6mm Anchor Cord Testing.

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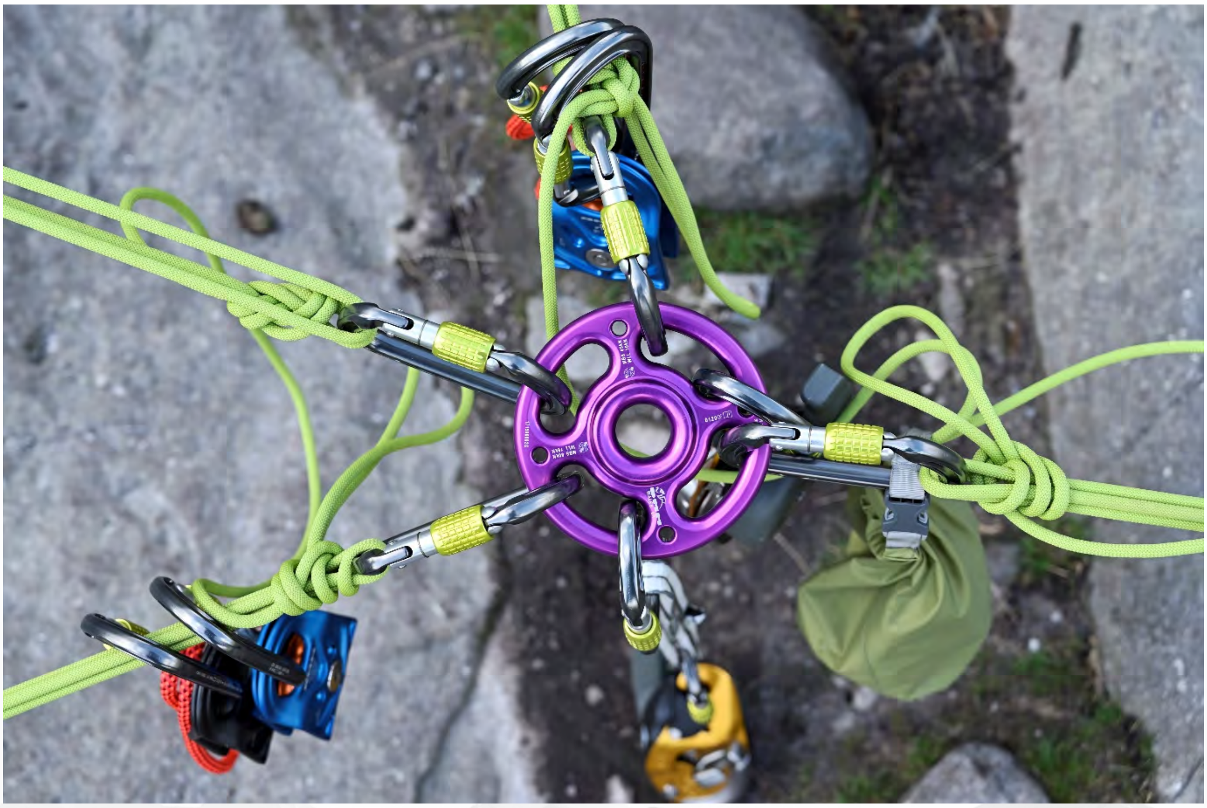
For the past couple of years, we have made great use of various 6mm aramid core accessory cords to build anchors for rescue and access systems. Primarily at Helix we have been using either the Sterling Rope 5.9mm 'Powercord' and the Edelrid 'Aramid Cord 6mm', often our kit contains a mixture of both types.

Specifications for both ropes are similar with Sterling claiming 19.7kN for Powercord and Edelrid claiming 20kN for their Aramid cord. Handling qualities are a little bit different between the two with the Edelrid cord being stiffer and feeling more durable, however the Sterling Powercord feels softer, is perhaps a little easier to tie knots in and pack away into stuff sacks.

