Carbon Fiber Spar

How to build a carbon fiber spar:

This file is an excerpt of our building notes. The complete building notes are much more detailed.

In this file, we will first look at the building of the profile, the tube, then we'll look at details like local reinforcements and examine how fittings are made and added. Important remark: the strength of those spars greatly depends on the quality of the lamination work. The making of a carbon fiber mast is NOT a beginners job however, after building a composite boat hull, one should have acquired sufficient skills to make a mast. The most important point is to build a laminate with the highest possible fiber content. We explain how to obtain that result with simple procedures like wrapping the wet laminate in peel ply fabric. If you doubt your skills, add some layers.

The spar profile:

There are several good methods to build a carbon fiber spar profile: around a mandrel or in a mold. A mold is not required for a one-off mast.

We will review different ways to build a spar around a mandrel.

(See building notes for complete text)

We will consider two types of mandrels: an insulation foam type suitable for small spars and a rigid foam type for larger ones. Each method uses our **carbon fiber** and biaxial glass sleeves laminated in **epoxy**.

1. Carbon fiber spar laminated on an insulation foam mandrel.

This method is suitable for spars of constant section to make masts for small-unstayed spars for boats up to 16' or booms and poles. It is possible to taper the foam mandrel if one wants a tapered mast. Some of the pictures and text are taken from a web page created by one of our builders. Lazlo Morocz: http://www.lmorocz.com/BoatBuilding/krakenbait.htm

(See building notes for complete text)

The lamination stack is made of . . .

Some reinforcements are added where local loads are expected. In the case of a mast, at the mast step, masthead, boom fitting, shrouds tangs etc. We will describe them in detail later. The foam runs on steel pipe longer than the mast and supported at both ends.

If your tube bends in the middle like this:

You can straighten the mast by using weights at the ends:

This is enough for small spars, for longer ones we use a different method with a rigid foam mandrel on a bench. We describe that method later.

The insulation foam tubes . . .

(See building notes for complete text)

If you want a tapered mast, cut a slit in the upper part of the foam.

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Local reinforcements:

We will add extra layer of glass in some critical places. To avoid the extra thickness, compress the foam with packing tape to make room for the reinforcements. (See building notes for complete text)

Build up the thickness with glass tape until you obtain a constant diameter. You can taper the reinforcement layers if you prefer.

Install the first layer:

(See building notes for complete text)
Pull the sleeve as tight as possible:
And apply resin

Once the glass is wet, try to squeeze out as much resin as possible but without starving the fiber for resin. A pass with gloves all around the spar is enough.

(This picture shows a solid foam mandrel but the resin "squeezing" technique is identical) Rotate the tube a few times during the cure to avoid drips. Let cure overnight.

This is how it should look when cured. Fully transparent glass and visible weave indicate a good inner lamination layer with no excess epoxy.
Now we have a good solid tube around which we will proceed with the carbon fiber.

Carbon fiber layer:

Using the same method than for the glass, pull the carbon fiber sleeve around the spar.

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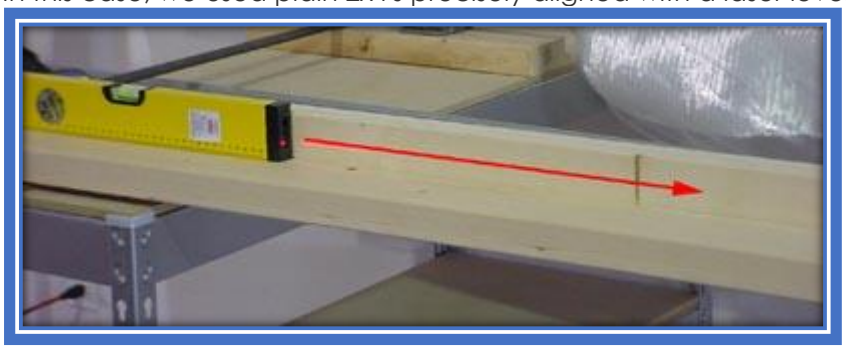
Again, tension is important, pull the sleeve as tight as possible.

