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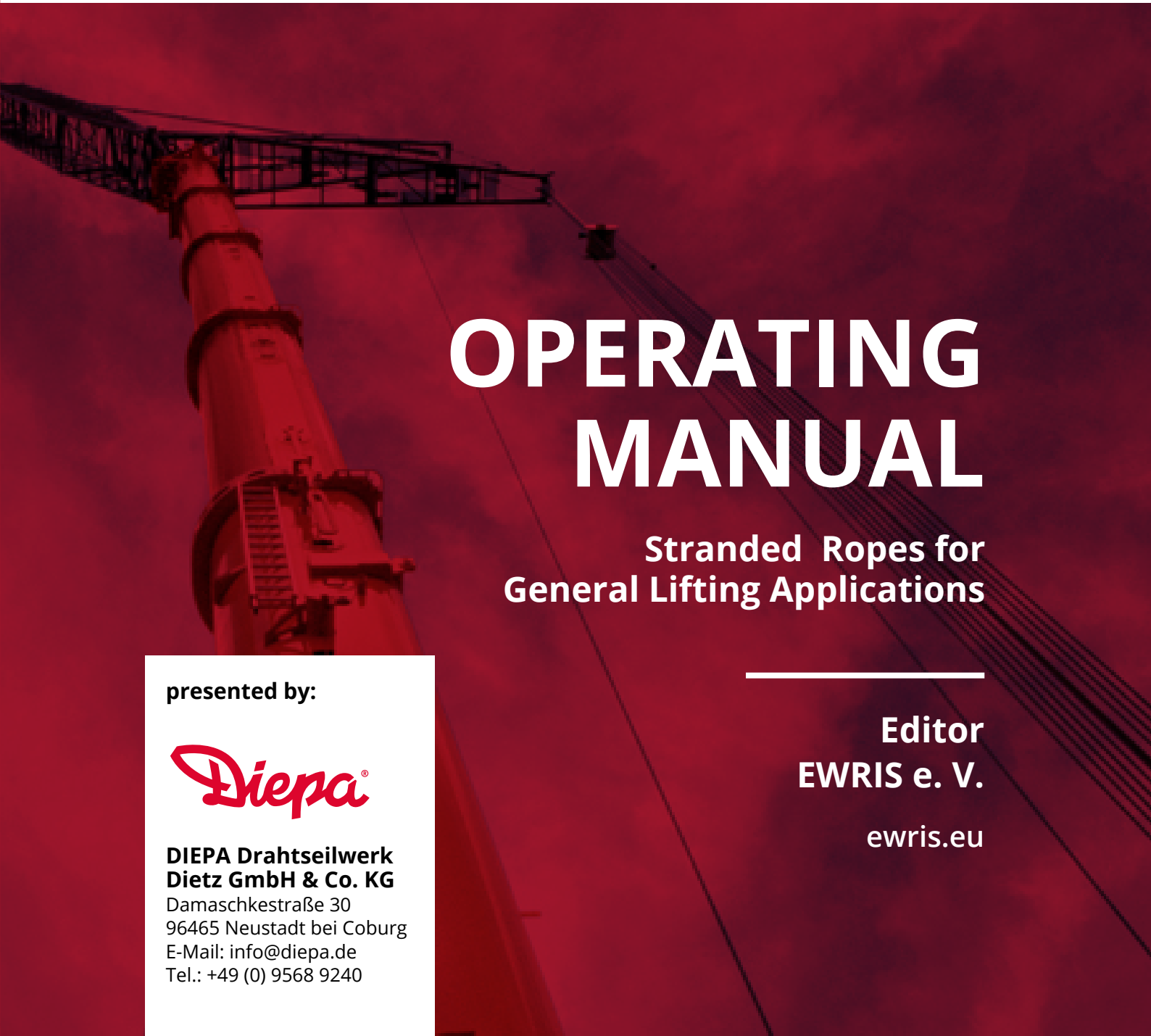
European Federation of Steel Wire Rope Industries



OPERATING MANUAL

Stranded Ropes for General Lifting Applications

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Original User Manual: Stranded Ropes for General Lifting Applications according to DIN EN 12385 – 4 according to Machinery Directive 2006/42/EC

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The present document is the product of a collaborative effort by the EWRIS member companies and subject to regular updating. The copy available for download on the EWRIS website is the most recent version of this document.

Inhalt

Legend of symbols

DANGER! Dangerous situation with immediate or imminent threat of loss of life or bodily injury if not avoided.

CAUTION! Dangerous situation with threat of damage to property if not avoided.

NOTE! Useful information and tips for use.

Use safety eyewear

Use safety helmet

Use safety gloves

Use safety shoes

Introduction

This document defines principles applicable to the handling, maintenance, inspection, and discard of steel wire ropes employed used on cranes, winches, and hoists in commercial use scenarios.
This information is provided without prejudice to any farther-reaching national regulations and laws which must still be complied with.

General safety instructions

DANGER! Always wear work gloves when working with ropes due to the risk of injury from wires and possible skin irritation caused by lubricants.
In addition, always wear a safety helmet, safety shoes, and safety goggles to avoid injuries.

Definition of a Competent Person

A Competent Person for the handling, maintenance, and inspection of wire ropes is someone who, due to his or her training, experience, and recent professional practice, has the relevant specialist knowledge and expertise needed to handle and inspect wire ropes.

1. Intended use

The ropes covered by this User Manual are stranded ropes used as hoist ropes, luffing ropes, trolley ropes, mounting ropes, auxiliary ropes, pendants, and stay ropes in commercial applications on winches, cranes, and hoists.

Their use as stranded ropes in elevators, as ropes for shaft hoisting systems and mining shafts, as track ropes and hauling ropes on ropeways for passenger transportation, as well as stationary ropes in buildings is not covered by the scope of this User Manual.
If, in the case of ropes installed in equipment, the specifications given in the equipment manufacturer's user manual deviate from the information provided herein, the equipment manufacturer's specifications shall apply in case of doubt. To resolve such discrepancies, we recommend contacting the respective equipment manufacturer.

The rope manufacturer refuses to accept any responsibility and product liability for any other than the intended use.

2. Rope selection

DANGER! The selection of a non-recommended rope or failure to observe the selection criteria may result in rope failure or serious operational disruptions. Rope breakage can result in death or serious injury.

NOTE! The selection of a non-recommended rope or failure to observe the selection criteria may impair the performance of the rope and shorten its service life.

The rope designs selected in cooperation with the equipment manufacturer and the required rope properties have been defined in accordance with the applicable standards and regulations. In the case of ropes of equivalent standard, changing the rope structure, the number of strands, or the wire strength can bring about significantly varying performance characteristics in use, e.g., with regard to the spooling behavior in multi-layer spooling systems. The choice of rope depends largely on the intended use and the basic properties required for such use.

This applies in particular to requirements in terms of abrasion and wear, surface treatment, lay direction and construction, rotational properties, as well as properties specifically required for the application, such as rope diameter tolerances, elongation, lateral pressure stability, etc.

Due to the large number of selection criteria, it is always advisable to opt for the original replacement rope when replacing a rope. If an alternative wire rope is to be installed, this must be done in consultation with the equipment manufacturer and/or the rope manufacturer.

2.1. Classification of wire ropes according to their intended use

- **Running ropes:** Ropes that are running over sheaves and/or are spooled onto drums (e.g., hoist ropes and luffing ropes)
- **Stationary ropes:** Ropes that are mostly fixed in a stationary manner and not moved over sheaves (e.g., pendants for booms)
- **Track ropes:** Ropes on which rollers of conveyance means are running (e.g., track ropes for cable cranes)

2.2. Classification of wire ropes according to their properties

Rotational properties:
- **High-performance rotation resistant rope:** typically ropes with 15 outer strands and more, in accordance with EN 12385-3:2021-08, Annex B.5, Category a)
- **Rotation resistant rope:** typically ropes with 11 to 14 outer strands or ropes with 3 or 4 strands, in accordance with EN 12385-3:2021-08, Annex B.5, Category b)
- **Non-rotation resistant rope:** typically ropes with 6 to 10 outer strands, in accordance with EN 12385-3:2021-08, Annex B.5, Category c)

Minimum breaking force:
- depends on the nominal rope diameter, the wire's tensile strength, the fill factor, and the spinning loss factor
- must meet at least the specification of the hoist equipment manufacturer

Lay type, lay direction:
- left-hand Lang lay (sS; alternatively also LHLL)
- right-hand Lang lay (zZ; alternatively also RHLL)
- left-hand ordinary (regular) lay (zS; alternatively also LHOL/LHRL)
- right-hand ordinary (regular) lay (sZ; alternatively also RHOL/RHRL)

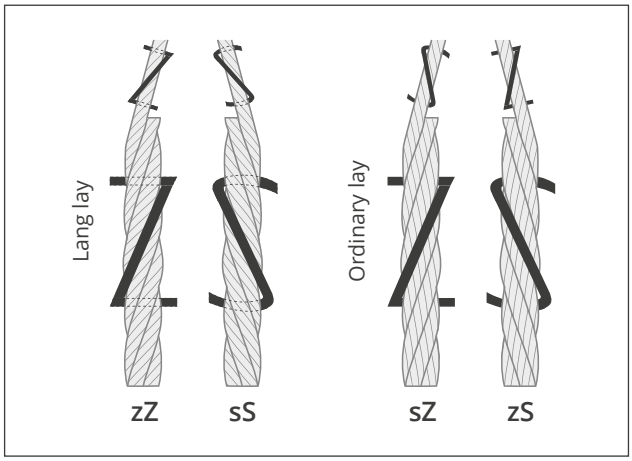


Fig.: Identification of lay type/lay direction

Rope core:
- fiber core FC (natural fiber core NFC, synthetic fiber core SFC)
- wire strand core WSC
- wire strand core with intermediate polymer layer EPWSC
- independent wire rope core IWRC
- parallel wire rope center
- independent wire rope core with polymer cover EPIWRC
- parallel wire rope center with intermediate polymer layer EPPWRC

Other properties:
- compaction (no compaction, strand compaction, and/or rope compaction)
- outer plastic cover of the rope
- rope lubricant and preservative

Surface finish / wire material:
- non-galvanized (surface finish U, to EN 12385-2)
- galvanized (galvanization classes A – D, to EN 10244-2)
- special coating (zinc alloy, zinc coating classes A and B, to EN 10244-2)
- stainless steel

3. Before the first installation of the rope

3.1. Inspection of rope and documents

The rope must be unpacked and inspected immediately after delivery. If damage to the rope or the packaging is found, this must be reported and noted on the delivery documents. It must be checked whether the delivered goods are in compliance with the order and the documentation, in particular with regard to diameter, length, rope end terminations, lay type, lay direction, and minimum breaking force. The documentation must be checked for completeness. Any deviations must be documented and reported immediately.

The Manufacturer's Declaration must be kept in a safe and accessible place, e.g., together with the crane manual, so that the rope can be identified when regular thorough inspections are carried out during operation.

3.2. Transport and storage

Depending on their diameter and length, ropes are transported:
- as a coil on a pallet or in a lattice box,
- wound up on a reel, lying on a pallet or in a lattice box, or
- wound up on a reel, standing on a frame.

In all cases, it must be ensured that the cargo is secured properly in transport. For this purpose, the instructions contained in applicable standards, regulations, and directives must be observed. In general, damage to the rope must be prevented if lashing means come into direct contact with the rope, e.g., when the reel is standing in an upright position.

Fig.: Transport of reel

In order to avoid accidents and damage, ropes must be unloaded with care. The rope reels or rope coils must not be dropped, and the rope must not be in direct contact with a metal hook or the fork of a forklift truck.

Damp packaging materials, e.g., sackcloth, or damp transport packaging materials, e.g., wrapping foil, must be removed immediately after delivery to avoid corrosion caused by condensation.

A clean, well-ventilated, dry, dust-free, and roofed place free from the detrimental effects of chemical vapors, water vapor, or other corrosive substances must be chosen for storage. Wire ropes must not be stored in areas that are permanently exposed to elevated temperatures above +40 °C, as this could have a detrimental effect on their properties.

The rope must be covered with a waterproof material if exposure to weather influences cannot be ruled out. The rope must not come into direct contact with the ground and with possible covering materials, and the reel must be stored in a way that allows air to pass underneath it.

If this is not ensured, the rope may become contaminated with extraneous substances, and corrosion may set in, even before the rope is put into service.

The rope must be stored and protected in such a way that it will not be accidentally damaged during storage, when being put into storage, or when being retrieved from storage. Rope reels must preferably be stored in a reel rack which must be placed on stable ground.

The stored rope must be inspected at regular intervals. In ambient temperatures above 25 °C, the rope must be rotated by 180° around the horizontal axis every three months in order to keep the lubricant from draining out. If there are signs of incipient corrosion, such as changes in color or flash rust, a suitable relubricant must be applied immediately to the affected areas. Such a relubricant must be compatible with the primary lubricant used during manufacture; if in doubt, consult the rope manufacturer / rope supplier. Incompatible relubricants may cancel out the effect of the primary lubricant used by the manufacturer and, as a consequence, have an adverse impact on the rope's properties.

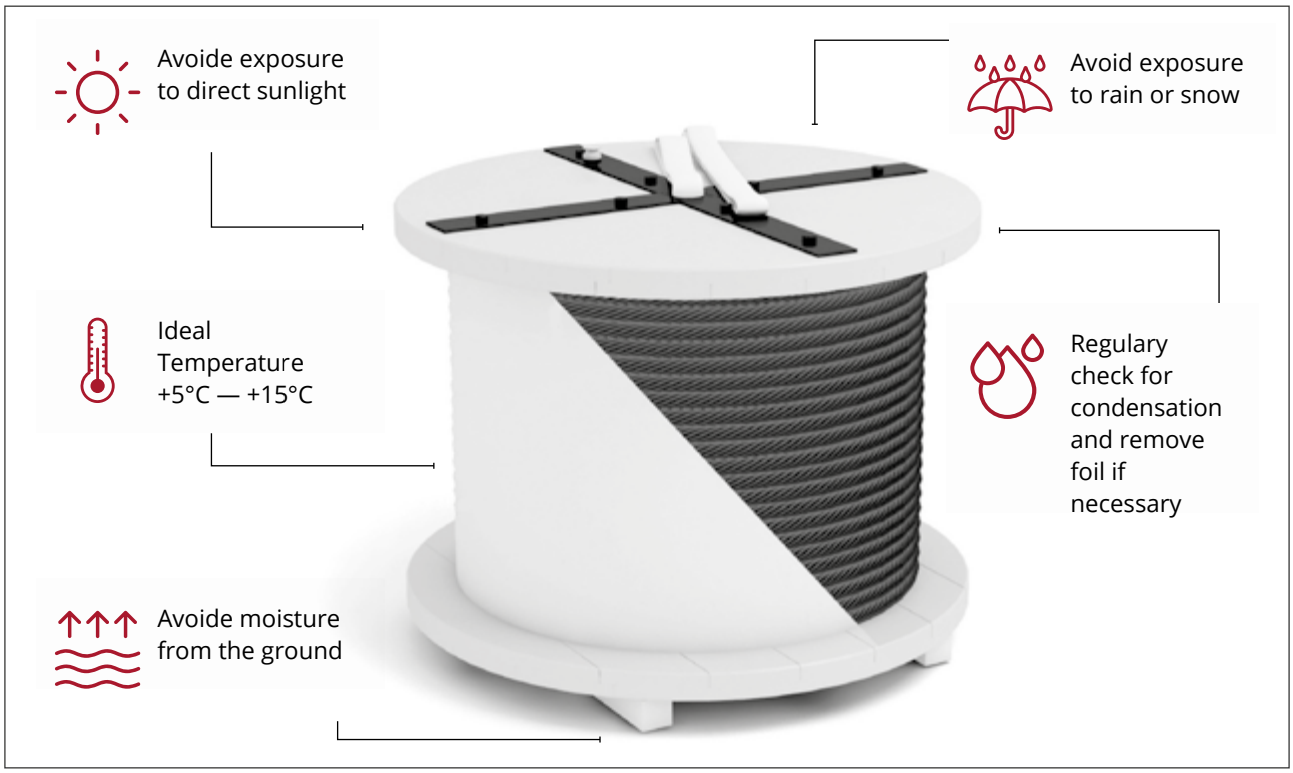


Fig.: Proper storage

For storage periods of more than 5 years, the rope manufacturer/supplier must be consulted as to whether relubrication is required prior to installation.

