Dyneema®/Spectra® Single Braid Line

Properties and recommendations for its use

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Dyneema® and Spectra® are different brand names for the same very strong fiber (chemically Ultra-High Molecular Weight Polyethylene - UHMWPE, referred to below as Spectra®). This fiber has very attractive properties: extremely strong (15 times stronger than steel fiber of the same weight) and low stretch for its weight, resistant to flex fatigue (Relative Flexlife: Dyneema® 100, Vectran 55, Aramid 8, stainless steel fiber 6), extreme chafe resistance (8 times lower dry abrasion and 40 times lower wet abrasion than all other conventional fibers) and quite UV resistant. It has been finding increasing usage aboard sailing vessels and has been recently approved as a life line material. However it does have some unique characteristics which require special techniques and care for optimal performance.

Splices

As in all line, splices are preferred to knots where possible. As with all line, a splice in Spectra® will be stronger than a knot. Generally a splice will be 90-100% of the line strength while a knot will be only 55-60% of the line strength (excluding the slippage issue discussed below).

There are two splices in common usage with single braid Spectra®: the locked Brummel (http://www.neropes.com/SPL_12Strand_EyeSpliceBrummel.aspx) and the Bury (http://www.samsonrope.com/site_files/12S_C2_EyeSpl.pdf) . The Bury is perhaps the simplest of all slices in all types of line. After making it once with instructions, most people can make it again without instructions. This splice must absolutely be lock stitched or it may slip under low load. With lock stitching it is absolutely secure. The locked Brummel is more complex and many people will require instructions each time they make it. In return for this complexity, the locked Brummel is more secure (without lock stitching) against low load slipping. However, if the buried tail is too short on a locked Brummel, the whole load can come off the 'knot like' locking portion and it will break at much lower than expected load. Recent testing indicates the buried tail must be 72 times the diameter of the line, which is longer than previously recommended and typically used in practice.

Both splices are acceptable, but the Bury splice is simpler and more resistant to improper construction, so is generally used.

One key to proper construction for both splices is a long smooth taper on the buried tail. If the tail is not tapered it will create a stress riser at its end and the splice will fail at that point. A second key to proper construction is that Spectra® is more slippery that almost any other fiber and splices can slip at quite low loads if there is an oscillating or jerky loading. To prevent this all splices should be lock stitched and the throat whipped.

Knots

Knots will weaken all lines, and can slip in Spectra® line. Some knots are much more resistant to these two problems than others.

Testing suggests that some common sailing knots are especially prone to slipping. A round turn and two half hitches slipped at 15% of breaking strength and a bowline slipped at 22%.

Testing (by the rock climbing and fire/rescue communities) suggests the double fisherman (http://www.animatedknots.com/doublefishermansrescue/index.php) is a better alternative for joining two Spectra® lines than the more conventional sailing knots (e.g. the sheet bend), and that the figure 8 loop (http://www.animatedknots.com/fig8followrescue/index.php) is a better alternative for making a loop than the conventional sailing knots (e.g. the bowline).

Offshore racers generally use splices with spectra line, but have also had success with the bunt line hitch (http://www.animatedknots.com/buntlineboating/index.php) or attaching halyards and sheets to shackles and rings, and the halyard bend (http://www.bethandevans.com/pdf/Halyardbend.pdf usually with a figure 8 stopper tied on the

end) for attaching reef lines to the boom. These two knots test very well in Dacron line, but for spectra single braid we only have word of mouth from the offshore racers and don't have any rigorous test results when tied in spectra single braid.

Knots should have the tail lock stitched to the standing part as this will eliminate the risk of slippage. To untie these knots you can pull the tip of the tail away from the standing part and slice the lock stitches with a razor blade.

Once the slippage issue has been dealt with by using the more secure knots and/or lock stitching the tails, moving up one line size will generally compensate for the loss of strength due to knots - 3/16" Spectra® line has a tensile strength of about 5,800lbs and ¼" line a tensile of about 8,500lbs.

Specifically related to Spectra® life lines, it is US Sailing's strong recommendation that they be terminated at both ends with splices and NOT with knots.

Chafe protection

Spectra® is one of the most chafe resistant fibers available. So, the single best way to protect against chafe is simply to use a larger diameter Spectra® single braid line. This will be both extremely chafe resistant and easy to inspect. When Spectra® chafes it shows quite visible fuzz on its surface.

If larger diameter line is not possible or desired, the second best method is to use a Spectra® sleeve in the area of chafe. Any other method will likely be less chafe resistant than the Spectra® and hide any chafe on the Spectra® from inspection.

Heat shrink tubing is a very distant third choice for chafe protection. It is likely to chafe quite easily, and as discussed below requires care in its application.

The single most important preventive measure to prevent chafe is to be sure all metal edges in contact with the line are smoothly rounded and there are no sharp edges or weld splatter.

Heat sensitivity

Spectra®'s one mechanical weakness is that it is sensitive to heat and will melt at relatively low temperatures (144C). So, you should be extremely careful to keep the Spectra® away from anything exceeding the boiling point of water.

Sometimes Spectra® is sleeved with heat shrink tubing. This tubing will start to shrink at 90-100C so it is possible to do this safely if done extremely carefully. But the typical heat gun has 400C at its nozzle so it would be very easy to melt some of the Spectra® fibers and weaken the line with a momentary lack of attention, and this might be invisible under the heat shrink. The best way to shrink heat tubing is in a carefully temperature controlled oven, or to sit the line with tubing in a pot and pour boiling water on it (note: do NOT put the line in a pot that is sitting on a burner because the metal can be higher than boiling temperature).

UV resistance

Spectra® is one of the most UV resistant fibers. The loss of strength depends on the line's specific construction, but generally the sort of small diameter line used for lifelines will lose about 15% of their tensile strength (=85% of original tensile strength) after 6 months of continuous strong sun exposure (testing in Mexico and Arizona) and at 5 years will retain about 60% of its tensile strength.

Line size should be selected to compensate for this UV reduction in tensile strength. 3/16" stainless wire has a tensile strength around 3800lbs, while 3/16" Spectra® single braid has tensile strength around 5,800lbs. So, picking the same size Spectra® as wire will roughly allow for equal strength after 5 years of intense UV.