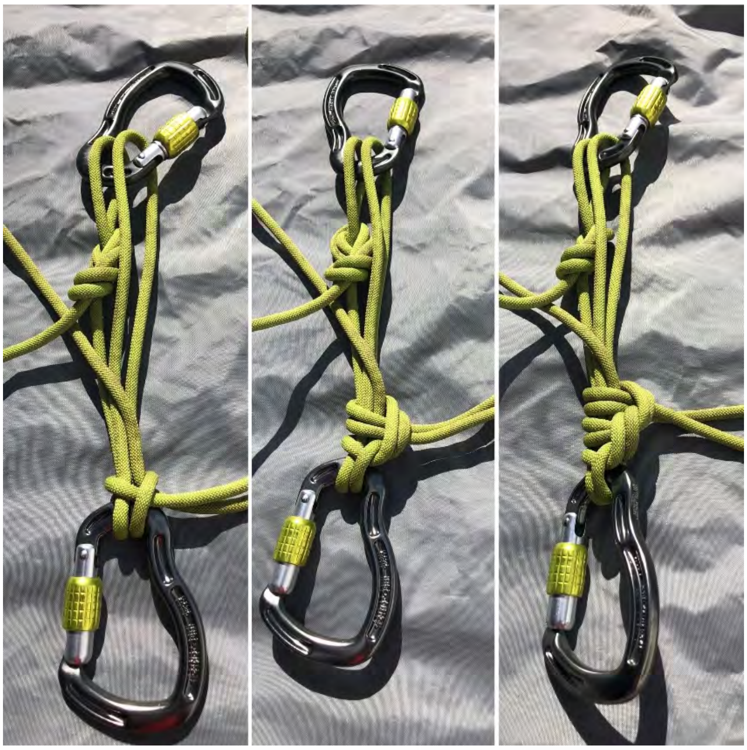
The anchor system below was built using the Edelrid Aramid Cord and creates a stable forward tensioned focal point, most importantly it offers excellent equalisation between legs and is less effected by individual leg lengths than other systems.



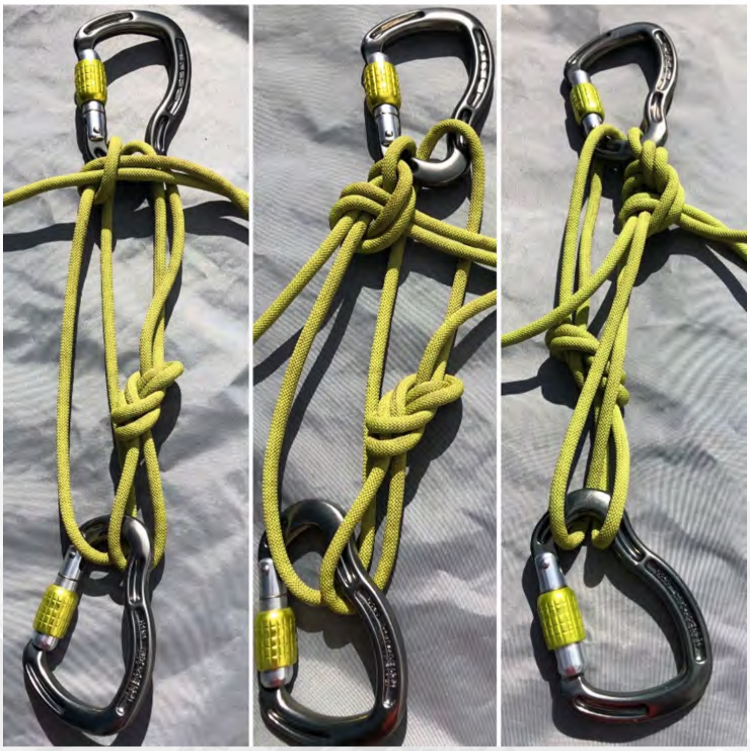
The typical method for building a system utilising these cords involves each anchor leg being built from three strands which form a tensioning system, the tension is taken in equally on all the anchor legs and they are tied off individually.

There seems to be two main tying off methods:

A) Tying off around all three strands.



B) Tying off around the last single strand.



