PLASTIC SAILPLANE FS-24 PHOENIX

by H. NAEGELE & R. EPPLER
Academic Flight Group of Stuttgart

(Editor's note: this article was translated from SWISS AERO REVIEW *for March, 1958, by George Timm of the Aerophysics Department, Mississippi State College.)*

1. The Development

The designers of the Phoenix had decided to develop and to build a high-performance sailplane as far back as 1951. Right from the beginning it was also decided to deviate from the then usual concept of a heavy sailplane with high wing loading; to be accomplished rather by less weight than by large wing area.

Photo: R. Lindner

Fig. 1. View of FS-24 Phoenix sailplane.

This in turn was the reason for the development of a new type of monocoque construction, the basic material of which was to be balsa wood with a reinforced skin of paper and glue laminations. The advantages as well as the malices of balsa wood were well-known to the designers from their experience in building models. A large number of tests proved the advantages of this construction method as far as weight and strength were concerned. It was possible to design the fuselage as a shell while a spar was inserted in the wing.

Unfortunately, due to financial reasons, the construction work of this prototype was extended over an unduly long period of time. Eventually it had to be abandoned, since the purely external difficulties became too overwhelming. The resignation may have been made easier because of the fact that in the meantime such tremendous strides in aerodynamics and shell construction had been made that a later and considerably improved design seemed to be more worthwhile than the completion of the old. Fortunately, the Academic Flight Group of Stuttgart was able to gain the support of the state of Baden-Wuerttemberg for this new design so that the construction and further research on construction methods were made financially possible.*

Thus, after several years, the new development was completed. New problems and difficulties continually arose which is only natural when new methods are being investigated and tested. Since the applied principles have been completely proved by flight testing, it seems right to report extensively about the new glider.

* Also in this place we want to thank the Landesgewerbeamt Baden-Wuerttemberg, and especially Dipl. Ing. Hammler, who followed the development with such great interest and understanding, that even newly arising difficulties could be overcome.

2. Construction Method

Balsa wood as filler for the sandwiched shell was retained. As the outer skin, fiberglass reinforced polyester resin has become available lately. Because of this fact, it was possible to shape the skin in any desired form and, at the same time, obtain extraordinary high strength. Furthermore, extensive strength tests have shown that the combination of balsa wood and fiberglass reinforced polyester resin have particularly high strength characteristics since both materials will carry the loads equally well. The rupture strains are similar to such an extent that both materials, combined, obtain their ultimate strength almost simultaneously. Balsa wood naturally shows a high degree of uncertainity and spread. This can be tolerated since the strength to weight ratio is favorable enough to assume high safety factors with relatively low weight.

Basically, the use of plastics is simple. Fiberglass cloth can be placed freely on a surface and the resin is then simply brushed on. Therefore, it was not necessary to consider at any place the shape of the shell skin. The balsa wood filling can, likewise, be formed in almost any desired shape; since balsa wood is easy to work with and to glue. The constantly varying thickness of the wing shell filler in particular does not constitute any difficulty. The direction of the loads is taken into account by applying the balsa wood and the fiberglass cloth in the same orientation. If in any particular case the loads are running in one main direction then a fabric with reinforced warp, 90% of all fibers are in direction of the warp, is used (Ref. 1). Thus it is possible to use the load carrying materials in the most favorable places with correct orientation, whereby considerable savings in weight are made.

A well-known difficulty with all polyesters, which are applied by hand, is the fact that they develop an undesirably sticky surface if polymerizing takes place in the presence of atmospheric oxygen. Closed molds which are used to overcome this are out of question, however, with a wing of 26 feet half span. To cover the wing with foils is also impossible since the resulting waviness, due to the complicated surface shapes of gliders, would have to be sanded down laboriously by hand. This difficulty was solved by using a special polyester, developed for lac-