Chafe Protection in Storms

One of Chip Del Coro's 3/4" nylon ... tors were starting to split, but were not ... the line failed internally from heat. Note the ... lack of external abrasion on the line.

Chip Del Coro, a BOAT/U.S. Member in Atlantic Highlands, New Jersey, wrote *Seaworthy* awhile ago about a near catastrophe he experienced with chafe on his 40' sailboat's mooring line. A gale had swept through the area with 55-mph winds, sinking seven boats at his Atlantic Highlands Yacht Club and beaching eight others. In all but one of the losses, the cause was a failed mooring pennant.

Chip's boat survived, but barely. He'd used two 3/4" nylon pennants, each three months old, with two feet of clear PVC tubing to guard against chafe. When the winds let up briefly, he motored out to the boat to inspect the lines: *"I went pale. Both plastic hoses had severe stress cracks and both lines had chafing failure inside the hoses. Two of the three main strands were worn through, and only a few mini strands of the third were still holding. If the winds had lasted another 30 minutes, my boat would have been on the rocks."*

The letter, with one of Chip's chafed pennants enclosed, sat around the *Seaworthy* offices for many months, not because the topic isn't important—it is extremely important—but because answers have been so elusive. Nylon, because it stretches and absorbs shock, has been the line of choice for mooring pennants. And a lot of experienced marine professionals once thought reinforced PVC tubing was the answer to chafe; it is flexible, rugged, and comes in almost any length. With each passing northeaster, however, it became apparent that nylon and PVC are vulnerable in a storm, perhaps more vulnerable than other types of line and chafe protection.

Jonathan Klopman, a marine surveyor in Marblehead, Massachusetts, sent *Seaworthy* another chafed nylon pennant that had been "protected" by PVC tubing until it parted in a northeaster. PVC, he said, might be OK for routine chafe in mild weather, but it is clearly vulnerable in a storm.

Learning from Past Hurricanes

After hundreds of boats dragged their moorings ashore in Hurricanes Gloria and Bob, many harbormasters replaced their mushroom and deadweight moorings with helix anchors, which can be screwed deep into the bottom of the harbor. Helix anchors have proven, over and over, that they have far greater holding power than anchors that sit on or near the surface (*Seaworthy*, July 1993). Another innovation, the Hazelette pennant, was developed to absorb shock and reduce a boat's sailing back and forth on its pennant. The Hazelette, which is meant to be used with longer conventional pennants in a storm, absorbs shock and reduces wear on the fittings, mooring anchor, and lines (*Seaworthy*, October 1996).

As for chafe, the two massive hurricanes also prompted the Massachusetts Institute of Technology to do a study—"Wear and Fatigue of Nylon and Polyester Mooring Lines"—on why pennants fail. While the study didn't recommend any specific type of chafe protection, it did gives clues, valuable clues, as to what could be done to reduce mooring line failures. Some of what the study found:

- Under heavy loads, the constant cycling—stretching and contracting—builds up heat, due to the frictional interaction between yarns. The line wears *internally*. [This is especially true of nylon, which can stretch to about 40% of its length vs. only 8% for polyester (Dacron).]

- Polyester is more abrasion-resistant than nylon under heavy cycling loads. When the polyester and nylon rodes are *wet*, the difference in abrasion resistance is even greater.

- Under *heavy* cycling loads, wet nylon yarn is more abrasion-resistant than dry nylon. Under light loads, the reverse is true—dry nylon yarn outlasts wet nylon.

Heat builds up because of friction between the fibers and also because of internal molecular friction. In a storm, then, wet nylon would last longer than dry nylon because the water would provide additional lubricity (good marine nylon line typically already has a finish that helps to reduce yarn-on-yarn friction) as well as cool the stressed fibers.

When examined closely, the failed nylon pennant sent to *Seaworthy* by Chip Del Coro had small welds—plastic lumps—at the ends of some of the failed strands which indicated that the line had failed internally. Furthermore, the broken strands showed no signs of *external* failure—yarns that had become "fuzzy" over a wide area after rubbing against the chock. Surveyor Klopman also noted that with lines he'd examined that had failed in storms, there were typically "micro welds" at the ends of the failed strands.

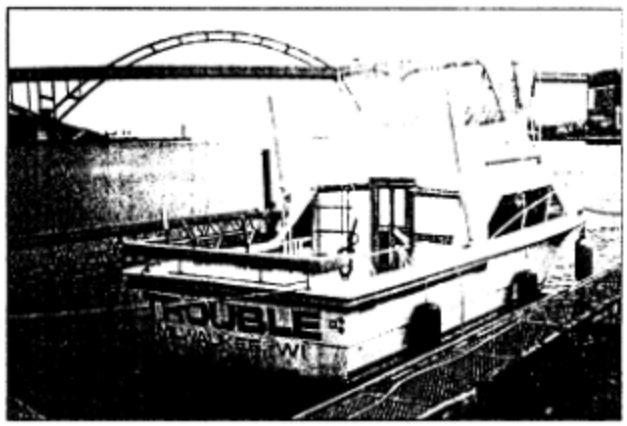
PVC: A Theory

Could it be that PVC, by keeping the line dry and providing insulation to retain heat in a storm, *hastens* the demise of the nylon line it is supposed to be protecting? "It sounds reasonable," says Stanley Backer, one of the authors of the MIT study. One of Backer's associates, Norm Doelling, the former Assistant Director of MIT Sea Grant, says the stiffer PVC increases the effective bending radius of the chock, which has the benefit of reducing heat, but he too worries that a long run of PVC tubing might also prevent water from reaching the stressed nylon fibers.

