2008 / 06

KISWIRE

verope®

rely on

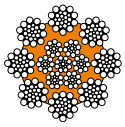
handling and inspection

verope special wire ropes

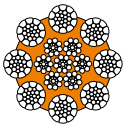
Verope special wire ropes are high-quality products with a long useful life.

The following instructions for handling and inspecting verope special wire ropes have the purpose of contributing to safe use of our products while maintaining their value.

Three basic forms of verope special wire ropes are available:

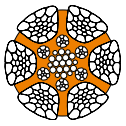


verostar 8

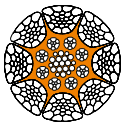


veropro 8

verostar 8 and veropro 8
Eight-strand rope constructions with a plastic-coated independent wire rope core. The veropro 8 rope construction has compacted outer strands.

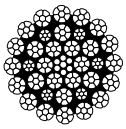


veropower 6

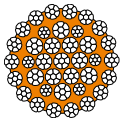


veropower 8

veropower 6 and veropower 8
Six- and eight-strand hammered rope constructions with parallel lay, precompacted strands and plastic-coated central core strand.



verotop



verotop P

verotop and verotop P
Low-rotational rope construction with compacted strands. The verotop P rope construction has a plastic-coated steel core.

The verope special wire ropes are available in the rope grades 1960 and 2160 with bright or galvanized wires in left hand- or right hand-Lang's lay or ordinary lay and are largely preformed, some with particularly stabilising properties due to a plastic-coated core. The ropes are produced with the right lubricant for each specific application.

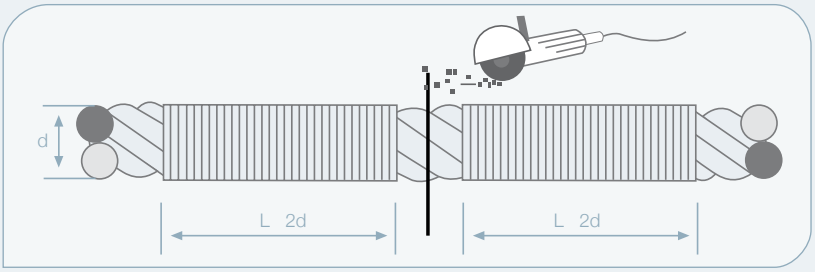
The wire rope construction and the rope lubricant have to be compatible with the rope reeving system, the system elements and the impact they have including environmental conditions.

On the following pages, you will find recommendations for handling and inspecting verope special wire ropes in order to use them safely for a long useful life.

handling

Storage and cutting

The rope supplied on reels or in coils have to be stored appropriately and should be protected from exposure to environmental influences. Verope special wire ropes are supplied with point-welded ends.



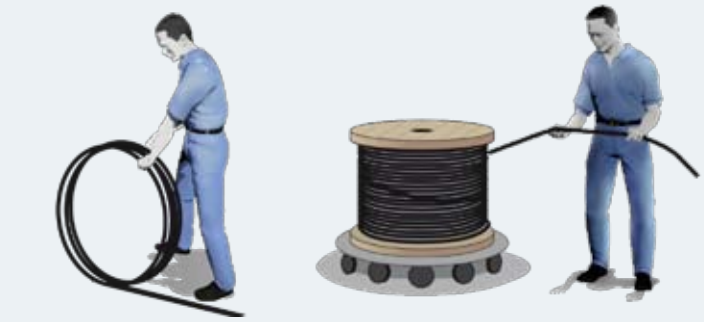
Always provide effective seizing at cutting (also with preformed verope special ropes).

Protect from exposure to weather

Unspooling

The rope supplied on reel or coil can be drawn from a turntable or wound off, in case of short length.

The reel may not be rolled!