(See building notes for complete text)

(This picture shows the peel ply on a dry mast)
(See building notes for complete text)
Optional post cure:
(See building notes for complete text)
Larger spars on a rigid foam mandrel:
Longer spars can be built with the method described above but as the length increases, it becomes difficult to keep the mandrel straight.
For that reason, we prefer to build the mast around a rigid foam mandrel on a perfectly straight narrow bench.

(See building notes for complete text)
We will look at the building step by step, first, building the bench.

In this case, we used plain 2x4's precisely aligned with a laser level.



The foam mandrel is built exactly like a hollow wooden mast.
We will need local reinforcements for mast step, mast top, shroud and spreaders attachments etc.
Those reinforcements can be made of high-density foam inserts or extra fiberglass layers.

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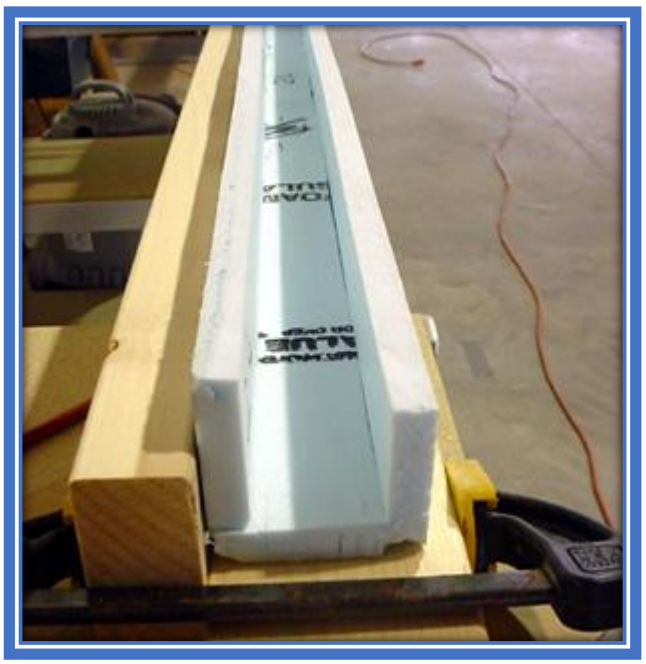
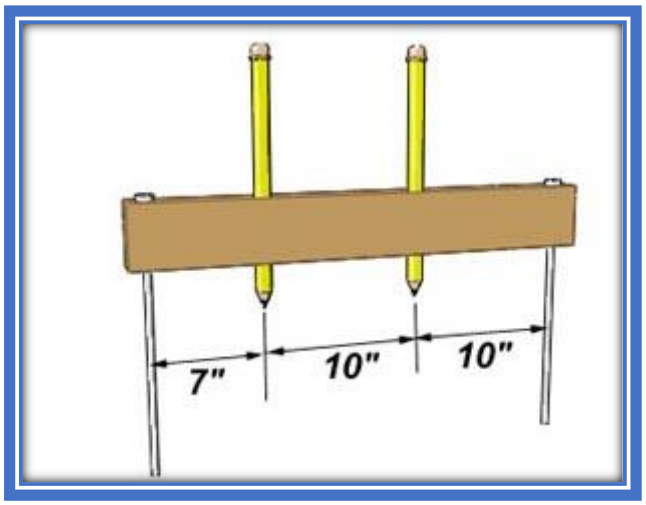
(See building notes for complete text)

Once the box is made, we can shape it in a round mast.
We will cut the corners to make an octagon, round those corners until we have a round shape.
To make an octagonal mast, we mark the corners of the box with a mast maker gauge:

