**EDMONDS MODEL PRODUCTS**

Manufacturers of MODEL AIRCRAFT KITS and other model accessories

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# PULTRUDED CARBON FIBRE SPARS

What makes a pultruded carbon spar any different from any other kind of carbon spar?

The reasons are as follows:- Let's first look at the "normal" method employed in carbon fibre spar manufacture. The usual way most modellers go about this is to make a channel in the wing core, say 10mm front to back and say 2mm deep over most of the span, into this channel are laid as many carbon fibre rovings wetted with epoxy resin as possible. Subsequently the outer wing skins are pressed into place to squeeze out as much excess resin as possible. After this stage, the whole thing is left to set. This is a hand laid up spar boom. The final result is spar boom that is approximately 50/50 by volume resin/carbon fibre in which hardly any of the fibres are laid perfectly straight. Now, not forgetting that our spar boom is a tension member at the lower surface of the wing and a compression member at the upper surface we must consider how those strength giving fibres are going to work for us. For the purpose of our gliders we need to worry more about the performance of that lower spar boom which is in tension. When a tension (tensile) load is applied to a spar boom which is hand laid up, the individual carbon fibres will be each differently loaded because they are not uniformly straight along the spar length. The fibre that is the straightest will carry the most load and will fail first, whereupon the load path transfers to the next straightest which in turn fails and so on:- the result is a sequential failure. Now back to that pultruded spar boom. Any article made of carbon fibre and epoxy resin by the pultrusion process has two major advantages over a hand laid up spar boom.

i) All the fibres are perfectly straight and therefore all carry load at the same level,

ii) Because the pultrusion process is a high pressure operation, the ratio of resin to carbon fibres is something like 34/66 by volume compared with the 50/50 by volume of the hand laid up article. This means that for a given cross section there are more working fibres than are possible with hand lay ups.

To see how the pultrusion process works, please refer to the diagram:-
The raw carbon fibres (a) are pulled from reels on a storage rack (b) and through a bath of epoxy resin (c) next the fibres now soaked in resin enter a heated steel die (d) the channel or passage through the die has the same cross section dimensions as the finished spar boom. The number of fibres chosen are sufficient to completely fill the die cross section leaving only the minimum of space for the resin. All surplus resin is squeezed out in the die taper (e) and runs back into the bath. A pressure of some 2000 p.s.i. is developed in the taper stage which ensures thorough fibre wetting. The resin is prevented from curing in the taper stage by the cooling jacket (f) The fibre/resin now enters the paraller or moulding section of the die which is heated, where it is fully cured. The finished product (g) emerges from the die under the influence of a pulling mechanism (h) (Hence the word 'Pultrusion') and is cut off into convenient lengths by an automatic saw (j).

We have performed many laboratory tests of both carbon fibre hand lay ups and carbon fibre pultrusions, also we have tested glass fibre equivalents for comparison. The results are shown below, expressed in engineers language with figures given according to each test samples Youngs Modulus of Elasticity "E" refers to the samples resistance to strengthing at given tensile loads, the higher the figure the better.

| | Youngs Modulus "E" |
|---|---|
| HAND LAID UP GLASS FIBRE | 30,000 |
| PULTRUDED GLASS FIBRE | 50,000 |
| HAND LAID UP CARBON FIBRE | 76,000 |
| PULTRUDED CARBON FIBRE | 139,000 |

By way of interest a sample of pultruded carbon fibre having a cross section of 12mm x 1mm failed in tension at a load of 1.76 tonnes.

THE ABOVE DATA WAS COMPILED BY ALAN COOPER ESQ.

## Prices

4 x 14.5mm x 1mm x 1metre £18.00
1 x 14.5mm x 1mm x 1 metre £ 4.60

2 x 29 mm x 1mm x 1 metre £15.20
1 x 29 mm x 1mm x 1 metre £ 7.80

1 sheet60mm x 1mm x 1 metre £14.00

Packing/postage per order £1.00