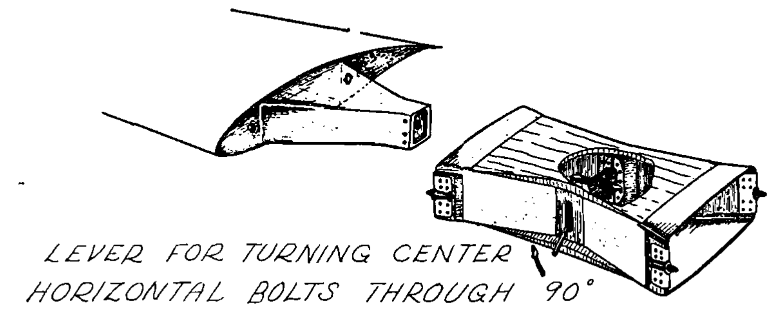

Figure 6. Wing juncture.

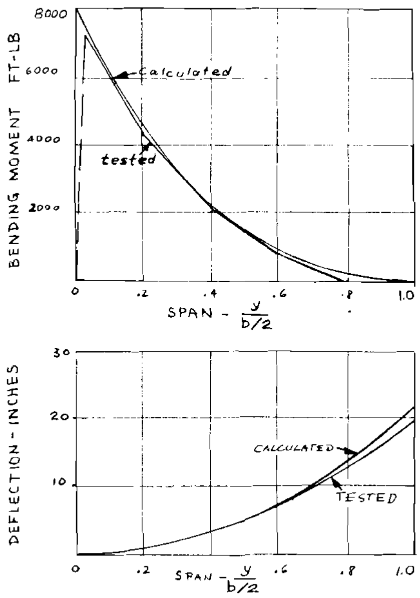

Figure 7. Maximum bending loads and resulting deflections along span.

ing the balsa thickness the fiber layer can be decreased. Tests have been conducted to get the required strength with a minimum of weight.

3. DESIGN CHARACTERISTICS:

The development of the fabrication methods has been influenced from the very beginning by the design of the FS-24 "Phoenix." Even so, there has been a big step from the fabrication method itself to the completed sailplane.

The wing, as mentioned, has three webs to prevent buckling. They are located at 15, 35, and 55% of the chord length. They take shear loads and part of the torsion in addition to compression. The balsa layer is 2/10 of an inch thick. Due to compression loads, the fiberglass skin consists of linen type cloth diagonally (45°) applied. Between the webs the airfoil thickness is rather large (maximum thickness of the airfoil is 14.3%). In this area the shell is reinforced as required by the bending forces. The nose and leading edge part are made of 0.2 inch balsa and one layer of fiberglass (2 ounces /sq. yd.) on both sides. The type of the connection between wings and fuselage has been suggested by U. Huetter. Three parallel bolts are used. The center bolt has a locking pin as a safety device, (Figure 6). The glass fiber method provides a very simple way to make the wing attachment. All fiber layers of the reinforced center part are brought to the end of the box and for reinforcement are bent around the corner, see Figure 6.

The wings were made by using two female molds. The molds originally were made out of wood. In the meantime plastic molds have proven to be more favorable; they are independent of humidity influences. The molds are made to utmost accuracy. They give the final shape of the wings.

The outer skin is layed into the mold. It consists of several layers of cloth in the reinforced part of the wing and of only one thin layer of cloth for the rest of the wing. After the fiberglass has set the balsawood is glued to it. On top of the balsawood the inner fiberglass layer is applied.

All ribs and webs are glued in place with the wing still in the mold; at the same time all fittings for ailerons and flaps are installed. The ailerons and flaps themselves are integrated in the wing and are not cut out before the upper and lower part of the wing are glued together. This gives optimum aerodynamic relations between wing and controls. The gap is completely covered by extending the top fiberglass layer. The fuselage was made over a wooden core in one piece. The skin was split in two halves, top and bottom part. Into the bottom shell, all accessories are installed such as seat, controls and landing gear. Then the two parts are glued together again. This process includes installation of the wing bridge. This gives a very clear design for stress analysis. The rear fuselage does not need any reinforcement against buckling.

The wing bridge is fixed to the fuselage. It is also connected by a structural member with the seat and skid.

Rudder and elevator are made by the same principles as the wings.

Final weights of the "Phoenix" are:

wing with aileron:	210 lb.
fuselage with instr:	135 lb.
rudder and elevator:	18 lb.
empty weight:	374 lb.
max. gross weight:	584 lb.

Compared to the sailplanes with laminar airfoil this means a reduction in empty weight of approximately 30%.

4. WING STRENGTH TESTS:

One wing of the FS-24 has been tested in order to prove the theoretical results on the strength of the shell, permanent deformations and stress distributions at the root of the wing. The program has been based on maximum loads stated in the German strength requirements for sailplanes.

Figure 7 shows the calculated lift distribution and its simulation during the test.

The wing was connected to a fixture simulating actual installation in the airplane. Four single loads at different positions have been applied. The deformation of the wing was recorded with precision instruments. The loads were increased and decreased in steps of 20% of the maximum load. The cycle was repeated several times. Deformation went linear with load. However, some hysteresis showed up. After unloading the wing 2 to 4% of the deformation at maximum load was still observed. One hour later it had reduced to less than 1%. During a 43 hour test with 30% of maximum load, deformation at the wing tip changed from 5.750 to 5.945 inches or 3.4%. Immediately after unloading a deformation of .236 inches was recorded. It reduced to .075 inches after 3.5 hours. No signs of buckling have been observed during the tests.

The modulus of elasticity of the warp re-inforced fiber cloth used for the stress calculation, of the wing root, has been determined by tension tests. The modulus of elasticity for other cloth combinations and sandwich parts have been calculated using published results on glass fiber - resin combinations (Ref. 5). Calculations and tests did not agree too well, especially since the shear values