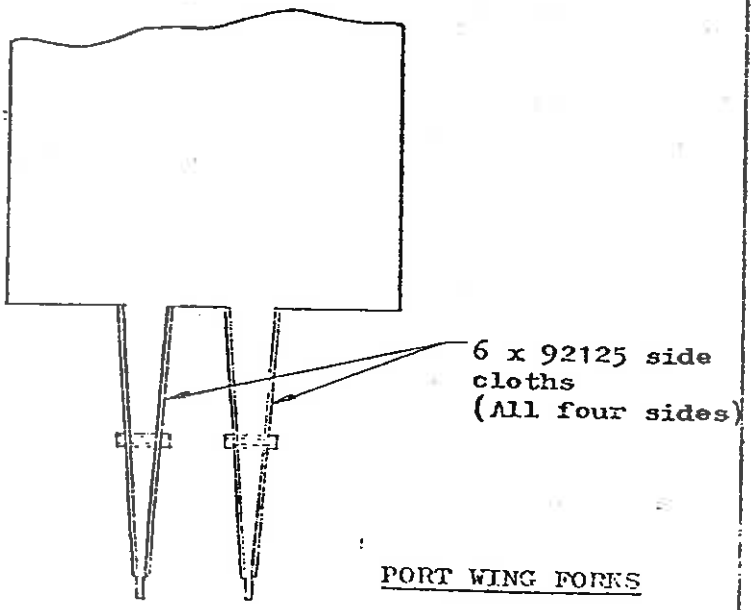


Fig.4

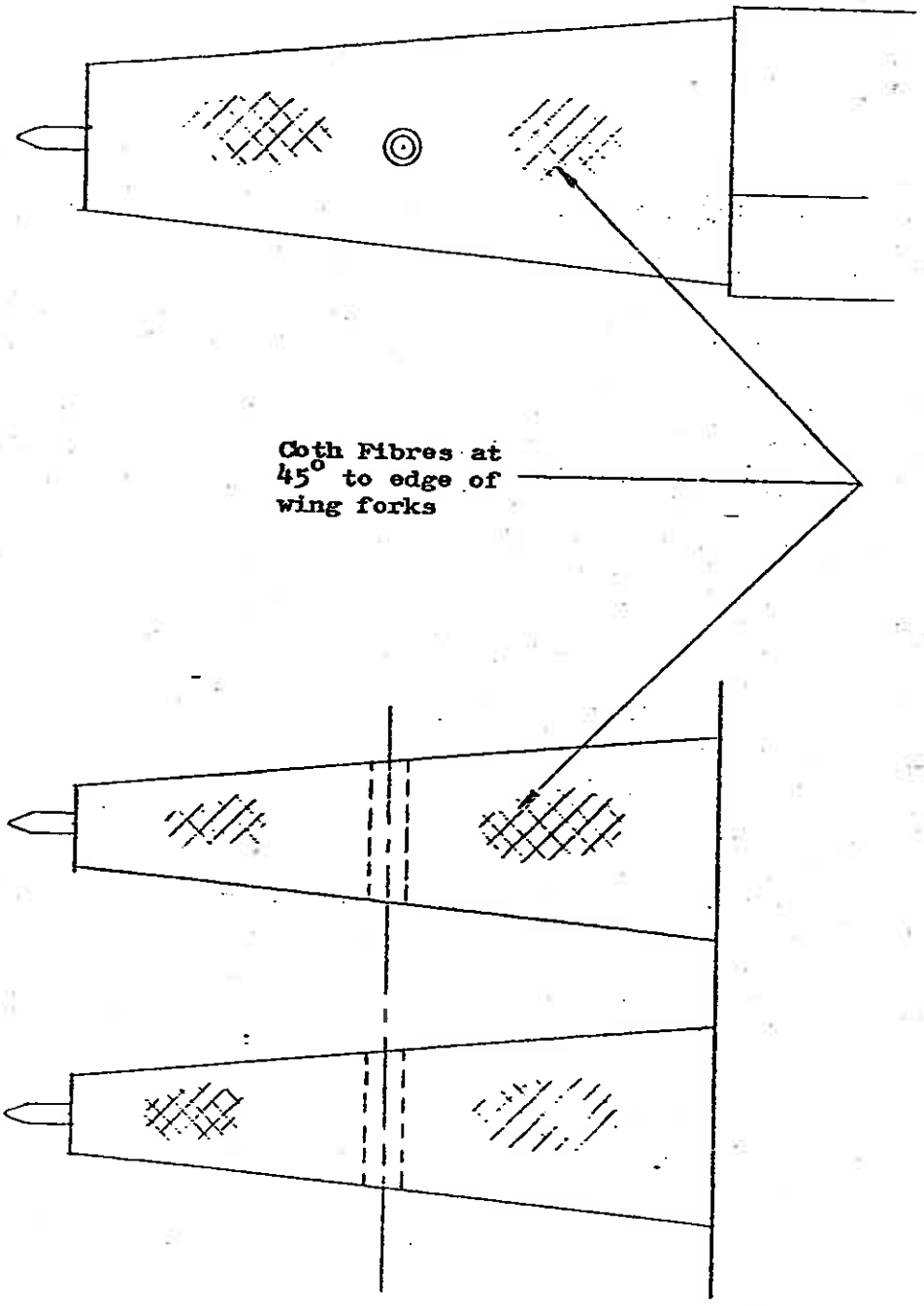


DIAGRAM SHOWING DIRECTION OF CLOTH
LAY-UP ON WING FORKS

Replacement of Spigots on Kestrel Fuselage Rigging Bar

This Data Sheet describes the method of replacing damaged spigots with hardened steel spigots in the Kestrel fuselage rigging bars. On later aircraft all the spigots are held in place by a nut and bolt, to replace these, the bolts are taken out and the old spigots removed. New spigots are then simply pushed into the rigging bar and fixed in place with the nut and bolt.

(Note:- One spigot is held in place by a $\frac{1}{4}$" rivet, this must be drilled out and replaced, when changing the spigots).

On earlier aircraft the spigots are welded to the rigging bar and the replacement process is slightly more complex.

