

SYNTHETIC ROPE APPLICATIONS IN APPALACHIAN LOGGING

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Abstract.—New ultra-high molecular weight polyethylene rope has shown good results as a replacement for wire rope in logging applications in the western United States. A single case study trial was performed in Appalachian forest conditions to assess the appropriateness of this technology for hardwood logging applications. The study focused on use of the rope in West Virginia and included a review of the legal status for using synthetic rope in logging and informal interviews with loggers and forest managers to understand which applications might be appropriate and what specifications are required for length, strength, and other characteristics. A 125-foot length of 5/8-inch synthetic rope was purchased and installed on a bulldozer for this case study. The synthetic rope has a premium price almost double that of wire rope. Such potential benefits as improved worker conditions, greater productivity, and decreased negative environmental impacts may lead to wide adoption and eventually lower prices. Trials were observed in a logging operation and road-clearing operation in which the rope performed well and loggers were impressed by the strength, ease of splicing, light weight, and flexibility of the rope. The trial illustrated issues, concerns, and possible techniques that may be applied by others seeking to be early adopters of this technology.

INTRODUCTION

Appalachian hardwood timber harvesting activities rely heavily on ground-based equipment for log extraction. A typical cable skidder or bulldozer is often used with a wire rope cable attached to a drum winch at the back of the machine. This winch line is used to pull logs in from the stump location to the machine, which is positioned on a skid trail. Once the logs have been pulled into the skid trail, they are pulled down the skid trail to a roadside landing. Wire rope has been used in these types of operations since the turn of the last century with slight improvements to increase strength, longevity, and other operational characteristics of the wire rope. While many of wire rope's characteristics are well suited for logging, other characteristics make working with wire rope difficult and at times dangerous. Wire rope is primarily constructed from steel, which although strong, is very heavy, will deform under stress and bending, stores energy under load, and can have very sharp edges and ends.

Ultra-high molecular weight polyethylene (UHMWPE) ropes can be substituted for wire rope in many logging applications to decrease many of the less desirable qualities of wire rope (Fig. 1). With increased flexibility and the weight per foot equivalent to one-ninth the weight of steel rope of similar diameter and strength (Pilkerton and others 2003), the rope is much easier to work with (Garland and others 2002). The reduced effort required by the logger means longer winching distances and increased abilities to work in and around sensitive areas are possible (Ewing 2003, Golsse 1996). Additionally, trials using UHMWPE have demonstrated some improvements in productivity with time savings of approximately 10 percent over use of wire rope (Garland and others 2002) because the synthetic rope is easy to carry, spool, and splice.

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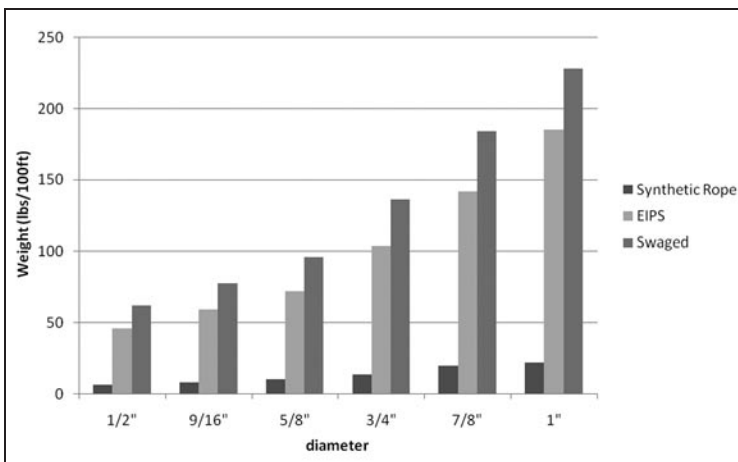


Figure 1.—Weight per foot of logging wire rope and UHMWPE synthetic rope at commonly used diameters.

In light of the many favorable applications and characteristics identified and tested in the West, a case study trial was established in Appalachian forest conditions to assess the appropriateness of this technology for hardwood logging applications.

