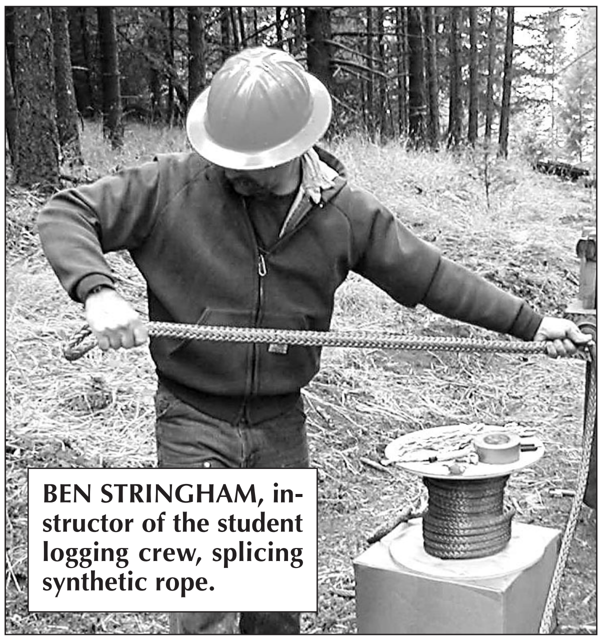
Synthetic Rope In Your Future?



BEN STRINGHAM, instructor of the student logging crew, splicing synthetic rope.

Preliminary studies on AMSTEEL-BLUE rope are encouraging

By Mike Crouse

The dream of using lighter cable in logging operations has been around for some time, and likely on many logger's minds, particularly at the end of a day's work. Earlier efforts of past years proved to be entirely unsatisfactory for heavy pulling, due to stretching and a relative lack of strength overall.

The new generation of synthetic line, however, is showing some genuine promise, enough so that it's being literally put to (and through) the tests in the Forest Engineering Department at Oregon State University, in Corvallis, Oregon with studies being funded by Oregon Occupational Safety and Health Administration (OR-OSHA).

First, the new generation of synthetic rope has little in common with its predecessors. The differences are vast. A number of synthetic ropes have been introduced into industrial use including ropes constructed from plastic fibers of nylon, polyester, polyethylene, and polypropylene.

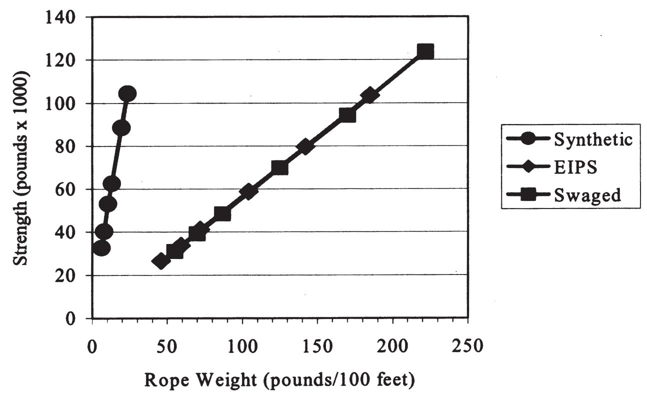
The particular rope being studied is ultra high molecular weight polyethylene (UHMWPE) fiber rope, under the product name of AMSTEEL-BLUE and is manufactured by Samson Rope Technologies (formerly, The American Group) of Ferndale, Washington (www.samsonrope.com). The polyethylene fibers are combined to yarns and the yarns are combined into strands that are formed into various rope constructions including twisted, plaited, and braided. AMSTEEL-BLUE is a 12-strand braided rope. This synthetic rope has a higher breaking strength to weight ratio than steel, by a factor of 9 to 10. Other favorable characteristics include high flexibility, low stretch (other than the newly formed eye-splice), and a specific gravity less than one (floats), and can be easily spliced. Coatings can be applied to increase resistance to abrasion, prevent contamination, and increase ease of splicing used ropes.

The synthetic is generally the same material commonly used for fuel containers.