It must be ensured that the original rope marking remains legible and undetachably affixed until the rope is installed in order to ensure its traceability and identifiability at all times.

If ropes are dismounted after use in order to be used again later, they must first be checked for their suitability for use in accordance with the specifications set forth in chapter 8. Prior to their storage, the ropes must be cleaned thoroughly and relubricated in accordance with the specifications set forth in Chapter 6.1. The storage is carried out according to the above-described conditions. The ropes must be traceably marked for future identifiability.

4. Rope installation

DANGER! Ropes, cords, straps, and the like that are used to secure the rope ends on the inside and outside of a reel are intended solely as means for securing the rope in transport and must be disposed of after unpacking. They must never be used as auxiliary means for pulling the rope during rope installation.

DANGER! Ropes packaged on a reel or as a coil are under tension. Rope ends whipping around can cause severe bodily harm. The means securing the outer and inner rope ends in transport may only be released in a controlled manner.

DANGER! Packaging materials, cable ties, strapping (steel or plastic), and other fixing cords are not suitable for use as load-carrying means, attachment or pulling points, but shall be used exclusively to package the ropes or secure them in transport.

DANGER! The working load limit of pad eyes must not be exceeded.

NOTE! The installation of the rope must be carried out by a competent person who is adequately qualified due to his or her knowledge and experience and has been provided with the necessary instructions to ensure that both the procedural steps required by the equipment manufacturer and those described below are carried out correctly.

NOTE! The inspection of the rope and rope drive elements to be performed before the rope is put into service for the first time may only be carried out by a competent person.

NOTE! It is indispensible to observe the instructions contained in the user manual of the equipment/system/machine when installing the rope, and to ensure its correct matchup with the relevant application.

4.1. Check of rope diameter

Before installing the rope, it is necessary to check its diameter and compare it with the equipment requirements. The diameter must be measured in an unloaded state. For the measurement, the rope must be straightened. The measurement is conducted at two measuring points which must

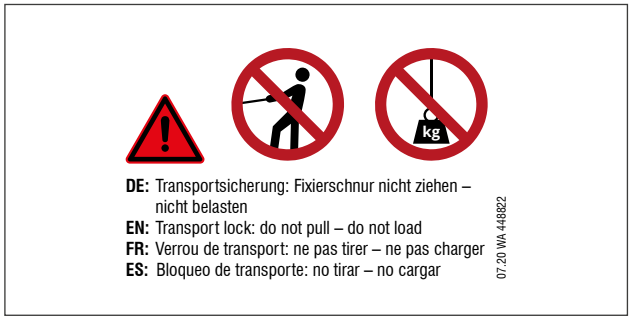


Fig.: Warning label Transport lock

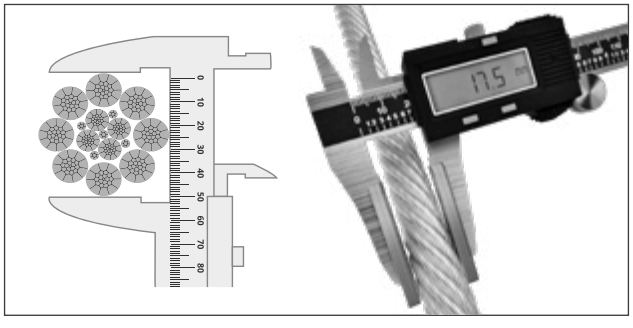


Fig.: Diameter measurement by means of a caliper gage with wide jaws

be 1 m apart and at least 2 m away from the rope end. At each measuring point, both the minimum and the maximum diameter of the circumference [FIG.] must be measured, regardless of their position relative to each other. Prior to this measurement, the measuring tool is set to zero, then applied to the rope with minimal pressure, whereupon the rope diameter is read and recorded.

NOTE! Generally, the measuring tool should be applied in a way that allows measuring across several outer strands. The use of caliper gages or measuring brackets with wide jaws has proven highly practical in this context.

The new rope's diameter determined in this way serves as reference (acc. to ISO 4309) for the future determination of the decrease in diameter, see Chap. 8.3.

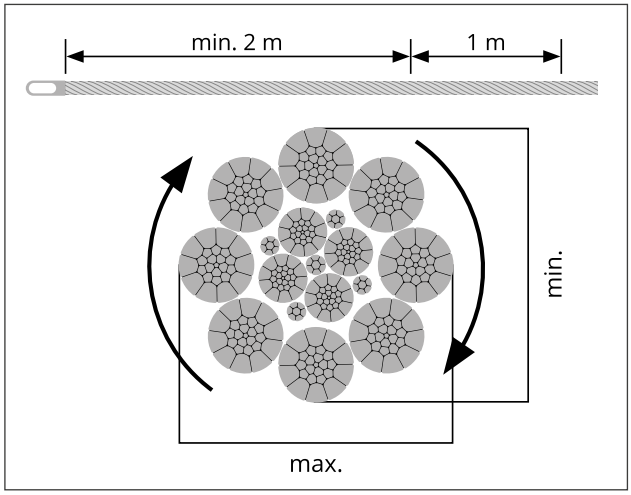


Fig.: Measuring points for diameter measurements on a new rope

4.2. Inspection of all rope drive components in contact with the rope

Before installing the new rope, the condition and dimensions of all components in contact with the rope, e.g., drum, sheaves, guide elements, and rope guards, must be inspected in order to ensure that they are within the defined operating limits and fully functional. For steel wire ropes, the actual groove diameter of the drum and the sheaves should be 5% to 10% greater than the rope's nominal diameter. In any case, it must be greater than the actual diameter of the rope.
The groove diameter must be measured by using a suitable gage. In this process, it is important to make sure that the outer diameter of the gage matches the printed-on value.

NOTE! Gages that already include the oversize tolerance for the nominal rope diameter are not suitable for measuring the groove diameter.

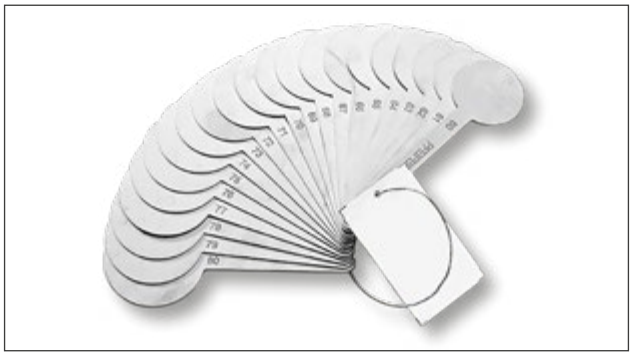


Fig.: Groove gages

NOTE! Wear on sheaves becomes manifest in the form of reduced groove diameters and/or of impressions of the rope profile in the groove. In both cases, the functionality of the rope will be impaired and the service life of the rope will be reduced significantly. Worn sheaves can cause damage to the rope even within a short period of time.

If the groove diameter is reduced, the rope will be crushed at its sides, the movement of strands and wires will be restricted, and the bendability of the rope will be reduced. In addition, with rotation resistant and high performance rotation resistant ropes, the internal torque balance will be disturbed, and the occurrence of rotation-related abnormalities such as birdcaging or corkscrew deformations or twisting of the hook block will be provoked. Negative impressions of the

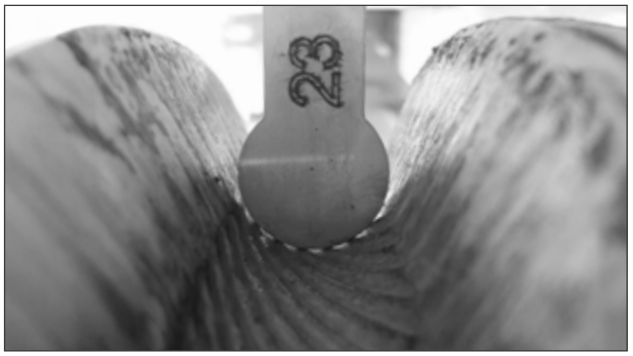


Fig.: Clearly visible impressions of a negative rope profile

rope profile cause interlocking between the rope and the sheave. This can also provoke the occurrence of rotation-related abnormalities or structural changes in all rope types.

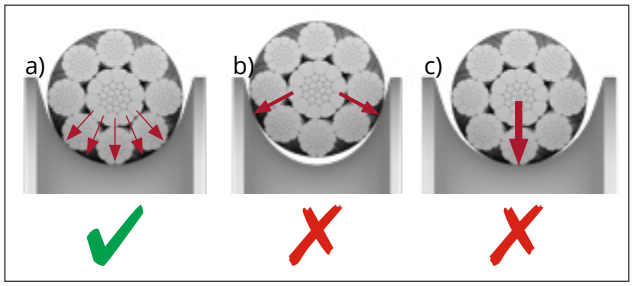


Fig.: Reduced groove diameter of a sheave
a) No space between groove and gage ▸ groove diameter
b) Space underneath the gage ▸ use smaller gage
c) Gage touches only bottom of the groove ▸ use bigger gage

The bearings of the sheaves and guide rollers must be checked for ease of movement. Sluggish or jammed bearings must be repaired.

All guide rollers and fixed rope-guiding components must be checked for mechanical damage (e.g., abrasion marks, impressions of rope profile). Damaged components must be replaced or repaired.

Wear on rope drums manifests itself in the form of a reduced groove diameter and mechanical damage. The consequences of a reduced groove diameter are comparable to those observed on sheaves. On drums with multi-layer spooling, wear can occur on the flange, e.g., in the form of abrasion marks, scouring.

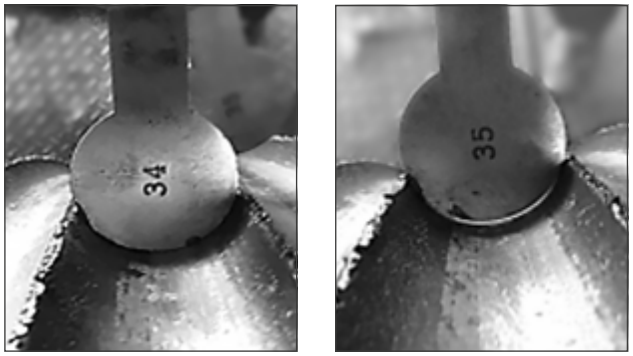


Fig.: Reduced groove diameter on a drum

DANGER! In addition to increased rope wear, wear on drums can also result in spooling problems. In extreme cases, this may eventually cause rope damage up to rope breakage, or it may cause the load to fall.

Fig.: Wear on a drum flange

Worn rope drive elements must be repaired or replaced before installing the new rope.

NOTE! The discard criteria for rope drive elements provided by equipment or component manufacturers must be observed.

4.3. Observing the drum rule and the reeving rule

When installing ropes, in particular on single-layer rope drums, it is essential to ensure that the rope and the drum have the correct type of lay direction in order to prevent rotational damage to the rope.

Unless otherwise specified in the equipment manufacturer's instructions, the lay direction of ropes for single-layer rope drums is determined according to the following rule:
The thumb points to the spot where the rope is fastened, the index finger points in the direction of the rope running off the drum.
In case of lifting applications that include two or more winches and ropes with different lay directions (e.g., a crane with two hoist gear units), particular attention must be paid to the correct allocation of the two ropes with different lay directions to the winch drums.

NOTE! Please refer to the illustration on the next page.

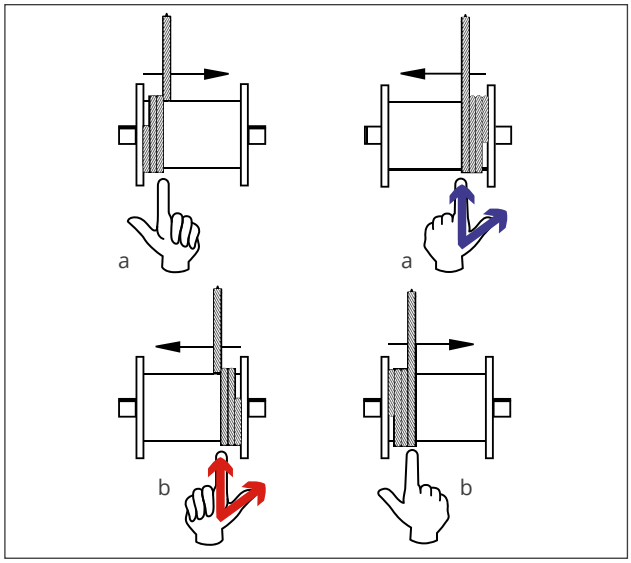


Fig.: a) left hand = left-hand rope needed
Fig.: b) right hand = right-hand rope needed

In the case of lifting applications with two or more winches with multi-layer spooling, the ropes with different lay directions must be allocated in accordance with the instructions of the equipment manufacturer.
Unless otherwise specified in the equipment manufacturer's instructions, the rope's lay direction for cranes including winches with multi-layer spooling is determined as a function of the reeving direction, according to the following rule:

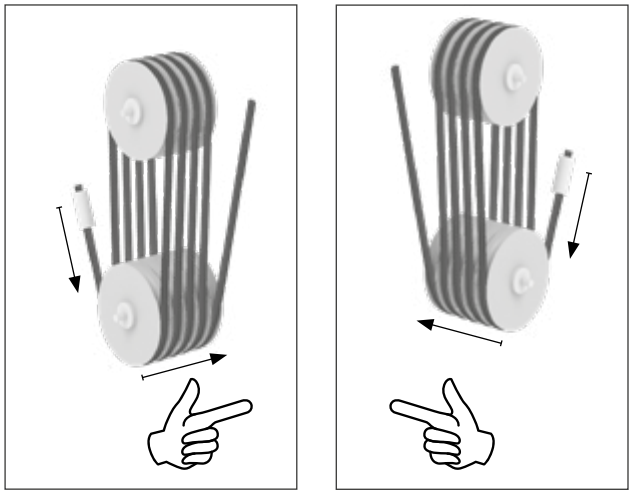


Fig.: Right- and left-hand reeving on mobile crane

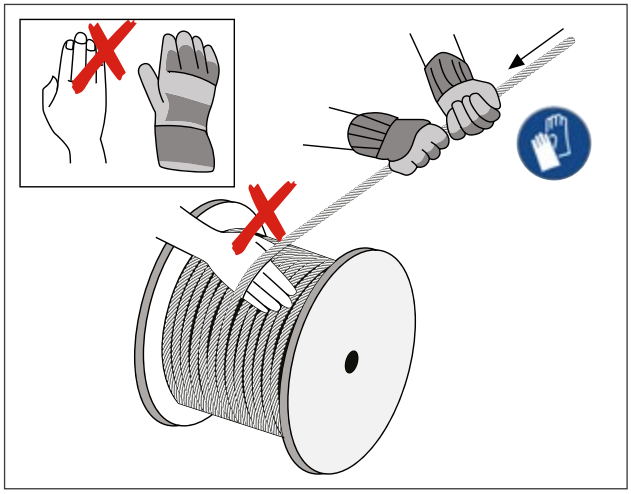
The thumb points to the spot where the rope is fastened, the index finger points in the direction of the rope exiting the reeving system.

