Key words:
- Innovation
- Skidding
- Synthetic rope

Skidding trial with synthetic rope: Pyrenean experience feedback

Within the project DEFOR*, we followed the implementation and the use of a synthetic rope on skidder for operations of skidding. This test was held for six months, from June to November 2007.
The results are encouraging for rope users in difficult regions and show the possibility of interesting prospects to set the synthetic rope for logs skidding operations in a general way.

Figure 1 Synthetic rope is a strong innovation for log skidding in mountainous areas

The technological progress made in the field of textile rope allows to be done under difficult forest conditions. However, if the material is powerful, it must also be adopted by the user. This test in real conditions made it possible to install it successfully by the operator. The synthetic rope is appreciated by this one, which is the best proof of the qualities of this product.
The durability of the synthetic rope is proven after six months under the Pyrenean conditions and it brings ergonomic advantages for the user.

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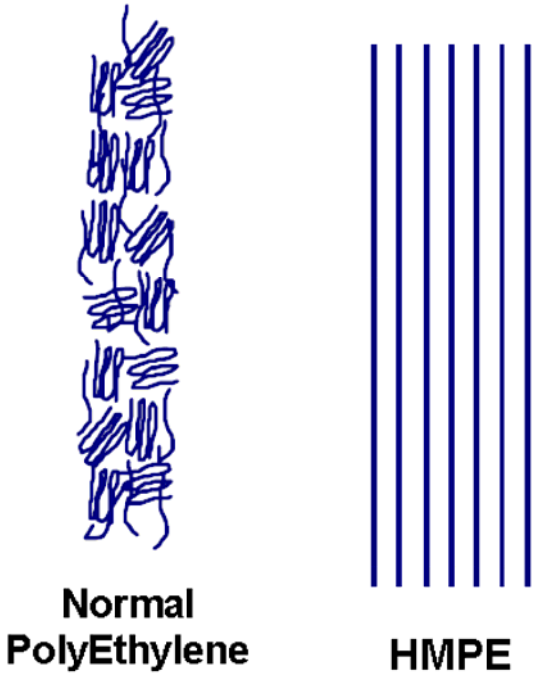
Presentation of the synthetic cable

The synthetic fiber

Skidding textile ropes consist of synthetic fibers. For a forest use, we use the particular polyethylene named HMPE, **High Modulus PolyEthylene**. These HMPE fibers have a specific orientation (cf figure 2) which gives then a tensile strength much higher.

There are at least two commercial brands for this fiber: Dyneema® and Spectra®.
This fiber is used in many uses (maritime, military) and is the raw material of the synthetic rope manufactures.

Figure 2 : polyethylene fiber scheme (Source Smeets)

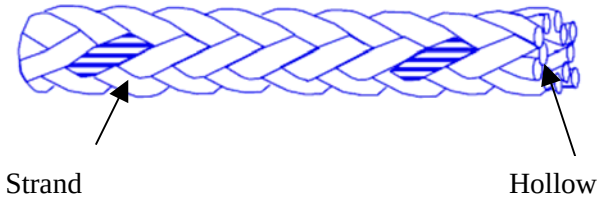


The synthetic rope

2 types of rope are available on the market:
- "naked" rope (hollow-braided & 12 strands)
- core-cover cable

We will concentrate on the "naked" cable which is used more frequently and a better investment.

Figure 3 : Hollow-braided rope scheme (source : Bexco)



The naked synthetic fiber rope is constructed in a specific way. It is generally assembled of 12 strands of HMPE (cf figure 3). These 12 strands are braided to obtain a hollow interior (a central vacuum) making it possible to do a splice (cf paragraph splicing) with the rope. The rope receives then a protecting coating to prolong its lifespan.

Features of the synthetic rope

The synthetic rope has many assets to set itself in the operations of skidding per cable.
This product has a tensile strength equivalent to that of steel (for the same diameter). The weight of the synthetic rope is lighter by 8 to 10 times than steel (for the same diameter).
This rope can quickly be spliced on the field in the event of breakage.
The risks of wounds to the operator hands are reduced in a very important way (no more meat hook).
The rope elasticity is lower than the traditional steel rope and its weight is lower too, so the "whip effect" is minimized.

Nevertheless, like all plastic cables, the synthetic cable melts and burns when the temperature rises a lot. Lastly, the wear and tear of the synthetic rope in a long term basis was still unknown in France.

Presentation of the study and results

■ Material and Methods

We chose to test a synthetic cable AmSteel Blue of Samson Rope. Rope features are 130 meters for 18 mm of diameter.
The synthetic cable was installed at the beginning of June on Skidder CAMOX F140 of SEBSO, a forest logging enterprise. This skidder has a double drum. The operator thus has of a steel cable and a synthetic cable on his machine.

