Advantage

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Contents

Life expectancy of synthetic fibre mainlines in cable skidding applications

Abstract

Past trials of synthetic fibre ropes have shown these to provide several benefits that operators prefer when compared with steel mainlines. These benefits include reduced hand injuries from broken wire strands, lighter weight, reduced lash-back when broken and overall lower handling fatigue. However, the high purchase price combined with the unanswered question on life expectancy has been a deterrent to their use. This study shows that life expectancy of synthetic rope matched that of steel. With current prices dropping for synthetic rope and rising for steel, the economic comparison of the two options may therefore be changing.

Keywords:

Synthetic fibre rope, Mainlines, Cable skidders, Skidder mainline, Breakage, Benefit cost analysis, Spectra® synthetic fiber rope, Dyneema®, Amsteel™ Blue, Samson Rope.

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Introduction

Over the past 15 years, Feric, now a division of FPInnovations, has been involved in a variety of trials related to the use of synthetic fibre ropes as a potential replacement for wire rope in skidding applications. These ropes offer several benefits, such as reduced physical demands on operators, increased safety and thus higher productivity (Dunnigan 1993, Golsse 1996, Hamilton 1997, Ewing 2003). On a diameter-to-diameter basis, the synthetic fibre ropes used in these trials not only provided an 8:1 weight advantage, superior handling and safety, but were also as strong as wire rope.

Figure 1. 19-mm Amsteel Blue used to extract a 5.2 m³ beech stem 80 metres up-slope (70%).

In addition to trials of synthetic ropes for mainlines, field experiments with several designs of chokers were also conducted with some degree of success. Feric's transportation group also tested synthetic fibre ropes for use as an alternative to wire ropes and chains for securing trailer loads .Various organizations in both the United States and Europe have also been conducting their own trials in local forest operations (Pilkerton et al. 2001, Villette, 2007).

Feric's studies have shown that synthetic fibre ropes are strong and well accepted by operators, and have several operational benefits when used instead of

steel mainlines. However, the question of cost and life expectancy has prevented them from entering mainstream operations. This report therefore aims to address the issue of life expectancy, breakage frequency and overall cost benefit of synthetic fibre ropes.

Study site conditions

In December 2006, a John Deere 640 cable skidder operating in the Mont Tremblant region of Quebec was set up for a long-term trial of synthetic fibre mainlines with the machine owner and operator, Richard Laquerre. Mr. Laquerre had previously equipped his machine's winch with a remote control to allow for precision winching at his harvest operations. Operating in the tourist region of Mont Tremblant, Quebec, Mr. Laquerre has many clients who place a high value on visual aesthetics. Much of his work therefore involves designing harvest operations that meet his client's goals. Consequently, it should be noted that this operation may not have been purely typical of regular commercial harvesting operations.

The skidder was equipped with a 45-metre length of 19-mm (¾ inch) Amsteel Blue rope manufactured by Samson Rope.

Figure 2. Typical wood size encountered during the study.

It was installed on the winch drum using a three-twist timberhitch. Instructions in splicing and work techniques associated with synthetic fibre ropes were provided to Mr. Laquerre by Feric at that time. Throughout the first winter, site visits were made approximately every three weeks to obtain production reports and evaluate wear on the mainline. Production data was reported by the operator himself, and included working hours, stems produced, skid distance and terrain conditions. Volume was calculated based on operator data, sample scaling and correlation to scale slips for loads delivered to various mills. Comments and a description of rope failures were also recorded by the operator on a case-by-case basis.

During the course of this study, operations were carried out at six different work sites all within the Laurentian region. Due to ground conditions, harvest operations were not conducted between April and May 2007 and were intermittent during June and July of that year due to the bad weather that weakened ground conditions. The type of terrain covered was variable, ranging from CPPA class 2.1.1 to 2.3.3. Skidding distance varied but averaged over 800 metres in most sites. The forest type was predominantly mixed tolerant hardwoods on the high ground with some intolerant hardwoods giving way to spruce, fir and some Hemlock in gullies and low-lying areas. Where required, all timber harvested had been marked according to Quebec Ministry of Natural Resources guidelines for partial cutting in these forest types. Products sorted at the landing included several species of hardwood sawlogs and softwood sawlogs for three different mills, and pulp and firewood as markets permitted.