4.4. Spooling of rope

DANGER! Ropes packaged on a reel or as a coil are under tension. Rope ends whipping around or loose windings can cause severe bodily harm. The means securing the outer and inner rope ends in transport may be released only in a controlled manner.

DANGER! When working with running ropes, there is a risk of getting pinched between the rope and elements of the rope drive. A sufficiently safe distance from the hazardous areas must be maintained. Failure to do so can lead to serious injuries.

NOTE! When spooling ropes, twisting and external damage must be avoided in order to ensure a trouble-free and safe operation.



DANGER! When unfastening the outer end of the rope from a reel or coil, it is essential to proceed in a controlled manner. When unfastening the bindings or the rope end attachment, the rope will want to straighten itself. Uncontrolled, this process can lead to injuries.

DANGER! When reaching the inner end of the rope of a reel or coil, it is necessary to reduce the spooling speed of the rope to avoid the uncontrolled release of the rope end. Failure to do so may result in injury.

4.4.1. Ropes supplied as a coil

Ropes supplied as a coil must be rolled out straight. Make sure that the rope is not contaminated with dust, sand, moisture, or other detrimental substances.

Never pull the rope away from a coil placed in a horizontal, lying position. Otherwise, this will cause the rope to be twisted and form kinks.

If the rope coil is too heavy to be uncoiled by hand, it must be uncoiled using a turntable. The correct procedures for uncoiling the rope from a coil are shown in Fig.

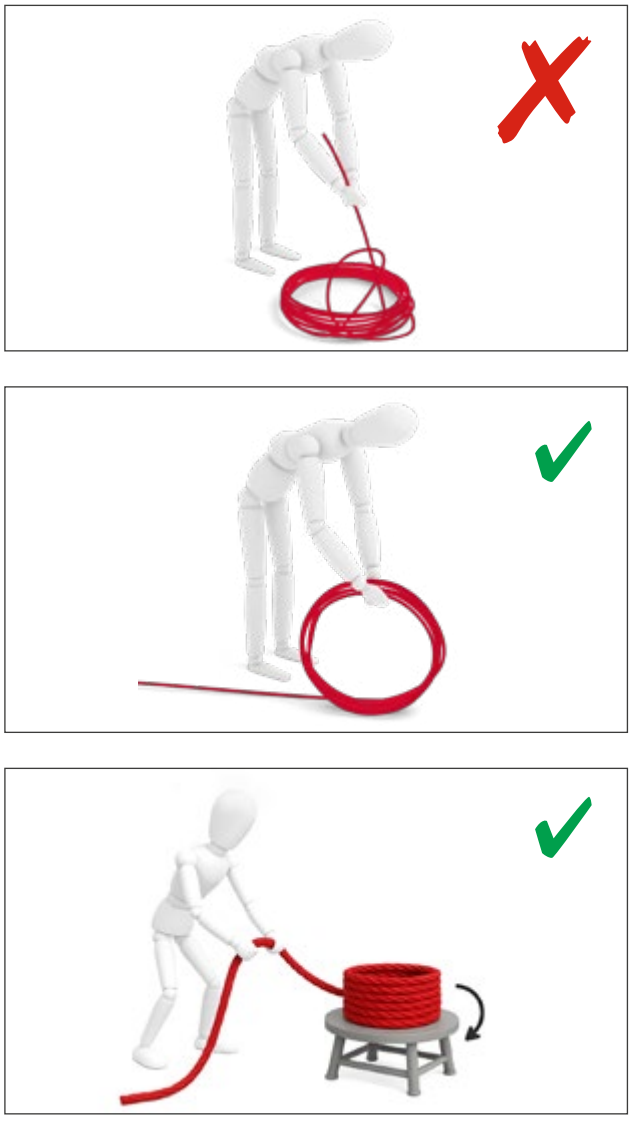


Fig.: Handling of rope coil

4.4.2. Ropes supplied on a reel

NOTE! Reels might have suffered damage during transport and storage. It must be ensured before work, that material and connections are in proper condition.

NOTE! When spooling from the reel, pre-tension of the rope must be limited to avoid damage of the reel.

Rope reels must be mounted on a suitable rack on which the rope can be unwound. A mechanism must enable braking the reel in order to:

- prevent the reel from running on in an undesired manner when the spooling process is interrupted;
- brake the rope while it is spooled onto the drum in order to ensure compact spooling.

Ensure that a perfectly regular spooling pattern is achieved on the drum.

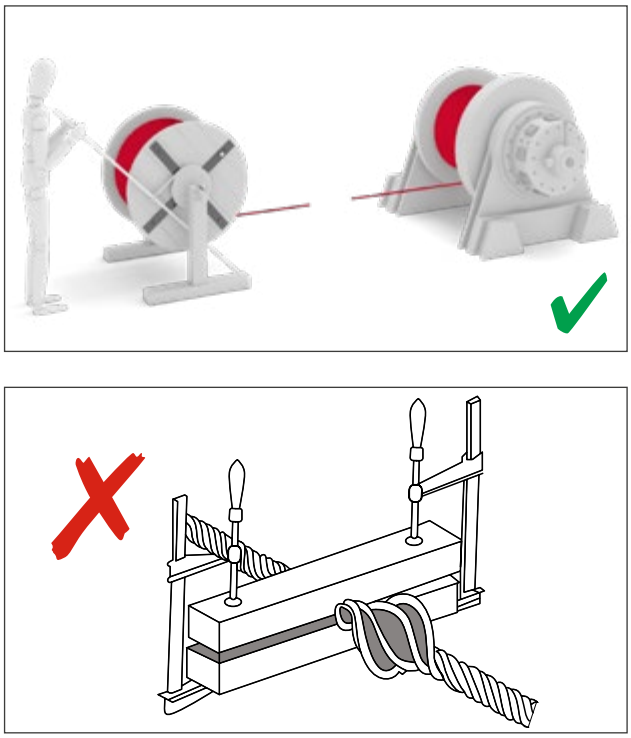


Fig.: Pretensioning on the reel

NOTE! see figure on following page.

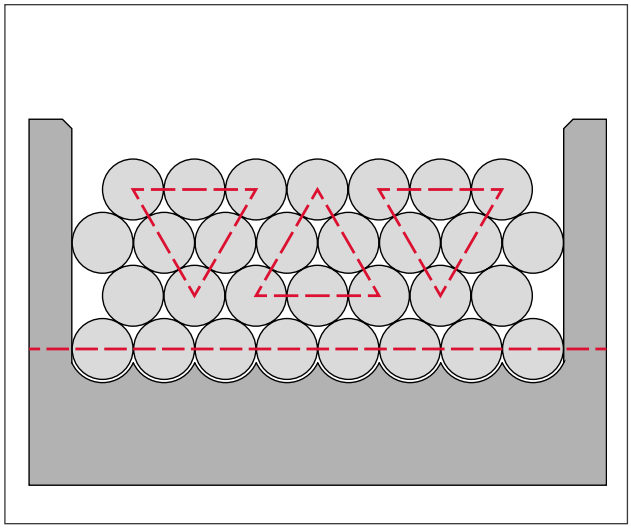


Fig.: Regular spooling pattern (single-layer/multi-layer)

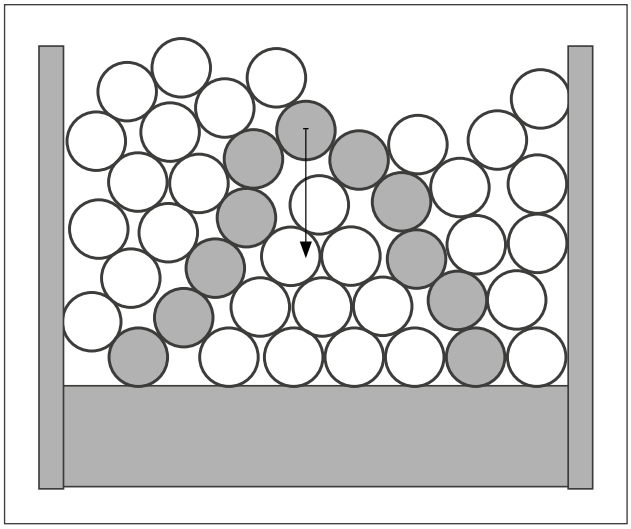


Fig.: Irregular spooling pattern

When spooling

- from a reel onto a drum
- from a reel onto a second reel
- from a reel to a deflection sheave

it is requisite to ensure a minimum distance (L) in order to limit the maximum fleet angle α of the rope during the spooling process. The following reference limits apply to the maximum fleet angle α:

- for non-rotation resistant ropes: α ≤ 4°
- for rotation resistant ropes: α ≤ 2°

Failure to observe these limits can cause damage to the rope during installation in the form of twist damage or structural changes, or lead to twist-related malfunctions.

For typical drum/reel widths, the following minimum distances apply as reference values:

Rope diameter	Minimum distance (L) to 2nd reel/drum	Minimum distance (L) to deflection sheave
up to 10 mm	6 m	3 m
up to 16 mm	10 m	5 m
up to 25 mm	18 m	9 m
up to 32 mm	30 m	15 m

It must be ensured that no counter-bending occurs when spooling the rope, i.e., if the rope is wound onto the drum from above, the rope must also run off from the top of the reel.

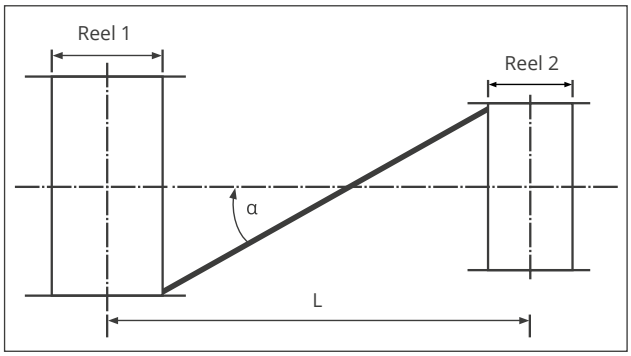


Fig.: Distance between reel 1 and reel 2

NOTE! Please refer to the illustration on the next page.

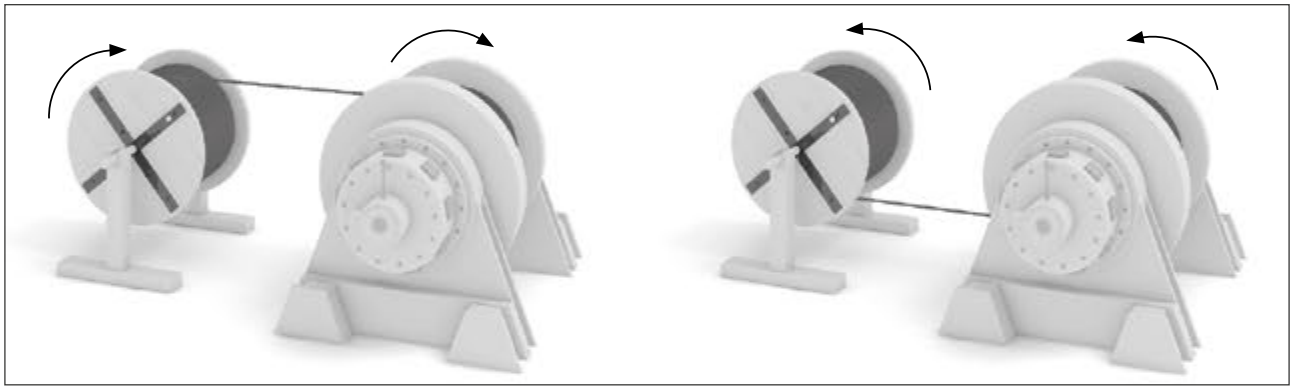


Fig.: Reel-to-reel spooling

4.5. Attaching the rope to the drum

The end of the rope is to be attached to the drum in accordance with the equipment manufacturer's instructions. The safety windings as specified by the equipment manufacturer form part of the attachment system and must never be unspooled during operation.

