SANDWICH CONSTRUCTION WITH RESIN-REINFORCED GLASS FIBER & BALSAWOOD

by H. Naegel, R. Eppler, *and* H. Langer - *Stuttgart**

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ABSTRACT:

The purpose of the report is to describe a sandwich construction made of glass fiber, resin and balsawood. The method has been developed by the Academic Flight Group at Stuttgart. It has been used to build the sailplane FS-24 "Phoenix." The special features of this construction method will be described and the danger of buckling will be mentioned. The fabrication of fuselage and wings of the glider "Phoenix" will be explained and strength tests with the wing will be discussed.

Photo: R. Lindner

Figure 1. View of FS-24 "Phoenix" sailplane.

One of the basic requirements for airplanes is to get high strength with low weight. Shells have proven very satisfying in this direction. Not beams or spars. but the entire skin as a shell takes the stresses.

The disadvantage of shells has been, that in order to avoid buckling of the thin walls in compression and shear a large amount of stiffeners has been required, so that fabrication has not been simplified too much. A step towards eliminating these troubles was to insert a light-weight filler material between two hard layers. This eliminated the number of stiffeners and improved buckling characteristics. In such sandwich constructions using plywood, light metals or similar materials together with foam, balsawood or honeycomb, excellent results have been obtained. But, also, these methods have been used mainly for components with low strength requirements such as rudders, noses and so on. The main parts of the airplanes such as wings and fuselage gave difficulties for fabrication due to their large sizes and complex shapes. They required big heating devices and presses. Wings in addition should be built with variable wall thickness to get higher strength at the root for optimum weight. The requirement of disconnecting the wings raises the difficulties of handling the force concentrations between the wings and the fuselage.

The recent developments in the field of glass fiber and resins looked very promising with respect to an outer skin for a sandwich construction. Pure molds were the only required jigs and fixtures. Wall thickness can be changed easily and glue joints are simple to make and give reliable results. Under this state of the art the development of the "Phoenix" was started about three years ago. Its proposed performance required not only low weight, but also a smooth, wave-free surface to get the laminar boundary layer flow. The "Phoenix" has been completed and the results are satisfying. Weight reduction against conventional type sailplanes with laminar airfoils is about 30%. The surface smoothness is equivalent to one which has been obtained so far only with high additional weight. The construction method of the sandwich shell shall be discussed briefly.

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1. GENERAL CHARACTERISTICS OF THE CONSTRUCTION METHOD:

1.1 Properties of Fiberglass Reinforced Resin: (Ref. 1.)

The large size of the components of the Phoenix made a manual method necessary. After the resin is applied to the fiberglass it starts to jell within 10 to 30 minutes and becomes semihard, within 1 to 3 hours. After a curing time of 1 to 3 days it obtains its full hardness. A resin has to be used which does not get sticky during air hardening. This is the case with only a few polyesters and with epoxy. Any shapes can be obtained provided that the cloth can be layed, and that the part can be taken off the mold later. Pressure and temperature which would increase the strength has not been applied due to the big sizes.

1.2 Strength of The Fiberglass:

The fibers used for commercial cloths have a specific weight of 2.54, a tensile strength of 40,000,000 psi. and a modulus of elasticity of 1,200, 000,000 psi. A fiberglass resin combination with all fibers in one direction and only little resin may result in a tensile strength of 20,000,000 psi, which are values not to be matched by steel or dural. Compression strength also is very high. This comparison, however, is misleading. The strength of the resin bonded fiberglass drops to only a fragment. if the force line is different from the direction of the fibers. As soon as mixed forces are applied the material doesn't look as favorable anymore. In addition, the stress properties drop considerably once more if cloths are used where the fibers are more or less twisted or woven, or if the cloth is applied to wavy molds. The fibers then are not parallel anymore to the force line. The actual strength of the resin-reinforced glass fiber is a function of the fiber direction as shown in Figure 2 (Ref. 4). It shows compression as a function of the direc-