Benefits From Using 7 Strand Ropes for Hauling and Hauling-Carrying Ropes

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The key point of my argumentation is to offer a better and innovative solution for ropes to be used on ropeways, in order to reduce the 2 major inconveniences that occur with the use of conventional 6 strand wire ropes: noise and vibrations.

As we can easily understand conventional 6-strand ropes do not have a smooth profile; this induces large movements of the roller supports, causing noise and vibrations.
Additionally, splicing a 6-strand rope implies large tucks, which can interfere with the vehicles' suspension grips.

To solve these problems Redaelli has developed and manufactured a new-patented wire rope construction with 7 strands.

The outcomes are that the profile of the rope is much smoother, preventing large movements of the roller support, and therefore reducing significantly noise and vibrations, additionally the splice results in smaller tucks, as each strand is smaller when compared to 6 strand ropes.

By increasing the outside surface, 7-strand ropes also reduce local pressure preventing roller wear and shut down time for maintenance.

The modern installations for passenger transportation work at very high speed ($\geq$10 m/s for hauling ropes and $\geq$ 5 m/s for hauling-carrying ropes). The high speed amplifies all the dynamics effects due to the non-cylindrical shape of wire ropes.

This is particularly true in some part of the installations, where the ropes move over fixed rollers instead of swinging pairs of rollers. Additionally, wire ropes are in touch with the rollers only for a very limited area creating very high localized pressure.

Seven (7) strand ropes will reduce the contact pressure producing less wear on the roller and sheaves, increase flexibility allowing to use more solid strand constructions (outer wires in a 7x19S have very similar size than in the 6x31WS).

These result in a possible reduction of the roller sizes and in maintenance costs.

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Design criteria:

All the ropes for hauling-carrying operation must have a fiber core in order to allow splices. Therefore the ropes must be produced with a single layer of strands over a core.
The number of strands must be not less than 6 to allow the splice (with a lower number of strands, the core diameter would be smaller than the one of the outer strand).

The best wire rope should have the following characteristics:

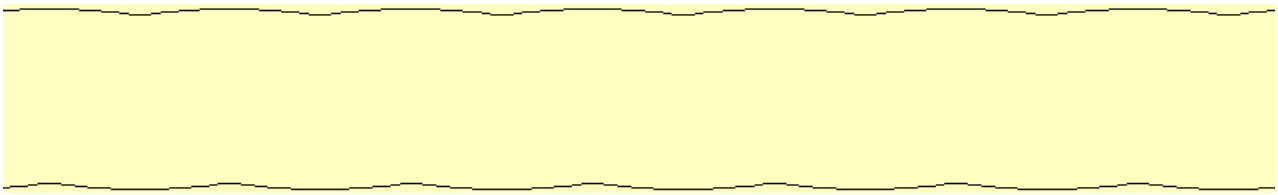
Table 1

Characteristic	Goal	Obtained by
High metallic area	To increase load capacity	6 outer strands
Roundness	To prevent vibrations	increased # of outer strands
Extended surface	To reduce the pressure over the rollers and sheaves	increased # of outer strands
Flexibility	To increase the contact surface with the grips To reduce bending stresses	increased # of outer strands
Large outer area	To reduce the rope wear	increased # of outer strands
Suitability for splicing	To prevent knots oversize	Increase # of outer strands
Low stretch	To prevent excessive shortening operations	6 outer strands

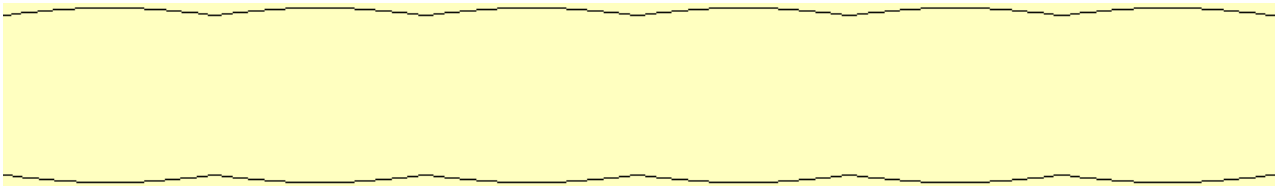
Seven (7) strand ropes can optimize all these requirements.

