STERLING®

AZTEK™ HEAVY-DUTY Rope Qualification

The AZTEK (Arizona Technicians Edge Kit) has proved itself through the years as an invaluable multi-use rescue tool with over 137 possible ways to be used.

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Made in U.S.A.
with U.S. and Globally Sourced Material

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AZTEK HEAVY-DUTY Rope Qualification

Intro

The AZTEK was created by Reed Thorne of Ropes that Rescue with Sterling developing the sewn cord components. The Kit has evolved through the years and in pursuit of constant improvement, we sought to better it. We've received feedback from users that they were looking for increased performance in some specific categories. We set out with these goals for improving the ropes for the AZTEK:

1. **Increased durability and abrasion resistance**
2. **Increased strength**
3. **Increased cut resistance**
4. **Arc Flash resistance**

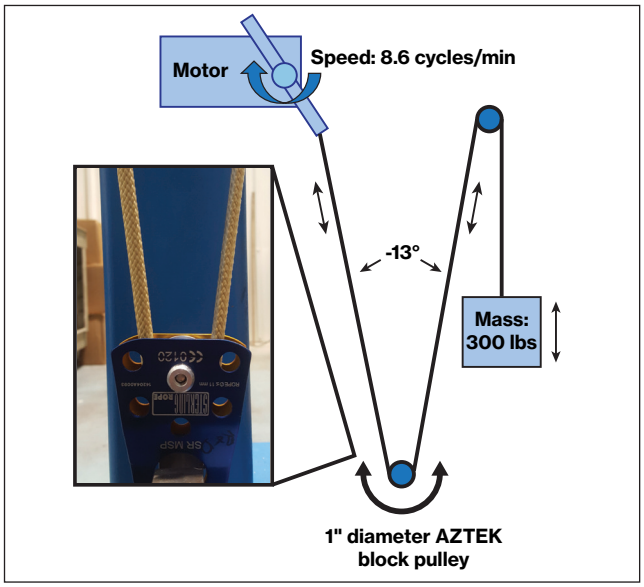
Using Aramid fibers such as Technora® seemed the obvious choice due to their strength and performance in thermal and abrasive environments. Having both passed the NFPA Elevated Temperature test, SafeTech™ and FireTech2™ were our top candidates for the host rope in the Aramid AZTEK in terms of thermal resistance. These ropes have also proven to be very durable and abrasion resistant in the field. However, aramid fibers are more susceptible to the effects of flex fatigue, requiring the Sterling Engineering Team to do some investigating. To be thorough, we also wanted to quantify abrasion resistance. Thus, our Rube Goldberg-esque cycle tester was devised, which is capable of subjecting rope samples to repeatable and consistent cycling over an object.

Flex Fatigue

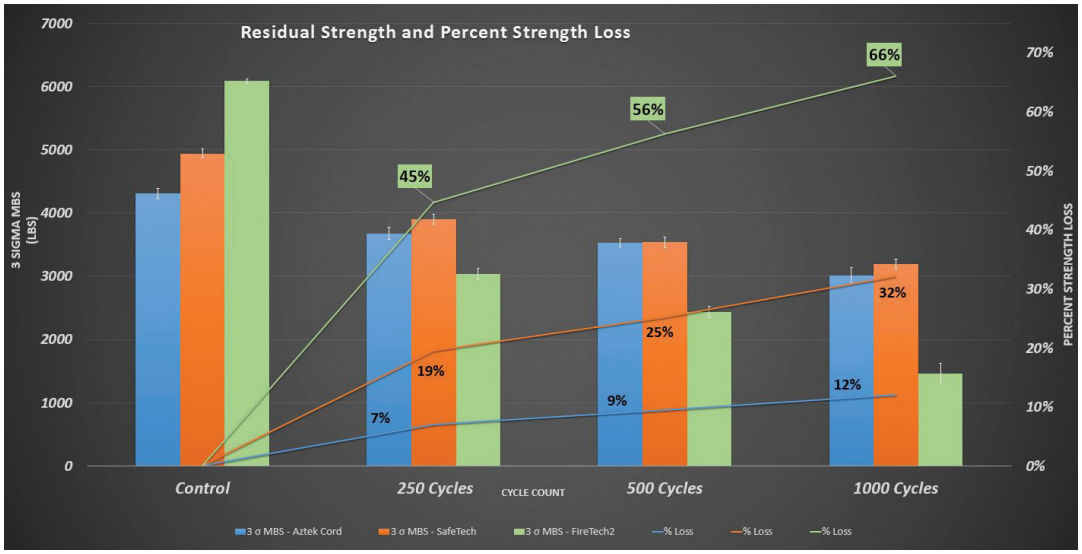
This terminology refers to weakening of fibers that are subjected to repeated bending stress; the bending under load causes internal and external fiber damage. Aramid fibers such as Technora are incredibly strong in tension but are not as strong in bending; the fibers break down at a faster rate than a nylon or polyester. This is also why aramid fiber ropes generally lose a higher percentage of strength in a knot when compared to nylon or polyester.