There has been some debate regarding which method produces the strongest or most reliable results, recently Sterling Rope published some test results based around their Powercord showing the differences between 3 strand tie-offs and single strand tie-offs. The link to their excellent article by Jim Ewing (Sterling Technical Advisor) can be found here: https://sterlingrope.com/logbook/225-tie-back-testing-which-method-is-strongest

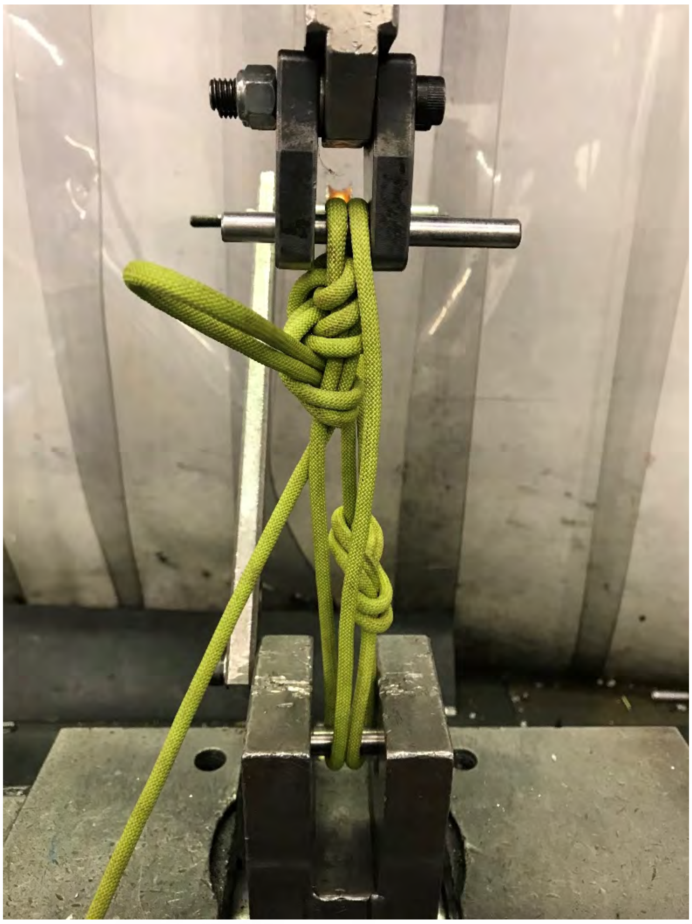
We found the results very informative, but as stated earlier we use both the Sterling and Edelrid versions of this type of cord, so we decided that for reasons of due-diligence we should run a similar series of tests on the Edelrid Aramid Cord 6mm.

We conducted a set of tests as Follows:

A) New Edelrid Aramid 6mm cord (black); tied off on final single strand.
B) Cycled Edelrid Aramid 6mm cord (green); tied off on final single strand.

C) New Edelrid Aramid 6mm cord (black); tied off on all strands.
D) Cycled Edelrid Aramid 6mm cord (green); tied off on all strands.

Single strand tie-off



We conducted 3 pulls on each variation, here are the results:

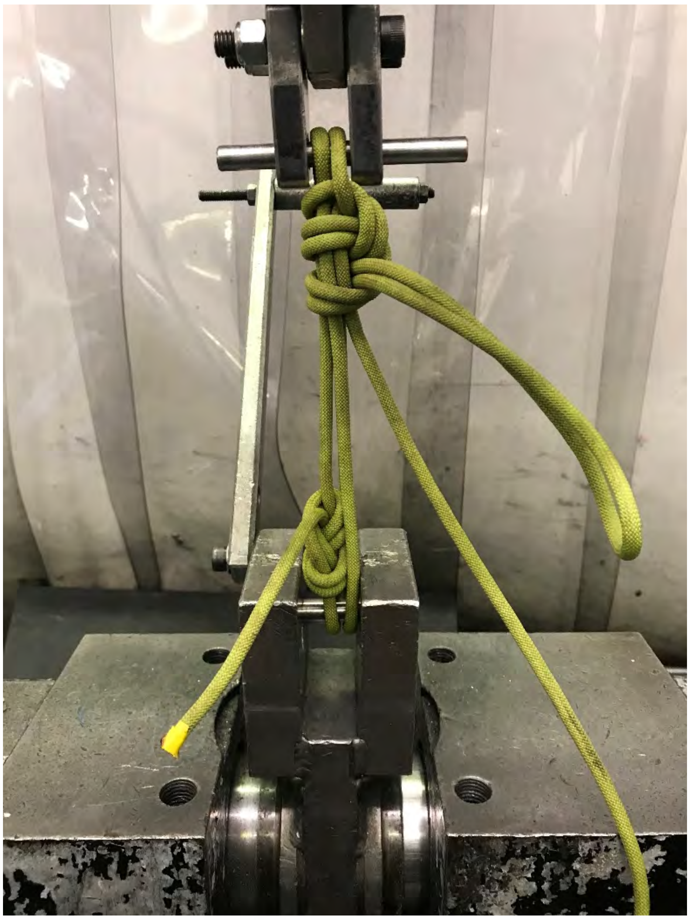
A) New Edelrid Aramid 6mm cord (black); tied off on final single strand.

