The perfect rope- Production and Use.

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1. The making of the perfect rope

Making a perfect climbing rope is an art. This art requires that diverse and often conflicting physical properties are combined, that as little material as possible is used, that the rope is at the same time tough and durable.
Over many years, the making of ropes has improved. Today, the state of the art in rope making is a construction method called kernmantle construction. In this construction, a sheath (the mantle) is tightly braided about a core (the kern). The corresponding machine is called a braider. In the braiding process, bobbins of sheath yarn spin around the core, intertwining with each other, to finally form a cover around the core yarns.

2. Raw material

2.1 Yarn

Polyamide yields the basic raw yarn that fulfills the requirements of the perfect rope. Polyamide comes in different flavors. Among these are Polyamide 6 and Polyamide 6.6. Polyamide is also used in related products, such as tyres.
In the first step, the Polyamide is processed by the rope manufacturers. The yarn is thereby stretched. The amount of the stretching determines the elasticity and will later determine the force and the elongation properties of the rope because the yarn is used in the core and the sheath of the climbing rope. The elasticity of the rope is a property that is later perceived by the experienced climber.

2.2 Twisting

The raw yarn is twisted into a twine. Besides the stretching, the number of twists per meter determines the force and the elongation properties of the rope. The twine is then twisted further into core strands or sheath twines. The tightness of the twisting is one factor that contributes to the abrasion resistance of the rope. The second factor is the number of fibers that are twisted together.
In the twisting phast, the fibres of the yarn are aligned along the length of the rope. It thereby ensures a robust sheath. If the yarn were not twisted, the fibers were susceptible to abrasion as the rope runs across sharp rock edges. Cheaply constructed ropes are not twisted across the rope length.

2.3 Shrinking

After the twisting process, the twines are prepared for shrinking.

The core strands are shrunk using a carefully developed shrinking program with a varying temperature over a defined time period. This shrinking program is optimized to the force and elongation behavior of the rope. This shrinkage process takes place in a „autoclave“, an oven-like apparatus, or in a continuous process.
The sheath twines are shrunk during the dyeing process. To allow the shrinkage, the sheath twines are wound onto special spools which collapse to accommodate the shrinkage. The dyeing process also requires the regulation of the temperature as the twines dye over time.The dye recipe is of utmost importance to the stability of the color, the resistance to UV light, which affect the performance of the rope.

3. Construction

3.1 Core construction

The core construction of the perfect rope builds on many years of experience in trying different construction methodologies. One fundamental finding is that the core has to be balanced. A balanced core may be compressed to make a round, maneable rope. Clearly, if one made a rope with three large core strands, the rope would be triangular. A properly twistet or braided core will provide a rope that is compact and has little sheath slippage, however a well constructed „strand core“, will also provide a compact rope with little sheath slippage.

3.2 Sheath construction

The construction of the sheath is of utmost importance in defining the characteristics of the perfect rope. The sheath construction defines the handling and the durability of the rope. The sheath has also an important influence on the weight, the diameter, the amount of falls the rope resists, to the impact force and the working elongation of the rope. Having determined the sheath yarn construction, the best machine must be chosen for the type of the rope. Braiding machines with more bobbins are used for ropes with larger diameters.
A rope is usually a 4 ply construction. The abrasion resistant, twines in S- and Z- Twists, are tightly braided in an optimum configuration about the core. This braiding gives a compact and tough, state-of-the-art sheath that also provides the perfect rope with its distinctive, firm yet supple texture. Soft ropes may appear to provide a better handling. However, they are prone to flattening during use and cutting or easier and faster abrading. Unfortunately, no harmonized standard exists by the abrasion resistance of different ropes that would allow a comparison among the different ropes.

4 Production process

4.1 Braiding

Climbing ropes are typically produced on braiders using different bobbins. The number of braiders plays a determining role in both the thickness and the feel of the sheath. Typically, a rope using the maximum number of bobbins for its diameter has the smoothest possible sheath, allowing the rope to glide easily through carabiners and over the rock with minimal friction. However, trying to put too much material into the sheath leads to a poor rope handling and no more correlation between sheath and core. The construction of the core an the sheath must be harmonized to create the perfect rope.

4.2 Braiding machine

Setting up a braiding machine is far from easy since many parameters can be varied. Among them are the braiding angle, the diameter of the braiding tube and the tension of the yarns. All these factors interact with each other to create the handling and the technical characteristics of the perfect rope.

5 Production finish

5.1 Duodess ropes

Ingenious Duodess designs yield a conspicuous change in pattern. It is thereby easy to make out the middle of the rope. Each sheath yarn is guaranteed to run the entire length of the rope without any knots. In contrast, in bicolor ropes, one color simply stops and another begins. Other markings, for instance with tapes or colours, do not give a durable marking.