Results

During the study period, the operator extracted 1930 m³ of roundwood products from six separate harvest sites. Mainline breakage initially occurred approximately once per five operating days, but became less frequent (approximately once per 15 operating days) in the latter stages of the study. Breakage was primarily confined to the terminal one metre where chokers accumulated during the "travel loaded" portion of the cycle. This part of the mainline initially deteriorates rapidly on the exterior surface due to abrasion, but then appears to stabilize and can be used for quite some time when not unduly loaded.

Average time spent by the operator repairing a mainline breakage with proper splicing techniques ranged from 19 minutes at the beginning of the study to just under 10 minutes by the fall of 2007. Similarly, breakages consumed approximately 1.7 metres of rope (per break) in the early stages, however this dropped to just under 1.0 metre as the operator's splicing skills and understanding of the rope dynamics increased. Based on operator comments and observations during this and other studies, breakage was also more frequent in the initial weeks of the trial as the operator was interested in determining the "rope's limits."

By September 2007, the mainline length was reduced to approximately 20 metres and an additional 45 metres was added to the winch drum. The new rope was placed directly on the drum while the remaining portion of the first rope was end-for-end spliced into the terminal position thus continuing to be in the high wear location. The study continued until February 2008 when all but 7 metres of the original rope had been consumed. The second 45-metre length only showed wear in the terminal 5 metres, and for all intents and purposes could be considered unused. Thus, over the 14-month period, this operation consumed 45 metres of 19-mm Amsteel Blue rope and produced some 1930 m³ of wood at roadside. This result compares favourably with the operator's experience regarding the annual replacement of the steel mainline.

Cost/benefit analysis

Ever since Feric and other organizations have conducted trials of synthetic fibre rope for forestry use, these ropes have always proven to be more expensive than wire rope. Their initial purchase price was two to four times higher than wire rope. One study quantified a production increase resulting from using the rope, an important component of the cost/benefit analysis (Anderson, 2006). In 2007, Feric staff assisted AFOCEL (France) in establishing a long-term field trial of Amsteel Blue. Preliminary results from these field trials indicate that the projected cost of synthetic fibre rope would be one to two times the cost of wire rope thus representing 0.5-1% of overall delivered wood cost. Final results of this study are pending.

Recently, several factors have changed and now increase the economic attractiveness of this rope for Canadian logging operations. They are:

- The purchase price of Spectra/Dyneema rope is dropping. Between 2000 and 2007, there was an 18% reduction in the quoted cost per metre of 19-mm Spectra/Dyneema rope. This lower cost is probably the result of a stronger Canadian dollar and an increase in raw fibre supply and competition between a growing number of suppliers.
- The cost of wire rope has been climbing steadily for the past few years as world steel prices escalate. This factor deserves

additional comment since there appears to be two varieties of wire rope on the North American market today. There is wire rope that has a certified breaking strength and usually carries a strand marker identifying the product's manufacturer, and then there is non-certified rope. This latter product sells for a fraction of the price of certified rope, but is hard to identify based on visual inspection and, in many cases, is produced by an unidentified manufacturer. It appears that the vast majority of wire rope being sold to the cable skidder market is of the unrated variety. For this reason, Table 1 outlines the comparative cost and other characteristics of Amsteel Blue versus rated and unrated wire rope. It is based upon productivity data collected in this study and does not reflect any increase in productivity that might be obtained by using synthetic fibre ropes.

Table 1 indicates that when Amsteel Blue and certified wire rope from a known manufacturer are compared, Amsteel Blue is found to be an economically viable alternative to steel. However, based on a survey of prices currently charged by suppliers/retailers of wire rope mainlines for cable skidders, one must assume that it is mainly of the unrated variety. Individuals who therefore wish to consider using synthetic fibre rope on their skidder will have to consult their records to determine the cost differential that applies in their situation. It will range from slightly cheaper than steel to up to 2.8 times more costly.

