# Fiber structures and fiber types

## Overview of fiber structures

**Monofilaments**
A few comparatively thick fibers (Ø 0.3 mm) are fed in parallel to the braiding process.

**Multifilaments**
Many very thin fibers (0.001 mm) are used as a bundle during the braiding process. This is the most widely used type of construction in yachting ropes.

**Textured fibers**

The fibers are not arranged in parallel in the bundle but exhibit a more or less random type of arrangement. This is why the fiber bundle has a comparatively rough surface.

## Overview of fiber types

**Polyethylene = Dyneema®**

DSM, the Dutch chemical corporation, changes polyethylene on a molecular basis and also turns the fibers in one direction. The result is Dyneema®, a material that exhibits increased breaking loads (very low elongation at break for synthetic fibers) and reduced stretch. Furthermore, Dyneema® has a very low specific weight that imparts buoyancy, good abrasion strength, and resistance to sunlight to the fiber. The only downside of Dyneema® is that it creeps. This means that the fiber will show permanent elongation under load. However, due to its impressive advantages, Dyneema® is the most widely used high-tech fiber in the yachting rope segment and particularly well suited for use as a core material for high-tech cordage. The core bears the load, while the cover merely serves as a protection against abrasion and light. Therefore, it is possible to remove the cover from the rope ends without reducing the rope's breaking strength. This is why Dyneema® can be used for all high quality products such as sheets, halyards, and trim lines.

**Liquid crystal polymer (LCP) = Vectran®**

Hoechst Celanese, the U.S.-based corporation, produces liquid crystal polymers (LCPs) under the Vectran® brand, which are highly complex, modified polyester chains. This product stands for minimal

stretch and highest breaking loads, high temperature resistance, and low sensitivity to bending and sharp edges. What is more, unlike Dyneema® it does not creep. However, its big shortcomings are its low UV resistance and the high price of its raw materials. Therefore, it is indispensable to surround a Vectran® core with a protective cover in order to counteract its UV instability. For this reason, this zero-compromises high-tech fiber is mainly used in regatta racing.

**Polybenzoxazole crystal polymer (PBO)**

The Japan-based Toyobo corporation produces polybenzoxazole crystal polymer under the name PBO. PBO is a high-tech fiber that combines highest breaking loads with minimal stretch and high temperature resistance. Its only weakness, however, is its extremely low resistance to sunlight.

**Aramid = Kevlar®, Twaron® or Technora®**

Japan-based Teijin produces Twaron® and Technora® fibers, while U.S.-based DuPont produces Kevlar®. Each of these products is a para-aramid fiber made of co-polymers. In the yachting cordage segment, this fiber is highly appreciated mainly because it exhibits zero stretch, highest breaking loads, and extremely high temperature resistance. This makes it ideal for use as a cover fiber for winches. However, using it on stoppers is not recommendable, as this fiber has only low resistance to bending across sharp edges. Another downside is its sensitivity to sunlight.

**Polyester (PET or PES)**

Polyester offers a great number of chemical and physical advantages. It boasts relatively good breaking loads and low stretch as well as salt water resistance, good abrasion resistance in both dry and wet conditions, and good resistance to sunlight. In view of this large number of benefits, PES is used frequently for the production of yachting cordage. In the cruising segment, it is employed as material for both cores and covers of halyards, sheets, and mooring lines. Due to the high density of this material and its sinkability, it can even be used as an anchor line. In high-tech applications, it is often used as a cover material in order to afford UV protection to cores made of more sensitive materials.

**Polyamide (PA)**

Apart from a high breaking load and stretch, polyamide has a special property, namely, its abrasion resistance which is better in wet than in dry conditions, as this fiber is able to absorb up to 7% water. For this reason, ropes made of PA are often used as mooring or anchor lines. However, when kept in contact with moisture for too long, the material can become stiff. Another downside as compared to polyester is its relatively lower UV resistance. For this reason, polyamide is increasingly replaced by polyester.

**Polypropylene (PP) = XLF**

PP is extremely lightweight and even buoyant and it exhibits sufficient abrasion resistance and temperature resistance. PP is used for simple applications in the yachting rope segment. Its relatively high stretchability

makes polypropylene a popular material for allround ropes, towing lines, and simple mooring lines. However, it is rarely to be found in high-tech ropes.

# Overview of products:

| Rope | Starting material | Strength | Specific gravity | Water absorption | Resistance to sunlight | Elongation | Abrasion resistance | Creep | Melting point |
|---|---|---|---|---|---|---|---|---|---|
| | mm | daN/mm² | kg/cm³ | % | | % | | | C° |
| Dyneema®/ Spectra® | VHMPE | 345 | 0.97 | 0 | good | 3.5 | very good | at high loads | 140 |
| Liquid crystal polymer | LCP | 280 | 1.41 | 0 | poor | 3.5 | good | not measur-able | 330 |
| PBO | PBO | 574 | 1.54 | 0.5 – 2.0 | low | 2.5 – 3.5 | very good | nearly not measurable | - |
| Aramid/ Technora® | Aramid | 250 | 1.45 | 3.0 | poor | 3.5 | very good | nearly not measurable | 450 |
| Polyester (PET) | PET | 110 | 1.4 | 0.5 | very good | 10 – 16 | very good | nearly not measurable | 250 |
| Polyamide (PA) | PA6/PA66 | 81 | 1.14 | 3.0 | average | 20 – 25 | very good | low. good | 250 |
| Polypropylene (PP) = XLF | XLF Multi-filament | 56 | 0.91 | 0 | good | 20 – 25 | sufficient | at high loads | 160 |