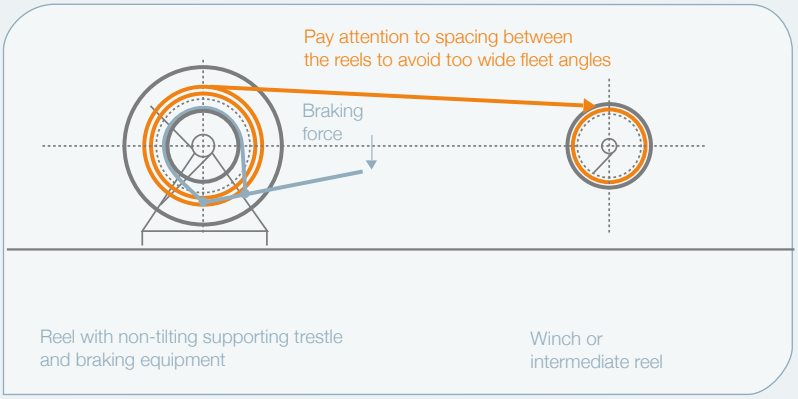
Lifting from the reel or coil opposite the spooling direction will twist the rope

Respooling and spooling

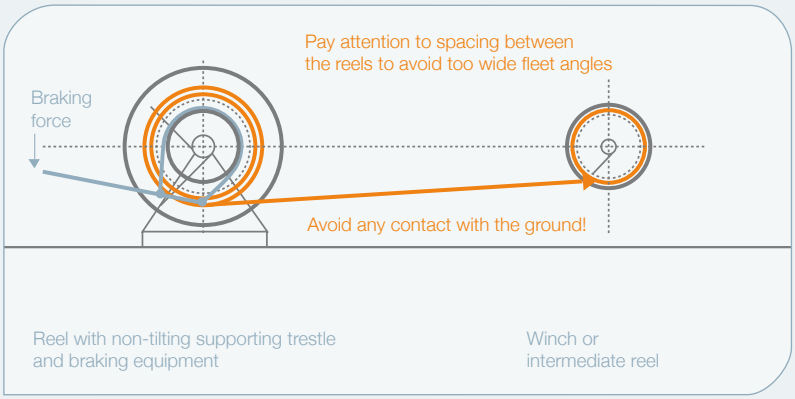
The rope should be respooled or spooled with pretension on the rope. This especially applies to multi-layer spooling.

Watch out for the fleet angle (no more than 10°).

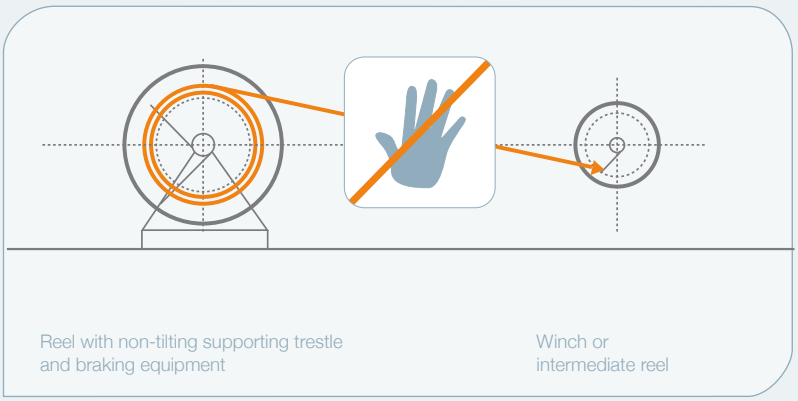
The direction of rope spooling should be retained because opposite spooling directions twist the rope. The rope should not be dragged over the ground, drawn over edges and bent or squeezed between edges.



Same direction of spooling



Same direction of spooling



Opposite direction of spooling

Rope installation

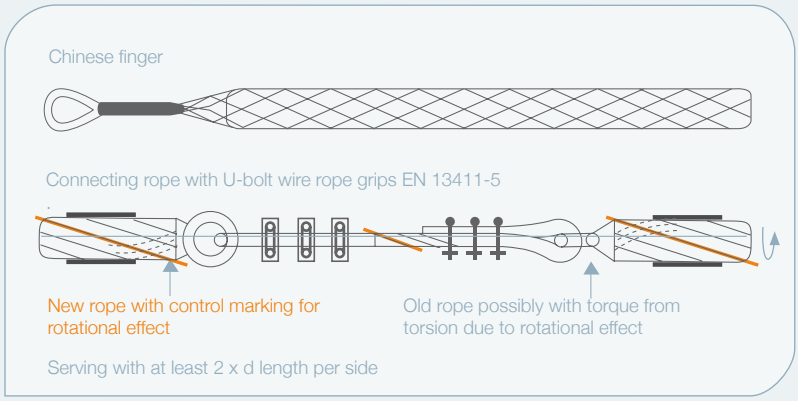
The rope should be installed in accordance with a detailed plan of procedure drawn up by the user and applying the necessary care and occupational safety when installing a rope.

