The Shelf Life Of Static Ropes For Life Rescue Lines

THE SHELF LIFE OF ROPE

The shelf life of rope is an issue that has been around for many years. It came to a head about 10 years ago when a copy of an article, which purported to have data to support the proposition that ropes have a shelf life and that ropes degraded at about 10% per year, was circulated. This article was without scientific basis and was patently wrong. I have certainly never seen a 10 year old rope spontaneously fail!

At the time, the matter was raised with the manufacturers of Edelrid Rope and Blue Water Rope. The technical staff at both factories confirmed that in their experience the rated strength and the energy absorbing properties of **unused** static ropes remain unchanged over time if the ropes are correctly stored.

By chance, we had an excellent opportunity to confirm the then view of the technical staff. We were approached by a scout leader who had found an "old" roll of Blue Water rope in a store room and was curious about its fitness for use. The roll of rope was found when the store room was cleaned out. The rope was still in its original carton, complete with serial number and had been stored in a cool dark place away from contaminants. The roll of rope was 12 years old. We swapped the old roll for a new roll.

The rope was sent to the test lab at Blue Water in the USA in time for a visit there by Philip Toomer and Judith Bateman. In the company of Blue Water USA technical staff we tested (energy absorption and tensile strength) the first half of the roll of rope. We then obtained the batch test results from when the rope was made.

When we compared the test results obtained with the original test results we found that the values were the same (within experimental error) and that the values obtained exceeded the **rated** strength.

Blue Water Australia has a program in place to evaluate the shelf life of static ropes. Ever since manufacturing commenced in Australia, in 1988, samples have been kept from the normal production samples. Some of these samples are now over ten years old. At five years some were tested and the rated strengths and energy absorption were found to be equivalent to those of the rope when it was made. It is intended that this will be an ongoing program.

We feel confident to say that the shelf life of a Blue Water static rope exceeds 5 years. We believe that it is far greater than that.

THE WORKING LIFE OF A ROPE

The issue of the working life of a rope is much more complex than the shelf life of a correctly stored unused rope. Many factors contribute. We have briefly discussed some below.

There is no simple, reliable, non-destructive way to determine if a rope continues to be fit for service. The NFPA standard required that only new ropes be used for live rescues as one way of overcoming this problem. We feel that solution is absurd, since used ropes are acceptable for training.

In our experience the best approach is to know the history of the rope, inspect it before and after every use and if there is any doubt about the condition of the rope don't use it.

Excessive Loads

Excessive shock loading and excessive static loading will reduce the performance of a rope. These are not things that happen without anyone noticing. However, one useful way to check a rope if this is suspect is to establish if the rope has permanently stretched. This, however, requires that the length of the rope after it has been washed, but before it was put into service, be known. Also the measuring conditions (including the tension used to hold the rope) are important.

Note: A NEW Blue Water II+ 11mm static rope can withstand 14 Fall factor 1 falls before failure!

Mechanical Damage

Blue Water **static** ropes are constructed in such a way that a significant amount of the polyamide used to make the rope is in the sheath. Each rope diameter from the 2.75mm cord right up to a 16mm Superline has a different sheath thickness. The number of ply yarns in the sheath varies when necessary as the diameter changes. For example, in 13mm Superline, 47% of the polyamide is in the sheath.

The sheath contributes to the strength of the rope in a well balanced rope, however, in a static Blue Water rope it has a significant role in protecting the core from damage. The 22 core bundles (in a 13mm Super Line) will each support a weight of around 150kg without failure. A simplistic view is that the core contributes 3,300kg of the rated strength of 4,100kg. The reality of making a balanced rope means that the view is not totally accurate. However, it does reinforce the point that the sheath on a Blue Water rope (this does not hold for all brands) has a significant role in protection rather than strength.

Given the above points inspection of the sheath of the rope for damage as a result of abrasion will give a good indication of the safety of the rope. If the rope is simply "fuzzy" this is not a great problem and in fact the fuzz on a Blue Water static rope will tend to increase its abrasion resistance. The fuzzing arises because the plied sheath yarns wear in a way that causes minimum alteration to sheath tension. When broken, individual fibres tend to stand out at right angles to the sheath because of the tension from the plying process.

If there is a significant reduction in sheath tension (regardless of the cause) at any point then the damaged section should be removed from the line. The best way to inspect for this is to pass the suspect area from one hand to the other while holding the rope in such a way that a large curve is made. If there is a significant reduction is sheath tension the rope will "hinge" at that point rather than continue to prescribe a curve.

Contusions and heat damage must be immediately suspect and the damaged section should be removed. Again these are a result of events which are unlikely to have gone unnoticed, even if they went unreported!

Contamination
The formal view of most rope manufacturers is that great care needs to be taken to prevent ropes from being contaminated with ANY chemicals. As a general principle, if moderate exposure to the contaminant will harm the skin of a person it should be considered as a risk to the rope. **This is not a concept that we recommend teaching as it is bound to be misused**. However, it does provide some guidance to expert users.

