

Thoughts on Synthetic Rigging

s/v Hoku Pa'a, 1980 Niagara 35 hull 74

Background

We bought our boat in 2013 with the original rod rigging still installed. Our intentions were to sail her offshore, starting with a passage from Victoria BC to the Gulf of California, Mexico. Before leaving in 2015, we had all the standing rigging replaced with either wire rope (forestay) or synthetic rope (remainder of rig).

What is Dux?

Dynice Dux (previously called Dynex Dux) consists of Dyneema SK-75 fibers heat-treated while under tension, resulting in a rope that is stronger than the same diameter of 316 SS. Some sample breaking strengths of various rigging materials are:

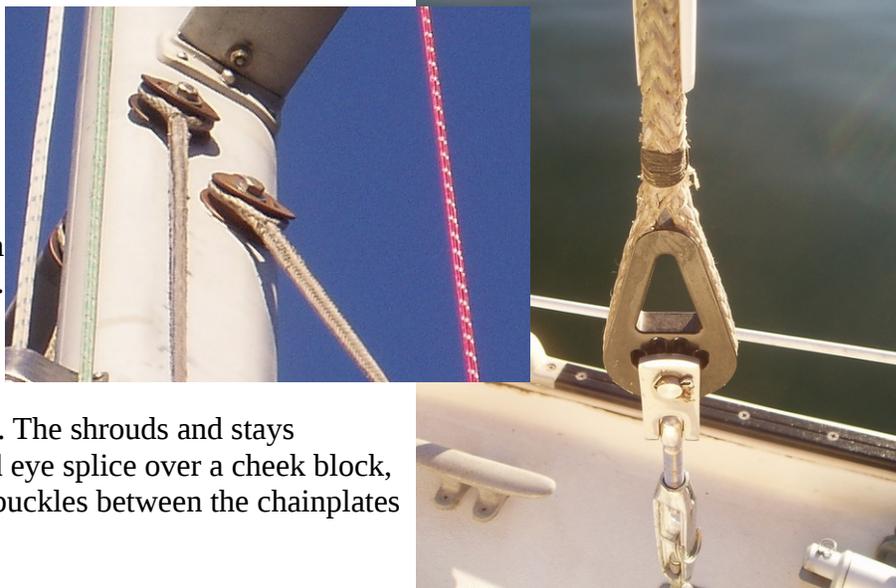
9.5 mm (3/8") 1x19 302 SS wire rope	-> 17500 lbs
9 mm 1x19 316 SS wire rope	-> 12944 lbs
Size -8 Nitronic Rod (original lower stays on N35)	-> 8200 lbs
Size -10 Nitronic Rod (original fore-, backstay and uppers)	-> 10300 lbs
9 mm Dynice Dux	-> 26400 lbs

You might wonder why, if Dux is so much stronger than the original rigging, why not just use a thinner diameter? It's because breaking strength isn't the only important parameter for the rigging; the amount of stretch when loaded is also important. When choosing the size of synthetic line to replace SS rigging, you want to keep the amount of stretch the same or less than the original yacht design called for. For the N35, 9 mm Dux has a similar amount of stretch to the original rod rigging. For a more detailed explanation of correctly sizing synthetic rigging, see Colligo Marine's excellent website (www.colligomarine.com). These folks offer a wealth of other information about synthetic rigging, and manufacture parts designed to work well with Dux line.

The great thing about spec'ing your rigging this way is that you end up with stays and shrouds that are 2 to 3 times stronger than original. This gives you a very comfortable allowance for significant deterioration of the lines before there is any concern about them failing.

Re-rig Procedure

Rerigging involved changing the rod stemball sockets for aluminum compression tubes welded through the mast at the locations of the shrouds and fore/aft stays. SS bolts pass through these compression tubes and fasten machined aluminum cheek blocks to the sides of the mast. Eye splices in the synthetic rigging pass over the cheek blocks and are secured in place by a machine screw closing the top portion of each block. The shrouds and stays terminate near deck level in a second eye splice over a cheek block, and are tensioned by traditional turnbuckles between the chainplates and the cheek blocks.



Advantages

User-replaceable. You won't need swaging presses or unusual tools to make new stays. Splicing skills are all that are needed - in fact, because Dux uses single-braid construction instead of double-braid (as on many rope halyards and sheets), splicing is quite easy.

100% Inspectable. All rig elements subject to wear or deterioration are exposed for easy inspection. You can visually confirm whether any chafing or UV damage has degraded the rigging, as this will show up as 'fuzzy' areas on the line where individual strands have parted. Contrast this with wire rigging, where corrosion and breakage of the wire strands can occur inside the body of the terminators, where it isn't easily seen.