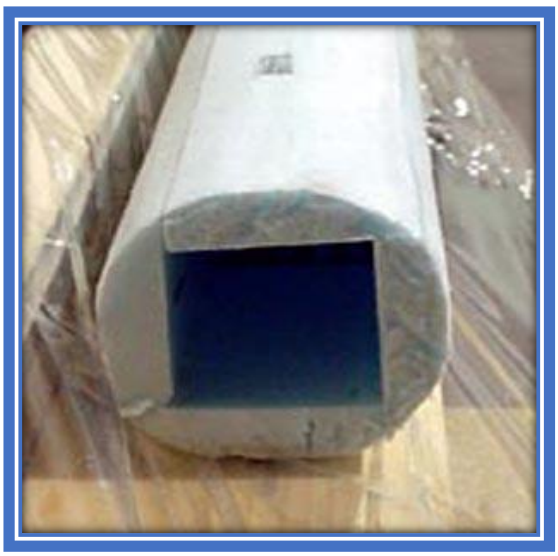


With the sides of the gauge pressed against the sides of the box, the gauge will draw a perfect taper.
The gauge can be made of any material: a piece of wood with nails or pens like above but the proportions are always as below:



7-10-7
Beware, the pictures is wrong, it should read 7-10-7

(See building notes for complete text).



(See building notes for complete text)

Oops, in this picture we did not grind enough foam to compensate for the mast step reinforcement.
We follow . . .
(See building notes for complete text)

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The sleeve covers the reinforcements and should be stretched as much as possible.

Apply the resin the same way than in the previous example and follow with more layers including carbon fiber according to your lamination schedule.
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The same remarks apply to peel ply, post cure, paint etc. but before painting, let's look at spars details like fittings and sailtracks.

Spar fittings, hardware etc.

We will consider two types of mast: stayed and selfstanding.

You can fit out a carbon spar as an aluminum one, with cast aluminum alloys and stainless parts but be sure that the fittings go on a reinforced area.

The picture above shows a combination of home made carbon fiber spreaders with store bought cast Al and SS fittings.
Corrosion is . . .
(See building notes for complete text)
A better way to fasten a metallic fitting like, for example a boom end cap or a masthead, is to epoxy glue them. It is safer and cleaner.
If custom fittings are made or required, make them from stainless steel 316 or better, from carbon fiber. Carbon fiber "hardware" is easy to make yourself and we will show some examples.

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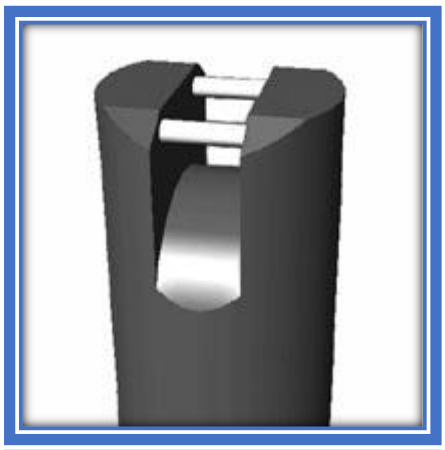
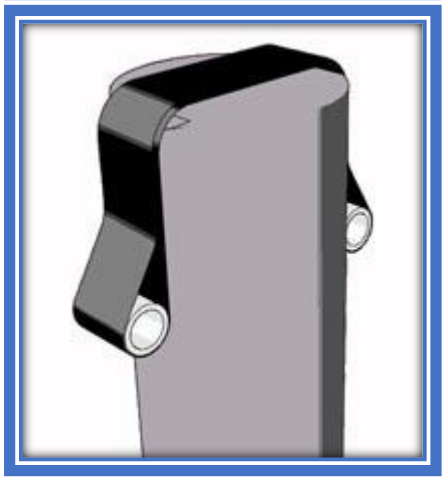
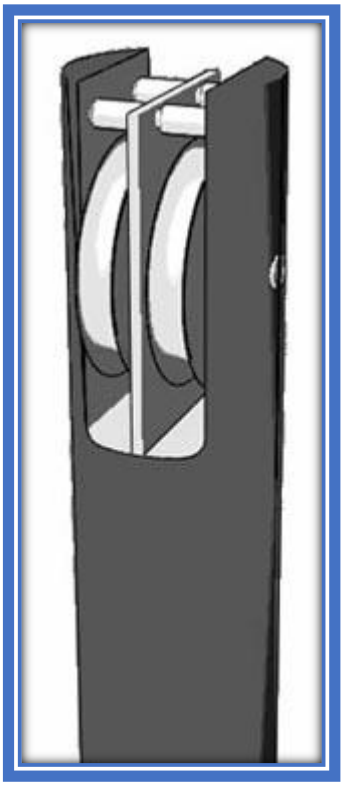