Before installing the rope, check the correct assignment of the rope construction and lay direction in connection with the drum winding and rope reeving system.

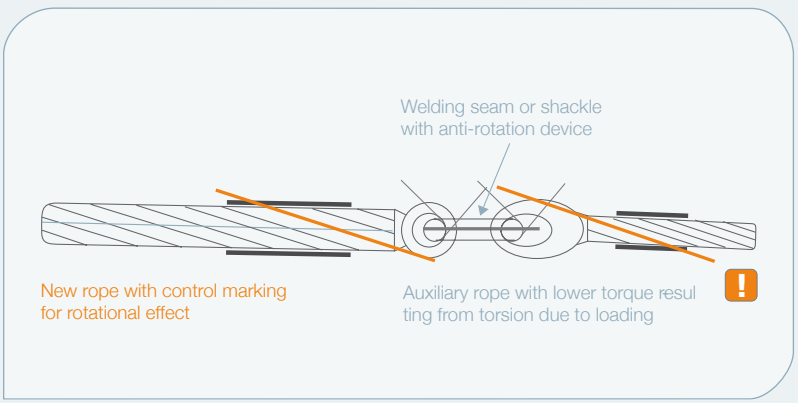
Also check the state and dimension of the rope grooves on the drum and sheaves. Wherever necessary, they have to be smoothed, particularly if the rope construction is changed.

Providing the new rope is pulled in with an auxiliary rope of a thinner diameter, it is necessary to use non-rotating auxiliary ropes or fiber ropes with good non-rotating properties. Providing the new rope is pulled in with the old rope, it is advisable to weld on the rope ends pad eyes or chain links which are joined by wire rope strands or thinner wire ropes. Possible build up twist in the old rope can be absorbed by the connecting strands or the thinner rope during the installation procedure. An often practised solution to connect ropes is the use of the so called "Chinese fingers".

To use the Chinese finger safely and to avoid slippage, the rope ends covered by the Chinese finger should be wrapped with tape in order to increase friction between the rope and the Chinese finger. Either a strand or a thinner rope is used to join the ends.



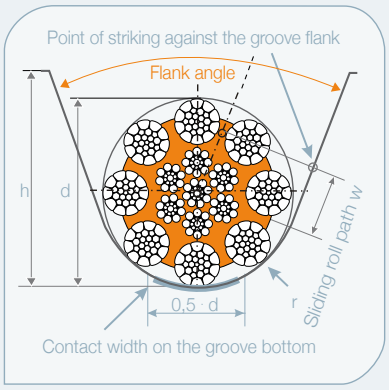
New rope and old rope with the same diameter



Auxiliary rope with a smaller diameter

Wear in the sheave groove

There can be wear from the sliding roll path w in the rope groove at a fleet angle ≤ 4° and on the groove bottom. With reference to the rope diameter *d*, the dimensions of the rope grooves should correspond to $r \approx 0.53 \cdot d$ and $h \approx 1.5 \cdot d$ at the flank angle of ≥ 45°.