Weight difference

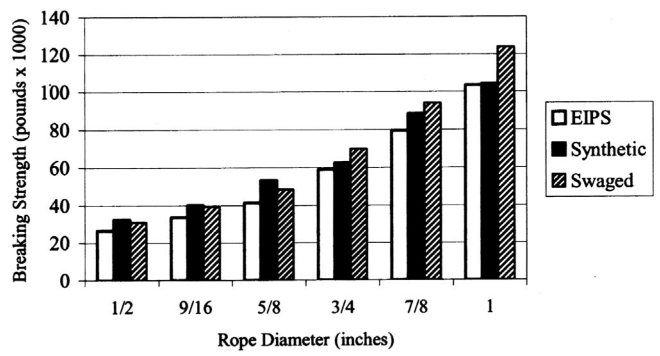
The most obvious plus of synthetic rope is the difference in weight. For a given diameter, steel wire rope is 7.5 (extra improved plow steel, EIPS) to 9 (swaged) times as heavy as a comparable length of AMSTEEL-BLUE rope (**See Fig. 1**). The synthetic rope is also flexible and does not produce "jaggers" (sharp, broken wires within a strand) as handling hazards common to wire rope. The cost is about four to six times that of wire rope in the specially produced quantities now available. The offshore drilling (anchoring) marine towing industries use similar synthetic ropes in applications parallel to logging.

FIGURE ONE. Nominal breaking strength as a functino of rope weight for rope diameters 0.5-1.0 inches.



The breaking strength of AMSTEEL vs. steel products is significantly higher than in previous synthetics as well (**See Fig. 2**). Comparisons between published breaking strengths for some common logging wire rope grades and constructions (EIPS and swaged) and those published for AMSTEEL-BLUE. At medium rope sizes (0.5-0.625 inch diameter), synthetic strength exceeds both EIPS and swaged wire ropes. At larger diameters, the synthetic advantage diminishes to about equal EIPS strength at a 1-inch diameter. Rope elongation is also shown for AMSTEEL-BLUE under loads in **Table 1** (on Page 8). These elongation values are an increase of 0.3 feet per 100 feet of rope length at loadings shown (an absolute percentage difference of 0.3 percent more than steel constructed ropes).

FIGURE 2. Ultimate breaking strengths of common diameter ropes used in logging applications: comparison of steel wire rope with AMSTEEEL-BLUE (UHMWPE) synthetic rope.



The testing protocols allow for a buried eye-splice as the end connectors for the test samples and the ropes nearly always break at the end of the splice. Thus, the reported ultimate rope strength is the strength of the eye-splice end connector You cannot use compression fittings on the synthetic ropes. Instead eye splices are called for. In tests, low temperature epoxies in poured sockets, tested for pulling strength, failed much below the strength of the rope. More tests with different epoxies are planned..

While the final elongation of rope sections at loads are similar to specifications, the test section has considerable elongation due to the buried eye-splice end connectors. These eye-splices would need to be pre-conditioned to about 50 percent of the rope's rated ultimate strength to take all of the "stretch" out of the eyes in the rope segment.

The current set of tests did not test abrasion or degradation in synthetic ropes, though in testing a sample of AMSTEEL 815 synthetic rope used three years as a guy-line for tail trees, and intermediate support trees, the 9/16ths diamerter rope residual strength was more than 65% of the original specifications.

Plusses for loggers

Much of OSHA's interest in the synthetic line is directly related to the flexibility, weight, and strength of the AMSTEEL-BLUE and its relative effect, both long and short term, in reducing injuries and reducing work loads. Reducing the weight, increasing the flexibility, they feel should result in both better productivity and fewer injuries, both in the short term, and longer term.

With fatigue being implicated in many logging accidents, serious disabilities, and even fatalities, the hope is synthetic rope will prove a significant advantage and have a significant impact on those risks. While the studies continue, results to date look very promising. "We have seen heart rate differences when using synthetic rope," said Dr. John Garland, of Oregon State, one of those involved in the study. "Scientifically measured, it is significant. Doing it (working with the synthetic rope studied) a full day could be even better."

The crew used in these studies note the work is "easier," beyond the demonstrable heart rates being measured during the study. Subjectively, Garland pointed out, "...carrying, pulling, and climbing, the workers were more sure footed, because the steel is more difficult to deal with in general."

Using the initial results from skidder winch lines trials implies a good potential for increased

(Continued on Page 8)
See "Synthetic Rope"

Synthetic Rope

(Continued from Page 7)

work output as well. "Using five turns per worker (during the trial) it is projected a 10% increase in productivity on a daily basis might be possible for a single machine operator setting his own chokers," Garland reported.