Flex Fatigue Test Set-Up

The test uses an electric motor to cycle a rope specimen back and forth through a set of pulleys with a free-hanging mass attached to the far end. A sensor counts the cycles and stops the test when the desired count is reached. The residual strength is then found by pulling the sample to failure in our tensile tester using the CI 1800 method over 4" bollards. 5 samples were tested for each cycle count, and a 3 sigma minimum breaking strength was then calculated.



Test apparatus for measuring flex fatigue.



Flex fatigue results.

RESULTS

As expected the nylon cord performed the best in this testing; it had the lowest percentage strength loss. The FireTech2 saw a 56% decrease after 500 cycles. The SafeTech lost 25% of the original MBS at 500 cycles but still maintained an MBS over 3000 lbs after 1000.

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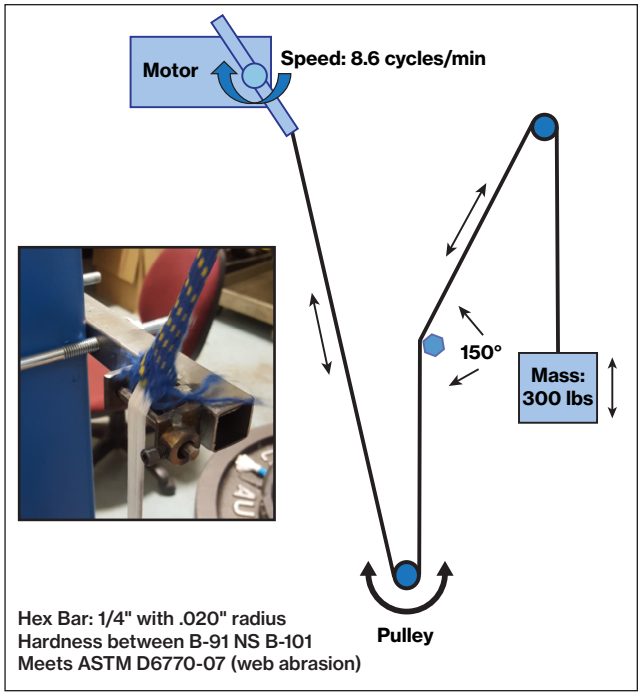
Abrasion Testing

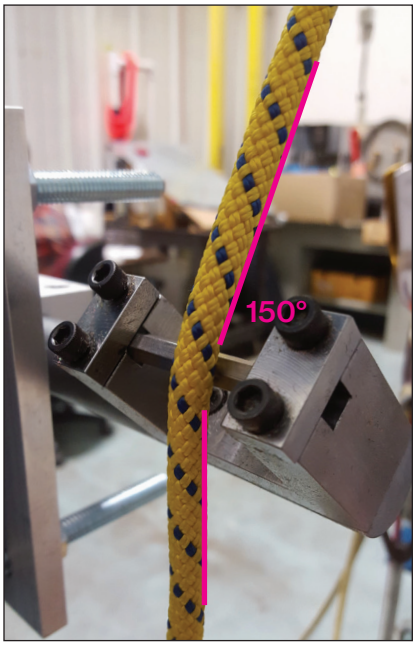
Abrasion testing of textile rope is a notorious challenge in the cordage industry. For years, rope manufactures and backyard rope enthusiast alike have attempted to crack the code that is a repeatable test method for quantifying the abrasion resistance of rope and cord. Arguments have centered around standardizing certain variables such as abrading edge, line tension, and pass/fail criteria. To add to this, rope constructions can vary significantly and are subjected to different environments. Hence the still non-standardized abrasion test. With the Aramid AZTEK kit in mind, the Sterling Engineering Team gathered knowledge from past and applicable attempts to solve this problem and modified our cycle test stand to accept a new abrasion test method.