Only connect the same directions of lay

Only connect the same directions of lay

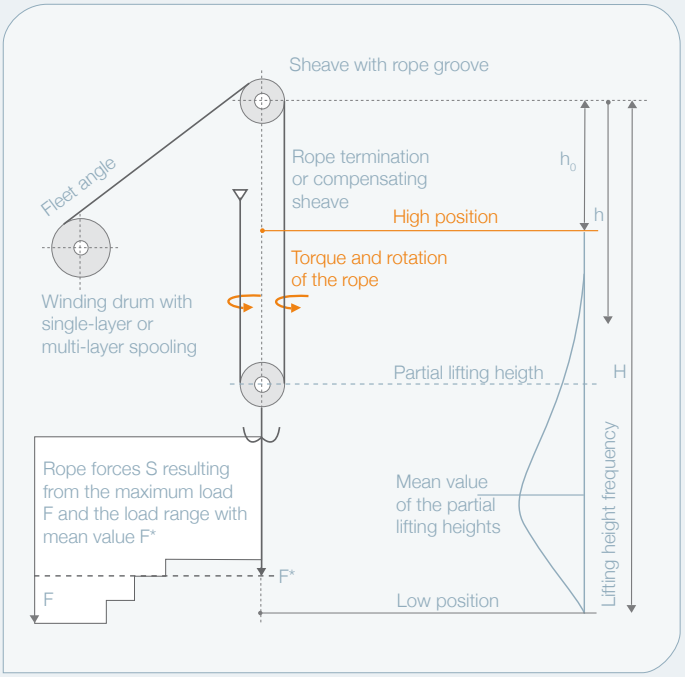
Inspektion

Strain conditions

Wire ropes are wear parts that have to be inspected regularly.

System elements and essential influences

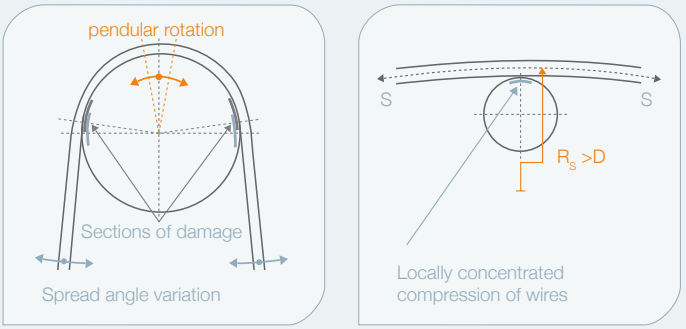
- environmental conditions and high or low temperatures
- properties, load-bearing behaviour and rotational behaviour of the ropes with a rotational effect on the load
- lifting heights, number of rope falls and fleet angle
- winding drums and sheaves with their dimensions and with the material, condition and dimensions of the rope grooves
- one- and multi-layer spooling
- rope torque and fleet angle with a rotational effect on the running rope



An example of a simple rope reeving system

Critical zones

The critical zones of multi-layer spooling are the first rope layers, especially the climbing zones into the next layer and the cross over points. Pendular rotation and/or spread angle variation can quickly damage the rope in non visible sections on compensating sheaves. Locally concentrated compression of wires also lead to premature wire breaks on line rollers.



Compensating sheave (*D/d ≥10)*; line roller (*D/d ≤10)*

Inspection

Daily inspection of visible rope length to control outer damages to the rope such as clearly visible changes in:
- the rope diameter *d*
- the lay length *H*

or if there is occurrence of:
- deformation
- wire breaks
- force being applied

Periodical inspection in compliance with the statutory regulations of the country where it is used, in conformity with the crane classification and taking the critical zones and rope sections in the rope reeving system into consideration.

Periodical inspection
in connection with the load range, the sum of the bending load cycles in the rope section under maximum stress and other critical zones due to lifting frequency, work cycles, useful life and environmental conditions.

Rope sections have to be especially observed
- in case of synthetic sheave grooves
- in the striking zones of compensating sheaves
- in the zone of rope terminations
- on reels with multi-layer spooling

The different positions in the rope, the critical zones or other rope sections under greatest stress in the rope reeving system should also be defined for inspection in keeping with the operational experience.

The load range with the exponential mean value F* and the lifting height frequency with the number of work cycles during the useful life of the rope should be known or recorded for inspection.

Maintenance

Maintenance should be carried out according to the recommendations of the rope manufacturer and the manufacturer of the applied lubricant, considering temperature-, maritime and sea water impacts and /or use of synthetic sheaves.

For relubrication use only lubricants compatible with the originally applied lubricant

Professionally dimensioned wire ropes can be safely discarded by applying the standard discard criterias

Damage to the rope

Outer damage to the rope and visible wire break numbers can be generally identified and evaluated.