Test 1	33.99kN
Test 2	29.47kN
Test 3	32.03kN
Std Dev	2.27
3-Sigma Rating	25.03kN

A) Cycled Edelrid Aramid 6mm cord (green); tied off on final single strand.

Test 1	27.22kN
Test 2	30.29kN
Test 3	24.85kN
Std Dev	2.73
3-Sigma Rating	19.27kN

All strands tie-off



A) New Edelrid Aramid 6mm cord (black); tied off on all strands.

Test 1	32.94kN
Test 2	33.96kN
Test 3	33.87kN
Std Dev	0.56
3-Sigma Rating	31.89kN

B) Cycled Edelrid Aramid 6mm cord (green); tied off on all strands.

Test 1	26.11kN
Test 2	28.82kN
Test 3	27.99kN
Std Dev	1.39
3-Sigma Rating	23.47kN

The important values in these results are the Std Dev (Standard Deviation) and the 3-Sigma strength.

Standard deviation is a measure of the amount of variation or dispersion in a set of data. A low standard deviation indicates that the values tend to be close to the mean, whilst a high standard deviation indicates that the values are spread out over a wider range.

The 3-Sigma value is calculated as 3 times the standard deviation subtracted from the average, it is the same statistical method DMM Engineering use to ensure products meet the required or stated kN rating. A 3-Sigma value gives a 99.7% probability that any other result taken will be at or above that value.

If we look at the values for new Edelrid Aramid Cord 6mm first, the standard deviation figures are 2.27 for the single strand tie-off and 0.56 for the three strand tie-off. This gives us final kN ratings of 25.03kN for the single strand tie-off and 31.89kN for the three strand tie-off.

If we look at the figures for the cycled Edelrid Aramid Cord 6mm, the standard deviation figures are 2.73 for the single strand tie-off and 1.39 for the three strand tie-off. This gives us final kN ratings of 19.27kN for the single strand tie-off and 23.47kN for the three strand tie off. Bear in mind that this cord is being tested at the point of retirement and has been used on several training courses and exercises.

Conclusion:

The final calculations are quite different to those published by Sterling Rope, drawing a conclusion from our figures would suggest the opposite to the results from Sterling, our lowest standard deviations were found on the three strand tie-off method rather than the single strand method.

If we were to look at our figures in isolation it would suggest that the three strand method is more consistent and gives a higher 3-Sigma kN rating on both the new cord and the retired cycled cord.

Interestingly the lowest 3-sigma figure for either tie off method in our results was 19.27kN on cycled (now retired) cord, considering that when building cord anchors we rate them at 20kN per leg, our current advice appears to be supported by our test data.

So, which tie off method should we recommend? It should probably be the one which the end user can confidently and most important, consistently tie off.

What other conclusions can we draw?

More testing is needed.

- We are comparing figures for Edelrid Aramid Cord 6mm and Sterling 5.9mm Powercord that were done at different times on different tensile testers in different locations. Back to back testing should be conducted with the same cords on the same test machines after conditioning the cords similarly; this is something we will aim to do this year.
- A larger number of test samples would give greater confidence in the results.

There could be differences between individuals tying knots so a larger sample of end users could generate results indicative of real-world variation.