Abrasion Test Set-Up

ASTM D6770-07 is the abrasion test specification for textile webbing such as seat belts or slings used by rock climbers and rescue personnel. Starting here, we were mainly interested in using the hex bar specified, since we've found that having a consistent and repeatable abrading edge is critical to gathering reliable data. We modified the line path in our apparatus to cycle a tensioned rope over the edge, and halted the test at the first sign of "core shot". We used 300 lbs as the test mass with a ¼" radius on the hex bar. Five samples were tested for each rope, then results were averaged and plotted in the chart below.



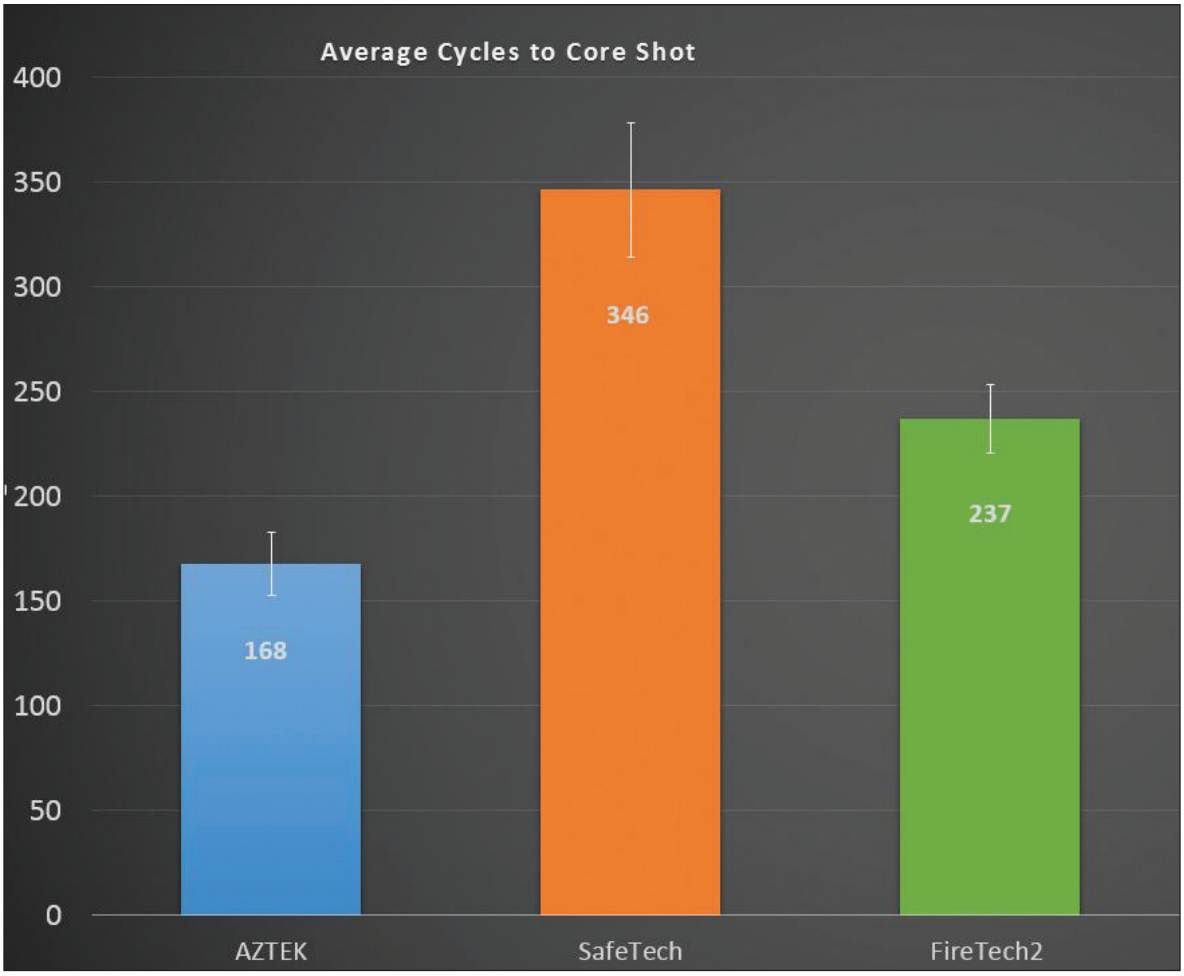
Test apparatus for abrasion testing.