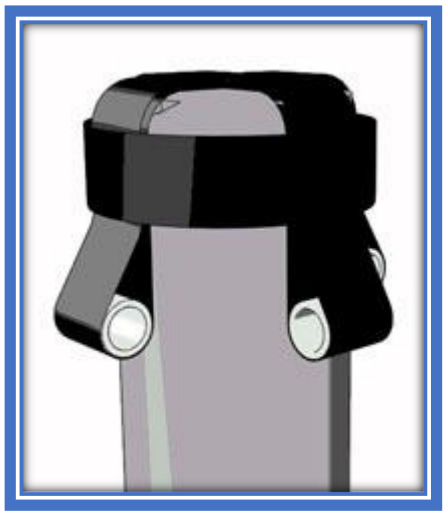
Build those parts from carbon fiber tape or tow with some UHMWP or SS bushings where needed. UHMWP means . . . (See building notes for complete text)

Fittings for self standing masts:

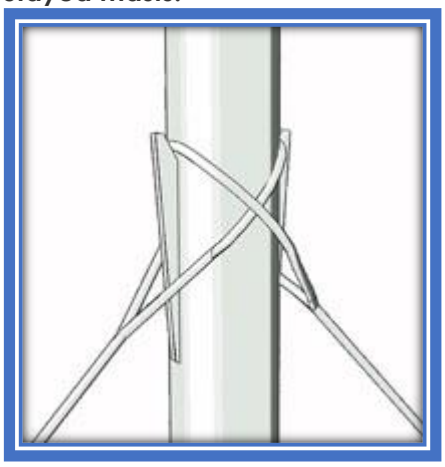
(See building notes for complete text. We show pictures only in this section)







Stayed masts:



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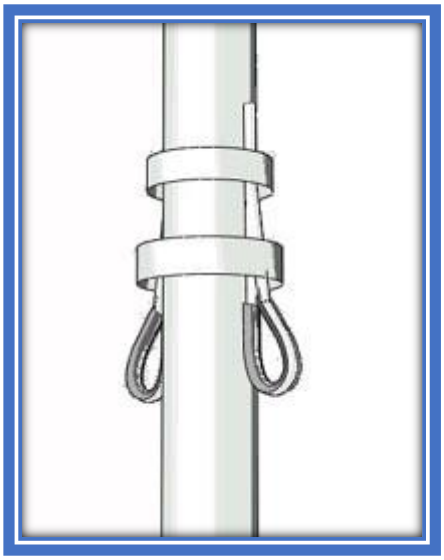

