Synthetic Resin Adhesive in Sailplane Construction

from Aero Research Limited, Duxford, Cambridge

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The majority of gliders are made of wood, and satisfactory gluing is fundamental to their safety. Casein glues are still used by some constructors, but they are not fully resistant to moisture and they are susceptible to attack by micro-organisms and insects. Synthetic resin adhesives are highly resistant to moisture and to biological attack, and have been widely adopted for building gliders.

The properties of a satisfactory adhesive for glider construction are: it must be strong under all the conditions likely to be experienced; it must be cold-setting; it must be gap-filling and permanent. A urea-formaldehyde glue such as Aerolite 300 (or its powder form Aerolite 306 which has a long shelf-life) fulfils all these requirements.

Taking these points separately, it is common knowledge that joints made with modern synthetic resin adhesives, when tested to destruction, break in the wood and not in the glue-line. Therefore, if the joints in a glider are properly designed, its safety is in no way impaired because it is a glued structure. The claim that Aerolite glues are in a class of their own has been established by exhaustive trials undertaken at such testing institutes at the Forest Products Research Laboratory, Princes Risborough, and by their selection by the Royal Air Force in preference to all other glues.

The resin and the hardener are supplied as separate components. The resin is applied to the one surface to be glued and the hardener to the other. No reaction takes place until the two parts are brought together. This means that on large components there is plenty of time to spread the glue; but when the two parts have been brought together, setting is relatively rapid, even at ordinary workshop temperatures. The clamps can be taken off after about three hours. It is usual to employ a coloured hardener so that it can easily be seen that this most essential component has not been forgotten. It is recommended that gluing should not be done at temperatures below 13° C.

Wood cannot be machined as accurately as metals, and is less stable than metals. Also there may be slight inaccuracies in the joints made. It is, therefore, essential that the glue should be gap-filling. Glues used in glider building should conform with the relevant requirement of British Specification 1204, 1956—that they must fill gaps of up to 1.3 mm. Early urea-formaldehyde resins had the defect that, except when used in very thin layers, they crazed, thus losing their strength. Some twenty years ago the German aeroplane designer, H. Klemm, sought to overcome this defect by adding a filler made by grinding up bakelite mouldings. This had an effect, but it is now known that it only delayed the crazing process. By use of a special liquid hardener Aerolite 300 forms a permanent gap-filling adhesive. It is thought that this is due to the hardener evaporating more quickly than the water so that hardening proceeds without setting up residual strains.

Resorcinol resin glues such as Aerodux 185 have all the same good qualities as the urea-formaldehyde glues just described and, in addition, they pass the requirement of some specifications that the glue must be proof against boiling water. They are rather more expensive than urea-formaldehyde formulations. Workshop temperature should be kept at or above 15° C.

Resin-glassfibre laminates are being increasingly used for various lightly stressed glider parts such as fairings. The

