INFLUENCE OF PARAMETERS IN THE ROPE CONSTRUCTION- M. Beal (BEAL)

Mr Karrer explained the great lines of the manufacturing of mountaineering ropes, and I am in charge of explaining the influence of the different factors that can vary in the construction. I also have to show the difference between a dynamic rope and a low-stretch rope.

PARAMETERS THAT ONE CAN VARY IN THE CONSTRUCTION OF THE ROPE

- The sheath/core ratio

Tests demonstrate that the energy absorption capacity of the rope is principally given by the core. The reason is that in the carabiner, or in the pivot edge if you consider the drop test, the lower sheath yarns in contact with the carabiner are compressed by the flexion, and the upper ones are extended. So just a part of the sheath works to arrest the fall. All the yarns which are compressed don't give energy absorption.

So, to improve the dynamic properties of the rope, you will increase the proportion of core and will reduce the amount of sheath.

On the other hand, the resistance to abrasion is more or less proportional to the amount of sheath. A thicker sheath resists abrasion better than a thin sheath, everything else being equal.

- The number of spindles in the sheath

The spindles are the bobbins that rotate to make the sheath. Climbing ropes are constructed with 32, 36, 40 or 48 spindles. As one increases the number of spindles, one diminishes the thickness of each yarn, and thus the thickness of the sheath.

If you use a thick yarn with 48 spindles, you will get a big hollow inside the sheath, and you will have to fill it with a large quantity of core yarns and will get a big rope of 12mm or 13mm diameter.

For the same diameter of 10.5mm for example, one will thus choose 48 spindles for dynamic properties, and 32 spindles for abrasion resistance which can be translated into 48 spindles for a sport rope and 32 spindles for a gym rope used in top roping on artificial climbing walls.

- The design of the sheath

Two options are possible : 2 on 1 or 2 on 2 (tandem).

The 2 on 1 system gives a smoother sheath, which resists abrasion a little better. On the other hand it gives less « grip », a sliding more important in belay devices and, above all, a much greater tendency to sheath slippage. Most of the ropes on the market are made with the 2 on 2 construction.

- The tightening of the sheath

Tightening the sheath brings the following consequences :

- More rigidity,
- More kinking,
- More resistance to abrasion,

…/…

▫ More resistance to cutting,

▫ More elongation,

▫ Less resistance in the knot.

A loose sheath will give a more supple rope, more pleasant to use, but more susceptible to abrasion, flattening and with a tendency to tangle.

Most of those assertions are obvious and don't need any development, but elongation and resistance in the knot are may-be not so clear.

▫ Why does tightening the sheath give more elongation ?

When you tighten the sheath, you increase the angle of the sheath yarns. So you get a larger elongation of the structure. The consequence, which is in opposition to the common feeling, is that a stiff rope has more elongation than a soft rope made with the same yarns !!

▫ The resistance in the knot of a supple rope is better because it flattens and thus works a better way.

▫ And what about the influence of tightening the sheath on the drop test ?

For the same reason, I mean flattening, in the standard drop test, all other things being equal, a supple rope will give better results than a stiff rope because its yarns will expand better in the pivot edge and will be able to work together better.

▫ <u>The construction of the core : twisted cores (strands) or braided cores</u>

The braided cores, which were very widespread twenty years ago have little by little disappeared from most manufacturers ropes. Their only advantage seems to be a greater facility to limit the sheath slippage. On the other hand, if the rope is made with one single braided core, its dynamic properties are not optimal. If it is made with 3 braided cores, the rope becomes triangular on use.

Multiple twisted strands are to-day the choice of most manufacturers. Without developing the reasons, you can expect that this choice was the consequence of many tests showing the superiority ot that construction.

<u>CONCLUSION</u>

The choice of rope construction is always a compromise between the principal qualities that one seeks : great durability, high fall number, low impact force…

When one talks of durability, one thinks in general of sheath wear, but one can also ask other questions.

The capacity of a rope to absorb energy decreases with usage : the number of falls it will sustain decreases. The impact force increases with successive falls. Its lifetime may thus be limited not only by sheath wear, but also by lowering of its dynamic performance.

Unfortunately, as it will be shown during this conference, rope performances suffer from other facts : they are very sensitive to water absorption and to sharp edges.

So yarn producers and rope manufacturers still have to focus on research and development to offer climbing ropes which would be 100% safe in any condition…