There are two production standards incorporated in earlier Kestrel gliders with welded steel fittings. The difference between the two standards is the diameter of the rigging bars, which are either 20mm or 13/16ths. When ordering yourKit of Parts from the manufacturers the figure for your aircraft must be given.

1. Loosen both rigging bars by drilling a 3/8ths inch diameter hole in the centre of the bar, fitting a tommy bar in the hole and twisting until the resin bond between the fibreglass and the rigging bar is broken. Having freed the bar, saw out sufficient tube from the centre of the rigging bar to allow the bar to be drifted inwards. Remove any paint from the bars which will prevent them moving easily through the fibreglass. Remove all traces of grease and oil from the bars with a suitable degreasing agent such as Acetone.

Using a shaped aluminium drift, which locates only on the end of the spigot, drift one half of the bar inwards until it is completely out of the wheelbox (or fuselage in the case of the rear pick-up). Repeat for the other half of the bar.

2. There should be two steel collars left in the outside edges of the wheelbox and fuselage. To remove these one of the half bars is used as a drift from the inside. It is advisable to first rub down the outside of the bar to make the drift a sliding fit in the glassfibre.

3. The wheelbox is now prepared to accept the new bar. The bar must be a tight sliding fit in the fibreglass. If it is necessary, ream out the fibreglass, removing the minimum from the layer of resin that covers the glass. The rigging bar must also correspond in length to the fuselage width (i.e. the longer of the two bars is used for the forward rigging bar). It is also advisable to remove about 0.010 inches of resin mix from the outside faces where the steel collars are to be positioned.

4. Degrease and abrade all the surfaces which are to be bonded (glassfibre and steel tube) as described in Data Sheet 15. After having completed a dry run, assemble the new rigging bar assembly into the fuselage, first coating the holes and the outside faces of the fuselage with epoxy resin (Data Sheet 100) and also the bar where it will rest in the fibreglass. Care must be taken not to get any resin on the flap controls on the aft rigging bar.
(Note: The riveted joint between the spigot and bar is positioned on the port side of the fuselage in the rear position.)

5. Abrade the steel collars before bonding into place, with the collars pressed well home and locating on the shoulder of the rigging bar. Leave to cure for at least 24 hours at a temperture in excess of 25°C or 48 hours at 20°C.

6. Finally, bolt the new spigots into the rigging bars. A small square cut out will have to be made in the accessary tray to enable the bolts to pass through the forward bar (Fig.1).

Parts Required

If only new spigots are required then the parts required are 4 off 59D-10-100. These are the four spigots and will not have the bolt holes drilled in them. On three of the spigots, a $\frac{1}{4}$inch hole is drilled 18mm. from the end of the spigot (Fig.1). The fourth spigot has a $\frac{1}{4}$ inch hole drilled at 62mm from the end to take the riveted connection.

If the spigots fitted to your aircraft are welded to the bar then you will require a complete set of new parts. There are two sets of parts for the two different standards embodied in the aircraft types.

For the 20mm diameter bars the Kit of Parts required is T59A-03-4.

For the 13/16th inch diameter bars the Kit of Parts required is T59A-03-5.