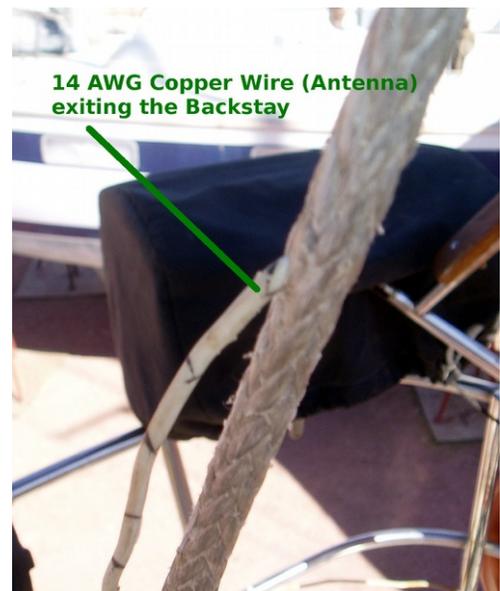
Avoids single point failure. One of the benefits of wire rope rigging over rod rigging is that one can lose a strand or two and the rig still won't fall down. Now imagine that instead of 19 strands of wire, you have thousands of strands in a synthetic line. Because Dux is at least 2 times stronger than the original rigging, you can afford to lose over half the strands before the strength drops to a level equal to the original rigging.

Lightweight. Dux is less dense than water (it floats); an entire set of stays and shrouds can be carried over one arm. We aren't racers, but we still appreciate saving weight aloft.

Easy to store spare shrouds. A length of Dux suitable for making a new stay can be bundled up and stuffed in a locker, without worrying about it clanking, getting kinked, or starting to rust.

Somewhat easier to cut away a rig in the event of a mast breaking. You can do it with a knife, rather than a hacksaw, but it is still hard to slice through the fibers. Dyneema SK-75 (the parent fiber of Dux) is very abrasion-resistant; it is used in forestry for dragging out cut trees.

Backstay can be used as an antenna without needing insulators. Just insert a stranded copper wire inside the hollow center of the Dux.



Disadvantages

Harder to recycle than steel. Dux is a plastic, and harder to dispose of without harming the environment.

Rigging tension changes more with temperature than when using SS rigging. Aluminum and Steel have more similar rates of expansion when heated, than Aluminum and Dux, so we find that our rig tension is lower on cool mornings than in hot afternoons. It's not a severe enough change that we are tempted to retune the rig every day, but it might be annoying to a racer. Note that this is what we've observed when cruising in the Baja Mexico area, where the daily temperature swing can easily be 25 C.

Several month break-in period, during which tension on rig needs adjusting. We found it took about 3 months after we installed our new rig before we didn't need to weekly or every few days tighten the turnbuckles. What was happening during this period was "constructional stretch" - the

splices and geometry of the rope strands were aligning under sailing loads. Even if you get your assembled shrouds pre-tensioned (e.g. at a rigging shop), you will likely still experience some elongation caused by the splices and braid settling into position. After several months, we stopped noticing any elongation and the rig tension remained constant (except due to temperature changes as mentioned above).

Expensive to change your mast over from rod or wire rope rigging. The synthetic line cost \$1044 (all figures in \$CAD), while the Colligo cheek blocks and other hardware cost \$1806. Labour of 56 hours was billed at \$4500. With dockage, crane and other miscellaneous rigging charges the total cost to re-rig came to \$10400. However, now that the mast has been modified, we can perform future rigging overhauls ourselves. We just need to buy the right length of Dux, and can then replace the shrouds ourselves. Cost should be well under \$1500.

May not be suitable for all purposes. We stayed with (pun intended) wire rope for our forestay since we have roller-furling and it isn't simple to inspect the condition of the stay when covered with the furling foil. We were worried about undetected chafe leading to rig failure. Having said that, the Dux is very abrasion resistant, and several well-respected riggers (e.g. Brian Toss) recommend synthetic forestays for use with hank-on sails.

Creeps over Long Periods. Unlike SS, Dux does creep over time when subjected to a constant load (this is one characteristic of plastics). For the amount of tension normally placed on shrouds, 9 mm Dux is expected to creep about 2.5 mm per year, or about an inch total over 10 years. Note that creep is permanent elongation, which is different from elastic stretch that all materials exhibit – elastic stretch recoils to the original length when the load is removed. Creep is also different from constructional stretch, which is the elongation caused by geometry changes (e.g. splices setting) when the rope is initially loaded. Creep can be easily enough dealt with by regular (annual or before big passages) checks of the rig and re-tensioning as needed. You can reduce creep by de-tensioning the rig when your boat is laid up for an extended time.

Unknowns

Whether it helps or hinders lightning-protection? Dux isn't conductive, so you won't get lightning following your shrouds down - current will flow through your mast. Depending on how easily it passes from there into the water, you may get less damaging effects. Hard to predict - lightning is a funny phenomenon.

Longevity in tropical sun? The boat with the longest experience with synthetic rigging that we have personally encountered in Mexico, s/v Daviana, has had Dux rigging for almost 7 years now and they are still very happy with it. It is showing some fuzziness on exterior strands, but is a long way from being dangerously compromised.

I hope these notes are useful. They are based on our experiences, our conversations with others who have synthetic rigging, and research. Please feel free to ask for any clarifications, or tell us about your own experiences.

Bjarne, s/v Hoku Pa'a