In this analysis, the life expectancy of Amsteel Blue was set to be the same as steel mainlines based on the results of this study. Yet based on breakage frequency that was experienced in the latter months of the study, it may be feasible to expect a greater life expectancy for synthetic ropes than for steel cables. Additional future long-term trials would be required to confirm these results. Another benefit that should be noted is, unlike steel mainlines that must be discarded when they are shorter than 20 metres or so, synthetic rope can be spliced end-to-end so that none is wasted. This greatly enhances the economic performance of the rope, once the initial rope has been purchased.

Table 1. Economic comparison of Amsteel Blue versus rated and unrated wire rope (19 mm)

	Amsteel Blue	Rated	Unrated
Breaking strength (kg)	29 272	26 727	< 26 727
Weight (kg/m)	0.2	1.55	1.27
Cost ($/m)	20.99	22.63	7.71
Cost ($/45 m)	$944.00	$1,018.00	$346.95
Cost/m^3	$0.49	$0.53	$0.18

Feedback from operators involved in the various trials and studies of synthetic fibre ropes over the years has provided a very clear understanding of these ropes' benefits. It is the undisputed choice, for ease of handling and user-friendliness. Once the splicing technique for synthetic fibre rope is mastered, it is far easier to do than tying a knot in a wire rope.

Concerns expressed by operators always involve the question, "How long will it last?" since the ropes appear to abrade fairly quickly with use. However, the fuzziness that starts to appear on the smooth surface of the rope is actually broken fibres, and as these build up they form a protective, somewhat "lubricating" barrier layer between the rope and other surfaces. Most of this wear is caused during the "travel loaded" portion of the cycle when the suspended load sways and the sliders accumulated in that region rub against the line. While this cannot be eliminated, it can be reduced by employing mainline sliders that have been previously used with a steel line. These sliders will have the original casting roughness polished off, and operators will only need to file any sharp edges smooth.

Implementation

Synthetic fibre ropes such as Amsteel Blue, which is constructed of Spectra/ Dyneema fibres, can be used as a replacement for wire rope on cable skidders. It does provide benefits in terms of being lighter and easier to handle, does not produce the jaggers common to wire rope and has very little elastic stretch so it does not tend to lash back when it breaks. Being lighter than wire rope, yet having equivalent strength (when compared on a diameter-to-diameter basis), enables operators to pull it farther, thus increasing the distance between skid trails and reducing the area subject to machine travel.

In this study of partial cutting of tolerant hardwoods, Amsteel Blue has shown to have a life expectancy equal to that of wire rope. The synthetic fibre rope used in this study has recently decreased in price, whereas the cost of certified or rated wire rope has increased. Furthermore, new suppliers provide material at a very low cost, resulting in a wide range of prices for wire rope. As such, the cost of switching to Amsteel Blue could prove to be nothing, or could result in mainline costs approaching three times that of wire rope, depending on the cost of your current mainline.

The key to successfully using fibre ropes is the interest of the operator to use this rope. Simply put, an unwilling operator can break anything. With an operator who is interested in reducing his workload, synthetic fibre rope can be a technology that will enable a skidder to work in areas that are otherwise not operable. Ease of learning splicing techniques and suitability to field operations pose no barrier to using this material. Feric has produced a user guide called "Spectra rope for skidder mainlines," that explains splicing techniques and provides additional information to assist an interested operator in achieving successful results with these ropes.

Synthetic fibre rope will not replace wire rope on all cable skidders, but it does have a place in areas where machine travel must be reduced or is not permitted. Older operators can benefit from a reduced workload, and everyone can appreciate not having the puncture wounds associated with wire rope usage. Steep slopes and long-distance winching are all made easier with synthetic fibre rope. With a comparable life expectancy and increasingly favourable cost compared with wire rope, it is possible that products such as Amsteel Blue will gain in popularity amongst cable skidder loggers.

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