AZTEK cord mounted in our abrasion test fixture.

Core shot SafeTech sample after abrasion testing.

Abrasion Testing Results



Abrasion Resistant Summary

The results of the abrasion testing were consistent and of good quality, showing a significant statistical difference from one another. Given their similar sheath constructions, it came as a surprise to see SafeTech outperform FireTech2. It appears that underlying factors, perhaps core density and elongation contributed to this result, though more investigation would be needed to be sure. The SafeTech also had double the amount of cycles compared to the nylon 8 mm so it gave us confidence that it would be significantly more abrasion resistant than the current nylon rope in the kit.

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Cut Resistance
For this purpose we are defining cut resistance as the ropes ability to withstand failure over a sharp edge during a dynamic event. This is different than the measure of abrasion resistance. Determining cut resistance is difficult, there are many factors that could vary the results. There's also not an industry standard or test method for measuring a rope's ability to withstand cutting.

Technora fibers are generally considered more cut resistance; these aramid fibers have more tenacity and are more difficult to cut but we wanted to see if an 8 mm rope made with Technora fibers would provide increased cut resistance that could be correlated to "real world" use.

To test the cut resistance we worked with Mike Forbes from Ropecraft. His test apparatus simulates a loaded rope sliding horizontally across a sharp edge. This would allow us to compare ropes of similar mass with different constructions. We tested 5 ropes; 100% nylon 8 mm, 8 mm CanyonLux™, SafeTech, FireTech2, and 8.5 mm CanyonPrime™.

Test set up:
1. 82.5 mm offset (the distance the mass is pulled away from the initial release point. This offset creates the horizontal force sliding the rope sample across the sharp edge).
2. Test Mass = 125 kg
3. The edge utilized is made from M5 steel with a 45 degree chamfer on the cutting surface.

Cut Resistance Summary:
The Technora sheathed ropes travel farther before failure; we can interpret this as resisting cutting for a longer duration of time. Based on these test results we determined that these ropes have an increase in cut resistance relative to a nylon rope of similar mass. It is important to remember that a rope identified as cut resistant is not cut proof.

RESULTS
Nylon PER 62.4 cm
FireTech2 73.2 cm
SafeTech 75.3 cm

Cut resistance testing samples.

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Arc Flash Testing

Why: There is currently an OSHA mandated requirement for some PPE and equipment to meet Arc Flash compliance. This is mostly applicable to tower workers in the transmission sector.

To see if the AZTEK would meet these requirements we had the rope components 3rd party tested to the arc flash criteria of ASTM F887. The components were exposed with incident energy of 40 + 5 cal/cm². There's not a specific standard for a rescue or haul system so we wanted to evaluate the residual strength of the components after the arc flash exposure.

Arc Flash Testing Summary

The testing shows significant strength loss due to the arc flash exposure. Though the Technora fiber provides some additional resistance over nylon we don't claim Arc Flash compliance for this kit. There was such a significant loss of strength, and far too many variables and configurations of the kit to know if the residual strength would provide a safe working margin for workers that could be exposed to an arc flash event.

Damage to AZTEK Kit cause by exposure to arc flash testing.