4.6. Pulling the rope into a rope drive system

While pulling it into the rope drive, the rope must be monitored carefully. It must be ensured that the rope is not hampered by building or machine parts that could damage the rope. If there exists the possibility of the rope rubbing against parts of the crane structure while being pulled into the rope drive, such points of potential contact must be

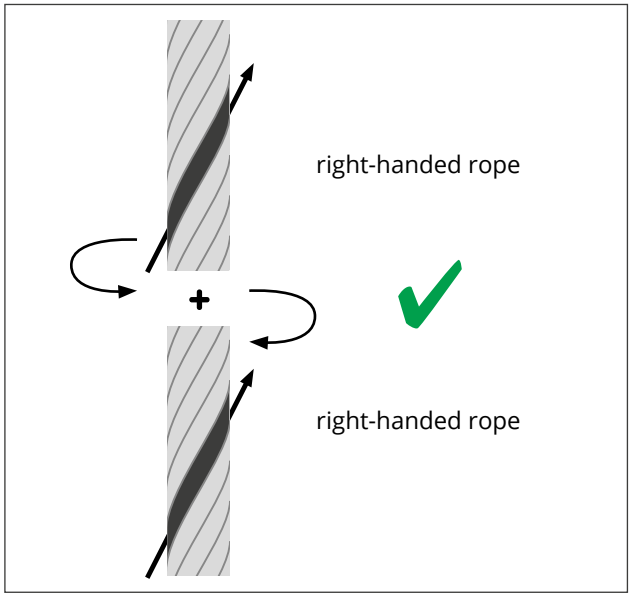


Fig.: Old and new rope with the same lay direction

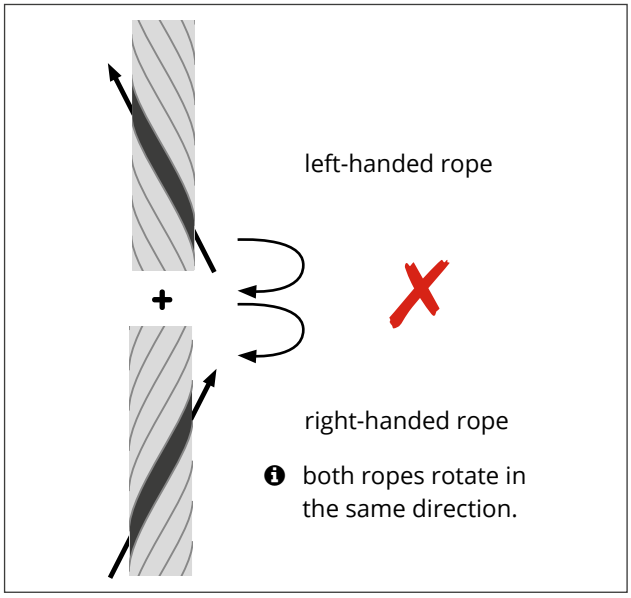


Fig.: Old and new rope with opposite lay directions

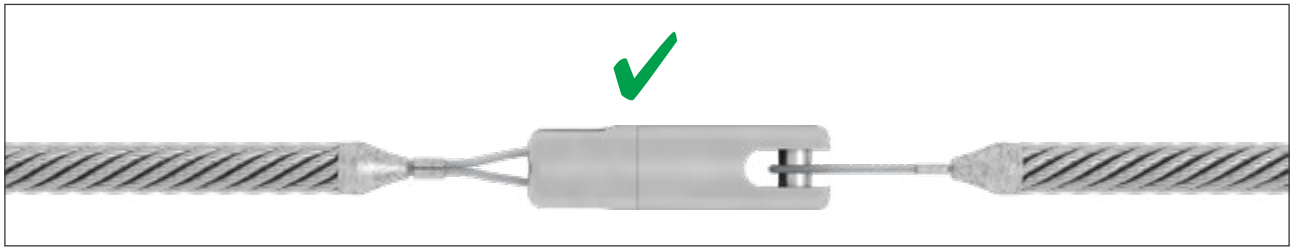


Fig.: Connection with swivel

protected in a suitable manner. Failure to do so can result in a significant loss of service life or even in the necessity of discarding the rope before first use. When pulling the rope into a rope drive, the following guidelines must also be observed:

- Where feasible, the new rope can be pulled in with the help of the old rope that is still in place or with the help of a lead rope provided for this purpose.
- In general, care must be taken to ensure that no rotation is introduced into the new rope by the old rope or the lead rope.
- There must be no rigid connection between the new and the old rope. For example, direct welding of the old rope to the new rope is prohibited.
- Only ropes having the same lay direction may be coupled, e.g., right-hand ropes only to right-hand ropes.
- Low-rotation ropes must be protected against forced rotation, e.g., by an interposed swivel.
- For connection purposes, the rope ends can be designed with pad eyes (welded-on eyes). Alternatively, suitable cable grips with crimped eyes/loops can be used. In such a case, the connection can be made, for example, by using a thin strand, a thin rope, or a swivel providing a sufficient working load limit.

If twist is introduced into the rope during installation, this can lead to rotational damage or twisting, e.g., of the crane's bottom hook block.

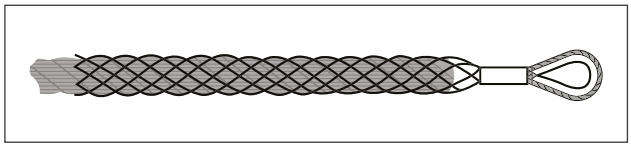


Fig.: Cable grips grip

Fig.: Pad eye

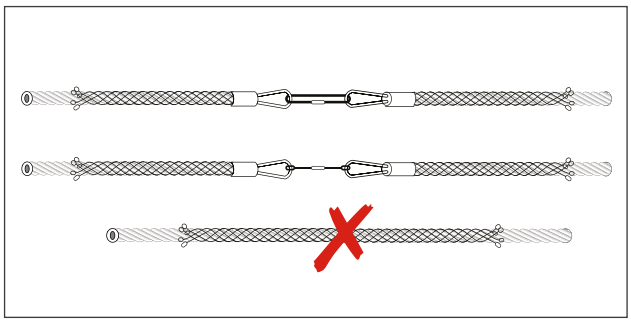


Fig.: Cable grips with eye, connection of two ropes

Cable grips must be approved for use with wire ropes. They must be mounted on the rope in accordance with the instructions contained in the user manual of the cable grips grip manufacturer. The working load limit must be observed.

DANGER! Unsuitable cable grips or an insufficient fit of the cable grips grip on the rope can cause the rope to slip or even crash.

NOTE! Welded-on eyes must meet the ISO 16841 standard. The maximum working load limit (WLL) of the welded-on pulling eyes must be observed.

4.7. Rope end terminations

DANGER! Unless otherwise recommended by the manufacturer of the hoist equipment, a swivel or anti-twist swivel may only be used in conjunction with high performance rotation resistant ropes (see Chapter 2.2). A failure to observe this rule can lead to serious bodily injuries and damage to property.

Fig.: Rope end terminations

DANGER! The specifications and instructions provided by the manufacturer of the rope end termination or contained in its user manual must always be observed. In the event of discrepancies, we recommend contacting the respective component manufacturers for a solution.

NOTE! When selecting a suitable rope end termination, the instructions provided by the manufacturers of the end termination and the rope must be observed.

NOTE! Particular care must be taken to ensure that the rope end terminations are mounted and secured in accordance with the equipment manufacturer's instructions (e.g., in accordance with the respective user manual). As a general rule, nominal sizes that are in line with the respective rope diameter must be used for all detachable components of rope end terminations (e.g., asymmetrical rope sockets).

NOTE! Depending on the efficiency factor of the rope end termination, the resulting characteristic breaking force of the overall system will vary. This must be taken into account when selecting the rope end termination.

Before the rope is installed, it is necessary to verify the free movement of the connecting bolts.

Asymmetric rope sockets (end wedge sockets, wedge sockets)

When installing asymmetric rope sockets, ensure that the life end of the rope (rope line under load) is inserted on the straight side of the socket and is therefore in alignment with the bolt hole. The dead end of the rope is led out at the opposite (asymmetric) side and must be secured with a wire rope clip. The length of the dead rope end should be 10 times the nominal rope diameter, in any case at least 150 mm. In this procedure, the rope clip must only be applied to the dead rope end, and never over both legs of rope. The maximum operating temperature for rope sockets is 200 °C. Clamping or fastening heat-affected (annealed or fused) rope ends must be avoided under all circumstances.

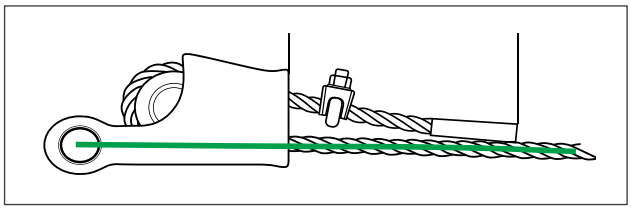


Fig.: Asymmetric rope socket

If a rope needs to be re-terminated with a rope socket, this can only be done after shortening the rope. The flattening of, and/or damage to, the rope caused by the previous attachment should no longer be present in the load-bearing leg of the rope or in the clamping area on both sides of the rope socket body and the wedge.

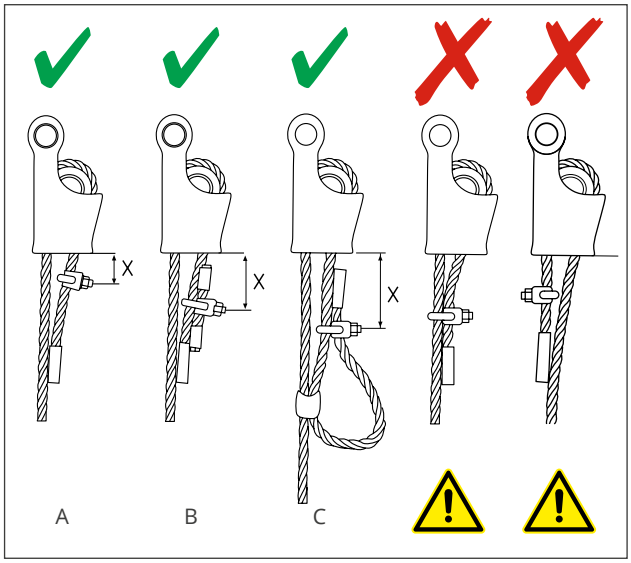


Fig.: Correct installation in asymmetric rope socket

Pouch sockets

When using pouch sockets, make sure that after inserting the rope end termination (swaged sleeve or cast socket sleeve), it must be secured against slipping out. The maximum operating temperature is 200 °C for swaged steel rope end terminations, and 110 °C for cast rope end terminations made of synthetic resin.

NOTE! Please refer to the illustration on the next page.

Fig.: Pfeifer pouch socket

Aluminum ferrules with sheet-metal, solid, or fork thimbles

It must be ensured that the rope is positioned in the groove of the thimble. The maximum operating temperature for swaged assemblies with aluminum ferrules is 150 °C.

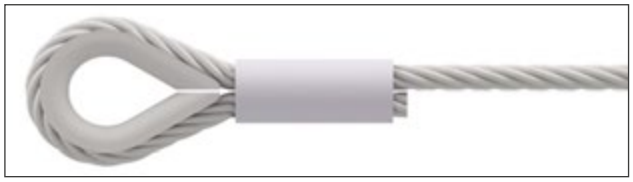


Fig.: Thimble swaging with fork thimble

Cast rope end terminations (cast sockets)

The maximum operating temperature for cast synthetic resin rope end terminations is 110 °C.
The maximum operating temperature for cast zinc alloy rope end terminations is 120 °C.

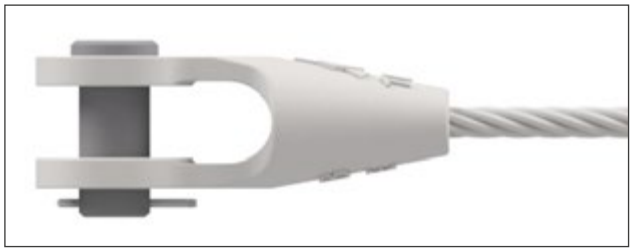


Fig.: Cast sockets

Wire rope clips

Wire rope clips are not approved for use as end fasteners of running wire ropes and for repeated loading. The maximum operating temperature for wire rope clips is 200 °C.

4.8. Running in of the rope

NOTE! Before the rope is put to use in the equipment, the operator must ensure that all elements of the rope drive are in proper condition (see also Chapter 4.2).

NOTE! If malfunctions occur during the run-in operation, in particular if the spooling pattern on the drum is irregular, or if the hook block is twisted, please contact the technical service department of the rope supplier or the rope manufacturer.

For hoist equipment with variable reeving, ensure that a reeving system is selected for the run-in operation which preferably allows the entire rope length to be spooled. During run-in, ensure that the spooling pattern on the rope drum is regular.

To run-in the rope, it is recommended to perform several operating cycles at low speed according to the following sequence:

- at least 5 operating cycles with a low rope pull force of about 10% of the maximum rope pull force in operation;
- at least 5 operating cycles with a medium rope pull force of about 20% - 30% of the maximum rope pull force in operation.

Finally, the rope must be spooled onto the drum with a rope pull force of approx. 10% of the maximum rope pull force in operation. Sufficient pre-tensioning of the lower spooling layers is a key prerequisite for trouble-free operation, especially on rope drums with multi-layer spooling.

Purposes of the run-in operation:

- to allow the rope structure to adjust itself to the actual conditions under which the rope is operated
- to balance out localized tension imbalances resulting from manufacture and installation
- to create a compact spooling pattern on the drum

4.9. Installation of stationary ropes

The installation of stationary ropes (e.g., pendants) must be carried out in accordance with the operating instructions of the equipment manufacturer. Any twisting of the ropes must be avoided under all circumstances to prevent damage to the ropes. Only ropes of the same lay direction and design may be coupled.

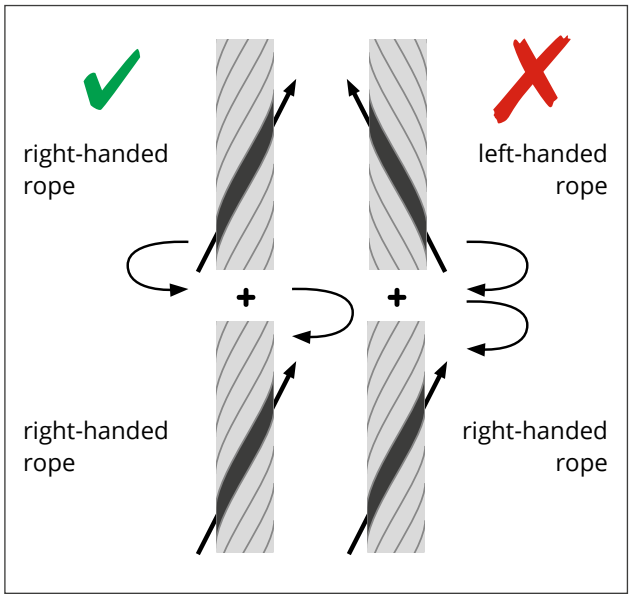


Fig. Coupling (lay direction + design)

5. Use

5.1. Basic rules for the safe and trouble-free use of ropes

- The operating instructions of the hoist equipment manufacturer must be followed at all times.
- All elements of the rope drive must be in perfect condition.
- Ropes and rope end terminations must not be overloaded.
- Ropes and rope end terminations must be serviced regularly (see Chap. 6.)
- Ropes and rope end terminations must be subject to a regular monitoring regime (see Chap. 7.)
- Once it has reached the point of discard, the rope must no longer be used (see Chap. 8.)
- Any contact of the rope with any components of the hoist equipment other than those of the rope drive must be rendered impossible.
- Any contact of the rope with building parts, power lines, or other objects in the immediate vicinity must be rendered impossible.
- Corrosive environments must be avoided.
- Excessive contamination must be avoided.
- Excessive exposure to heat must be avoided (see Chap. 5.4.)
- A proper spooling pattern on the rope drum must be maintained.
- Where feasible, the entire length of hoist ropes should be used.
- Any slackening of the rope on the drum must be avoided.
- External twist must not be introduced into the rope.
- Any abrupt loading and unloading of the rope, e.g., by abruptly removing a load, must be avoided.
- Excessive diagonal pull and exceeding the following fleet angles is not permitted:
  - for non-rotation resistant ropes: permitted up to 4° max.
  - for non-rotation resistant ropes: permitted up to 2° max.