# Explanation of products specifications


| Ø | Length | MBL | Weight | Color/Item no. | | | | |
|---|---|---|---|---|---|---|---|---|
| mm | m | daN | g/m | gray-red | green-neon green-gray | black-purple-anthracite | black-gray-anthracite | blue-gray-anthracite |
| 6 | 200 | 2,200 | 25 | 0713 | 3405 | 3410 | 3415 | 3614 |

**Ø = diameter (mm):**

The nominal diameter is always the maximum diameter

**Length = rope length (m):**

The rope is cut into lengths taking the EN ISO 2307 standard into consideration. Rope length: per spool or coil

**MBL = minimum breaking loads:**

The value in daN (1 daN is about 1 kg) indicates the load at which the rope would break. The specified breaking loads are values determined in testing in our laboratory. In practical use, these values may deviate depending on the type of use. The breaking loads were determined for free lengths of rope and will be decreased by splices or knots. When defining a rope's dimensions, we recommend to apply a ratio of working load to breaking load of at least 1:5!

**Weight = weight per meter (g/m):**

The specified values in grams are related to one meter of rope. The length of the rope can change during use. As a result, there may also be deviations from the specified weight.

# Rope constructions

### 3-Strand

3-strand ropes are made by gathering fibers to form 3 twisted strands and twisting these strands into a rope. Most twisted ropes are made of polyester and polypropylene. This type of ropes is widely used, especially because they are inexpensive. Their other benefits include high elasticity, excellent abrasion resistance, and great ease of splicing. However, one of their downsides is that these ropes offer relatively little in terms of breaking force, as their individual strands can come apart when subjected to high loads. Furthermore, unlike braided ropes, these ropes do not have a consistent and round shape.

### Single braid

Single braids or so-called "single braided ropes" consist of an even number of strands braided according to a circular pattern, half of them clockwise, the other half counter-clockwise. This type of rope offers a somewhat higher breaking force than a twisted rope, which makes it a bit more expensive. In most cases, these ropes consist of high-strength fibers such as Dyneema® so that they are very light and very easy to splice.

### Double braid

Double braids are ropes that have an inner hollow braid as their core. An outer hollow braid is braided around that core and forms the cover. The final result is a rope within a rope, which makes it possible to distribute loads evenly or unevenly between the core and the cover. Often, the cover serves the purpose of protecting the more sensitive, however load-bearing core from environmental influences. This type of rope is generally very flexible, strong, comfortable to handle, and easy to splice. Be sure to exercise caution with all types of use where the cover moves over winches, cleats, and other hardware. In those cases, the cover could rub against the core and thus cause damage that would be invisible from the outside.

### 8 Plait

The 8-plait rope was developed to compensate for the negative characteristics of 3-strand ropes, i.e., twisting and hardening. It boasts excellent shock absorption characteristics with 40% stretch and abrasion resistance. Ropes of this type are perfectly suitable to be stowed without reels or coils, without twisting or kinking.

# Rope care

By observing the following care instructions, you can prolong your rope's service life, and you will be able to enjoy its first-rate characteristics for a long time.

### Storage

You should keep your rope in a clean and dry place. For longer storage periods, we recommend that you wash the rope in fresh water before storing it, as salt and dirt will shorten its life span. Furthermore, avoid any direct contact with sunlight and extreme temperatures (also see "High temperatures"). Do not drag the rope over rough surfaces or dirty ground, as dirt can penetrate between the fibers and cause abrasion damage.

### Coiling up a rope

A 3-strand rope can suffer damage when taken off a reel incorrectly. Be sure to always keep that in mind, and watch out for any kinks that can open the 3 strands and damage the rope.

When taking a braided rope off a reel, make sure that it runs unimpededly on a central axle so as to avoid twisting and kinking. In order to achieve best running characteristics when using the rope again and to avoid twisting, it is recommended to coil up braided ropes in a figure-eight sling.

### Chemicals

Contact with chemicals can greatly decrease a fiber rope's strength. Also, impregnating a rope with unauthorized products may alter the properties of such rope. Therefore, we recommend not to use any conventional solvents or cleaning products and to consult your Robline® distributor instead.

### High temperatures

As a general rule, any contact with localized heat sources must be avoided. In this context, "high temperatures" are those above 40 °C, as they can temporarily or permanently alter the characteristics of a rope. Only in some cases can high temperatures bring about a positive change in a rope – for example, during pre-stretching or heat-setting.

### Frictional heat

Heat generated by friction can cause the fibers of a rope to melt, which in turn may impair the rope's performance. This happens especially on winches. We have special cover designs developed for that specific purpose that withstand the generated heat. Your Robline® distributor will be happy to assist you in finding the best rope for your needs.

**UV radiation**

Ultraviolet rays may affect the quality and lifetime of synthetic fiber ropes. This applies to smaller diameter ropes in particular. Therefore, it is essential to limit any contact with sunlight to an absolute minimum.

**Abrasion**

Generally, one should avoid any situations where the rope is brought into contact with sand, dirt, and other abrasive particles. They, and also sharp edges, cause general damage to the rope that may be inflicted inside the rope and be invisible from the outside, while still impairing the rope's strength. Therefore, be sure to avoid having ropes run across any type of non-movable surfaces, unless they were designed for this purpose (e.g. rings).

**Sheaves and blocks**

Generally, the use of sheaves decreases the strength and service life of ropes. This holds true especially for sheaves having a V-shaped profile. The use of such sheaves should be avoided entirely, as they compress the rope and cause local friction that will shorten the rope's service life even further. Where sheaves are used, we recommend using a sheave diameter that is about 8-9 times the rope diameter.

**Winches**

A rope that runs across a winch needs a different cover design from a rope that is only used on cleats. This is important to know as the abrasive action of winch drums may quickly cause signs of wear on your rope.