RESULTS

Average residual strength after arc flash exposure

6 mm Travel Restraint: 6.4 kN
8 mm Edge Restraint: 11.3 kN
Full System: 14.7kN

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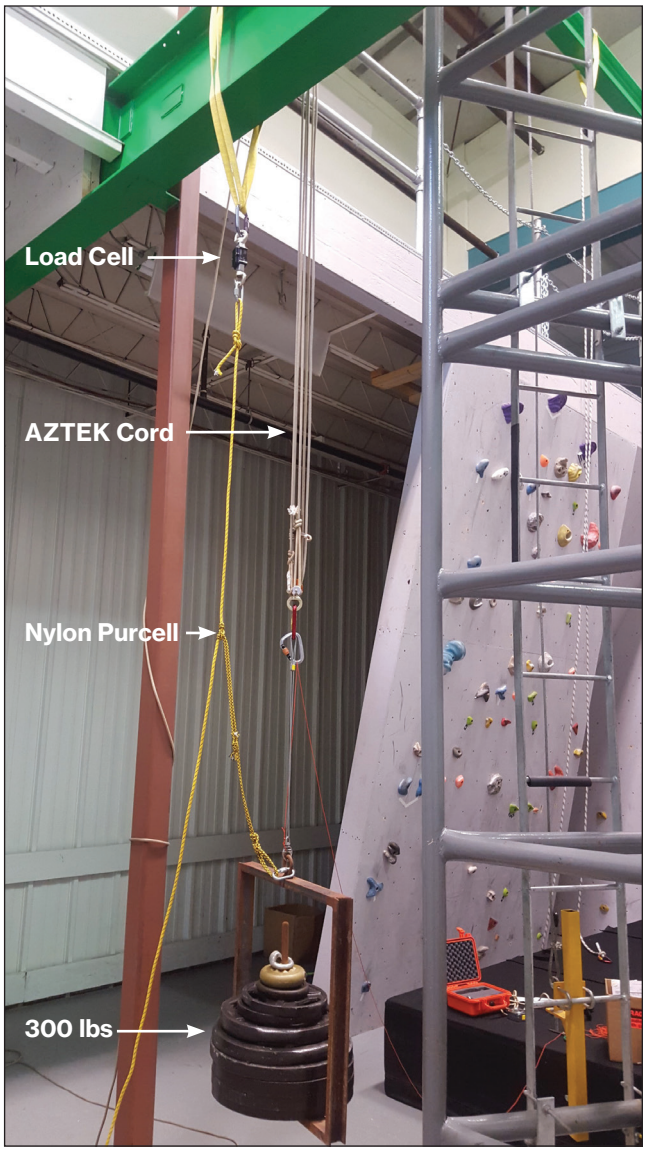
Additional Testing

To ensure that the ropes and cords perform to a high level Sterling conducted both in house and field testing. Because the system relies on the interface of the hitch cords and host rope we tested to confirm compatibility and also to provide data for users on how the system will perform. We tested the Safetech Edge Restraint and the 6 mm TRC cords for the following:

- **Load for slippage of ratchets**
- **Load for slippage of travel restraint**
- **Break strength of system**
- **Impact force from free fall drop**

Drop Test Set Up

Mass: 300 lbs
Hitch: 3 wrap prusik
FF: .3 (1 m of host, .7 m of purcell, .5 m drop)
Mass connected to a 3" loop at purcell



Nylon/nylon purcell impact force testing.

RESULTS

	SafeTech	Nylon
Average Impact Force	3.7 kN	4.65 kN
Average Slip on Host	16 cm	9 cm
Average Slip on Purcell	22 cm	5 cm

Travel Restraint max load 3.5 kN with constant slippage at 2.5 kN on slow pull testing.

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Final Summary and Disclaimer
After completion and review of all of the in-house and field testing we finalized the kit by choosing the SafeTech as the Edge Restraint and the 6 mm TRC as the Travel Restraint Purcell and Ratchet. The Technora sheath with nylon core gives the best performance for increased heat, abrasion, and cut resistance while still performing well in the system, and also limiting the strength loss from flex fatigue.

The system is 3rd party certified by UL to NFPA 1983 General Use for a Manufactured System.

The results from these tests cannot be considered definitive, are not exhaustive, and may not be representative of results from actual use in the field. Users need to follow all user instructions provided with this system.

AZTEK HD
The AZTEK HD takes this simple and versatile mechanical advantage rigging tool to the next level, with increased durability and cut resistance.

For those operating in the most severe environments, this iteration of our popular AZTEK features the extremely durable 8 mm SafeTech® cord for the edge restraint. The nylon core offers the right amount of give and packability, and is protected from abrasion and cutting by the Technora® sheath. This combination ensures you have the best blend of abrasion resistance, flexibility and resistance to flex fatigue.

The ratchets and travel restraint are made with a specialized 6 mm cord, that also uses the durable nylon/ Technora construction featured in the edge restraint. Colored tracers in each ratchet offer convenient color coding for connecting to the appropriate block.

Weight: 3.8 lb / **MBS:** 36 kN

KIT INCLUDES:

- **(1)** 2 AZTEK Omni Block Swivel Pulleys
- **(2)** 50' of 8 mm SafeTech Edge Restraint
- **(3)** 2 6 mm Sewn Ratchet Prusiks
- **(4)** 3 SafeD Twistlock Carabiners
- **(5)** 8 mm Steel Screwlink
- **(6)** 6 mm Travel Restraint
- **(7)** AZTEK HD Carrying Bag

System Certification **NFPA 1983: General Use Auxiliary System** (w/o carabiners)

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