The logging conditions during the test was defined by a job done in a mountainous area. The logging site had a steep slope from 45 % to 80 %. The skidder worked from the path and winched in the load from below. The winching distance was about 60 to 120 meters. The logs to winch were mainly beech (80 %), fir and oak (20 %). The DBH of these trees was inside a range of 35 to 50 cm, and the log length was about 12 to 15 m.

The installation was closely followed during the first two weeks on the field. The monitoring continued by a telephone contact every week for 6 months.

The objective of this study were:
- to compare it with traditional steel rope
- to check the resistance (breaking strength) of the synthetic rope
- to know the lifespan of the product
- to assess the economic impact of the rope on the woodsupply cost

Every volume quoted in this document is delivery volume. When we needed, we used a conversion factor such as $1m^3$ = 1 ton.

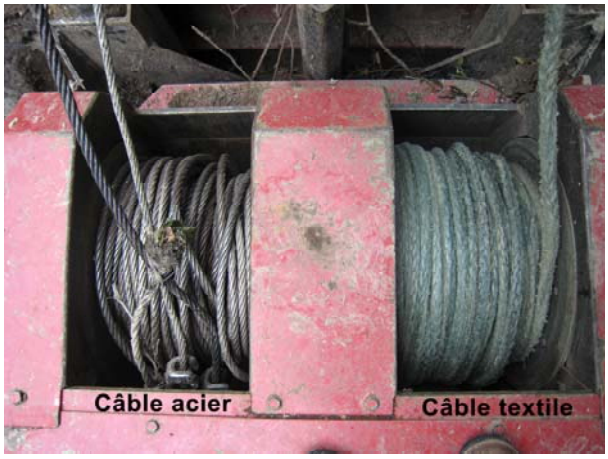
■ Assessment and comparison between the synthetic rope and a steel rope.

▪ The operator is satisfied with the material tested after 6 months of daily use, he even said to have more confidence in the synthetic rope than in the steel rope. The user is thus convinced by this product.
This higher confidence of the operator shows that we may “enlarge” the synthetic rope size. We will therfore recommend to replace this rope by a 16 mm diameter rope to the next replacement.

Figure 9 Sliders friction on the end connection

▪ The sliders used on the synthetic rope are rather aggressive (cf.figure 9) close to the end connection. We will soon test a new end connection to try to reduce the scrape of the cable by the sliders.

Figure 10 Drums winch comparison



- The winch-in on the winch-drum is very suitable (cf Figure 10). In comparison with the steel rope, it is much better : compact and without crossing of cables. In addition, there is no crushing, twisting or wedging of the rope. Its flexibility and its lightness are also assets, it does not damage when twisting the strands. Finally, one can reduce the inertia of the drum which facilitates the winch out.

- The main asset of the synthetic rope concerns ergonomy and safety. It is more comfortable to work with synthetic rope, because it is light. It is less tiring. In the case of an uphill skidding process, we need only one person instead of two.

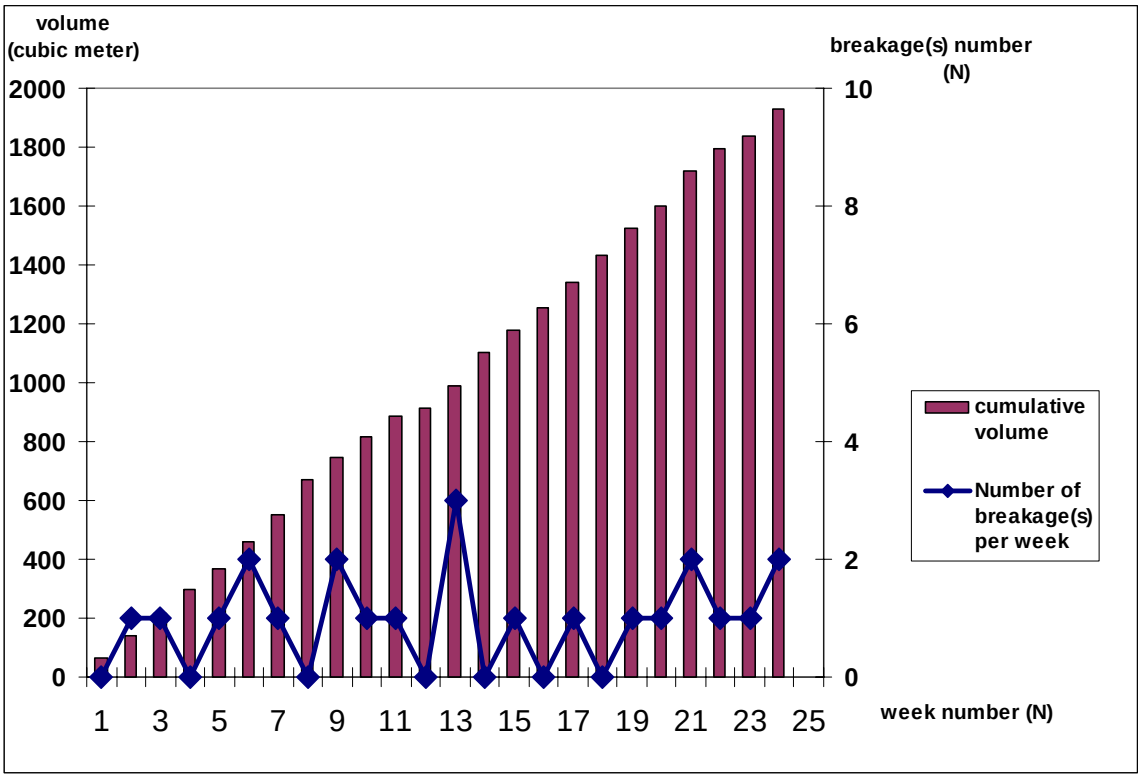
The “whip effect” in the event of breakage is minimized in comparison with the cable steel, because the synthetic cable has a very weak modulus of elasticity and its low mass limits the risks of injury.