Visible broken wires or wire meshings in the strand gaps and reduction in the rope diameter *d* under load are an indication of inner damage to the rope.

Inner damage to the rope and wire break development cannot generally be identified. Professionally dimensioned wire ropes can be safely discarded by applying the standard discard criterias.

Discard criteria following the allowed number of broken wires

Ropes should be discarded not later than at reaching the number of allowed broken wires as mentioned in the table below.

In cranes and hoisting equipment the two generally recognised rules of technology for discard criteria can be applied for verope special wire ropes. Also the operator`s experience and product knowledge and the national regulations have to be taken into consideration.

In some hoisting systems other issues are to be considered, such as: dimensioning rules, operating conditions and specific regulations.

Two methods enable you to estimate the **bending load cycle numbers** by calculation up to visible and non-visible wire break numbers on the rope construction in the critical zones or the rope sections under greatest stress of the rope reeving systems.

The wire break numbers estimated by calculation have to be compared with the acceptable visible wire break numbers from ISO 4309 (Tables 1 and 2) or DIN 15020, page 2 and the damage behaviour in accordance with your application experience during the useful life.

Discard criteria applied on verope special wire ropes

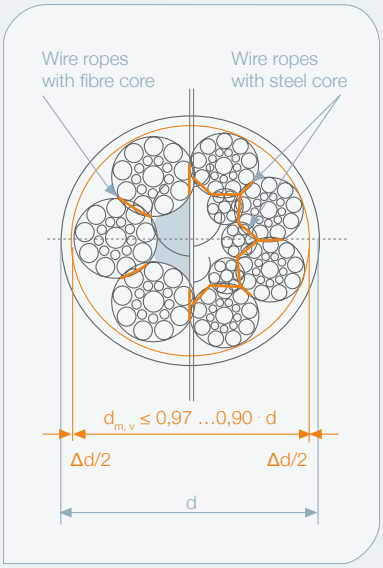
Wire break numbers according to ISO 4309 and DIN 15020, p.2

Number of visible wire breaks which must not be exceeded.

VEROPE special wire ropes						ISO 4309 [2]				DIN 15 020 p. 2			
Name	Characteristics of the outer strands					M1 - M4		M5 - M8[3]		$1E_m$ - $1A_m$		2_m - 5_m	
	Number and type		Strand wires			6.d	30.d	6.d	30.d	6.d	30.d	6.d	30.d
vero **star 8**	8	WS	26	**208**	RL	9	18	18	36	9	18	18	35
ISO - RCN 06					LL					4	9	9	18
vero **pro 8**	8	K-WS	26	**208**	RL	9	18	18	36	9	18	18	35
ISO - RCN 09					LL					4	9	9	18
vero **power 6**	6	K-WS	26	**156**	RL	6	13	12	26	6	13	13	26
ISO - RCN 06 [1]					LL					3	6	6	13
vero **power 8**	8	K-WS	26	**208**	RL	9	18	18	36	9	18	18	35
ISO - RCN 09 [1]					LL					4	9	9	18
vero **top**	16	K-M	7	**112**	LL	2	4	4	8	2	5	5	10
ISO - RCN 23													
vero **top P**	18	K-M	7	**126**	LL	2	4	4	8	3	6	6	11
ISO - RCN 23													

1) ISO 4309 – The assignment to the ISO-RCN number is only approximate
2) ISO 4309 – The wire break numbers may apply to steel grooves or plastic rope grooves and multi-layer spooling (for the rope section under greatest stress); they do **not** apply to plastic rope grooves and one-layer spooling. In this case it is particularly important to watch out for inner damage and non-visible inner wire breaks.
3) The higher wire break numbers only apply if the ropes are used in work or on mechanisms with a known classification according to M5-M8.

Discard criteria for rope diameter reduction



Inner damage to the rope and reducing the rope diameter *d* by *Δd*

Inner damage to the rope can reduce the rope diameter d by *Δd* to $d_{m,v}$.

Reducing the rope diameter *d* by *Δd* to $d_{m,V}$ can indicate inner damage.