METHODS

A case study investigation was utilized to address the feasibility of synthetic rope in Appalachian logging conditions and identify additional variables and questions for further research. The use of synthetic rope is an emerging topic in forest harvesting research, there is little experience with this topic in general, and even less with direct applications in Appalachia. To address these needs, the case study research methodology begins with preliminary data collection from the following sources:

1. State and Federal agencies and published legal references
2. Synthetic rope manufacturers and distributors
3. Logging machine equipment distributors and published reference materials
4. Informal interviews with logging contractors regarding experiences and needs.

Given the favorable feedback from the preliminary data, the researchers purchased 125 feet of 5/8-inch diameter synthetic rope and installed the rope on a skidding dozer as a field trial. Follow-up data were collected from the machine operators after the initial installation and after using the rope for 1 day, 1 week, and finally after 1 month.

RESULTS

A review of federal Occupational Safety and Health Administration (OSHA), West Virginia state, and other regulations that apply to West Virginia indicates that no regulations explicitly require the use of any particular material for the cable or rope used in winching or other logging activities. Some other states with additional local OSHA standards specify the type and sometimes size of wire rope to be used in certain logging applications, such as in the state of Alaska (2003).

Given the legal ability to use synthetic rope for logging operations in West Virginia, logging applications were identified for use in the case study. The obvious application was the replacement of wire rope on the back of a cable skidder or dozer used to drag logs to the landing. Log skidding is the primary activity where

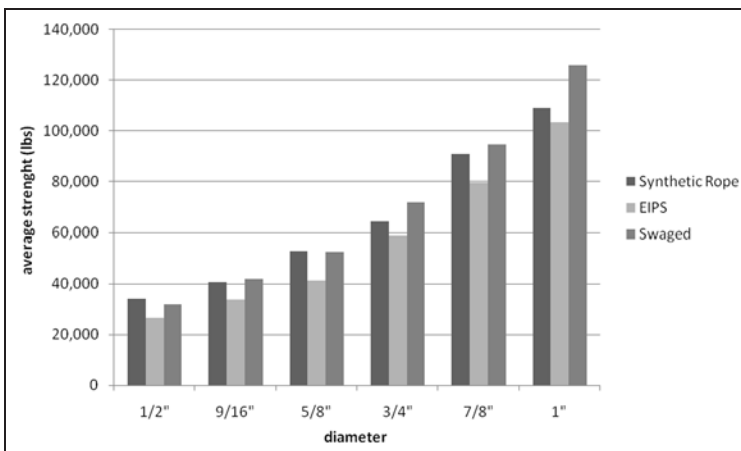


Figure 2.—Strength per foot of logging wire rope and UHMWPE synthetic rope at commonly used diameters.

wire rope is used in the Appalachian region. In the West there are many more activities where wire rope is used, such as in skyline and high lead logging systems.

Informal interviews with loggers and foresters working with logging contractors illustrated some initial hesitation to use the rope. While this reluctance is not unexpected, continual support and successful trials will be required to encourage broader use. Each of the five loggers interviewed said that pulling the wire rope uphill was the most difficult part of skidding activities, which is exacerbated when the slopes are steep and cover long distances. As expected, most responses also indicated that any decrease in work would be very desirable. Other concerns that were identified with existing wire rope were the inflexibility of the rope and the sharp wires that often are present with broken strands. Although most loggers wear leather gloves, the chance for puncture wounds to the hands and other body parts are high, especially when the rope must be pulled around obstacles. Each of these responses supports the adoption of UHMWPE rope as a potential method to minimize some of these issues.

Also collected during the interviews was the diameter of the wire rope each logger used, so as to select an appropriate UHMWPE rope diameter. Diameter to diameter the wire and synthetic ropes have very similar breaking strengths (Fig. 2). A smaller-sized dozer typically had 100 feet of 5/8-inch wire rope and used chain slides and chokers. Pilkerton and others (2004) reported that more UHMWPE rope than wire rope can often be accommodated because of synthetic rope's improved spooling and compaction.