While prospects are very encouraging at this point, Garland emphasized there is more research to be done, particularly in real-life logging applications. Still, results to date are encouraging.

TABLE ONE. Elongation as a function of loading for AMSTEEEL-BLUE (UHMWPE) synthetic rope.

	5/8-inch diameter rope			1-inch diameter rope		
Deflection (percent)	Steel Payload (pounds)	Synthetic Payload (pounds)	Percent Increase	Steel Payload (pounds)	Synthetic Payload (pounds)	Percent Increase
4	1645	2743	67	4096	5373	31
8	3779	5512	46	9450	10814	14
12	5824	8177	40	14581	16052	10

Future potentials

As noted in their paper submitted in the skyline logging symposium at the University of Washington this past December:

"If synthetic rope could increase payloads for cable systems or allow access to difficult terrain, substantial benefits might be attributed to the synthetic rope through reduced costs by replacing the need for more expensive harvest systems or additional roading. Gains might also come during cable equipment set-up, faster manual work, use in helicopter logging, balloon logging and many applications not yet considered.

"The light weight and high strength of synthetic rope provides the potential to increase skyline payloads. The benefits will be greatest at low deflections where the ratio of total line weight to net payload is greatest. Table 2 illustrates the potential benefits of using synthetic rope (AMSTEEL-BLUE) and wire rope (independent wire rope core, EIPS). Two rope diameters are compared for a 1500-ft span, zero chord slope, where a load is fully suspended at mid-span. The maximum payload that brings each rope up to its design load (1/3 of breaking strength) is calculated. At low deflection (4%) the synthetic rope provides a 67% increase over the fully suspended payload for the 5/8-inch wire rope and 31% for the 1-inch rope. The percentage increase declines as the

(Continued on Page 9)
See "Synthetic Rope"

STEVE PILKERTON, researcher at OSU,setting a "twister" with synthetic rope. OSU researchers are in the second installment of research on the synthetic line's potential uses and how it functions in real world logging conditions. To date, the results appear to be promising, with more research to be completed over the next two years.

SPLICING EQUIPMENT, the splicing spool and equipment, including an aluminum fid.

Synthetic Rope

(Continued from Page 8)

deflection increases."

The studies now underway involved using the rope in more rigorous real-world settings with contract loggers including:

- Static lines as guylines, etc. with 3 industrial logging contractors
- Establish wear and damage criteria for users
- Verify ergonomic potentials with ground-based logging with Student Logging Crew and logging contractors
- Test new rope formulations with different coverings and braiding construction
- Test the use of synthetic ropes to replace wrappers on log trucks with three firms including one woman log truck driver
- Produce an illustrated user's guide for synthetic rope applications in logging
- Summarize ergonomic and workload reductions from using synthetic ropes.

In addition, OSU's ongoing research on synthetic rope looks to test, develop, and evaluate new products and uses include:

- Evaluate end-connectors comparable to those now available for wire rope
- Use synthetic rope in running line applications and develop design criteria for cable harvesting software
- Conduct materials properties tests for running line applications
- Evaluate manufacturer's rope coverings for running line applications
- Assess winchline mechanics and spooling issues of synthetic rope
- Identify operating limits and procedures for running lines
- Work with a carriage manufacturer to develop slack-pulling and tensioning device for spooling
- Assess the ergonomic benefits from running line applications
- Estimate the economic benefits from using synthetic rope with running lines.

"I'm excited about this," said Dr. Garland. "This could be one of the breakthroughs for cable logging. Lower weight and greater payloads could change the whole system, particularly if you could get into the blocks as well. It could removed some of the disadvantages from cable logging... and could be a big plus."

As summarized in their presentation to the skyline symposium, "We expect to learn a great deal about logging applications with synthetic ropes with exciting research in the next few years. Great promise exists for improvements in logging safety, worker ergonomics, and economic efficiency. Quantification and description of safe applications, limitations, and useful life/replacement criteria may lead to industry-wide implementation and benefits. These areas of research, with foundations in the wire rope and cable harvesting research of the 1960's and 1970's, will advance the field with 21st century materials and applications. As with the case of many logging activities, innovation can then be advanced further once the rope is in the hands of practitioners."

Patience is the key at this point in research. However, the promise of lighter, stronger line, once its limitations and benefits are fully explored could make a big difference to future operations, with a definite payoff for working loggers.