Engineered to stand alone

Eric Sponberg explains design and construction techniques for carbon-fiber spars

The modern freestanding mast may be one of the most promising and exciting sailing developments of recent years. By using advanced composite materials and technology to make it strong, stiff, and light, a freestanding rig eliminates much of the drag associated with a conventional stayed rig. For the same amount of lift, less drag means that more thrust is available to make the boat go faster.

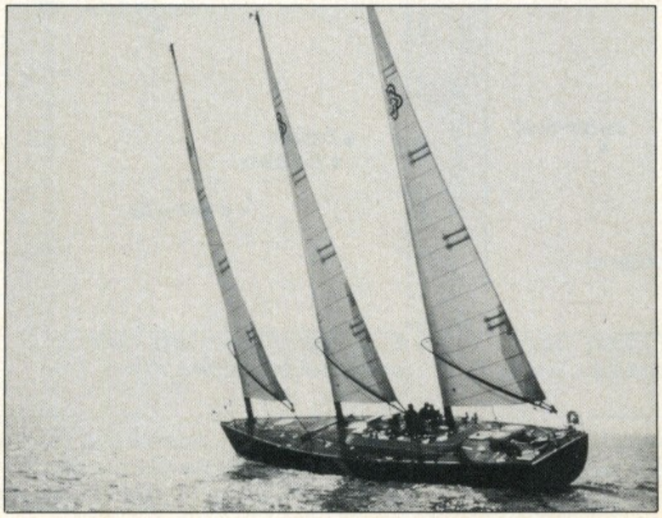
The advanced composite materials (or composites, for short) used in the building of freestanding masts comprise both fibers and resins. *Carbon fiber* is the basic ingredient of composite freestanding masts. It is a tremendously strong and stiff fiber that is 91 to 95 percent pure carbon (as opposed to graphite fiber, which is better than 99 percent pure carbon and is much more expensive). The biggest producer of carbon fiber for the marine industry is the Celanese Corporation (Celion carbon fiber).

Any of three other fibers is used in conjunction with carbon fiber. *E-glass* is the standard glass reinforcement, including the woven products and unidirectional fabrics used to build fiberglass boats. In masts it is used for circumferential (or hoop) strength and stiffness and as a protective layer against abrasion and impact.

S-2 glass, which is twice as strong as E-glass, was originally developed for the military as S-glass. S-2 glass is similar in makeup to S-glass, but it has less stringent manufacturing specifications. In masts, S-2 glass replaces E-glass at a slightly higher cost.

Kevlar 49, an aramid fiber that is lighter than glass and carbon fiber, is halfway between glass and carbon fiber in stiffness and has very good impact resistance (it is the

Kriter Lady II on sea trials shortly after her launching in 1981. She carries the largest freestanding carbon-fiber masts to date



Celanese Corporation