Fig. 1. Split block construction of ribs — Stage 1

Fig. 2. Split block construction of ribs — Stage 2

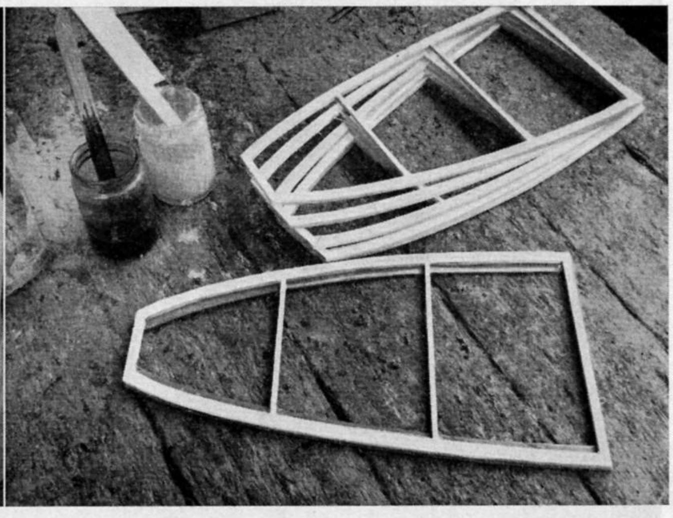

Fig. 3. Split block construction. Complete component with plywood edging

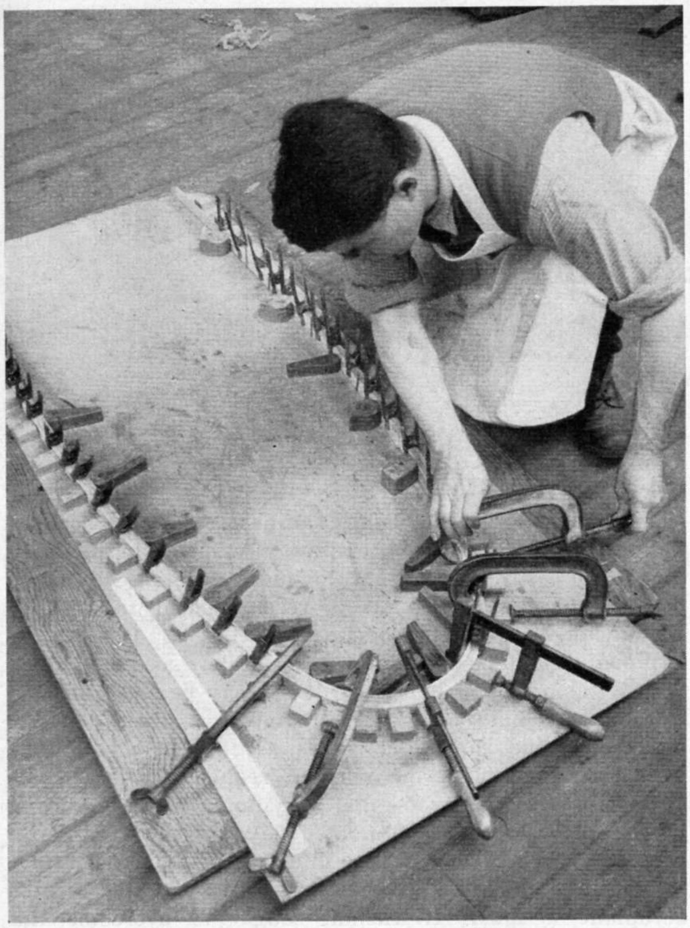

Fig. 4. Cramping a laminated frame

resins usually employed are polyesters. Epoxy resins such as Araldite have greater adhesion to glassfibre than polyesters and the laminate is, therefore, stronger weight for weight, and by the use of epoxies some economy of weight may be effected.

The two leading companies of glider-makers in the United Kingdom, Slingsby Sailplanes Limited, of Kirbymoorside, Yorkshire, and Elliotts of Newbury Limited, Newbury, Berkshire, have kindly co-operated with us by enabling us to show pictures demonstrating the use of Aerolite 300 in their workshops. Both these companies use Aerolite 300 exclusively for wood gluing in glider construction, the only exception to this being that Araldite epoxy resins are employed for certain purposes described below.

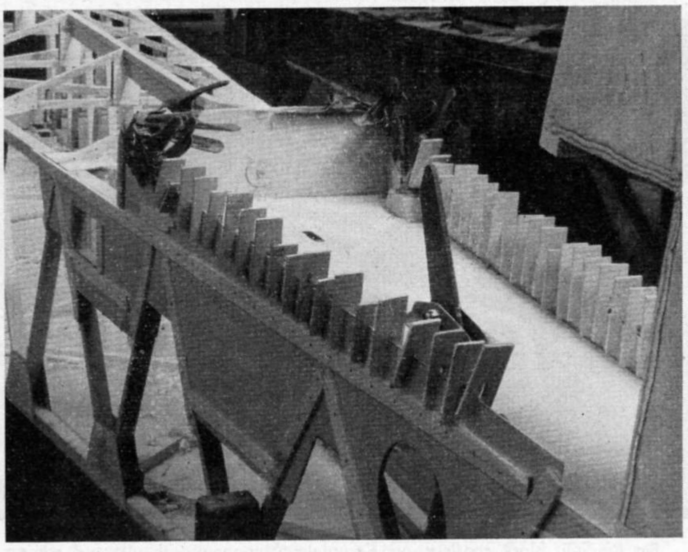

Fig. 5. Wooden peg clamps in rear fuselage construction

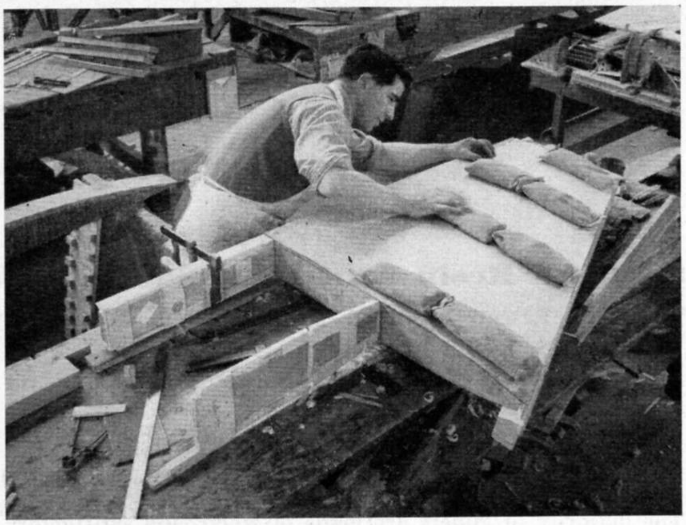

Fig. 6. Lead shot bags for holding down skin during gluing

Slingsby Sailplanes Limited

The labour of making many frames and ribs to approximately the same pattern is lessened considerably by Messrs. Slingsby by the adoption of the so-called split-block construction. The method consists of making each part in the form of a wide block from which slices of appropriate dimension can be cut. The parts are first glued up in a jig, as shown in figure 1. It will be seen that a number of butt joints and end-grain joints are involved, but these can be regarded as temporary attachments, the final strength of the component depending not on these joints but upon a plywood edging member or gusset. Figure 2 shows the glued block being cut into slices on a band-saw, and figure 3 illustrates in the foreground the component complete with plywood edging 1 mm thick and about 1 in. wide.