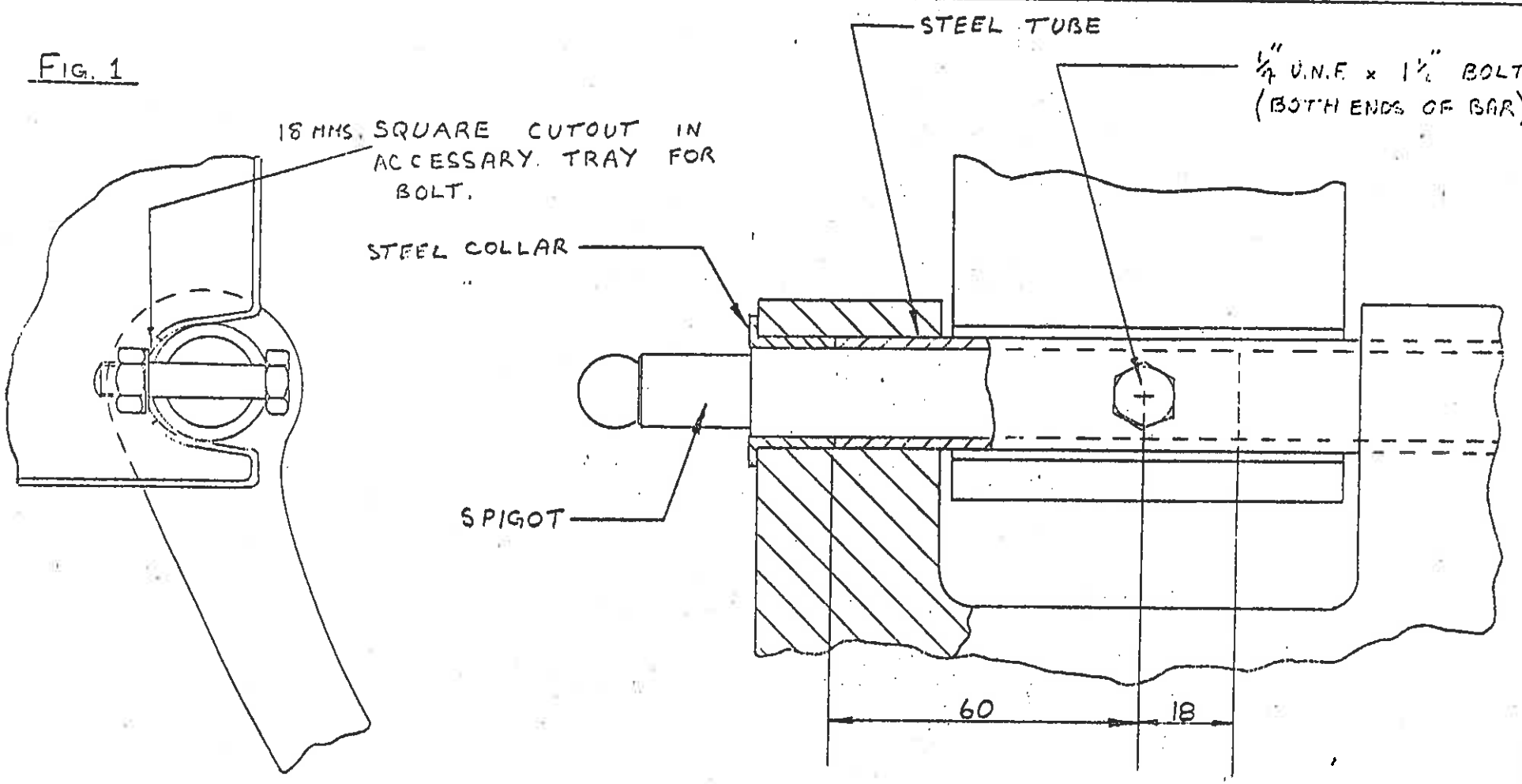
Hardened Steel Spigots

4 off T59D-10-100

20mm diameter Rigging Bars, Kit T59A-03-4

13/16th inch diameter Rigging Bars, Kit T59A-03-5

FIG. 1



FORWARD RIGGING BAR. (STBD. AS DRAWN - PORT SIMILAR)

Installation and Removal of Roller Box Assemblies

This Data Sheet applies to all roller box assemblies.

1. Remove roller box assembly and securing cloth using a sharp chisel, being particularly careful not to damage the parent cloth.

2. Clean the general area on which the roller box assembly is to be fitted , according to G.R.P. Repair Manual Data Sheet No.15.

3. Position the roller box assembly by sliding the relevant push rod through the rollers and assembling complete. Adjust the roller box to give equal clearance either side of the push rod and draw a pencil line around the box assembly.

4. Fix the roller box assembly in position using a small amount of cotton flock, according to G.R.P. Repair Manual Data Sheet No. 109 and allow to set hard.

5. Check position of push rod relative to rollers and, if necessary, repeat operations 3 and 4.

6. Cut 8 pieces of 92125 cloth as per Figure 1. (2 on each face).

7. Lay-up cloth layers as shown in Figure 1, according to G.R.P. Repair Manual Data Sheet No.16.

8. Allow the laminated cloth to cure and inspect, according to G.R.P. Repair Manual Data Sheet No.18.

9. Check the push rod control for full and free movement

Installation and Removal of Roller Box Assembly

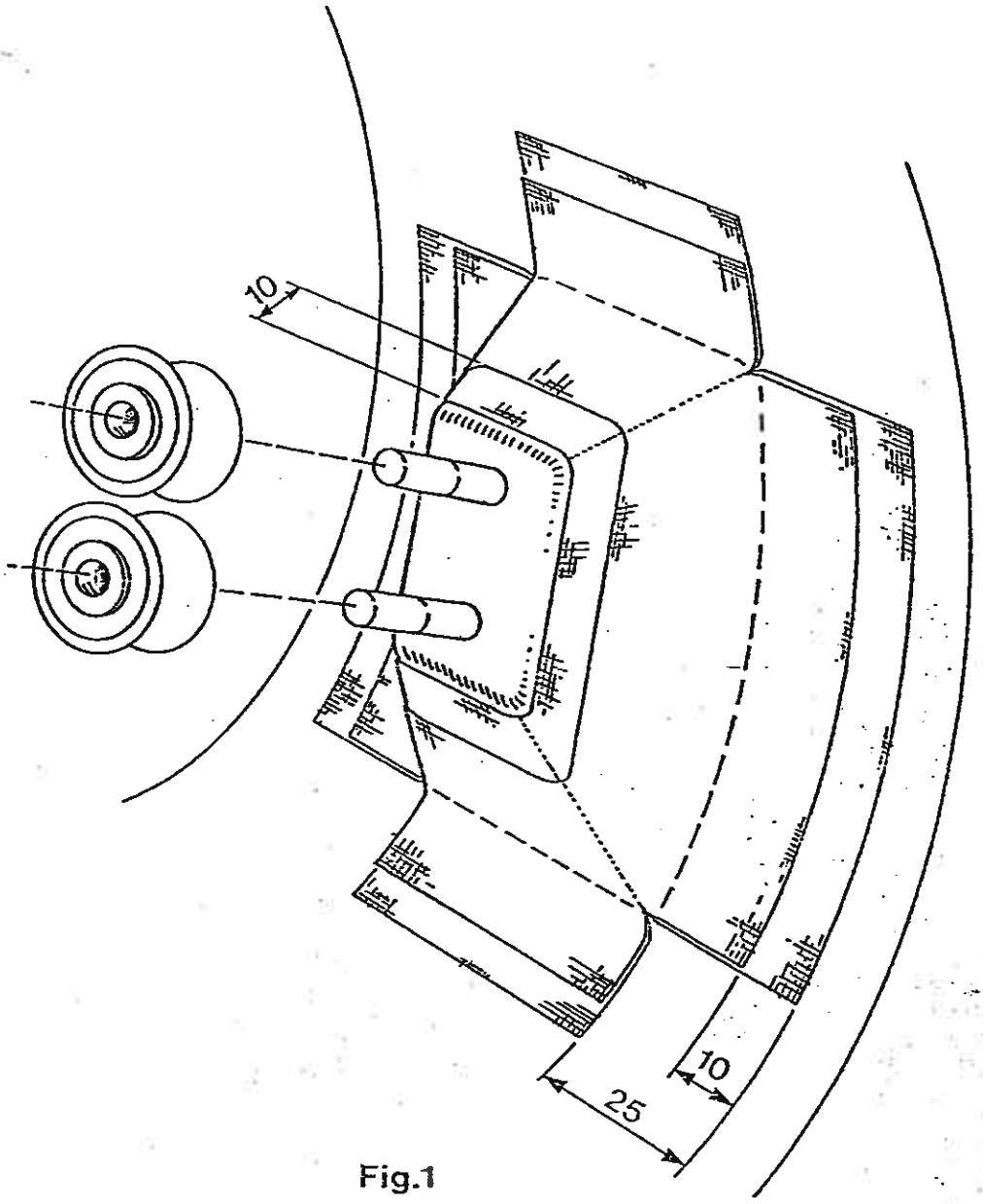


Fig.1

BROKEN FUSELAGE REPAIR

This Data Sheet describes the repair technique for a broken fuselage.