The following graphs represent the profile of a 7 and a 6 strand rope, highlighting the advantages in terms of straightness.

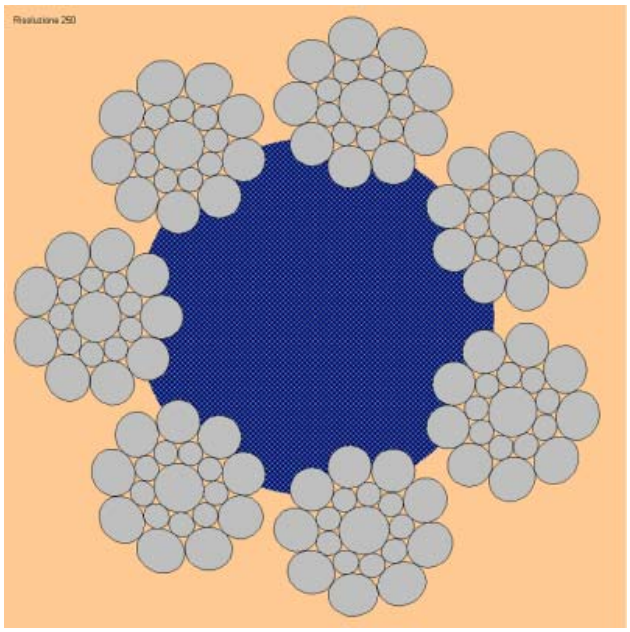
7-Strand Rope



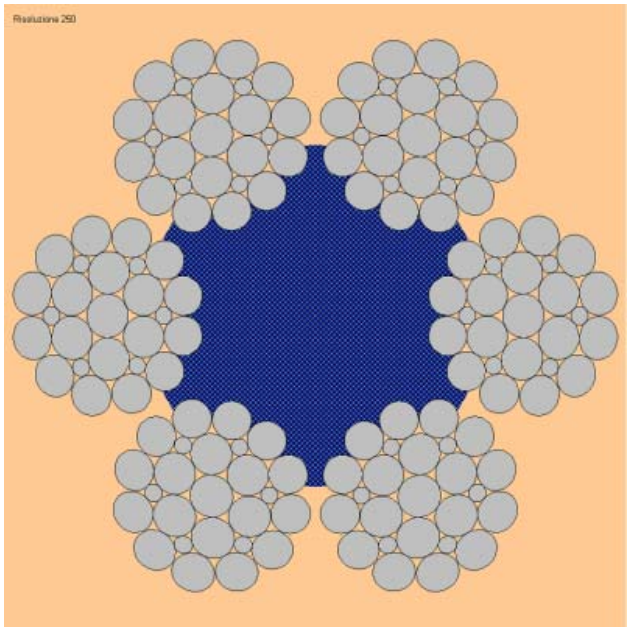
6-Strand Rope



7- Strand Rope



6-Strand Rope



Fibre core dimensioning

The core is the key to obtain a stable and long lasting rope.

The materials to be used for the cores must not be sensitive to environmental conditions (low and high temperature, UV rays deterioration, water absorption, aging etc.).

The core must be designed taking into account that the air trapped between the fibers must be eliminated during the rope closing by the combined action of pressure (generated by the outer strands) and time (depending by the closing speed). For this purpose it is crucial to know the amount of the core volume which can be contained in the rope, and to produce a core having a structure that is easy to modify in order to assume the shape that the core will take due to the outer strands.

Rope pre-stretching

The scope is to reduce the elongation of the rope when loaded.

Knowing that the splice area is the most critical part of the rope, the absolute value of the rope elongation should be selected to allow one additional rope splice (Rope with no elongation at all, can not be re-spliced)

This process consists of loading and bending the rope during its manufacture over a double traction winch (the first half of the machine increases the load to the rope, the second half lowers the load). The tension applied at the rope can be adjusted, using an hydraulic driven sheave, up to 90 tons.