The method is very satisfactory in producing strong components of good dimensional accuracy, and a large volume of components can be produced with relatively few jigs.

Good clamping is a most important part of glued construction. In figure 4 we show various kinds of cramps used for holding a typical lamination while the glue sets. In the picture are metal G-cramps of two kinds, Little Nipper metal clamps and wooden cam pieces attached to the jig. It will be appreciated that all these kinds are not necessarily used on one job, but are in the photograph for demonstration purposes only.

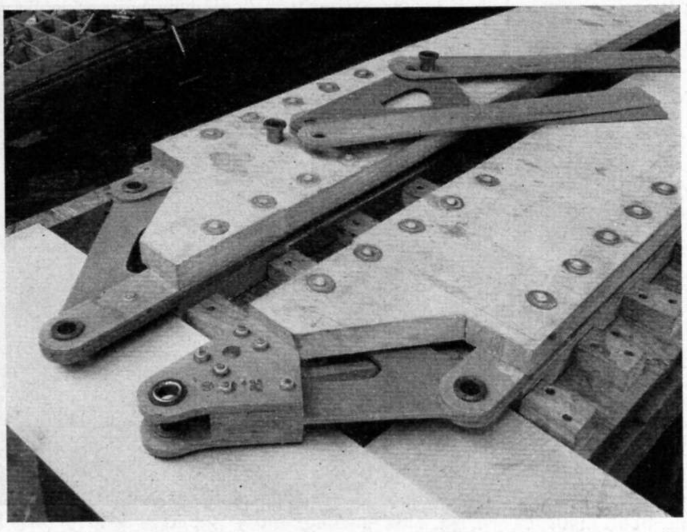

Fig. 7. Metal wing root fittings incorporating Araldite 103 in the joint

Figure 5 shows the rear section of a Slingsby 21 B two-seater sailplane with wooden peg clamps in position.

In figure 6, the plywood skin has been applied and bags of lead shot are being used to hold it down while the adhesive sets.

When the metal wing root fittings of Slingsby machines are bolted to the spars (fig. 7), Araldite 103 is incorporated in the joint. The use of this adhesive obviates creep or any other movement in the joint.

Elliotts of Newbury Limited

Messrs. Elliotts of Newbury Limited are at present engaged in building the Olympia EON Marks 4/19 and 4/15. These have spans of 19 and 15 m respectively; the latter being for the standard class.

In these machines balsa wood, which has very good gluing properties, is used for the web material of wing ribs and certain other control surfaces. This form of construction can be seen in figure 8 (Wing of Olympia EON Mark 4/19). Figure 8 also shows the attachment of one of the preformed laminated plywoods sheets. The adhesive used for this purpose is a formulation based on Araldite 103. This adhesive contains no solvent and there is, therefore, no risk of any swelling and subsequent buckling of any of the parts when it sets.

It is not to be supposed that the field of synthetic resins in glider construction has been fully explored. Gliders of necessity require to be dismantled for transport and this means that there must be metal fittings at the root ends of spars for attachment to the fuselage. Such metal fittings are often fixed to the spars only by means of bolts. It is suggested that designers might well explore the possibilities of a bonded metal-to-wood structure in this part of the machine.

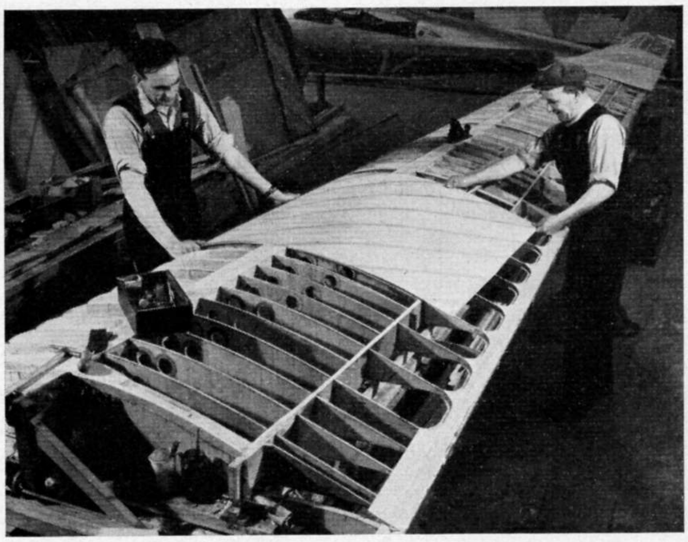

Fig. 8. Balsa web construction in Eon Olympia wing ribs and attachment of pre-formed skin

In the de Havilland Hornet fighter, the Redux process, which is highly successful in joining metal to wood, enabled the designers to develop a composite wing structure of great strength in which the main tension stresses were carried on tapered T-section aluminium alloy booms in the floor of the wing and the main compression stresses were carried by two plywood skins forming the upper surface of the wing.

The Redux process is most valuable for the attachment of wood veneer to a metal surface so that wooden members can be subsequently bonded on using a cold-setting adhesive.