A brand of the Prysmian Group

Development of elevator ropes

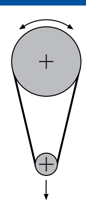
TECH TIP 15

More than ever before, buyers around the world expect elevator ropes to offer long service lives while at the same time being available at competitive prices. The Gustav Wolf Rope and Wire Works with headquarters in Gütersloh, Germany has been a reliable vendor to its customers for many years and is untiring in its efforts to develop new, cost-optimized ropes.

Gustav Wolf produces steel wire and wire ropes today at six sites around the world. Elevator ropes account for a significant part of the firm's manufacturing output. Gustav Wolf has a variety of equipment available for on-site testing of wire and ropes. Included are bending endurance testing units with up to six test pulleys. It was against this background that the service lives of various rope designs were examined in order to identify cost-favorable alternatives for our customers.

Table 1 - Test conditions

Test conditions
Single bend
1 crank rotation = 2 bends
Crank rotation speed = 39 rpm
Bending length = 660 mm
Ambient temperature = approx. 21°C
Wrap angle = 155°
No rope re-lubrication



Test pulley 240 mm with HRC 60 hardness

Rope tensile force (kN)	5.9	11.7	17.55	23.4	27.3
Round groove r/d = 0.53	•	•		•	•
Undercut groove α = 90°		•		•	•
Vee groove γ = 35°		•	•	•	

Elevator ropes – state of the art

Normally used in elevator engineering are steel wire ropes in an 8x19 Seale or 8x19 Warrington design, with natural fiber cores in each case.

The selection of the rope will depend on the application. Variation options are presented by differing rated strengths for the outside wires (1180 N/mm^2, 1370 N/mm^2, 1570 N/mm^2 or 1770 N/mm^2). To handle unusual circumstances one may also use special ropes with nine strands and an all-steel core or double parallel-lay rope.

One may differentiate between two fundamentally different situations in the use of elevator ropes: The ropes are either used as replacements, i.e. they are installed on existing elevators, or they are used for new elevators. In the latter case, the engineering for the elevator and its ropes can be attuned precisely one to the other, thus optimizing the system as a whole. In the event of replacements, by contrast, the rope tensile force, referenced to diameter, is a given. It is possible to implement only minor variations while staying within the fixed constraints.

Compacting elevator ropes – will this work in practice?

Being aware of the fact that compacted ropes are used in crane engineering, it seemed plausible to examine their suitability for elevators.

It is generally known that both complete ropes, or the strands alone, can be compacted by applying any of a number of processes such as drawing, hammering or rolling.

During such processes the shape of the wires is changed but the metallic cross section remains the same unless the wire diameter is increased. The rope or the strands are compacted.

Outside wires with larger diameters are used to avoid the rope falling below the required diameter after compaction. One further result is that the compacted rope exhibits a greater metallic cross section than a comparable, non-compacted rope. Moreover, the pressures exerted during compaction will smooth the surfaces of the individual strands.

Objective of the investigations

As regards ropes with natural fiber cores, the intention was to determine whether compacting the strands would in and of itself extend the rope's operational life. Further aspects considered in testing were stretch properties and the influence of the greater metallic cross section on service life. Moreover, it was to be determined whether the strands, as a consequence of compaction, are more resistant to transverse pressures.

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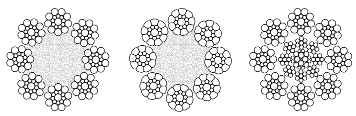
Selection of the test ropes

Three types of ropes were selected for examination. Tested in addition to the standard 8x19 Seale rope with natural fiber core (8x19S-NFC) were an identical design with a steel core (8x19S-IWRC) and a compacted rope with natural fiber core (8xK19S-NFC).

The limitation to standard designs was deliberate so as not to lose sight of the reduced manufacturing costs associated with higher production volumes.

Table 2 - Design and Construction Comparison



Rope design conditions	8x19S NFC	8xK19S NFC	8x19S IWRC
Number of wires	152	152	227
Nominal diameter (mm)	10	10	10
Measured diameter (mm)	10,55	10,12	10,18
Lubrication	Standard	Standard	Standard
Strength (N/mm^2)	1570	1570	1570
Metallic cross-section (mm^2)	34.86	39.22	47.44
Min breaking load (kN)	46,50	51.70	59.60
Metallic cross-section (%)	**100**	**112**	**136**

Description of the tests conducted

- Number of bends to break as a factor of pulley parameters
- Number of bends to break as a factor of rope design
- Cross section development and transverse pressure stability
- Stretch properties

Summary

Ropes with natural fiber cores are widely used in elevator engineering, all around the world. Compacting these ropes will result in an improvement in the service life.

Ropes with steel cores, at identical tensile loading, offer even longer service life than compacted ropes with natural fiber cores. This is a result of the greater metallic cross section. A further advantage is a reduction in rope stretch and this will cut costs in mass production and service.

Resistance to transverse pressures is not improved significantly by compacting natural fiber core ropes. By contrast, steel-core ropes exhibit a markedly greater stability when subjected to transverse pressures.

It was found that compacted ropes were less subject to stretch than non-compacted ropes. Thus there is a savings potential to be found in the use of compacted ropes.

It can be concluded from these trials that compacted ropes represent a potential alternative for use in elevator engineering. They show properties in all areas which are similar to steel-core ropes. Field testing will be required to verify and confirm the results of laboratory testing.

About the authors

Dr. Ernst Wolf is CEO at Gustav Wolf Rope and Wire Works.

Dr. Andreas Franz has been employed by Gustav Wolf Rope and Wire Works since 1998 and as Technical Director, he is technical manager for the steel wire rope division. He is a member of the Technical Commissions of the DSV and the EWRIS.