DANGER! If ropes are used despite wear, excessive loading, misuse, damage, or improper maintenance, they can fail. Any failure of wire ropes can lead to serious injuries or even death.

5.2. Maintaining the pre-tension of hoist ropes in multi-layer spooling systems

A lack of pre-tension of the rope on the drum may lead to spooling problems in multi-layer spooling systems. This results in excessive rope wear, particularly in the lower spooling layers, gaps forming in the spooled rope package, and the rope cutting into the lower spooling layers. As a consequence, the operation of the equipment will be significantly disrupted.

If, e.g., due to the configuration of the hoist equipment, the lower rope layers on the drum are hardly used or not used at all, it will be necessary to restore the pre-tension in the entire rope from time to time.

In the case of hoist equipment with variable reeving options, it is important to choose a reeving configuration which preferably allows the entire rope length to be spooled. During this process, it is necessary to maintain a regular spooling pattern

on the rope drum.
To restore the pre-tension in a rope, the rope must be unspooled all the way to the safety turns and respooled with a rope pull force of approx. 10% of the maximum rope pull force in operation or approx. 2% of the minimum breaking force of the rope.

A rope works most economically in multi-layer spooling systems, if its entire length is used. If only a part of the hoist rope is used over extended periods of time, it is advisable to use an adapted, i.e., shorter, rope length. This applies in particular

- to longer lasting, unvarying work for which only the upper layers are used,
- to equipment where only the upper layers are used and where unspooling the entire rope length is not possible, e.g., on lattice boom cranes.

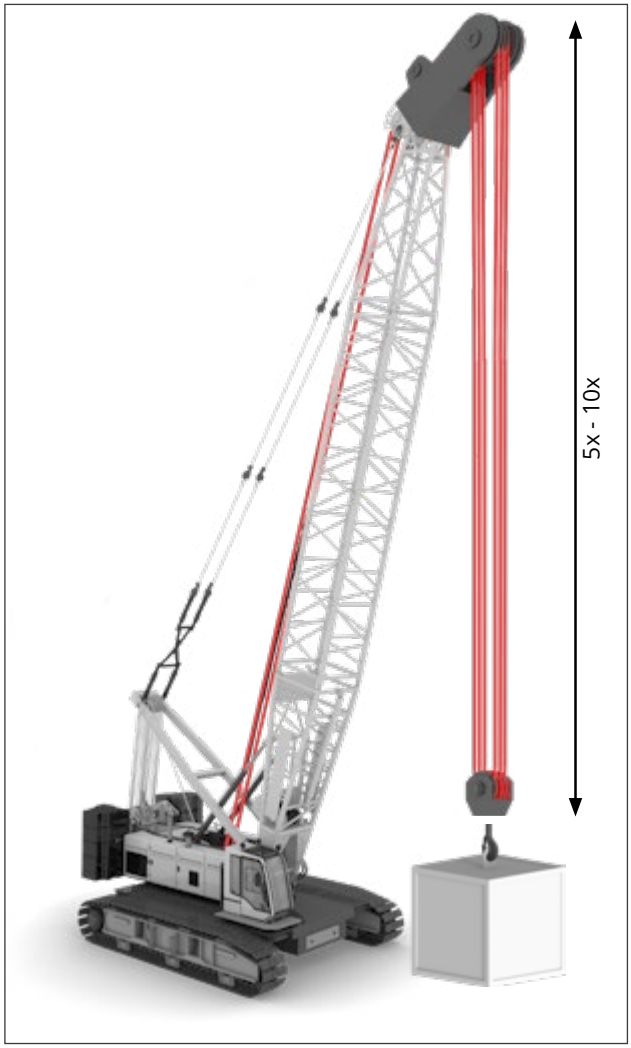


Fig.: Restoring pre-tension of the rope

5.3. Re-reeving of the hoist rope

The following aspects must be taken into consideration when re-reeving the hoist rope:

- Any twisting of the rope must be rendered impossible.
- In order to avoid unnecessary twisting, the rope must be pulled out straight to a length of approx. 10 m to 20 m after each time it is inserted through a hook block or top block.
- When using a wedge socket or an anti-twist rope end termination, the rope must be attached to the fastening point without twist. If the bolt can only be inserted by twisting the end termination, this must be done with as little twisting of the rope as possible.
- Before inserting it into the wedge socket, the rope must be checked for damage.
- Damage caused by bending or crushing must be ruled out.
- Should the rope come into contact with the ground, it must be cleaned of any dirt.

5.4. Operating temperature limits

When using steel wire ropes, certain temperature limits must be observed. These result from the effects of high and low temperatures on the rope and the rope end terminations.

The following limit values apply:

Ropes with fiber core	–40 °C to +100 °C / without limitation
Ropes with steel core	–40 °C to +100 °C / without limitation from greater than +100 °C to +200 °C with 10% loss in minimum breaking force
Swaged rope end terminations	
• Aluminum ferrule	–40 °C to +150 °C
• Steel ferrule	–20 °C to +200 °C, upon request, from – 40 °C
Cast rope end terminations	
• Cast from synthetic resin	–50 °C to +110 °C
• Cast from metal	–40 °C to +120 °C

5.4.1. Operating temperatures above + 65 °C

NOTE! At operating temperatures above +65 °C, it is recommended that the intervals for rope inspections be significantly shortened. Due to changes in the steel structure, a reduction in wire tensile strength and thus a partial loss of the rope's breaking force must be expected at temperatures of +100 °C and above.

Depending on the lubricant, a complete loss of the lubricant and thus of the lubricating effect is to be expected at operating temperatures of approx. +65 °C and higher. This will cause an increase in internal and external friction, which in turn will lead to increased wear, and therefore, in some cases, a significantly reduced service life of the rope.

5.4.2. Operating temperatures below 0 °C

At low operating temperatures, the effectiveness of the rope lubricant is likely to change. It is therefore recommended to check the lubricating effect more frequently and to relubricate the rope, if necessary (see Chapter 6.1.).

At low operating temperatures, increased bending stiffness of the ropes is also to be expected. This may require the use of additional weights on the hook blocks, for example, in the case of hoist ropes being used in combination with highly reeved lightweight hook blocks.

For equipment, e.g., mobile cranes or tower cranes, that is transported on the road in wintery weather conditions, salty water makes it necessary to ensure sufficient rope lubrication, particularly for reasons of corrosion protection.

When using ropes outdoors, it is recommended that ropes that are iced up (e.g., due to frost) be run at low speed under load at the start of each operating period in order to chip the layers of ice off the rope and keep the ice from depositing and accreting in the grooves of the sheaves, which can lead to subsequent damage.

The use of de-icing agents is not recommended due to potential adverse effects on rope lubrication and environmental hazards.

6. Maintenance and care

NOTE! Maintenance and care of wire ropes may be carried out only by competent persons.
Regular rope maintenance preserves the rope's functionality, helps to significantly extend the rope's lifetime, and ensures the rope's safe operation. The condition of the lubrication must be checked at least once a month.

Depending on the application, the use, the environment, and the type of wire rope used, maintenance of the wire rope must be carried out monthly in the event of regular use, or based on the actual operating hours logged.
Inadequate or no maintenance will shorten the rope's lifetime. This applies in particular in cases where the rope is used in an environment with a corrosive atmosphere and no rope corrosion protection can be used, which may be the case in certain types of use or operation. In such cases, the maintenance intervals must be shortened accordingly.

6.1. Lubrication of the rope during operation

DANGER! In systems with traction drive/traction sheaves, any relubricating of the ropes must be carried out strictly in accordance with the system manufacturer's instructions.

CAUTION! If ropes are not relubricated in good time, this can lead to malfunctions of the rope in the rope drive and to external and internal corrosion.

NOTE! Only wire rope lubricants approved by the rope manufacturer/rope supplier may be used. The instructions of the lubricant manufacturer must be observed. Relubricants must be compatible with the original rope lubrication.

NOTE! Relubricants may contain solvents to enable application in a liquid state or as a spray. After application to the rope, regular rope operation must not be resumed until the solvent has evaporated to ensure a good adhesion of the lubricant to the rope. Failure to observe this may result in a loss of lubricant and contamination of the system and the surrounding area.

If too much or the wrong lubricant is applied, this can lead to an excessive adhesion of dirt to the surface of the rope and to contamination of the area surrounding the rope drive. This can in turn lead to wear on the rope, the sheave, and the rope drum. In addition, it makes it considerably more difficult to detect the discard criteria.

Heavily soiled wire ropes should only be cleaned mechanically, e.g., by using wire brushes. Solvents and other cleaning agents must not be used.
The lubricant used in manufacture protects the rope against corrosion during transport, storage, and in the initial period of use. It is selected by the rope manufacturer depending on the intended use of the rope and the environmental conditions to which the rope will be exposed.

Wire ropes must be relubricated at regular intervals which depend on the operating conditions, and before the rope shows signs of drying out or corrosion. In the same operating conditions, well-lubricated ropes can achieve up to four times the service life of non-lubricated ropes.

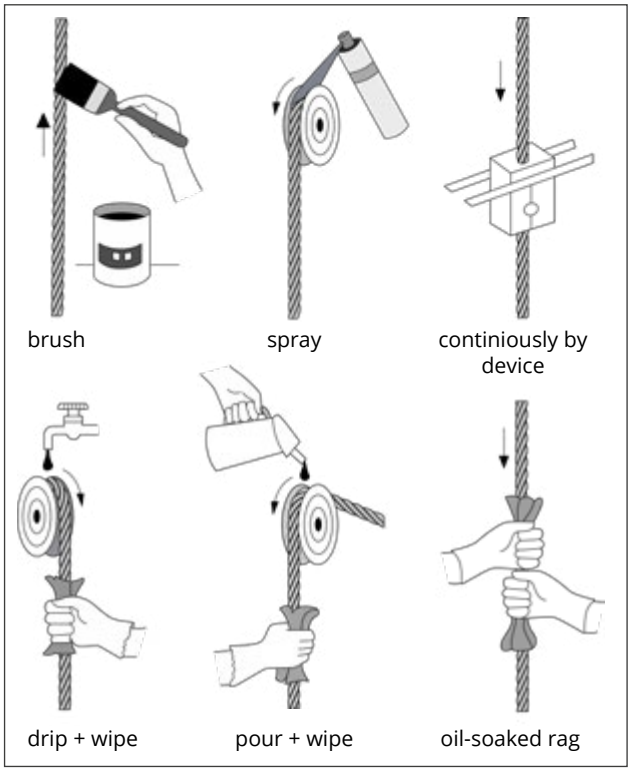


Fig.: Methods for lubricant application

Typical methods for rope lubrication include application with a paintbrush or cloth, drip lubrication, spraying from a spray can, and pressure lubrication. With the latter method, the rope is relubricated under pressure and also cleaned in this process, with moisture, residues of old lubricant, and other contaminants being removed.

Regardless of the lubrication method used, it is important to ensure that the rope is lubricated evenly all around.

6.2. Removal of protruding broken wire ends

There is an increased risk of injury from broken wire ends.

A single broken wire does not reduce the safety of the rope. However, protruding broken wires can be bent over and overlap neighboring wires and eventually damage them, which is why they should be removed immediately. To do this, use pliers or a screwdriver to bend any broken wires back and forth until they break. Cutting them off with wire cutter is not advisable.

For future reference, the position of the removed wire end should be recorded in a log (see Chap. 12).

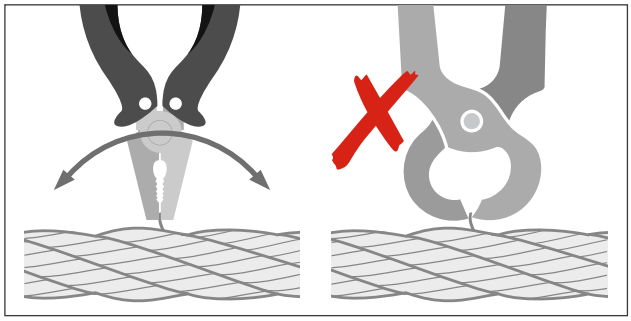


Fig.: Removal of protruding wires

6.3. Rope shortening in multi-layer spooling

In the cross-over area (C) of multi-layer spooling drums, rope windings crossing each other cause increased wear.

Fig.: Wear in multi-layer spooling

Any mechanical fretting wear is clearly visible on the surface of the strands in the form of "flattened areas" of the wires and a resulting reduction of the remaining wire cross-section.

In this case, it is possible to significantly extend the rope's lifetime by shortening the rope at the fastening point on the drum by a length corresponding to half the drum diameter (A) (1). This measure (2) shifts the pre-damaged rope areas in the spooling package from the climbing zone to the parallel zone (P). Such a shortening/shifting procedure cannot be carried out more than twice.

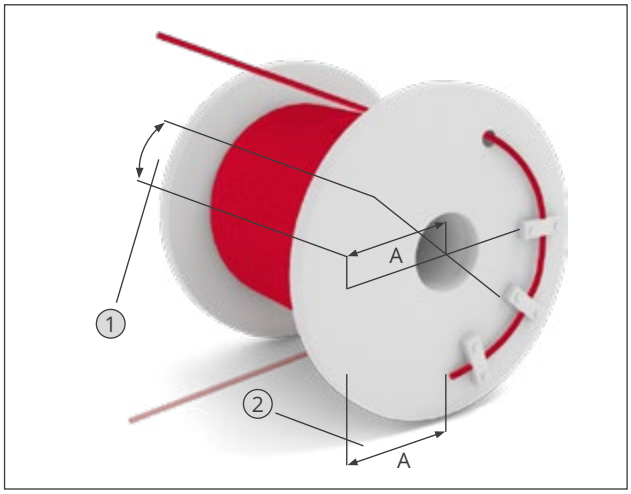


Fig.: Rope shortening procedure

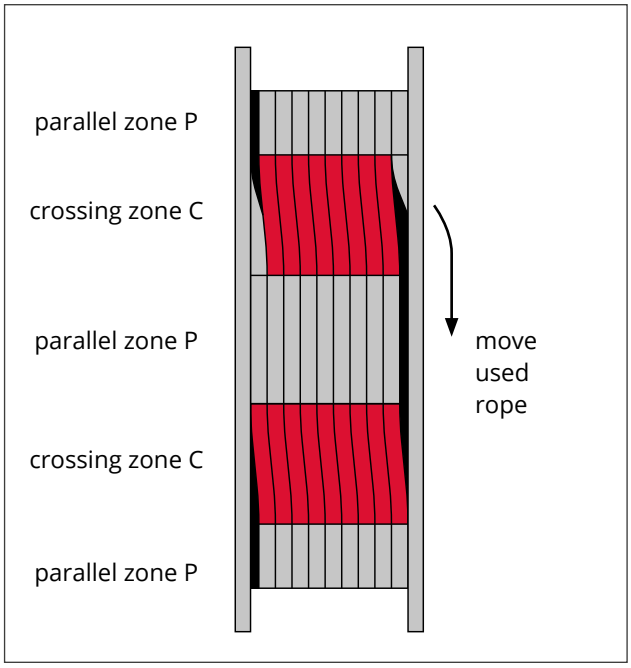


Fig.: Parallel and crossing zones

The shortening of the wire rope should be carried out by a competent person. The rope must be secured on both sides of the chosen cutting point with seizings (wire or strand) or by soldering, and then severed perpendicularly to the rope axis by means of abrasive cutting.