5.2 Superior Super Dry Treatment

The cheapest way to produce a rope which can be claimed to be super dry treated is to impregnate the sheath fibers. The impregnation can be combined very cheaply with the yarn-dying process and is a common practice. However, if the sheath fibers are impregnated before braiding, the treatment tends to wear off, partly during the braiding process itself. The last vestiges of this treatment then quickly disappear during the first weeks of use. In addition, the small open pores between the fibers allow the core to become saturated in wet conditions.
Better ropes are impregnated throughout the core and sheath. The rope becomes water repellant because the whole rope is sealed in this impregnation process. The rope is first soaked in a special chemical solution and then treated with heat. The perfect rope becomes durable. Tests show that an impregnated rope absorbs less than 10 % of it´s weight when completely submerged in water.

5.3 Rope length

Ropes are braided under tension. If a rope is cut into finished lengths soon after braiding, some shrinkage can be expected to occur. The perfect rope is therefore allowed to „rest“ for at least several days after braiding to allow the rope to return to its natural length. In addition, our ropes are added 2% in length before being cut. This ensures that the declared rope length is ensured upon delivery.
It is important to note that the measurement of a climbing rope is very difficult to undertake at home. The length of the rope depends on different parameters, such as climatic conditions and the amount of tension applied to the polyamide. In addition, any rope shrinks by merely being unraveled.

Even delivering a perfect rope, we cannot guarantee the length of the rope after it has been used.

5.4 Sealing the end of the rope

The core of a Kernmantel rope has the tendency to seperate and protrude from the mantel. It thereby creates an untidy and possibly dangerous frayed end. Ropes are sealed with melting or ultra sound over a short distance at each end, fusing core and sheath.

6 Quality control

The quality control process behind a perfect rope begins with regular testing of both, the core strands and the mantel. The testing includes the material for static strength and elasticity. Each of the following production batches of the perfect rope is then extensively tested in the laboratory to ensure that it meets the appropriate standards. Testing in these steps includes diameter measurement, mantel slippage, stiffness, weight, static elongation and drop testing. In addition, every meter of climbing rope is visually and electronically inspected for possible braiding defects. The weight of a finished rope is controlled to ensure the correct length.
All this quality mamagment is regulated in a QMS ISO 9000.

7 Rope characteristic

7.1 Durability, Knot and Edge Strength

Climbing ropes are prone to abrasion and cutting under load (falling, abseiling, hanging, jumaring, sack-hauling or rescue work). Sharp rock edges are extremely dangerous to ropes. Judicious rope management and careful attention to the rope when weighted (by abseiling for instance) can prevent dangerous or expensive damage!

To prolong the life of the perfect rope, it is important to understand how the rope absorbs the energy for a fall. After being stretched by the force of a fall, the fibers take time to return to their near original state or in the original position.
During the UIAA test, the rope is allowed to rest for a period of 5 minutes between two drops. If the rope is subjected to repeated falls over a very short time period, the yarn loses its capacity for energy absorption more quickly. It is therefore prudent to allow your rope to rest after heavy use. Simply climb on alternate ends of the rope!

Careful rope management when climbing also avoids unnecessary and undesired effects. The use of extension slings allows the rope to run freely around obstacles. Be particularly careful how the rope runs over the cliff edge when abseiling, jumaring or top roping.
Ropes generally wear most quickly near the ends of the rope. Most falls are relatively short and the wear point is therefore close to the climber.
It is possible to cut this damaged section from the end of the rope without any loss of security. However, there is a great chance that the core brakes from the sheath of the rope during further use.

7.2 Kinking, Coiling

A new rope has no twist bias. Modern belay techniques and abseiling introduce twist into a rope, causing the rope to kink. Links should be removed regularly by running the length of the rope through your hands, or by hanging the end of the rope down the cliff face.
Coiling the rope in the classic oval fashion also introduces twists! Rather „lap coil“ your rope instread. Coil double from one end or even both ends. Take an armspan`s length and take this back to the hand, holding the ends to form a loop on one side of the hand. Take another armspan`s length and lap it across your hand. Continue lapping the rope from one side of the hand to the other until the rope is completely lapped. Finish by passing the ends around the top of the „lap coil“ and then through the hole that has been formed.

7.3 Control

Check your rope for possible damage before each use. Devote particular attention to sheath damage. A sheath damage may also indicate a damage to the core. For sake of your own safety, never delay the replacement of an old climbing rope for too long.
Care in use.
Particles of dirt within your rope can damage the yarn by abrasion. Dirt particles can also cause friction between the yarns and reduce the suppleness of your rope. Whenever possible, take care where the rope is uncoiled. Use a rope bag. Wash with luke warm water and a mild soap when the rope is dirty or losing its suppleness. Store your rope in a cool, dry place, away from strong sunlight or electric light. To avoid damage from other hazards, such as oil or battery acid, transport your rope in a rope bag or rucksack.

7.4 Service life

It is impossible to predict how long a rope may be expected to last, given the many variables affecting its rate of wear. Bear in mind that each fall, jumar or abseil permanently elongates the rope to varying degrees. A rope should be discarded after a hard fall or if it shows obvious sheath damage. A rope that has become very stiff and lost much of its elongation should also be retired to „light-duties“
No label, not even that from UIAA, guarantees a rope to be unconditionally free from cutting or resistant to destructive influences. Any rope can fail under exceptional circumstances (unchecked deterioration, bad rope management, chemical acids, etc.)

The rope is the climber’s lifeline.
If there is any doubt as to its condition, replace it at once.