Discard criteria without visible and non-visible wire breaks which temporarily also apply to special wire ropes in conformity with ISO 4309:

- diameter $d_{m,V} \leq 0.97 \cdot d$ for low-rotational ropes
- diameter $d_{m,V} \leq 0.90 \cdot d$ for non-low-rotational ropes
- diameter $d_{m,V} \leq 0.93 \cdot d$ just for outer wear

An example of outer wear on Veropro 8 . IWRC is well protected by using the steel-plastic combination production method

verope special wire rope are , due to the unique steel/ plastic combination, more resistant to inner rope damage

The plastic coating of verope special wire ropes substantially reduces the inner compression between the wires of the strands and steel core.

The wires of the compacted outer strands distribute the compression more evenly in the zone of inner wire contact. The strand gaps are filled with plastic.

The inner wire contact from compression and wear on the plastic coating only begins after longer usage in contrast to ropes without plastic coating. The inner wire contact with notches and wear can reduce the diameter *d* by *Δd* to the wear diameter $d_{m,V}$.

Change in lay length due to the rotational effect

The rotational effect during rope installation or in the rope reeving system can measurably change the lay length *H* of the rope.

Untwisting results in wire loosening with Lang‘s lay and in loosening of the outer strands on ropes with a steel core.

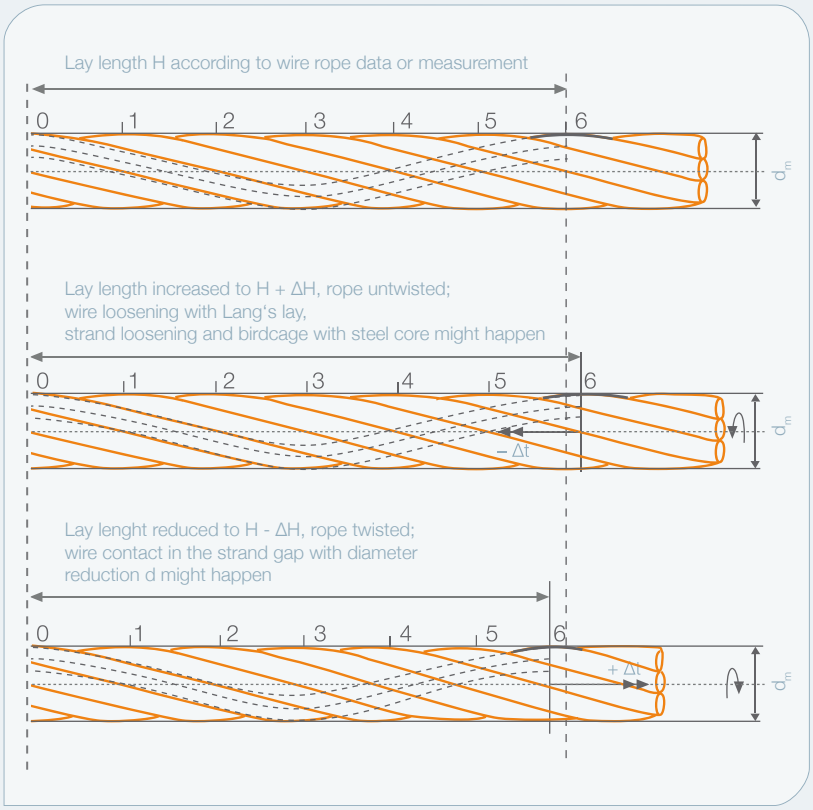
The load-bearing behaviour is changed after loosening of the outer strands. The rope force is only carried by the steel core that can be damaged quickly.

Induced twist reduces the strand gap spacing and can cause strand blocking and , in case of ordinary lay, wire loosening.

The steel core can be compressed. This disturbs the run in the rope reeving system.

The change *ΔH* in lay length facilitates wave development.

Measure the lay length during the inspection



One-layer round strand rope with 6 strands as an example for the change ± *ΔH* due to the rotational effect ± *Δt*

Discard criteria for wave development

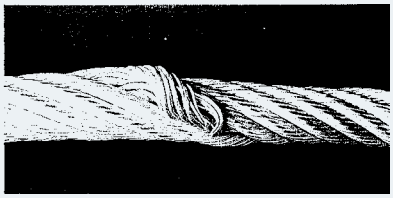
Wave development may be caused by the rotational effect in the rope reeving system.