Both Backer and Doelling stress, however, that the best way to assure a line won't fail is to use polyester rather than nylon rode, the deck cleat out past the chock (see next page). This provides increased chafe protection on deck while also providing elasticity to absorb shock. (Doelling, who keeps his 38' sailboat on a mooring, says that chocks with sharp edges should also be replaced with *rounded* chocks.)

Chafe at a Dock

Chafe can occur anytime, anywhere, even when the weather has been fair and the boat is kept in a well protected slip. Water, wind, and tide will keep the boat in constant motion, which means a line that rubs against a metal stanchion or chock, even slightly, day after day, week after week, will be vulnerable to external abrasion. Salt crystals and dirt in the fibers accelerate wear, but any line that rubs against a hard surface—metal, wood, or fiberglass—will chafe if it isn't protected.



This Wisconsin boat which was protected from Lake Michigan only by a bridge, had its mooring line chafe through after being rocked by a late season storm. The line didn't appear to have any chafe protection. Note the distance from the boat's port side to the outer piling. Longer nylon docklines stretch more and can be more vulnerable in a storm (Claim #9708587A).

With most docklines, a short piece of chafe protection at potential trouble spots will prevent abrasion and keep the line healthy. Three things that may warrant using polyester line from the cleat to the chock and/or adding beefed-up chafe protection on a dockline: longer runs of line, over about 12'; lines that pass over sharp angles; and boats that are kept in slips that aren't well sheltered.

The longer the line, the more it will stretch, which builds up additional heat and increases its vulnerability at chafe points, typically a chock. A line attached to a cleat that is several feet away from the chock is more vulnerable than a line that is secured next to a chock. When the line passes over the chafe point at a sharp angle, it is even more vulnerable. And if the boat is kept at an exposed location, the probability of a line failing is that much greater.

A boat in Wisconsin (above), for example, kept at a slip that was protected from Lake Michigan by a bridge, had its mooring line chafe through after being rocked by a late season storm. The line didn't appear to have any chafe protection (Claim #9708587A).

Will the Boat Be There After the Storm?

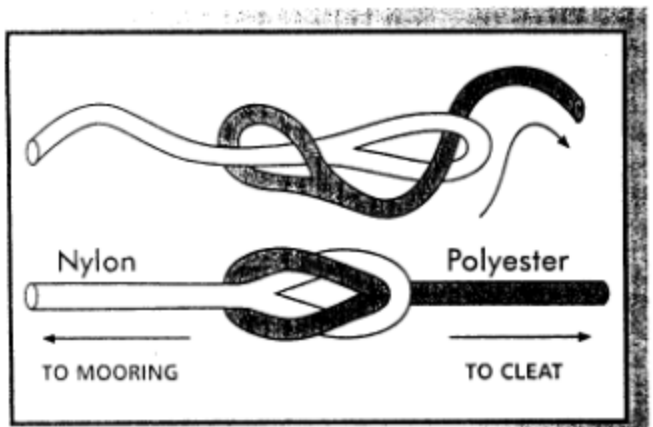
The strain on a line in a storm can be severe, almost beyond comprehension. Joe Schorle, a BOAT/U.S. Member in New Jersey, watched the bow of his 38' sailboat being tossed high in the air by an especially fierce northeaster that came through the area two years ago. The boat survived the storm, a feat he attributes more to a redundancy in lines—he used *four*, 5/8" braided nylon lines—than to the short pieces of rubber tubing he used for chafe protection. Two of the lines that were used had been reduced to a few strands and two remained intact. He too has since changed to the polyester Perimeter chafe protectors, which he feels will do a better job of protecting lines.

While there are certainly no guarantees in a storm, the idea of redundancy, using three or four mooring lines, is a technique that has been used successfully by skippers for centuries. And MIT's research makes a strong argument for using polyester lines from the cleat through the chock to reduce abrasion failure. As for protecting the polyester lines from chafe, using the same material—polyester—is a promising solution.

Will all of the lessons learned in Gloria and Bob mean that boats will be better protected in the next category three or four hurricane? As one harbormaster said, "Whenever we've had a bad storm up here, we've always found out what doesn't work." With the introduction of the helix mooring, Hazelette pennant, better chafe protection, combination nylon/polyester bridles, as well as more and larger lines, it could be that after the next hurricane we may finally get a better idea of what works.

Polyester line may be more chafe-resistant than nylon but tests have found that it too builds up heat, although far less heat than nylon, and is subject to internal as well as external chafe under heavier storm loads. Is there a material that protects the line from abrasion while also keeping it cool internally? *Seaworthy* called several boatyards to see what was being used. Some are still using PVC while others have returned to leather, even though leather chafe protection had often failed during Gloria and Bob (*Seaworthy*, July 1992).

Jono Billings, who owns a boatyard in Jamestown, Rhode Island, says he has been using a canvas-like tubing made by Perimeter Marine Products to protect the outside of the line from abrasion. Billings said he's never had a line fail that was protected with the material, and that includes lines that have been through some strong northeasters. Aside from protecting the line from external chafe, the material wicks water, which helps reduce heat buildup inside the line. And what is this newfangled chafe protection made of? Polyester, the same material that the MIT tests found is resistant to chafe.



A Simple, Inexpensive Method for Strengthening Mooring Pennants

A simple way of providing durability is to make up a piece of polyester line the same diameter as your existing nylon line. According to Norm Doelling (*Seaworthy*, April 1995), it should be at least six feet long and can usually be ten to 20 feet long.

Make an eye splice, leaving a large eye about a foot long, be sure to have at least five, and preferably six tucks in the splice. The polyester line can be passed through the existing nylon line in an eye-to-eye fashion as indicated in the illustration. This gives a dock or mooring line the best features of both types of ropes—nylon's stretch and polyester's abrasion resistance.

Doelling said he keeps two polyester bridles with eyes stowed aboard his boat so that the lines will be fresh and ready to go, should they be needed.