1. Place the two halves of the fuselage on cradles and fit the broken ends together. N.B. The cradles should be securely anchored to the floor.
2. Check the fuselage is properly aligned, and fully together, using a straight edge at four positions on the fuselage, i.e. each side, top and bottom as shown in Fig. 1.
3. Check the wing to fuselage geometry using the aircraft rigging drawing, and adjust as necessary.
4. Securely anchor the two halves in this position.
5. Cut through the fuselage from top to bottom at two sections, X-X and X^1xX^1 each just outboard of the farthest damage in each direction. In addition, cut vertically through the top half of the fuselage at two sections Y-Y and Y^1-Y^1 each 75mm outboard of sections X-X and X^1-X^1 and down to section a-a only. (Fig. 2).

   Chisel away the remaining fragments of the top half of the fuselage between sections (X-X and Y-Y) and (X^1-X^1 and Y^1-Y^1) as shown in Fig. 3.
6. Take a small sample (approx. 2 x 2 inches square) from each end of the removed portion of skin and carry out a burn off test on each to determine the number of layers of cloth, the cloth type/s, and the fibre direction/s. Notes should be taken so that the repair will be identical to the parent laminate.

The number of layers of cloth found from the two burn off specimens may differ depending on the region in which the failure has occurred. However, if the two cloth layers do differ, the larger of the two should be used over the whole of the repair area.

7. Chamfer the inside of the lower fuselage half in accordance with Data Sheet 21 page 1.

8. Clamp onto the outside of the repair area of the fuselage bottom half a pre-released piece of ply (or other suitable material) to form a backing piece - according to Data Sheet 15 Section B.
Also, bond in position thepre-released shoulder pieces as shown in Fig. 4.

9. Using the ply board as a mould lay-up the new fuselage bottom half according to Data Sheet 20 (stages 4 - 7) using the cloth configuration obtained from the burn off test.

10. When the newly laid laminate has hardened the ply backing board (mould) may be removed.

11. Inspect the laminate according to Data Sheet 18.

12. Cut off the newly laid up bottom half of the fuselage along section a-a between vertical sections Y-Y and Y^1-Y^1 as shown in Fig. 5.

13. Any fuselage ribs (formers) to be replaced should be bonded in position at this stage using cotton flock.

14. Cut to size the preformed top half of the fuselage repair (supplied by the manufacturer or moulded from a mould taken from the same position on an aircraft of the same type). The fuselage rib may need abrading in order to accurately locate the fuselage top piece.

15. Fit the preformed fuselage top half to the fuselage (and fuselage rib, if applicable) using cotton flock to Data Sheet 106, as shown in Fig. 5.