The pre-stretching machine, which is about 80 meters (260 feet) long, increases the time during which the rope is under tension, improving the effect of the prestreatching.

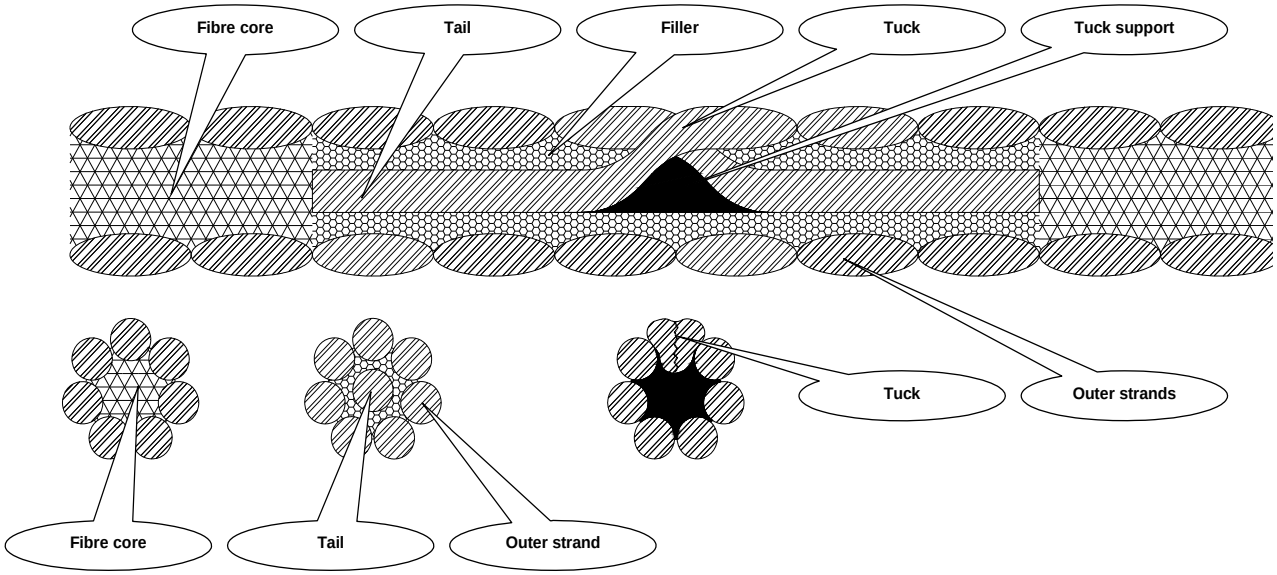
Tail wrapping material

To maintain the requested stability of the splice, the tails must be wrapped in order to be "forced" inside the outer strands in place of the fiber core.

The material to be used for the tail wrapping must be wound in the exact quantity to ensure the longest working time and to keep the geometrical dimensions of wire rope constant.

For this purpose the most modern method of wrapping uses reinforced rubber hose cut longitudinally and wound over the tail. This choice of material allows a splicer to find a variety of dimensions and types in the market to operate with on any kind of rope and size.

The following scheme below represents the longitudinal and the cross sections of the splice area of a 7 strand rope.



Experimental results:

The practical results of the installation of 7 strands rope confirm the suitability of the rope for the scope of reducing vibrations and noise.

A	Chairlift	34 mm x 1400 m – bright –	2002 – replacement of the old rope
B	Chairlift	36 mm x 2150 m – galvanized –	2002 – first equipment
C	Cableway	32 mm x 1740 m – bright –	2002 – replacement of the old rope
D	Cableway	34 mm x 1740 m – bright –	2002 – replacement of the old rope
E	Chairlift	30 mm x 2050 m – bright –	2002 – replacement of the old rope
F	Funicular	33 mm x 1600 m – bright –	2002 – replacement of the old rope
G	Cableway	32 mm x 1850 m – bright –	2003 – replacement of the old rope

In particular the ropes used in the cases C, D and G was able to solve the very strong noise problems due to the passage of the ropes over the tensioning sheaves.

The rope used for the case F increased dramatically its lifetime reducing serious problems of wear over the support rollers.