Internal Damage
The core of the rope is impossible to inspect without damaging the rope. Blue Water ropes have both a thick sheath and a tight sheath. Both of these factors provide a significant mechanical barrier to the ingress of abrasive particles. Action which opens the sheath in the presence of abrasive particles (such as standing on the rope) can permit particles to pass through the sheath into the core. In theory it is then possible for the rope to be destroyed from the inside. We have never seen this with a Blue Water rope. We have seen it in a Kevlar core rope and we have seen it happen in natural fibre laid ropes. I have heard of it in ropes of a braid on braid construction.

There have been a number of brands of rope sold into the rescue market in Australia where the core fails well before the sheath fails. This is normally considered as indicating a very badly balanced rope. If this happens the rope will **suddenly** get longer (assuming that the force that caused the core to fail does not cause the sheath to fail soon after). The diameter will also be **markedly** reduced **over the broken section of core.**

Appropriate training will substantially remove the causes of internal damage. Thorough inspections of the rope are likely to identify "unusual" sections of rope and in the absence of other signs, core damage should be suspected.

Degradation due to storage conditions
While a rope has a very long shelf life when correctly stored, a number of things can diminish its performance. Many of the known factors are difficult to quantify.

Prolonged exposure to excessive heat will certainly degrade both the polyamide and any surface treatments. How much and how long is hard to quantify. It is worth noting that the dry treatment applied to some Blue Water static ropes and most Blue Water dynamic ropes involves a "cooking" process. Some treatments are applied to individual yarns prior to the manufacture of the rope and some are applied to the

finished rope. The temperatures are confidential but they are well above what we would consider ambient. The rope specifications are for the ropes after the treatment.

Volatile chemicals such as solvents and acids can become adsorbed onto active sites on the polyamide. These can cause degradation of the rope. Ropes simply should not be stored in places where routine exposure to chemical contaminants will arise.

Prolonged exposure to Ultra Violet (UV) light can cause degradation of polyamide fibres. Sources of UV include the sun and fluorescent lights. The sheath of the rope provides a substantial physical barrier to UV and so it is unlikely that UV will cause life threatening damage to a Blue Water static rope. In addition the technology of UV inhibitors has continued to advance and most rope making polyamide fibres have very effective UV inhibitors. Typically partial fading of a bright coloured sheath is an indication of exposure to UV.

Rope transportation while stored is another possible problem. When stored in a vehicle a rope may be subjected to abrasion. Lines should be stored and transported in suitable packs, which will provide protection against contamination and abrasion.

Usage

Prior to putting a rope into service it is strongly recommended that the rope be washed in cold water and allowed to air dry. This action will preshrink the rope (less than 5%) and will increase the abrasion resistance considerably.

We have routinely withdrawn from service our training ropes after a period of two years. This was based on the fact that the ropes had a very hard life (up to 100 day's usage per year) and generally were starting to look a bit fuzzy. When we first started this process we had sections of the rope tested for energy absorption and tensile strength. In every case the ropes retained in excess of 80% of the rated strength and withstood at least 2 and sometimes 3 standard drop tests (a new rope withstands 3 and sometimes 4).

Concern is sometimes expressed about taking a rope around tight bends, such as a karabiner. This concern is based on the problems experienced with three strand hawser laid rope, where, around a sufficiently tight bend, the three strands were individually loaded and could thus fail sequentially. We have tested many kilometers of rope in hundreds of knot tests. We have never had a Blue Water kernmantle construction static rope fail around a rod (even down to 9mm). The knots invariably fail at the point of maximum compression.

In normal rescue usage the greatest risk to the rope is probably a life support line being used for some other task where excessive forces can be applied.

Comments from Blue Water USA

I also have a response from Blue Water USA to the issue of the Edelrid decision to give ropes a two year shelf life. The comments from Richard NEWELL (the CEO) are as follows:

> "All of the new Edelrid markings are as a result of the CE Mark. This type of information is required on the new hang tags. The shelf life is to be determined by the manufacturer of the product. In this case Edelrid have decided to make it three years. Blue Water plan to show five years. No one has any data as to exactly

what it should be since no long term study has been completed to indicate exactly what it should be. Everyone is covering their rear ends"

We believe that there will be further developments of this issue over time. We are concerned that there will be no incentive on the part of manufacturers to have a long shelf life since their sales of ropes will increase if people are required to replace ropes at fixed short intervals. As both a users and suppliers we would prefer some genuine rationality but we suspect that this may be difficult to achieve in the short term.

Conclusion

It is unlikely that any simple time span can be given for the working life of a line. It is perfectly possible to wreck a line on the first use and equally possible for it to survive many hundreds of days of usage. I believe that good training is the key to managing this issue.

Ensure that ropes that have been subjected to treatment that makes them suspect are withdrawn from service, inspected and condemned and destroyed if necessary. Encourage a culture within your organisation where equipment problems are discussed and not hidden.

Ensure that all lines are inspected by a competent person before and after every use. In this way any damage to a line should be found before anyone is required to trust it with their life.

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