UHMWPE rope distributors were identified in our region and through the Internet, and a 125-foot length of 5/8-inch UHMWPE rope was purchased for \$4.26 per foot, about twice as expensive as wire rope. Additional rigging materials such as a splicing kit, slides, and chokers were also purchased for this study. The rope was installed on an older John Deere 450C bulldozer usually used for log skidding and road construction/clearing activities. The equipment and operators were provided by the West Virginia University (WVU) Research Forest. An eye splice was created that looped through the catch on the winch drum to affix the end of the rope to the spool. The rope was then spooled onto the drum under light tension in order to have a compact and well formed spool. While there were few if any rough metal places on the drum or other pieces of this winch system, grinding down any burrs or rough spots could help minimize damage of the rope by the winch.

Two different logging operations were tested with the rope. The first operation was a log skidding in a recovery operation, in which hardwood trees were felled away from a power line right-of-way. The trees to be extracted were often >20 inches in diameter at the stump, 30 to 40 feet in length, topped, and delimbed on three sides of the tree. Most trees were not positioned to lead, increasing the extraction difficulty. The ground surface in this area was very rocky and there were many stumps, slash, and other obstacles that the rope would have to work around. Four chain chokers and slides were strung on the UHMWPE rope, with the last one secured with an eye splice in the rope.

The rope performed flawlessly on this operation, providing no noticeable difference in strength or abilities than the wire rope that was used previously. The first few logs that were pulled stretched the rope out and allowed the spool to become more compact, but the rope did not dive in on the spool, where extra effort would have been required to remove it. One concern was that the UHMWPE rope was not as easy to pull off the winch drum as was expected, probably because it is hard to adjust the free spool of the winch. On this particular machine the adjustment for the free spool is located under the skidding arch, so any adjustment would require the complete removal of the arch, a labor-intensive activity that was not completed for this case study. With a lighter-weight rope, the free spool setting could be adjusted to allow for easier spooling off the drum to the log to be choked.

The UHMWPE rope was also used for a second job during this trial during a road clearing operation, in which very similar results were obtained. While the trees were slightly larger and on more of a slope (approximately 20 percent and less rocky soils), the rope performed well. The equipment operators were impressed with the strength, ease of working and splicing, and the rope's light weight.

DISCUSSION

Loggers can convert to UHMWPE rope without much effort. Very few adjustments to the usual practices are required as the UHMWPE rope performs in a manner very similar to the customary wire rope. In most cases, the logger would find some immediate advantages with the synthetic rope in winding the rope onto the drum as spooling can be done very quickly with almost no additional equipment. They will also find that splicing and hooking up rings, sliders, and other rigging pieces will be very simple. Many times during the first days of use, loggers will probably say, "I could never do that with the wire rope," as they carry the entire length over to the machine, or pull the rope through the woods to each log choker. Splicing the rope is one new step that loggers must master as they make the switch, but they can learn how in a manner of minutes and with very little practice.

As this project was a single case study, the results and identified applications may or may not be applicable to other operations in the region. The favorable results from the use of the rope convinced the loggers at the WVU Research Forest to keep the rope on the machine and continue using it in their operations. Long-term use of the rope and the longevity of the rope in comparison to wire rope will need to be further studied. Given the very similar results of this trial to research completed in the Northwest United States, we can expect a similar product life. Hartter (2004) notes that while UHMWPE rope cannot endure many of the types of abuse that steel rope withstands, a failed rope can be quickly respliced in the field. Additionally, many of the failures reported in the western U.S. studies were a result of abrasion from rough pieces of metal on the winch or other part of the equipment. New equipment or care in smoothing all metal surfaces that the rope comes in contact with, can minimize these failures. In this single study, abrasion with logs, soil, and other natural objects in the Appalachian forest had little impact on the rope other than discoloring

it. While the more abrasion the rope is exposed to, the shorter the working life, this characteristic also applies to wire rope. After the case study had ended, the loggers reported that following 3 months of use, the eye splice that held the chain choker broke. After cutting the end off clean and resplicing the eye, they were back logging in just minutes.

Based on this case study, further dissemination of UHMWPE rope for test applications in logging should be continued. This study was limited in its scope but points to the need for scientific research regarding the operating life, use of different connecting techniques to the winch, and interactions with chokers and slides or rings. Given the current level of use and research on the topic, any logger converting to UHMWPE rope would still be considered an early adopter. We would expect operators to find valuable improvements in their operations that could possibly outweigh the risk involved with trying something new.

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