Finally the wear of cable causes pilling on the outside, this one protects fibers inside and does not injure the hands at all.

Presentation of the results of resistance

During a 24-weeks test, the operator has winched 1927 cubic meters with the line “synthetic rope” (and 2570 cubic meters were skidded with the two lines in 6 months).

Figure 4 cumulative skidded Volume and weekly breakages



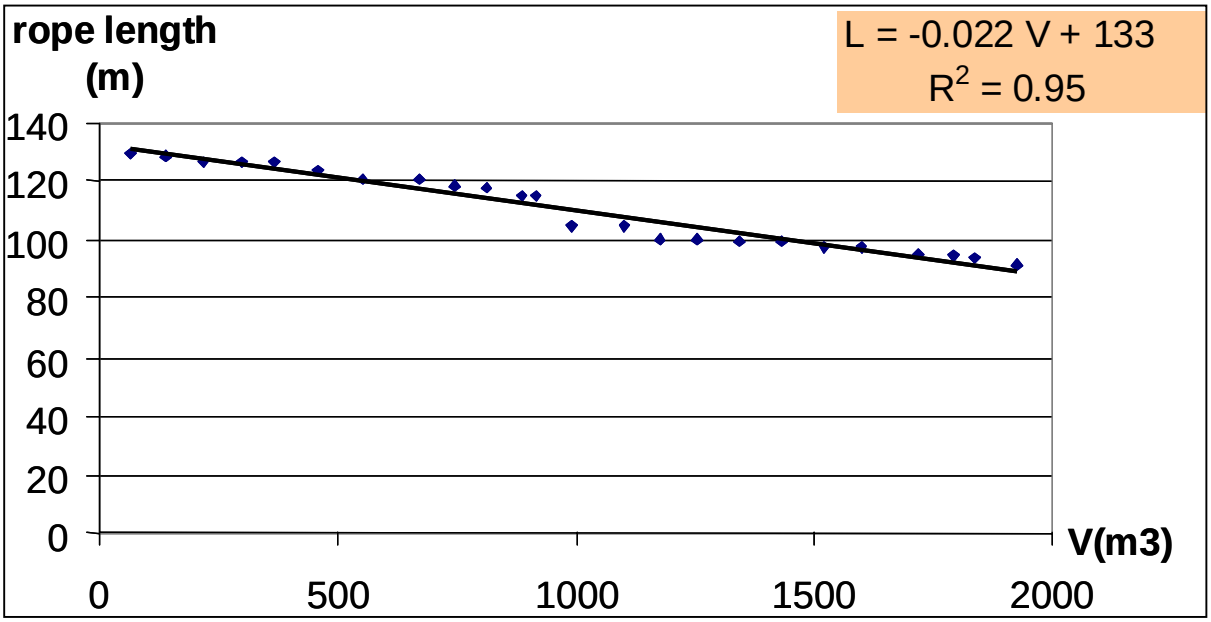
The average frequency of breakage is lower than once a week with 23 breakages in 24 weeks. The breakage number is linked to the skidded volume, one breakage for each 80 skidded cubic meters.
The down time (repairing time) with splicing is about 15-20 min, it is carried out on the field. It does not penalize the daily production. The frequency of breakage and the speed of repair are satisfactory, splicing is thus not regarded as a disadvantage by the operator.