16. Chamfer the outer faces of the top half of the fuselage as far as section b-b, as shown in Fig. 6.

17. Effect a single skin type repair according to Data Sheet 20 (stages 4-7 only are applicable). See Fig. 7.

18. Inspect the hard laminate according to Data Sheet 18.

19. Apply gel coat to the outside of the fuselage to fill, according to Data Sheet 19.

Fig.1

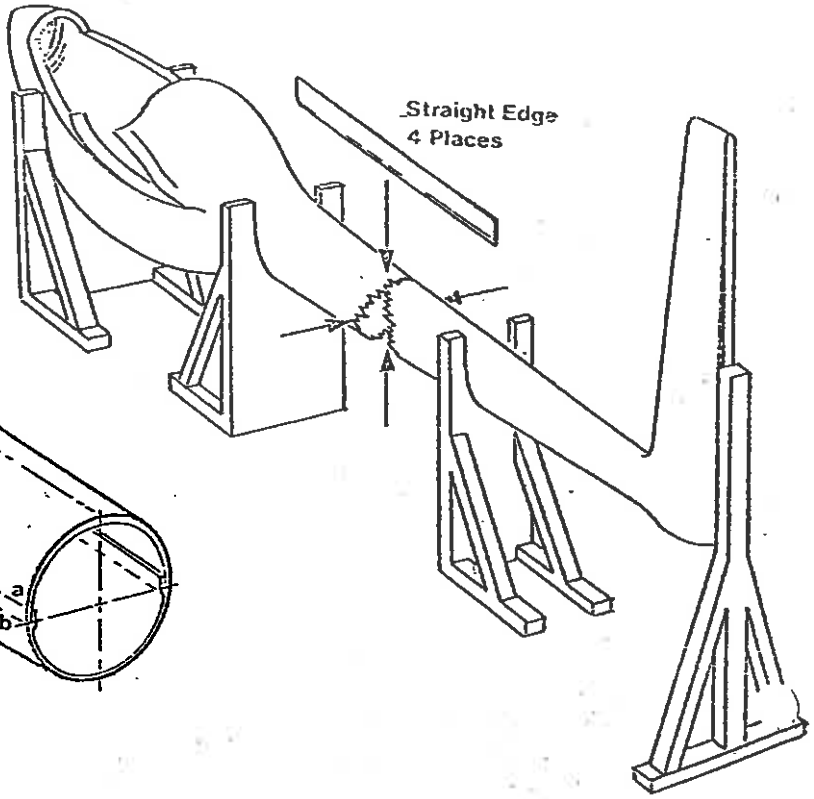


Fig.2

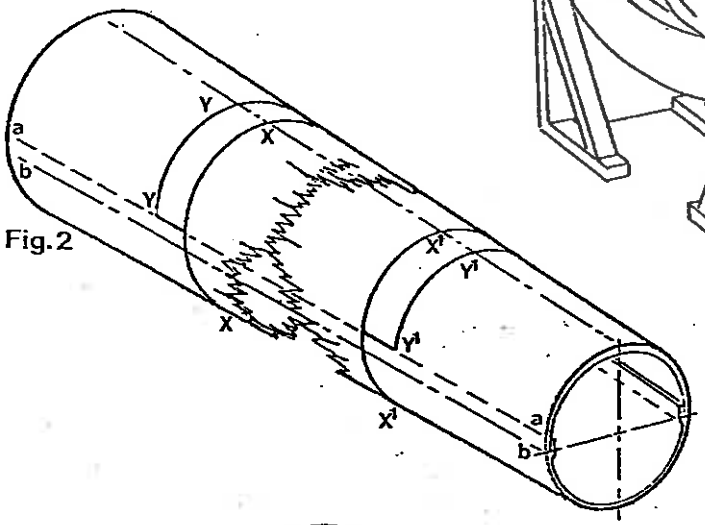


Fig.3

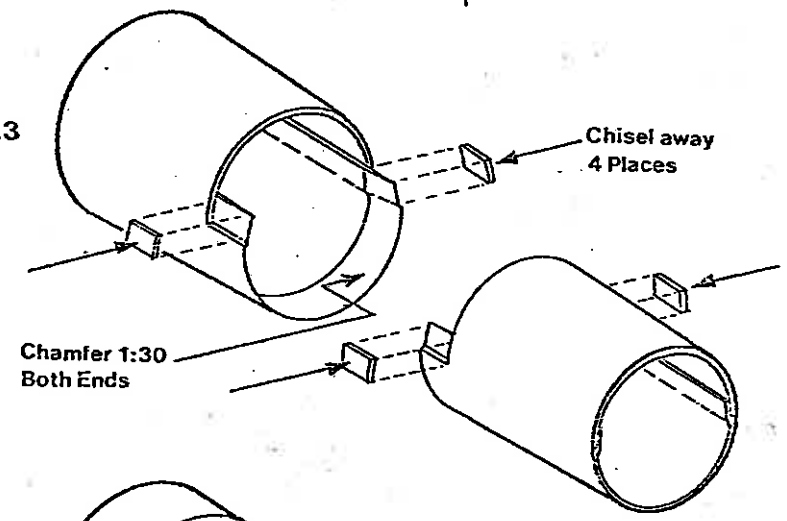


Fig.4

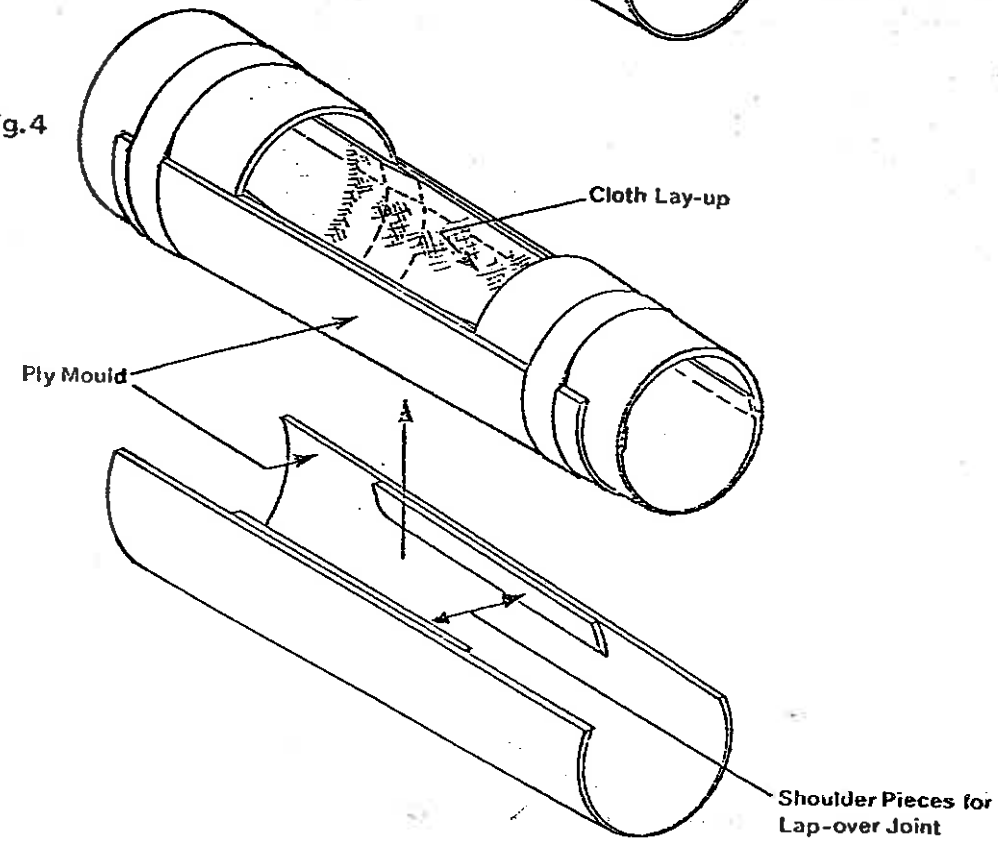


Fig. 5

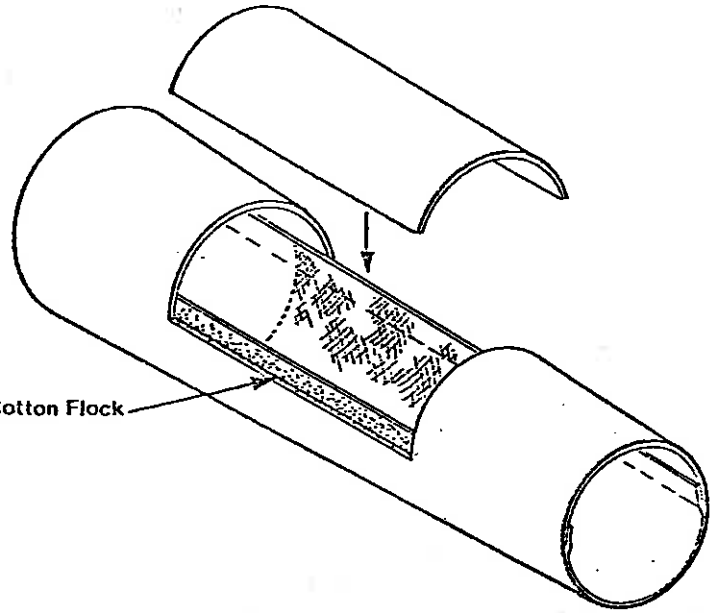


Fig. 6

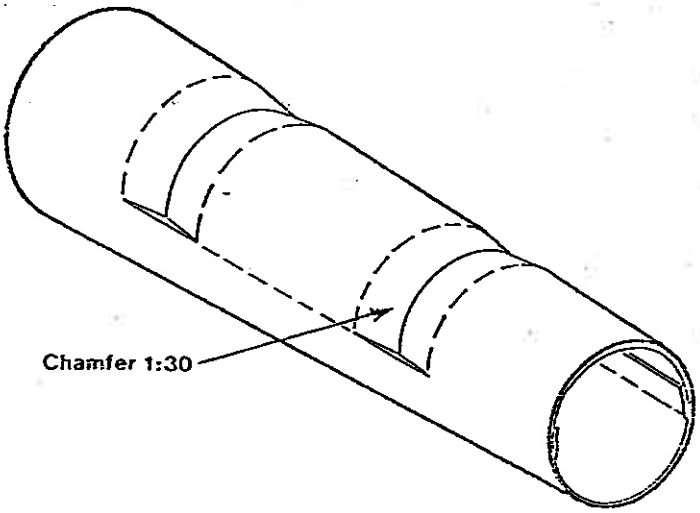
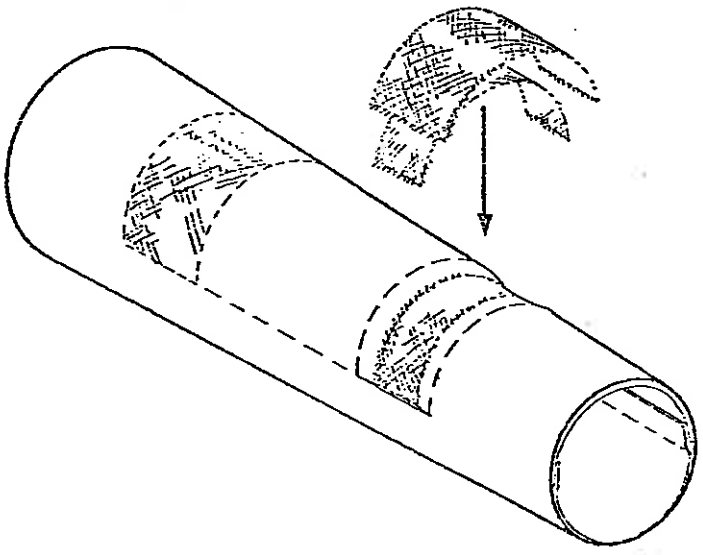


Fig. 7



G.R.P. CONTROL SURFACE HINGES

(Removal and Installation Instructions for Ailerons, Flaps and Elevators)

Procedure

1. Remove ailerons using instructions shown in "Pilots Notes and Operators Handbook" - Ref: A.2.3.

2. Remove aileron hinges and securing cloth using a flat chisel - being particularly careful not to damage the spar. See Data Sheet 3.

3. Clean all relevant surfaces. See Data Sheet 15.

4. Temporarily fix the replacement hinges in position on the aileron pins using plasticine. The hinges should be fixed at an angle allowing the aileron to move through its full arc. See Fig. 1, also rigging diagram in "Pilots Notes and Operators Handbook".

5. Fill the aileron hinge 'V' channels with cotton flock mix to Data Sheet 106.

6. Position the aileron and hinge assembly to the wing. Fully support the aileron weight and leave the flock mix to cure.

7. After curing, the plasticine can be removed and the aileron checked for:-

   (a) Freedom of movement
   (b) Full arc of movement.

   Extreme caution is needed when checking the aileron for movement as the weak cotton flock bond may be broken.

   If either (a) or (b) are not satisfactory operations 6. and 7. must be repeated.

8. The aileron should now be removed from the wing. Care should again be exercised when performing this operation.

9. For each hinge cut two oversize pieces of 92125 cloth, with a cut-out for the cloth to fit over the lug. See Fig. 2.

10. Lay up one layer of 92125 cloth to cover the area shown in Fig. 3; and to Data Sheet 16. (Use laminating resin to Data Sheet 100).