NOTE! Please refer to the illustration on the next page.

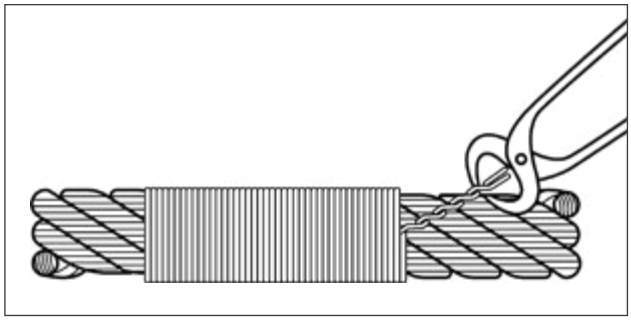


Fig.: Making a seizing

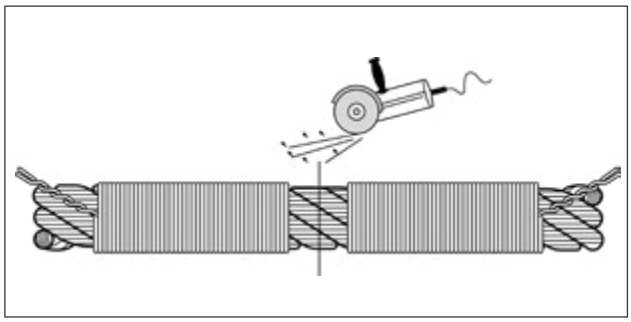


Fig.: Severing the rope between the seizings

6.4. Remedying twist in the hook block on hoists (especially on cranes)

⚠ **CAUTION!** As soon as the rope falls above the hook block collide, there exists a risk of serious damage to the rope. In most cases, this is due to external twist introduced into the rotation-resistant hoist rope that may be caused by a variety of influences and faults.

Compensating for this twist requires extreme caution and high expertise. This procedure may only be carried out by competent and specially trained persons or in consultation with the equipment manufacturer, the rope manufacturer, or the rope supplier. Improper execution can lead to severe rope damage even up to an extent requiring discard.

Where damage caused by twist, such as waviness, birdcages, or structural damage, already exists, the rope must be checked in accordance with Chapter 8 and discarded if necessary!

⚠ **CAUTION!** Risk of damage to the rope!

- Proceed with extreme caution when carrying out the following procedures!
- Strictly observe the following instructions!

NOTE! If the procedure described below is not successful, you should contact the technical service department of the equipment manufacturer, the rope manufacturer, or the rope supplier immediately.

Before measures are taken to untwist the rope, all elements of the rope drive must be checked in accordance with the instructions set forth in Chapter 4.2. The cause of a hook block twisting is often found in wear of rope drive elements. Worn or nicked components must be replaced immediately. If necessary, relubricate the rope.

6.4.1. Procedure for mobile cranes or luffing-boom tower cranes

Untwisting the hook block on a mobile crane, or on a tower crane with a luffing boom, is done by turning back the hook block and by rotating the rope end in the rope end termination, respectively. It is important to ensure that the rotation is introduced into a free portion of rope that is as long as possible. By carrying out empty hoisting cycles, this rotation is to be distributed over the entire length of the rope.

⚠ **CAUTION!** Never forcibly rotate a short portion of the rope as this might irreversibly damage the rope structure.

Option 1: Untwisting by pretensioning the hook block

This procedure works with the fastening point of the rope at the tip of the boom and an even number of rope falls, or with the fastening point of the rope at the hook block and an odd number of rope falls.

Procedure:

1. Turn the hook block back into its neutral position
2. Continue to turn it in the same direction by another half or full rotation in order to pretension the system
3. Set the hook block down on the ground
4. Carefully detach the rope at its fastening point so that the torque can be relieved.

   ⚠ **CAUTION!** Secure the rope's fastening point against uncontrolled untwisting; then, allow the twist to dissipate in a controlled manner

5. Carry out at least 2 to 3 full lifting cycles to allow the twist to dissipate over as long a rope length as possible
6. Repeat this procedure, if necessary

Fig.: Turning the hook block into its neutral position

Option 2: Untwisting by means of an end termination attached to the rope (e.g., wedge socket or pouch socket with blocking device)

This procedure works only with the fastening point at the hook block and an odd number of rope falls.

Procedure:

1. Turn the hook block back into its neutral position (directions A or B acc. to Fig. 6.4.B), and set it down on the ground
2. Pouch socket: Fix the swaged sleeve in the pouch socket by means of the blocking device
3. Unbolt the rope with the end wedge socket, or the pouch socket with the rope
4. Turn the rope back a half turn against the direction in which the hook block was turned when it was brought into its neutral position (pretension rope)
5. Bolt-connect the end wedge socket or pouch socket again, and secure it
6. Carry out at least 2 to 3 full lifting cycles to allow the twist to dissipate over as long a rope length as possible
7. If necessary, repeat the procedure until a twist-free condition has been achieved.

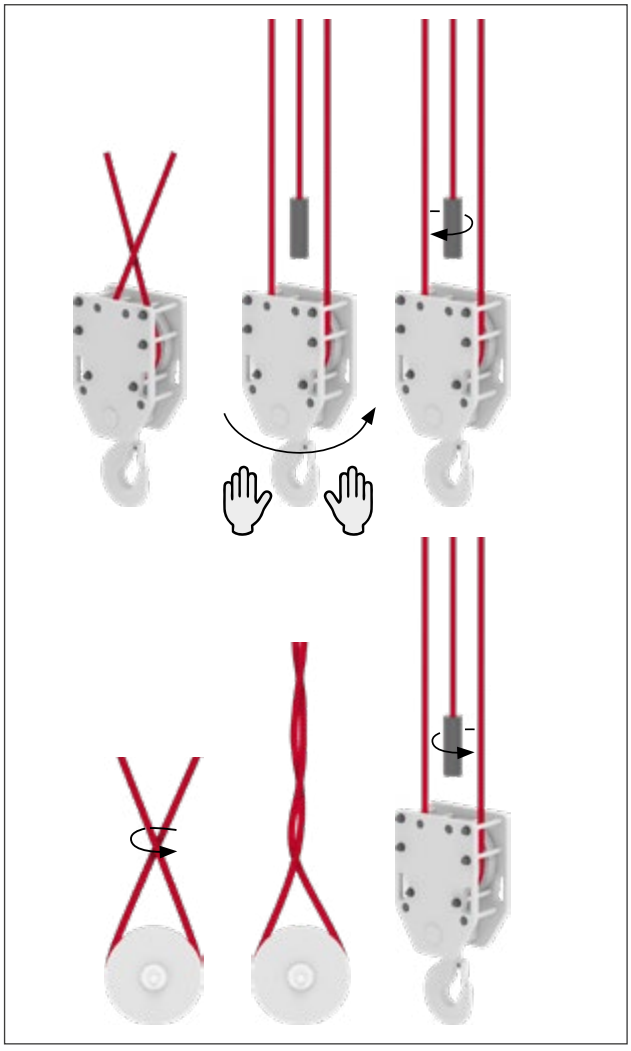


Fig.: Untwisting by blocking the pouch socket

6.4.2. Procedure for tower cranes with trolley jib

Untwisting the hook block is accomplished by executing defined lifting and trolley motions. The anti-twist swivel at the rope's fastening point at the tip of the boom must be able to rotate freely and orient itself in the direction of the rope. It must be ensured that there is an unobstructed work area below the boom.

For untwisting, the following positions must be approached in the described order. This will be done with a load attached.

1. Hook block 1 m above the ground, trolley at minimal outreach **(A)** from tower
2. Lift load to maximum hook height
3. Move trolley toward tip of boom to maximum outreach **(B)** from tower
4. Lower hook block back to start position

Repeat this procedure, if necessary.

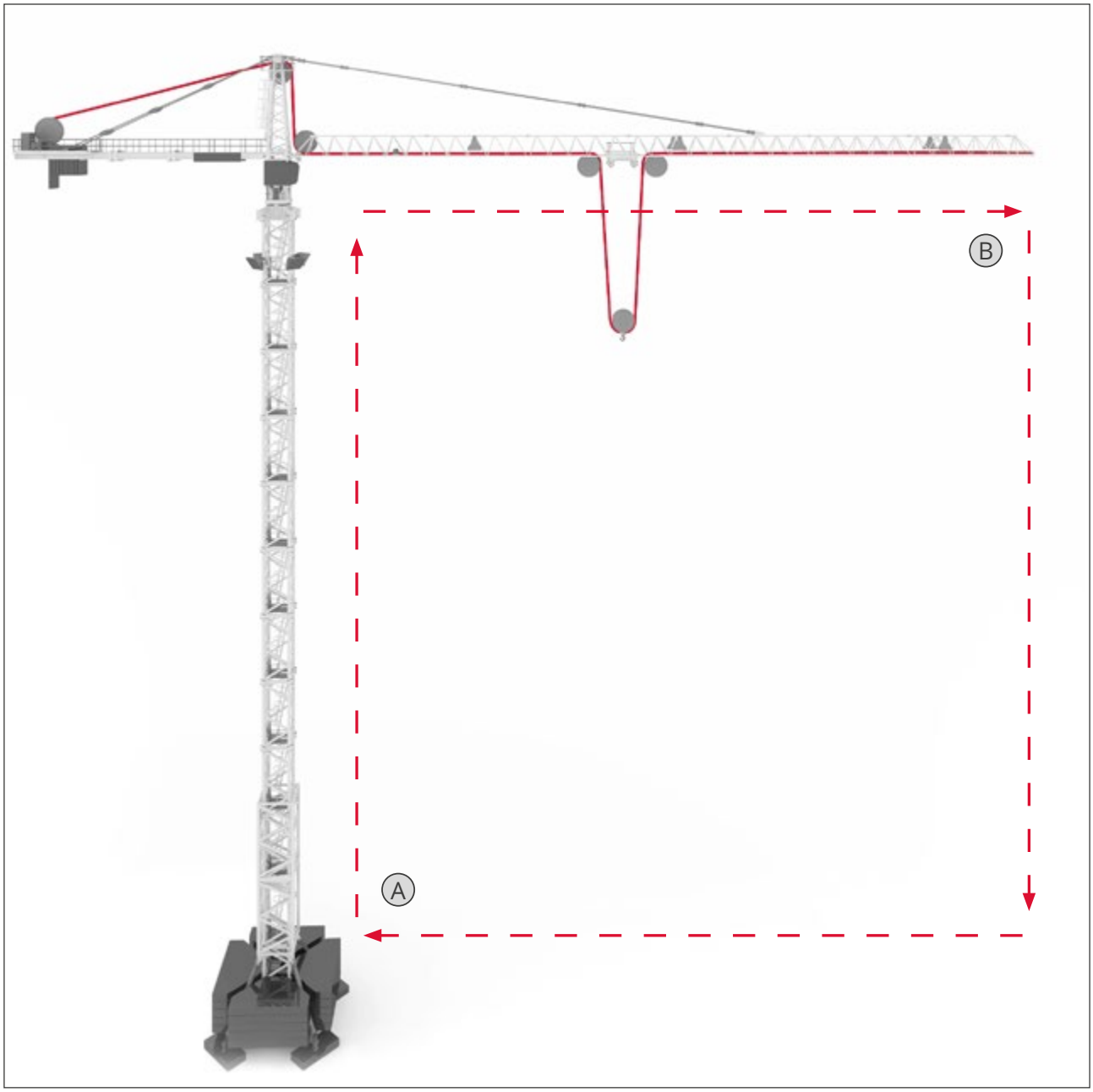


Fig.: Untwisting by moving through the load quadrangle

7. Monitoring inspection

NOTE! Wire rope monitoring must be carried out by competent persons only.
Unless otherwise specified by the equipment manufacturer, the principles of ISO 4309 shall apply.

NOTE! In addition to the provisions and instructions contained in this user manual, other rules and regulations may need to be observed (country-specific, location-specific, ...).

7.1. Operational safety criteria

The operational safety of the ropes must be assessed according to the following criteria (see also Chapter 8):

- Type and number of wire breaks
- Location and chronology of occurrence of wire breaks
- Decrease of rope diameter while in use
- Corrosion, abrasion, rope deformation
- Heat exposure

For each regular and each special monitoring inspection, the inspector must maintain a log of the respective inspection. A template for such a log can be found in Chapter 13. The log must be kept for the entire service life of the rope.

7.2. Frequency of monitoring inspections

NOTE! Depending on the condition of the wire rope or the operating conditions of the rope drive, it may be necessary to shorten the interval between inspections.

The ropes must be inspected regularly, especially during the initial period after installation; the same applies after exposure to extreme loads, in the event of suspected, non-visible damage, or when the first signs of rope damage or wear appear. The intervals for the inspection and the thorough examination for discard criteria in accordance with ISO 4309 shall be determined by a competent person.

Any incipient changes in the condition of the rope must be monitored and documented with particular attention.

7.2.1. Daily visual inspections

Daily visual inspections must be carried out by the operator or by an appointed person (operating personnel).

Every day, before operation is resumed, all visible parts of the wire ropes must be inspected to the greatest extent possible, with the aim of detecting general damage and deformations. Particular emphasis must be given to inspecting the fastening points and rope end terminations. Furthermore, it should be checked whether the rope is correctly guided in the elements of the rope drive (e.g., drum and sheaves).

If the reeving is changed at any given time, e.g., when transporting the hoist equipment to a new installation site or changing the number of rope falls, the rope must be subsequently subjected to a visual inspection.

Any visible change in the condition of the wire rope must be documented. The condition of the wire rope must then be assessed by a competent person.

7.2.2. Regular monitoring inspections

The regular monitoring inspections must be carried out by a competent person.
In order to determine the intervals for the regular monitoring inspections, the following aspects must be taken into account:

a. the statutory provisions governing use in the relevant country,
b. recommendations by the equipment manufacturer,
c. the type of hoist equipment, and the environmental conditions in which it is operated,
d. the drive mechanism of the hoist equipment/ rope drive,
e. experience from previous monitoring inspections regarding this or comparable applications,
f. the period of time during which the wire rope has been in use,
g. the frequency and type of use

Wire ropes must be inspected as instructed by the competent person, or at least once a month.

7.2.3. Special monitoring inspections

The wire rope must be inspected if an incident has occurred that could have caused damage to the wire rope and/or the rope end termination, or if a wire rope is to be reused after its removal and subsequent reinstallation.

If any equipment or machinery has been out of operation for three months or longer, the wire ropes must be inspected before resuming operation.

7.2.4. Monitoring of ropes running over plastic sheaves or metal sheaves with plastic lining

If, in a rope drive with a drum with single-layer spooling, a wire rope runs over plastic sheaves or over metal sheaves with a plastic lining, a high number of internal wire breaks may occur in this area.

