ON THE USE OF POLYURETHANE FOAM

by Stan Hall, Chairman, SSA Research Committee

Polyurethane foam, of the foam-in-place variety, is gaining increasing popularity among sailplane designers and builders. In practice one mixes two interacting liquids together and pours them into the cavity to be filled. In a few seconds the mixture turns to foam, expanding some 30 to 35 times its original volume in the process. In ten minutes the material is rigid and can be formed with wood working tools.

Polyurethane foam is being used for such sailplane applications as stabilizing the ply on D-tube spars (to prevent thinner plys from eventually sinking between the ribs), for adding torsional stiffness to long and thin plywood or metal-covered control surfaces such as ailerons and flaps, for contouring flat gore-sided fuselages, and for making fillets.

Some Cherokee II builders have found yet another application; they fill the whole wing forward of the rear spar with foam and fiberglass over it. Since the Cherokee takes no torsional loads through its leading edge this technique is a natural. I am using it on my new bird, Ibex. The resulting surface is superb and long lasting, although not quite as resistant to the pressure of the thumb, for example, as a plywood surface. One can permanently indent it without too much trouble.

* * *

Interesting and productive as the use of polyurethane foam is, it brings with it some problems, problems which can be side-stepped if you know they are there. Here are some I discovered, along with the help of Jack Lininger, who put me on to polyurethane and helped me understand its vagaries.

One of the more important problems is that the foam will continue to expand long after you think it has stopped and this can, under the right (or wrong) conditions, be disastrous. I must re-skin the empennage on Ibex on this account. The photo in Figure 1 will show you why.

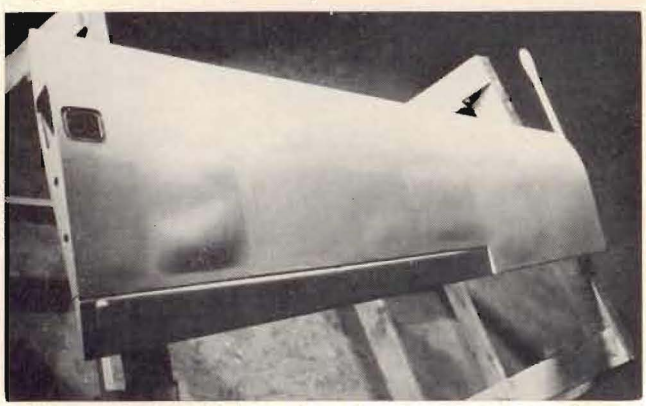

Figure 1, showing effects on plywood surface of expanding foam.

I made the mistake of building the surfaces first and pouring the polyurethane in afterwards. Bad show. The instructions on the cans warn about the pressure this material can build up in foaming. I chose to slight this warning because, after all, foam isn't very strong, is it? My attitude seemed to find support in what turned out to be poor advice on the part of a self-styled expert (not Jack). He told me that foam, in encountering an obstacle, merely increases its own density as it expands, and that my surface wouldn't swell. As a potential safeguard against this advice, however (I was concerned at least somewhat), I pumped the liquid a little at a time through a steel tube which I inserted into the surface from one end, allowing a half-hour or so between charges. I was delighted with the results – for about a month. Then the surfaces started to bulge, showing large, unsightly bumps, with every rib showing like a spavined horse in reverse. As a result I had to re-skin the surfaces. I later heard about a chap who, a few years ago, decided to stiffen up a metal sailplane wing by filling it with polyurethane. As the story goes he upended the wing, tip down, and poured the liquid directly into it through a hole in the root rib. Not only did the wing swell up, it even popped a number of rivets!

* * *

When I built the ailerons and flaps for Ibex I tried a different approach, one which worked. (See Fig. 2.)

I built a lower-surface jig for the surface on a large plywood sheet and tacked the skin to it. I glued the spar and ribs to the skin and then, with the whole surface open, I poured in the foam. Later I glued on the top skin. After six months the surfaces are perfect. I did the foaming outside where the hot sun could assist the process of expansion. I let it set for a day and then sanded the foam down to the ribs with a long, straight 2x4 to which sandpaper had been rubber-cemented. After this I forced the foam to swell even further by applying heat with lamps. I maintained a good El Mirage 130°F for 15 minutes per foot. And swell it did. In fact I got some nice big, golf-ball sized bumps which I went gleefully after with my sanding board. Imagine my dismay when I sanded right into big, hollow bubbles, each complete with crater. Obviously I had gotten the foam too hot. I should have backed the heat lamps away a little and kept them on the foam longer, allowing a more gradual swelling. My newest technique is to cook the foam until, when I place my ear about an inch from it, I can no longer hear the little popping noises it makes as it expands – and then I give it 10 minutes more.

On the matter of the craters, I compounded the crime in the process of effecting repair; I should have refilled the cavity with more foam, but I decided to use a paste made of polyester resin and microballoons instead. When the filler hardened I started sanding it down flush. This turned out to be a very poor technique. First, as the sanding started taking the filler down, small chunks would break loose and gouge bigger chunks out of the foam. Also, since the filler was harder than the foam around it the foam would wear away, leaving the filler to stand above it no matter how much I sanded. All very discouraging. After a short nap to calm the beast within me I carved out the filler and did what I should have done in the first place – fill the cavity with foam.

Incidently, one will always have the problem of the foam wearing away more quickly than the wooden