11. Cut "lay-up" cloth to dimensions shown in Fig. 3.

12. Lay up second layer of 92125 cloth as operation 10. See Data Sheet 16.

13. Cut second "lay-up" cloth to dimensions shown in Fig. 3.

14. Allow the laminated cloth to cure and inspect according to Data Sheet 18.

15. Clean up the laminated area. See Data Sheet 19.

16. Finally replace the ailerons and check as in operation 7. See "Pilots Notes and Operators Handbook" - Ref. A.2.3.

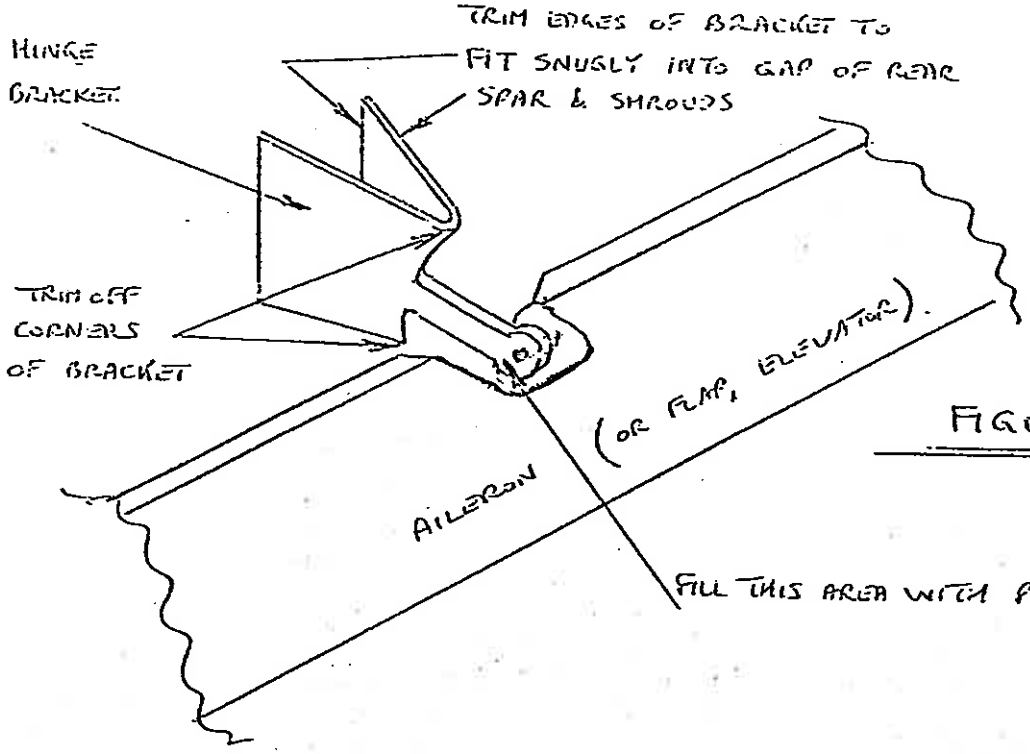


FIGURE 1

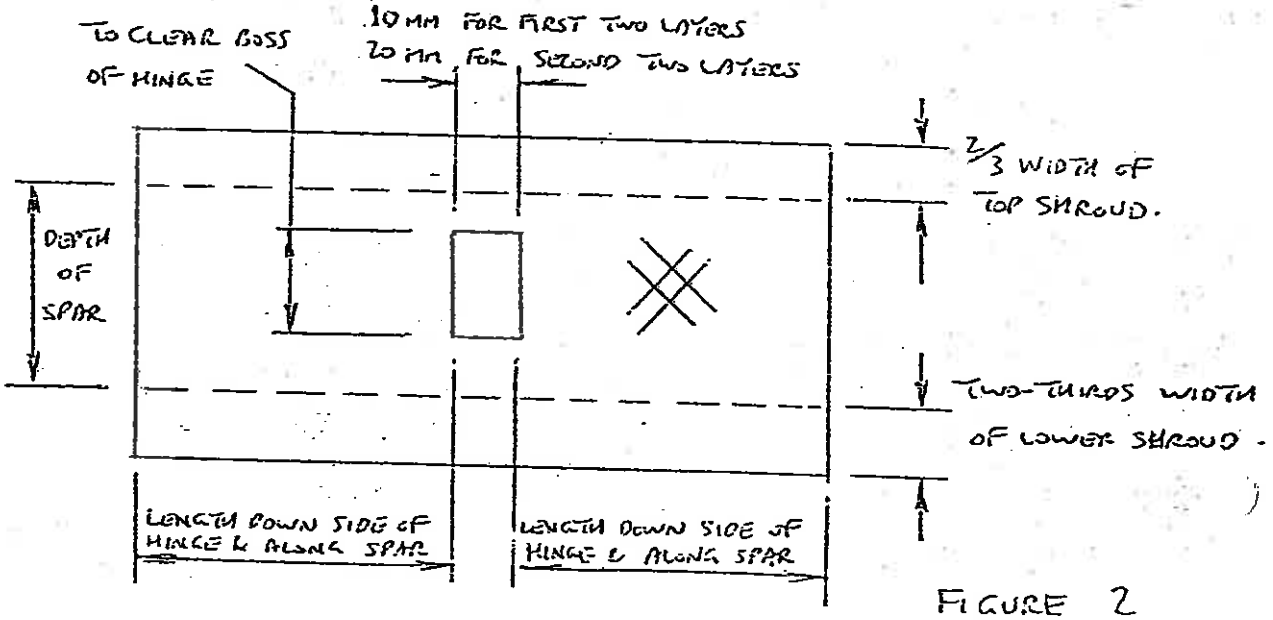


FIGURE 2

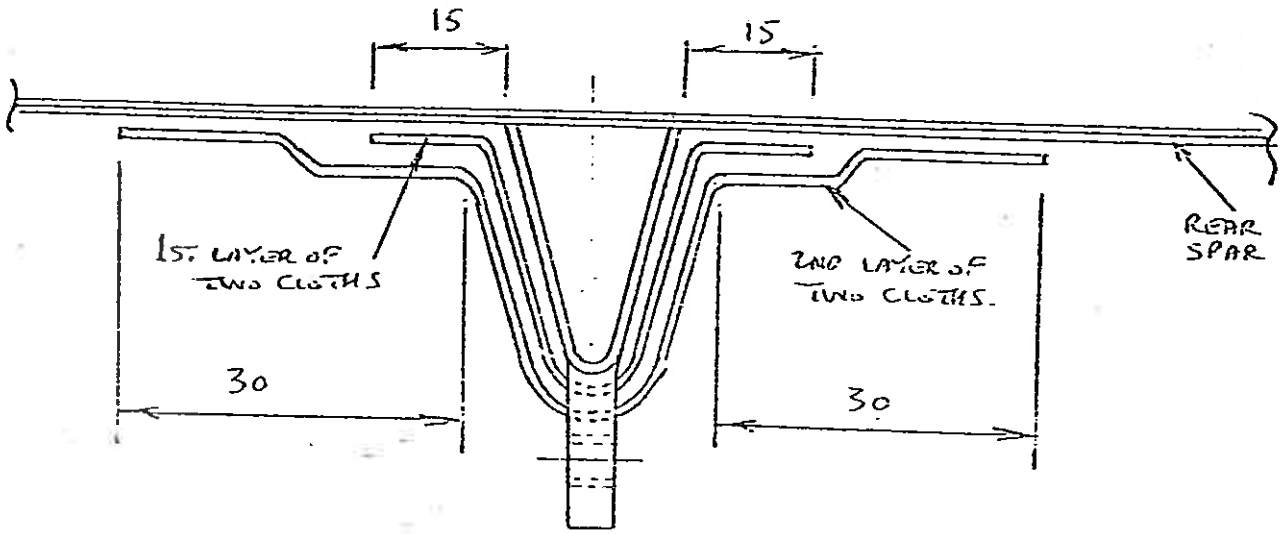


FIGURE FIGURE 3

ABE 11-1-76

MATERIALS SECTION

Some Do's and Don'ts

DO refer to the manufacturer in any case of doubt.