⚠ **CAUTION!** In this case, no externally visible signs of wire breakage or wear may be recognizable.

For these conditions, the maximum service life of the rope must be defined by the equipment manufacturer.

7.2.5.Monitoring of local anomalies regarding rope lubrication

Particular emphasis must be given to inspecting localized areas of a rope where drying out or denaturation of the lubricant can be detected. A competent person must be consulted if there is a change in the condition of the rope.

7.3. Elements to be covered by monitoring

7.3.1. General information

Generally, the entire length of the rope must be monitored. Particular attention must be devoted to the following areas:

a. the rope end terminations;
b. the safety turns, and the fastening point on the drum;
c. the portions of the wire rope that run over sheaves;
d. the portions of the wire rope that are spooled onto the drum(s);
e. the portions of the wire rope that are positioned on compensating sheaves;
f. all portions of the wire rope that are subject to abrasion by external components;
g. all portions of the wire rope that are exposed to temperatures above 60 °C;
h. all areas which, e.g., due to vibrations, may come into contact with stationary components, such as the crane structure, during operation.

The results of the monitoring inspection must be recorded in the monitoring log. A template for such a log can be found in Chapter 13.

7.3.2. Rope end terminations

At the rope end termination, the rope must be monitored with particular attention, as this point is critical for the occurrence of material fatigue (wire breaks) and corrosion. The rope end terminations themselves must also be monitored for deformation, damage (e.g., cracks), corrosion, or wear. The applicable manufacturer's instructions and standards for monitoring rope end terminations must be observed.

The following special details must also be taken into account:

- Swaged rope end terminations must be subjected to monitoring inspections for slippage / marks on the rope (shiny parts at the exit from the swaged termination).
- In the case of cast rope end terminations, any remaining seizing must be removed for the inspection. Slight one-off seating effects of the socket basket after previous exposure to loads are not critical. In the case of cast rope end terminations, it should also be checked whether water can penetrate into the end termination at the entrance. This entrance area must be sealed separately.
- Detachable rope end terminations (e.g., end wedge clamps, rope fastening points on the drum) must be checked for tight fit. Wire ropes must be subjected to monitoring inspections inside the rope end termination and at its exit.

If wire breaks or damage can be detected on a running wire rope near or inside the rope end termination, which would result in the rope reaching the point of discard, the rope must be replaced. It may also be possible to shorten the wire rope, and to reattach or replace the rope end termination.

NOTE! Shortening the wire rope may restrict the working range of the hoist. In the case of a possible parallel operation (tandem operation) of two wire ropes, it is usually necessary to shorten both ropes. In each case, it must be ensured that the required minimum number of safety turns on the drum is observed.

NOTE! Any shortening of the wire rope must be carried out by competent skilled personnel.

NOTE! Any repair of ropes with cast end terminations or with swaged end terminations for use in pouch sockets must be carried out by competent skilled personnel.

8. Point of discard

NOTE! If the competent person has any doubts when assessing the extent of damage to the rope, it is imperative to discard the rope or contact an expert for the testing of wire ropes.

Wire ropes used in hoists are components subject to wear. They must be replaced when their condition has deteriorated to a point where continuing to use them would compromise the safety of the hoist. This point in time is referred to as the point of discard.

The point of discard of a wire rope is determined based on the presence or extent of various criteria. These criteria and their significance for the point of discard of wire ropes in cranes and hoists are presented below. The detailed description of the criteria, their quantitative assessment, and the description of the combined evaluation of several criteria is contained in the standard ISO 4309: “Cranes - Wire Ropes - Care and Maintenance, Inspection and Discard”, as amended from time to time, to which explicit reference is made herein.

8.1. Overview of discard criteria

NOTE! On drums with single-layer spooling, the exclusive use of plastic sheaves or metal sheaves with plastic linings is not recommended. In this case, large numbers of wire breaks would inevitably occur inside the rope structure before wire breaks or signs of heavy wear become visible on the outside. For this reason, no discard criteria are specified for this combination. In such cases, the crane or system manufacturer must define clear criteria for the point of discard or the service life.

NOTE! Ropes with transparent or colored plastic covers cannot be clearly evaluated on the basis of the criteria described in this chapter. The use of these ropes is only permitted if the crane or system manufacturer has defined clear criteria for the point of discard or the service life.

NOTE! If an inaccessible installation situation makes it impossible to detect discard criteria, the crane or system manufacturer must define clear criteria for the point of discard or the service life.

If rope damage occurs that is not the result of normal wear (e.g., crushing, abrasion marks), the causes must be determined and rectified before a new rope is installed. Damage and abrasion marks on components of the hoist equipment can provide valuable insights.
Wire ropes must be discarded immediately, if one of the following criteria is detected. These criteria are described in detail in the following chapters:

- Reaching of the defined number of wire breaks acc. to Chap. 8.2.1
- ccurrence of wire break nests acc. to Chap. 8.2.2
- Occurrence of wire breaks in the strand valleys acc. to Chap. 8.2.2
- Occurrence of wire breaks at a rope end termination acc. to Chap. 8.2.2
- Decrease of the rope diameter, constrictions acc. to Chap. 8.4
- Breakage of a strand acc. to Chap. 8.5
- Significant corrosion acc. to Chap. 8.6
- Corkscrew-like deformations acc. to Chap. 8.7.1

- Birdcaging, loosening of the rope structure acc. to Chap. 8.7.2
- Protrusion of core acc. to Chap. 8.7.3
- Formation of loops in wires acc. to Chap. 8.7.4
- Local increase in rope diameter acc. to Chap. 8.7.5
- Flattening acc. to Chap. 8.7.6
- Kinks or permanent deformations acc. to 8.7.7
- Bends acc. to Chap. 8.7.8
- Heat exposure acc. to Chap. 8.8

Combined point of discard
Ropes may require discarding if several discard criteria are present at the same time, even if individual discard criteria within a damaged portion of rope are only partially fulfilled. These must then be assessed on aggregate.

Procedure:
- The severity of the individual discard criteria must be assessed separately and expressed as a percentage.
- The aggregate severity of the discard criteria on a given portion of rope is calculated by adding up the individual values for the rope portion concerned.
- If the aggregate severity is above 100%, then the rope must be discarded.

Example:
A rope will have reached its point of discard if the following individual discard criteria were detected within a damaged rope portion:
- moderate corkscrew with a waviness of 5% of the nominal diameter (severity: 50%)
- 6 wire breaks, if the number of wire breaks requiring discard is 10 (severity: 60%)

► In this case, the combined severity of the discard criteria is 110% ► the rope must be discarded.

For assessing the discard criteria caused by different deterioration factors, the following methods are employed:

Type of deterioration	Assessment method
Number of visible wire breaks (including randomly distributed wire breaks, wire break nests, wire breaks in strand valleys/strand shoulders, and wire breaks at or close to the end termination)	Counting
Decrease in rope diameter (due to external wear/abrasion, internal wear, and deterioration of the core)	Measurement
Strand break(s)	Visual inspection
Corrosion (superficial, internal, and fretting corrosion)	Visual inspection
Deformation	Visual inspection and measurement (corkscrew deformation only)
Mechanical damage	Visual inspection
Damage caused by heat (including arcing)	Visual inspection

8.2. Type and number of visible wire breaks

The "normal" operation-related wear of a wire rope used as intended becomes manifest primarily in the occurrence of wire breaks and external wear and thus a decrease in diameter.

Typically, the development of wire breaks does not happen in a linear progression. Once the first wire breaks have occurred, the increase in the number of wire breaks can be expected to accelerate.

Wire breaks occur inside the rope due to friction processes between wires and strands and on the rope's outer surface due to friction between the rope and elements of the rope drive. ISO 4309 stipulates limit values for the number of externally visible wire breaks, which also take into account the existence of internal wire breaks.

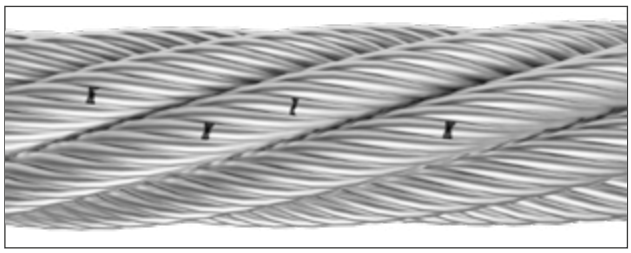


Fig.: smooth external wire breaks

A singular wire break, which is detected even before the rope is actually put into service, may, for example, have resulted from its manufacture, transport, storage, or installation. Such a singular wire break does not constitute a deterioration of the condition of the rope and may therefore be disregarded in the subsequent assessment of wire breaks caused by wear or fatigue.

Wire breaks caused by wear or fatigue are classified into different types as follows:

8.2.1. Randomly distributed wire breaks

The following applies to wire breaks occurring in a randomly distributed manner in ropes that run over steel sheaves or are spooled in one or multiple layers:

Depending on the rope design, the numbers of wire breaks requiring discard according to ISO 4309, contained in the tables for single-layer and parallel-closed ropes, and low-rotation ropes, respectively, shall apply. A distinction is made between rope portions that run over sheaves or are spooled in a single layer and rope portions that are spooled in multiple layers. The numbers of wire breaks requiring discard are specified for two reference lengths (6xd and 30xd), with "d" standing for the nominal rope diameter.

NOTE! The corresponding numbers of wire breaks requiring discard can be determined from the following table, by using the RCN (Rope Category Number) on data sheets and rope certificates provided by rope manufacturers or rope suppliers. If the RCN is unknown, the number of load-bearing wires in the outer strands must be determined based on the rope design.

Single-layer and parallel-closed ropes

Number of visible wire breaks which, once reached or exceeded, indicates the point of discard for single-layer and parallel-closed ropes:

Rope Category Number (RCN)	Total number of load-bearing wires in the outer layer of strands of the rope [a] *n*	Number of visible outer wire breaks [b]					
		Portions of rope running over steel sheaves and/or spooled onto a single-layer drum (random distribution of wire breaks)				Portions of rope spooled onto a multi-layer drum [c]	
		Classes M1 to M4, or class unknown [d]				All classes	
		Regular lay		Lang lay		Regular lay and Lang lay	
		over a length of					
		$6d$ [e]	$30d$ [e]	$6d$ [e]	$30d$ [e]	$6d$ [e]	$30d$ [e]
01	$n \leq 50$	2	4	1	2	4	8
02	$51 \leq n \leq 75$	3	6	2	3	6	12
03	$76 \leq n \leq 100$	4	8	2	4	8	16
04	$101 \leq n \leq 120$	5	10	2	5	10	20
05	$121 \leq n \leq 140$	6	11	3	6	12	22
06	$141 \leq n \leq 160$	6	13	3	6	12	26
07	$161 \leq n \leq 180$	7	14	4	7	14	28
08	$181 \leq n \leq 200$	8	16	4	8	16	32
09	$201 \leq n \leq 220$	9	18	4	9	18	36
10	$221 \leq n \leq 240$	10	19	5	10	20	38
11	$241 \leq n \leq 260$	10	21	5	10	20	42
12	$261 \leq n \leq 280$	11	22	6	11	22	44
13	$281 \leq n \leq 300$	12	24	6	12	24	48
	$n \geq 300$	$0{,}04 \times n$	$0{,}08 \times n$	$0{,}02 \times n$	$0{,}04 \times n$	$0{,}08 \times n$	$0{,}16 \times n$

NOTE:
In this table, ropes having outer strands in Seale design, where the number of wires per strand is 19 or less (e.g., 6×19 Seale), are placed two rows above the row in which the rope design would normally be placed based on the number of load-bearing wires in the outer strands.

RCN = Rope Category Number

a) For the purposes of this International Standard, filler wires are not considered load-bearing wires and are not included in the value of *n*.
b) A broken wire has two ends (counted as one wire).
c) The stated values apply to deterioration that occurs in the cross-over zones and overlaps of windings due to fleet angles (and not to rope portions that only run over sheaves and are not spooled onto a drum).
d) Twice the indicated number of wire breaks can be applied to ropes on drive mechanisms of groups M5 to M8.
e) *d* = nominal rope diameter.

Low-rotation ropes

Number of visible wire breaks which, once reached or exceeded, indicates the point of discard for low-rotation ropes:

Rope Category Number (RCN)	Total number of load-bearing wires in the outer strands of the rope [a] n	Number of visible outer wire breaks [b]			
		Portions of rope running over steel sheaves and/or spooled onto a single-layer drum (random distribution of wire breaks)		Portions of rope spooled onto a multi-layer drum [c]	
		over a length of			
		$6d$ [d]	$6d$ [d]	$30d$ [d]	$6d$ [d]
21	4 strands $n \leq 100$	2	4	2	4
22	3 or 4 strands $n \leq 100$	2	4	4	8
at least 11 strands in the outer layer					
23-1	$71 \leq n \leq 100$	2	4	4	8
23-2	$101 \leq n \leq 120$	3	5	5	10
23-3	$121 \leq n \leq 140$	3	5	5	11
24	$141 \leq n \leq 160$	3	6	6	13
25	$161 \leq n \leq 180$	4	7	7	14
26	$181 \leq n \leq 200$	4	8	8	16
27	$201 \leq n \leq 220$	4	9	9	18
28	$221 \leq n \leq 240$	5	10	10	19
29	$241 \leq n \leq 260$	5	10	10	21
30	$261 \leq n \leq 280$	6	11	11	22
31	$281 \leq n \leq 300$	6	12	12	24
	$n \geq 300$	6	12	12	24

NOTE:
In this table, ropes having outer strands in Seale design, where the number of wires per strand is 19 or less (e.g., 18 × 19 Seale – WSC), are placed two rows above the row in which the rope design would normally be placed based on the number of load-bearing wires in the outer strands.

RCN = Rope Category Number

a) For the purposes of this International Standard, filler wires are not considered load-bearing wires and are not included in the value of *n*.
b) A broken wire has two ends (counted as one wire).
c) The stated values apply to deterioration that occurs in the cross-over zones and overlaps of windings due to fleet angles (and not to rope portions that only run over sheaves and are not spooled onto a drum).
d) *d* = nominal rope diameter.

8.2.2. Other types of wire breaks

- Local accumulations of wire breaks **(Fig. 1)** in rope portions that are not spooled onto a drum: If the wire breaks are concentrated on one or two strands, the point of discard may already be reached at wire break numbers below the values given for 6 x d in the table.
- Wire breaks in strand valleys **(Fig. 2)**: The point of discard is reached if there are two or more wire breaks within 6 x d.
- Wire breaks at a rope end termination **(Fig. 3)**: The point of discard is reached if there are two or more wire breaks.