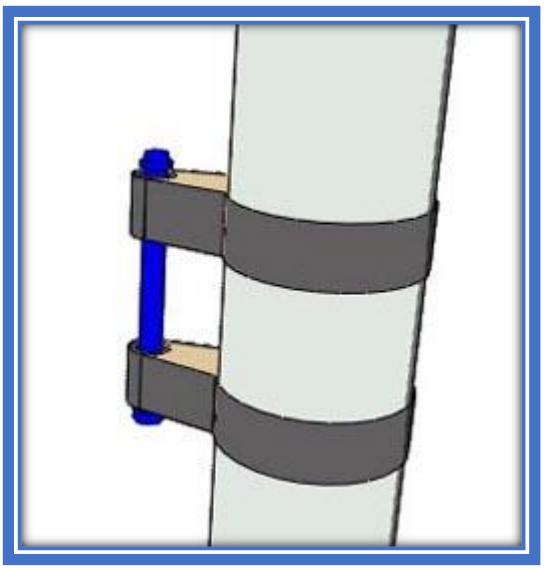

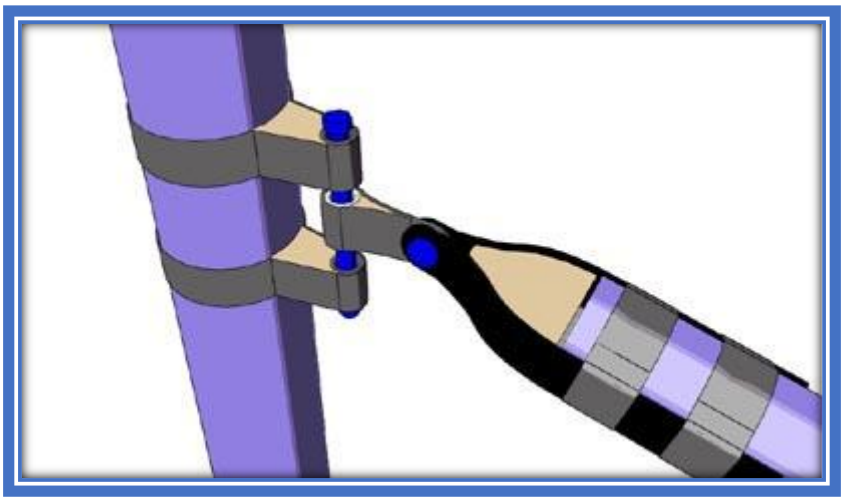

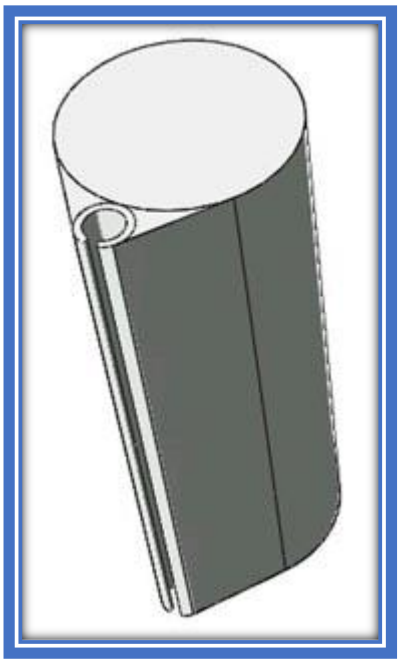

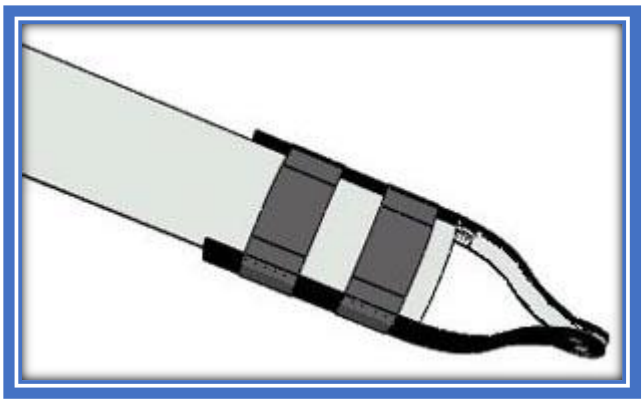

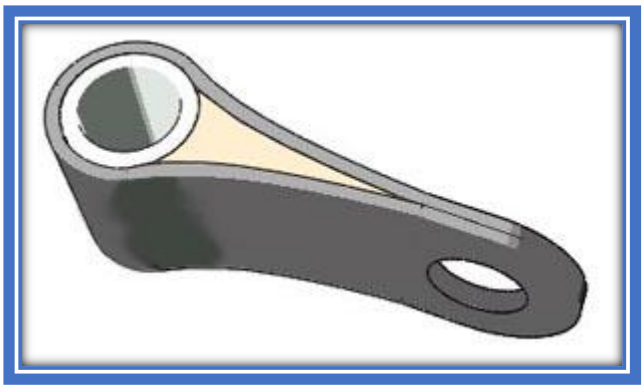

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