DO remove all damage back to solid glass fibre laminate.

DO remove all gel coat from any bonding surfaces.

DO stagger all layers of cloth and use the correct splice angles.

DO mix the resin well and in the correct proportions.

DO use clean working surfaces and tools.

DO check all control movements after completion of the repair.

DO NOT contaminate the repair with oil, wax, grease, etc.

DO NOT use dirty mixing pots or brushes.

DO NOT use oversize patches.

DO NOT lay the cloth in a different direction to the original.

DO NOT disturb the repair until the resin has cured.

DO NOT use waxed pots.

DO NOT forget to check the soundness of the repair before flying the glider again.

DO NOT leave dust, tools, chippings, sandpaper, etc., in the glider.

Laminating Resin - Epikote 162

This data sheet gives details of Shell Epikote 162 which is the currently recommended laminating resin.

Storage	As Data sheet No. 2. Shelf life unlimited.
Safety Precautions	As Data sheet No. 4.
Hardener	Shell Epikure 113.
Mixing Proportions	By weight: 100 parts resin to 38 parts hardener. By volume: 2 parts resin to 1 part hardener.
Cure Cycle	Mass 100g. - Pot life at 23°C = 50-60 min. Mass 500g. - Pot life at 23°C = 15-25 min. After the resin has hardened it must be post cured for 8 hours at 54°C before its full strength is obtained.

Gel Coat Resin - Lesonal Werke

This data sheet gives details of the gel coat which is currently recommended.

Manufacturer's Details	Lesonal Werke (Germany) Gel coat (polyester) - part number 3.6912 Catalyst (hardener) - part number 7.2051
Storage	As Data sheet No. 2. Shelf life - 6 months.
Safety Precautions	As Data sheet No. 4.
Mixing Proportions	100 gms. of resin to 2 cc. of catalyst.
Colour	White
Application	The gel coat should be applied with a brush, as evenly as possible and will dry to a tacky surface (ready for laminating) within 60 mins. at 23°C. The surface must always be just dry before any laminating is attempted or any further coats are applied. Any laminating must be done within 24 hours of gel coat application.

Glass Fibre Fabric - Interglas

This data sheet gives details of recommended glass fibre reinforcement materials.

Four types of glass fibre fabric are in current use.

Manufacturer's	Approx. Resin weight reqd. for one metre^2 of cloth	Dry Weight (gm/m^2)	Weave Type	Approx. Laminate Thickness (mm)
90070	52	78	Plain	.08
92110	107	160	Twill	.17
92125	187	280	Twill	.29
92145	140	210	Unidirectional	.22

Manufacturer — Interglas (West Germany)

Storage — As Data sheet No. 2.

Glass Fibre Unidirectional Rovings - Silenka

Manufacturer's Part No	1055 - 2400 tex
Dry Weight	2.4 gms. per metre length.
Manufacturer	Silenka (Holland)
Storage	As Data sheet No. 2.

Release Agents

This data sheet gives details of the release agents recommended for glass fibre repairs.

Scott Bader Crystic Release Agent No. 1

Furane Resin (Borden Chemicals).

Either of the above release agents may be used to seal timber mould surfaces.

Simonize Wax Polish (not with Silicone modification).

Used for polishing mould surfaces.

Scott Bader Crystic Release Agent No. 2 (PVAL).

Liquid release agent to be brushed or sponged onto the mould surface. Allow to thoroughly dry before gel coat application.

Microballoon Epoxide Bonding Paste

This data sheet gives details of the microballoon bonding paste and filler which is currently recommended.

Mixture	Epikote 162 laminating resin	- 100 parts by weight
	Epikure 113 hardener	- 38 parts by weight
	Microballoons	- 30 parts by weight
	Aerosil	- 0-2 parts by weight

Do not mix more than 500 gms. at once.

Use within 30 minutes of mixing.

Curing time - 24 hours at 23°C.

Cotton Flock Epoxide Bonding Paste

This data sheet gives details of the cotton flock bonding paste which is currently recommended.

Mixture	Epikote 162 laminating resin	-	100 parts by weight
	Epikure 113 hardener	-	30 parts by weight
	Cotton flock	-	20-40 parts by weight depending upon desired thickness

Do not mix more than 500 gms. at once.

Use within 30 minutes of mixing.

Curing time - 24 hours at 23°C.

P.T.F.E. Bush Filler Material

This data sheet gives details of the P.T.F.E. bush filler material mentioned in Data sheet No. 26 for rebuilding bushes carrying moving parts.

Mixing Proportions	Epikote 162 resin	100 parts by weight
	Epikure 113 hardener	38 parts by weight
	Marble Flour	150 parts by weight
	P.T.F.E. Powder	25 parts by weight

Cure Cycle Pot life approx. 45 min.

The filler must be cured for 8 hours at 54°C before its full strength is obtained.

Safety Precautions Highly toxic fumes are released when P.T.F.E. burns. On no account must naked flames or cigarettes be near when handling the P.T.F.E. powder or filler mix.

Bush Filler Material

This data sheet gives details of the bush filler material mentioned in Data sheet 26 for rebuilding bushes carrying non-moving parts.

Mixing Proportions	Epikote 162 resin	100 parts by weight
	Epikure 113 hardener	38 parts by weight
	Marble Flour	360 parts by weight

Cure Cycle

Pot life approx. 45 min.

The filler must be cured for 8 hours at 54°C before its full strength is obtained.

Glass Flock Epoxide Mix

This data sheet gives details of the glass flock epoxide mix which is currently recommended.

Mixture	Epikote 162 laminating resin	-	100 parts by weight
	Epikure 113 hardener	-	38 parts by weight
	Glass flock	-	50-70 parts by weight depending upon desired thickness

Do not mix more than 500 gms. at once.

Use within 30 minutes of mixing.

Curing time - 24 hours at 23°C.