"Corkscrew" can develop if there is no longer radial support for the strands of one-layer strand ropes after damage to the core. The rope force is largely shifted to the withdrawn strands.
= discard criteria

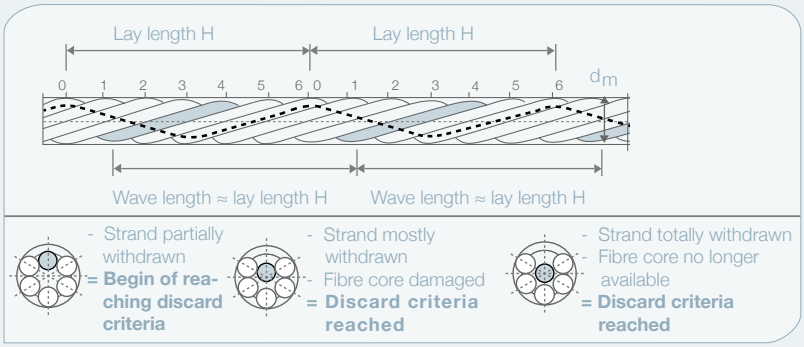
Birdcage deformation can develop during handling & installation, caused by concentrated buildup twist in sections of the rope system which did little work. The load is shifted to the strands of the core. Wave height $d_1 > 4d/3$ without rolling-over and $d_1 > 1.1d$ with rolling-over
= discard criteria ISO 4309

Compressed steel core can occur by twisting in connection with the "birdcage", primarily in strand ropes with parallel lay.
= discard criteria

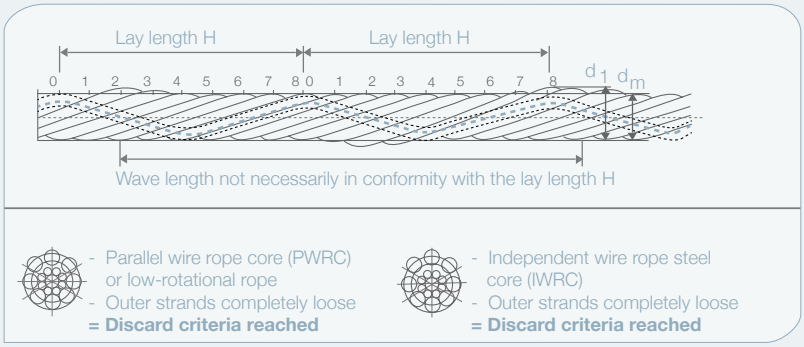
Loosening of the outer strands



Upsetting of the steel core



"Corkscrew", primarily in wire ropes with fibre core



"Birdcage" might happen in wire ropes with a parallel wire rope core (PWRC) or in low-rotational ropes, also with an independent wire rope steel core (IWRC)

Corkscrew changes the load-bearing behaviour

The rope force is only carried by the steel core

Basic literature:

Jehmlich, G.: ”Anwendung und Überwachung von Drahtseilen. VEB Verlag Technik Berlin 1985.”

Feyrer, K.: ”Drahtseile. Bemessung, Betrieb, Sicherheit. Springer - Verlag Berlin Heidelberg 1994 and second revised and enlarged edition 2000.”

Personal experience from work and publications as well as descriptions in company publications of the competition.

Abbreviated reference to basic standards:

EN 12385-1 to -4; ”Steel wire ropes; Safety; ...”

EN 13411-5; „Terminations for steel wire ropes; Safety; Part 5: U-bolt wire rope grips”

DIN 15020 page 1 and page 2; ”Lifting appliances; basic principles for rope reeving components; ...”

FEM 9.661:06; ”Berechnungsgrundlagen für Serienhebezeuge; Baugrößen und Ausführung von Seiltrieben.”

ISO 4309; ”Cranes; wire ropes; care, maintenance, installation, examination and discard.”

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