■ Estimation of the lifespan

With each breaking off of the synthetic cable, the length of cable is reduced (cf. figure 5). If the breaking is close to the end connection, one loses about half a meter and this loss can go up to 3-5 meters in rare cases.
The average loss is approximately 1.65 meters. The end connection receives a lot of friction with the sliders tight in tension. So, it is a brittle zone.

The current length of rope is approximately 92 m after six months. One can estimate, thanks to the regression carried out (cf figure 5) that the synthetic cable will not measure more that 65 meters linear when the skidded volume reaches 3000 cubic meters. The rope will then have lost half of its initial length and we will have to be replaced.

Figure 5 rope length according to the skidded volume (raw data and regression)



The maximum lifespan to work under satisfactory conditions corresponds to 3000 cubic meters. It is about the first life of the cable. With a long splice of 2 ropes (cf paragraph splicing) of 65 m, we can create a second life rope. These second life rope can skidd at leat 1000 cubic meters more. Finally, 4000 cubic meters can be skidded in the whole life of a synthetic rope.

■ Economic analysis

On the basis of real consumption data for steel ropes provided by the professionals, we carried out an economic analysis. This analysis compares the consumption of steel and the consumption of synthetic cable measured during our test.
This approach includes the splicing capacity of synthetic rope (which gives it a second life) and a range of woodsupply costs.

Figure 6 table of economic assumptions

SYNTHETIC ROPE	
linear meter cost18 mm	16.25 €
130 m rope cost	2 112 €
consumed rope length (life 1)	65m
skidded volume (life 1)	3000m3
skidded volume (life 2)	1000m3
skidded cubic meter cost	0.53 €

STEEL ROPE	
linear meter cost15 mm	2.22 €
130 m rope cost	266 €
consumed rope length (life 1)	65m
skidded volume (life 1)	1000m3
skidded volume (life 2)	0
skidded cubic meter cost	0.27 €

estimated extra cost per skidded cubic meter	+	0.26 €

The cost of the cable per skidded cubic meter is 1 to 2 time more expensive for the synthetic rope compared to the steel one. The estimated extra cost would be about 0,5 - 1% of the wood supply cost, delivered to the factory in the Pyrenean zone.

To limit the extra economic cost, we can try a synthetic rope of 16 mm diameter only. This one costs 15 % to 35 % less , but it will be necessary to compare its breakage frequency in comparison with the saving.

■ Overall assessment table of synthetic rope

PROS	CONS
Weight (8-10 times lighter than steel) reduces tiredness and increase the work area	Important purchase investment
No hand injury (no meat hook,…)	Melting possibility to the heat
Quick and efficient fixing (splicing)	Extra cost in the woodsupply cost (about 1 % of the whole delivery cost)
Minimized “whip effect”	
Better winch in and hollow-braided structure increase the drum capacity	

Splicing, a crucial working technique for the skidder operator

Splicing is a repairing technique for synthetic rope. This technique is used following a rope breakage (cf. figure 7 & 8) or during a synthetic rope set up (cf. figure 7). This technique is easy and fast (15 minutes of down time on average). This technique makes it possible to carry out a splice alone, on the field. It requires no particular or expensive tools.
Its easy implementation is an important asset for the development of the synthetic cable in the skidding forest operations.

This technique replaces the use of knots advantageously. The knots should not be used with the synthetic rope because they cause an important weakening in the strength, up to 70% in certain cases (source: FP Innovations, division FERIC).

Nevertheless, a short specific training (2 days) is necessary to control splicing. This training can avoid possible failure in the set up of the synthetic rope.

Figure 7: Eyed splice (an end connection)

(source : Garland, FERIC)

Figure 8: Long splice (fixing of 2 divided pieces)

Conclusions and prospects

■ Conclusion

The ergonomic interest of the synthetic cable is proven, it is the main asset. The lightness of the product and the absence of risk of injury is very positive for forest workers. Splicing is an efficient technique to have an operational tool permanently, this technique is thus robust and reliable. The main barrier to the development of this technique is economic, even if the extra cost on the whole woodsupply is weak, the investment for the skidder remains high.

To carry out a satisfying set up of the synthetic rope in the companies, it is also recommended to train the operators in the splicing technique.

■ Which prospects ?

The future stakes of research will focus on cost reduction. Two important ways will be explored :

-diameter reduction in synthetic rope to decrease the cost of purchase,

-end connection set up to decrease abrasion and increase the skidded volume during the lifespan,

To keep on using the synthetic cable, it will also be necessary to test synthetic chokers (cf. figure 11) to decrease the weight moved by the operator. A study should also begin for the cable-yarding, with anchorage lines.

Figure 11 Two synthetic rope chokers

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