

Emergency Rudder Design - the Soft Rudder

by Paul Kamen

The emergency rudder is one of those required big-ticket items that can become a complicated and expensive part of Pacific Cup boat preparation. Although there are off-the-shelf options based on wind vane steering hardware, these are not always effective on larger boats and may be too heavy and expensive for small boats. Most emergency rudders are custom fabrications, designed to fit the geometry of the stern and sized for the size and weight of the boat.

One easy option is the soft rudder, essentially an underwater sail that can steer the boat. It is light, inexpensive, easy to build, easy to deploy, easy to stow, and sometimes more effective than a solid blade because of its large area. It is not as durable as a solid blade, being more susceptible to chafe and other kinds of failures. But the parts that can wear out or break are easily replaceable with materials found on board. Remember, this is not a rudder to win the race with, or even to get you to the finish in time for the parties. This is an emergency system to get you to the finish line (or back to California) without requiring outside assistance. It doesn't have to work efficiently, but it does have to work.



The smallest version of the soft rudder, pictured here, has been tested on a Merit 25 and J-24 with very good results. On a J-24, the main rudder was removed to simulate failure.

Larger versions have been built for a Cal-40, a Santa Cruz 52 and a Beneteau 57.

The most successful big-boat test was on the Santa Cruz 52, where it provided very good steering control including tacks and jibes in moderate wind with the main rudder either locked or free. The Cal-40 version was never tested but met Transpac requirements (Unlike Pac Cup, Transpac rules do not require a live test). The Beneteau 57 version passed the Pac Cup live test but probably should have been built with more sail area and rigged to more effectively limit twist (it needed more "vang.")

The soft rudder concept is to steer with an underwater sail supported by two spars. One spar is the mast/rudder stock, the other spar is the boom/tiller.

This system has the advantage of adding a lot of rudder area, which could be critical for regaining directional stability after the rudder is lost, especially on very modern boats with extremely high-aspect keels placed forward of the boat's center of gravity.

The soft rudder is very easy to deploy because there are no gudgeons and pintles to line up. The attachment to the boat is via lines led through pad eyes.

Repair is easy: Replace lines as they chafe. If a spar breaks, cut off an appropriate length of spinnaker pole or even part of the main boom, if it comes to that. Again, remember that the project here is to get you back to a boatyard without outside assistance, even if it means cannibalizing other boat parts.



For small boats, the sail can be made from the top part of a windsurfer sail, and the spars can be a windsurfer mast cut in half.

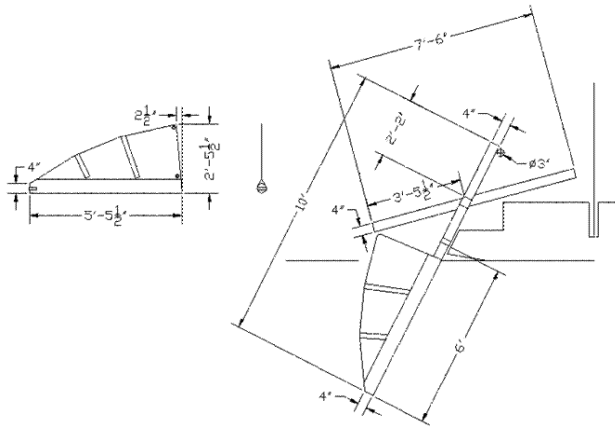
The bottom "gudgeon" is a pair of pad eyes low on the transom. Gudgeon lines are lashed to the spar just above the rudder sail and lead through these eyes and then up to cleats on deck to hold the spar close against the transom.

The top gudgeon is at the lifeline level. In this case, a short spar is clamped between the two corner pulpits with an attachment point on centerline for the top lashing to the rudder stock/mast.

It's important to keep the separation between top and bottom supports as large as possible, to reduce loads on these attachments. On boats with swim steps or cutaway

transoms, the top support point will almost always be on a wire or small spar spanning the stern between the corner stern pulpits at lifeline height. It's not necessary for it to be on centerline if there's a backstay or other hardware that interferes.

Santa Cruz 52 Soft Rudder



Note that it is necessary to control twist. This is done with a "vang" between the top end of the stock/mast and the aft end of the tiller/boom. To keep the gooseneck lashing from slipping aft under thrust from the vang and sail, an inhaul is rigged from the gooseneck lashing to the forward end of the tiller/boom.

For the Santa Cruz 52, Cal 40 and Beneteau 57 designs, the sails were professionally built to order.

For the Santa Cruz 52, parts of broken carbon spinnaker poles from boats of similar size were used. The as-built dimensions were smaller than as-designed to match the size of the spar fragments available, but the rudder still proved to be very effective during tests under sail.

The Cal-40 and Beneteau 57 versions are designed to use the primary spinnaker poles as the emergency rudder spars. Similar diameter spars were used for testing, but not brought along for the race.

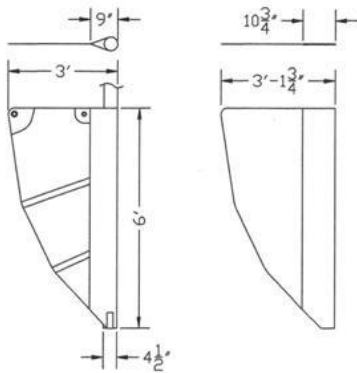
As rule of thumb, a big boat's own spinnaker pole is probably only about half as strong as necessary for this design to survive at speed under full stall deflection. However, loads can be moderated by carefully limiting the length of the tiller so that a human driver will not be able to push hard enough to overload the spars. As noted, broken spars can be replaced as needed from the supply of spinnaker poles on board.

Spars prepared in advance for this type of emergency steering could be wrapped with additional fiber and resin to increase strength in way of areas of high bending load.

Another possible problem is flutter caused by periodic vortex shedding around the circular spars. This has not been observed to any significant extent in trials, but a possible fix would be a larger luff pocket in the sail with a foam insert to fair in the trailing edge of the spar.

"Underwater luffing" has not been observed, but it seems desirable to keep the rudder sail very flat and to use battens to suppress any tendency to flutter.

Beneteau 57 Soft Rudder

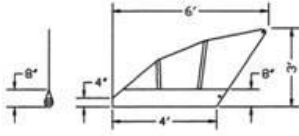


Emergency Rudder Sail
for 4.5" diameter sprinker pole as mast/rudder stock
("masthead" detail like Laser luff pocket masthead)



Cal 40 Soft Rudder

Cal 40 Emergency Rudder



Luff pocket to accept 4" diameter spar all the way to the end, with retainer strap across top (like Laser mainsail).

Batten positions approximate.

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