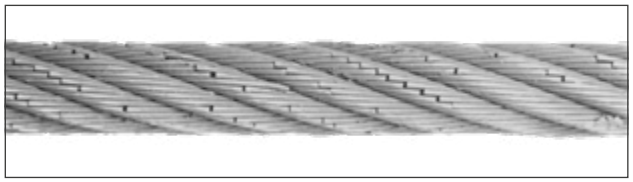


Fig. 1: local accumulation of wire breaks

Fig. 2: Wire breaks in strand valleys

Fig. 3: Wire breaks at rope end termination

8.3. Magneto-inductive rope testing

NOTE! Magneto-inductive rope testing (MRT) must be carried out by a competent person. Sufficient experience in handling the test equipment and in interpreting the measurement results is indispensable for carrying out and correctly evaluating a magneto-inductive rope test.

NOTE! The MRT test equipment should meet the requirements stated in DIN EN 12927-8 or ASTM E157-11(2016)e1.

NOTE! If an MRT test is planned as part of the regular inspection, it is advisable to carry out an initial test on the brand-new rope prior to its first use and rely on the test results as reference for future measurements.

Functionality

An MRT can be employed as an additional means to identify damaged areas, particularly in the case of long rope lengths or if the rope's internal damage situation is unclear.
When used correctly, an MRT provides information on so-called local faults (LF; primarily wire breaks) or on the loss of metallic cross-sectional area (LMA). To detect and assess local faults, information on the wire diameter of all wires and the number of wires in the rope, or else on the maximum wire diameter and the metallic cross-sectional area of the rope, must be available. To evaluate the loss of metallic cross-sectional area, the original metallic cross-sectional area of the rope must be known. In an MRT, the discard criteria are determined irrespective of the rope design.

Discard criterion for LF

The permitted maximum numbers of wire breaks at 6 x d and 30 x d, respectively, are calculated as follows for the local fault discard criterion:

where A metallic cross-sectional area of the rope
δ_{max} biggest wire diameter

Over a length of 6 x d	Over a length of 30 x d
$\frac{0{,}06 \cdot A \cdot 4}{\pi \cdot \delta_{max}^2}$	$\frac{0{,}1 \cdot A \cdot 4}{\pi \cdot \delta_{max}^2}$

Example:
rope with diameter 24,0 mm, fill factor f = 0.672

$$A = \pi \cdot \frac{d^2}{4} \cdot f = 304\ mm^2$$

δ_{max} = 1,7 mm (gemessen)

► on 6 x d: 8.03, rounded to a maximum of 8 permitted wire breaks
► on 30 x d: 13.39, rounded to a maximum of 13 permitted wire breaks

Discard criterion for LMA
The permitted maximum loss of metallic cross-sectional area over a length of 30 x d is 10%.

8.4. Decrease of rope diameter

Ropes are manufactured with a tolerance on the nominal diameter. For example, if the diameter tolerance is +2% to +4%, the actual diameter of a new rope with a nominal diameter of 20 mm will vary between 20.4 mm and 20.8 mm.

The actual diameter of a wire rope changes during operation due to wear, seating processes, and other external influences. The decrease in diameter can therefore provide insights into the wear status of the rope. For determining the magnitude of the decrease in diameter, it is necessary to take an initial diameter measurement immediately after the new rope has been installed.

To ensure the comparability of the measurements, measurements should always be conducted on the unloaded rope, or always under the same load conditions. The measuring points on the used rope are selected in line with the relevant requirements. Usually, the diameter values are measured in different zones of the rope, e.g., in the area of the spooling package on the drum, in the reeving system, and near the end termination. If rope wear is present, measurements should be taken specifically in the affected areas. In order to determine the usage behavior or the presence of spooling faults, especially in the case of multi-layer spooling systems, it is necessary to take measurements in the climbing and parallel zones of each spooling layer.

Fig.: Local decrease of rope diameter

To determine the change in diameter under load, the rope diameter can also be measured at different rope pull forces. The rope pull force applied in each case must also be recorded.
Properties that are critical to the use of the rope in the system are dependent on the diameter being correct. Particularly in the case of multi-layer spooling on rope drums, compliance with the narrow tolerance range is essential for a proper functioning in multi-layer spooling.

If spooling faults occur in multi-layer spooling as a result of a decrease in diameter, it may be necessary to replace the rope, even if due to the uniform diameter reduction the point of discard has not yet been reached according to ISO 4309.
To determine the point of discard due to an excessive decrease in diameter according to ISO 4309, the percentage value of the uniform decrease in diameter is determined using the following equation:

$$\Delta d = \frac{d_{ref} - d_m}{d} \cdot 100\%$$

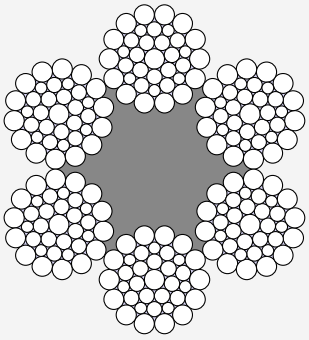
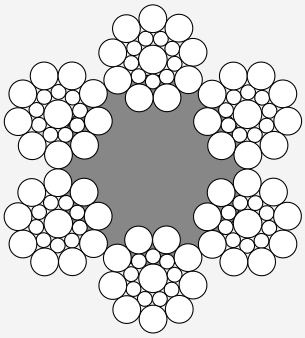
where Δd uniform decrease in diameter
d_{ref} reference diameter measured immediately after installation and before loading the rope with a pull force; if such reference diameter is not available, it is possible to measure the diameter directly adjacent to the end termination
d_m measured mean diameter
d nominal diameter

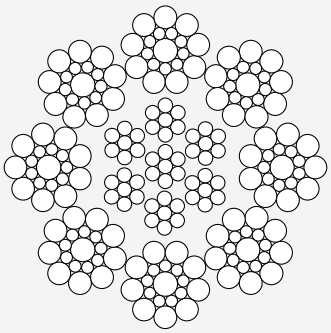
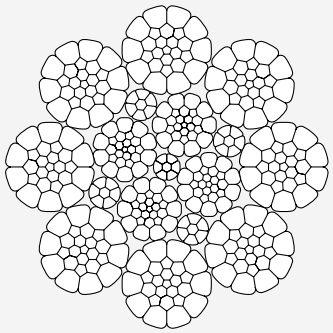
For the determination of the actual diameter of a wire rope, the diameter dm of the circumference is measured at several points, with the smallest and the largest value at each measuring point being recorded. The mean value of the smallest and the largest value represents the mean rope diameter d_m.

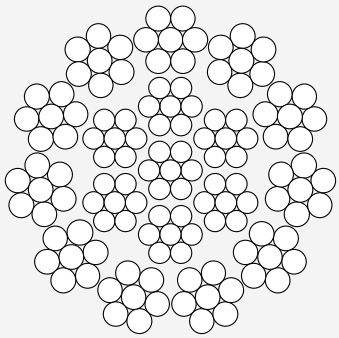
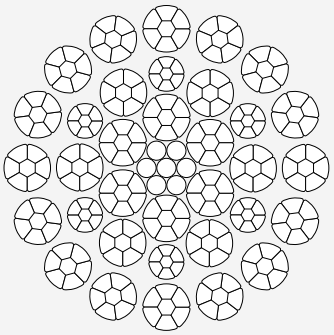
The values contained in the following tables express the degree of necessity of discard as a function of the decrease in diameter. They do not apply to rope portions that coincide with cross-over zones or other rope portions that are similarly deformed as a result of being spooled onto a drum in multi-layer spooling.

Generally, spooling onto drums will cause a reduction in rope diameter. On drums with multi-layer spooling, such reduction has to be measured and determined in the parallel zones. For climbing zones, the mean value of the diameter reduction from the two adjacent parallel zones has to be used. The resulting severity rating for the climbing zone must be combined with the severity rating of other discard criteria found there, e.g., externally visible wire breaks.

The rope cross-sections shown are to be understood as examples.

Non-rotation-free ropes, single-layer with fiber core Ropes with 5 and 8 outer strands					
Examples of rope cross-sections					
					
6x36WS FC			6x19S FC		
In case of a decrease in diameter by					
Δd < 6 %	6 % ≤ Δd < 7 %	7 % ≤ Δd < 8 %	8 % ≤ Δd < 9 %	9 % ≤ Δd < 10 %	**Δd ≥ 10 %**
discard severity rating					
0 %	20 %	40 %	60 %	80 %	**100 % discard required**

Non-rotation-free ropes, single-layer with steel core, or double-parallel ropes Ropes with 5 to 10 outer strands					
Examples of rope cross-sections					
					
8x19S IWRC			8xK26WS PWRC(K)		
In case of a decrease in diameter by					
Δd < 3,5 %	3,5 % ≤ Δd < 4,5 %	4,5 % ≤ Δd < 5,5 %	5,5 % ≤ Δd < 6,5 %	6,5 % ≤ Δd < 7,5 %	**Δd ≥ 7,5 %**
discard severity rating					
0 %	20 %	40 %	60 %	80 %	**100 % discard required**

Low-rotation and extremely-low-rotation ropes Ropes with 11 and more outer strands					
Examples of rope cross-sections					
					
18x7			35xK7		
Examples of rope cross-sections					
Δd < 1 %	1 % ≤ Δd < 2 %	2 % ≤ Δd < 3 %	3 % ≤ Δd < 4 %	4 % ≤ Δd < 5 %	**Δd ≥ 5 %**
discard severity rating					
0 %	20 %	40 %	60 %	80 %	**100 % discard required**

Without access to information about the rope cross section, in most cases the number of outer strands can be used to classify the rope into the correct one of the three above-mentioned categories. In cases where it is not known whether a non-rotation-resistant rope contains a fiber or steel core, it should be assumed that the rope has a steel core.

In cases of a localized decrease in diameter, which may be caused by a damaged rope core, for example, the rope must always be discarded.

8.5 Strand breaks

In the event that an entire strand breaks, the rope must be discarded immediately.

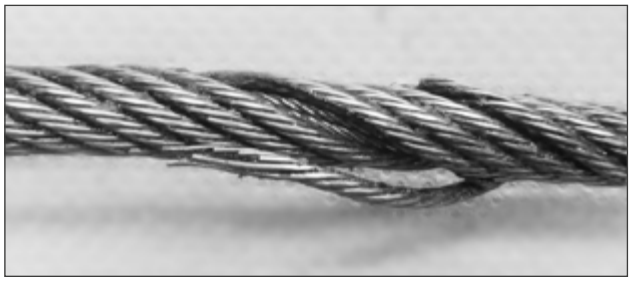


Fig.: Broken strand

8.6. External and internal corrosion

NOTE! In the event of any doubts with regard to corrosion, it is imperative to discard the rope or contact the rope manufacturer or rope supplier.

Generally, corrosion will occur due to a lack of corrosion protection, i.e., particularly due to inadequate lubrication, and as a result of particular ambient influences such as marine air or polluted industrial environments. It reduces a wire rope's breaking strength by reducing its metallic cross-section and accelerates material fatigue by causing surface irregularities that in turn lead to the formation of stress cracks. Severe corrosion can result in reduced elasticity of the wire rope.

Fig.: Superficial corrosion, rust film

Fig.: Slight corrosion, 0% - 20% severity

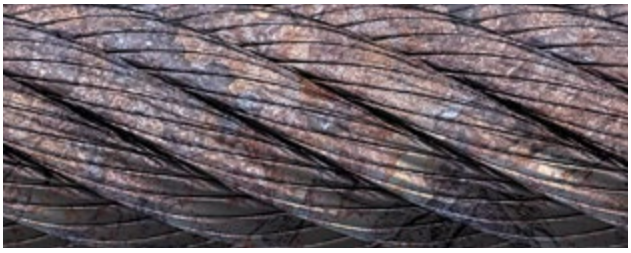


Fig.: Medium corrosion, 40% - 60% severity

Fig.: Heavy corrosion, 80% - 100% severity

Fig.: Internal corrosion - 100% discard

According to ISO 4309, we distinguish between the following types of corrosion:

- Superficial corrosion ("flash rust") which can be removed by wiping: no discard required
- External corrosion with rough wire surface: discard severity up to about 60%
- External corrosion with heavily pitted wire surface, slack wires: 100% discard severity
- Internal corrosion, detectable due to emerging corrosion particles: 100% discard severity

8.7. Deformations and mechanical damage

Visible changes in the shape of a wire rope often occur locally or over a short length of the rope and can lead to an uneven load distribution within the rope, sometimes significantly reducing operational safety.
Deformed or damaged areas can be cut off, provided that this does not make a continued safe and cost-effective operation of the rope impossible. Should this measure require the removal of a rope end termination, the feasibility of a replacement or a repair can be determined in consultation with the rope manufacturer or rope supplier.

8.7.1. Corkscrew-like deformations

Corkscrew-like deformations usually occur as a result of twist acting in the rope's closing direction. This type of deformation does not necessarily entail a loss of strength, but can generate vibrations that lead to an irregular operating behavior. Over longer periods of time, this can lead to rope wear and broken wires and also cause damage to the sheave bearings.
When showing a corkscrew-like deformation, a wire rope must be discarded if, on a straight portion of the rope, which runs over sheaves or onto a drum, the height of the waviness above a straight line is 1/10th of the nominal diameter of the rope or more: $g \geq 1/10 \times d$.

The rope must also be discarded if, on a straight rope portion that never runs over a sheave and is never spooled onto a drum, the height of the waviness above a straight line is 1/3 × d or more: $g \geq 1/3 \times d$.

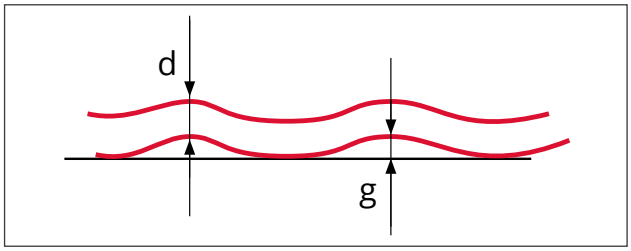


Fig.: Measurement of waviness

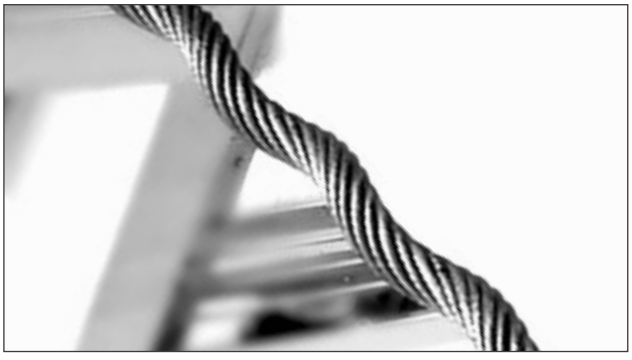


Fig.: Rope with corkscrew-like deformation

8.7.2. Birdcaging

Birdcage or basket deformations are the result of a difference in length between the rope core and the outer strand layers. This can be caused by external torque acting on the rope, e.g., due to large fleet angles in rope travel over sheaves, but also due to the rope and especially the outer strand layers getting pinched when traveling over nicked sheaves ► loosening of the rope structure!

Both cases make it impossible to distribute the load evenly over the entire cross-section. Consequently, wire ropes with birdcage deformations must be discarded immediately.

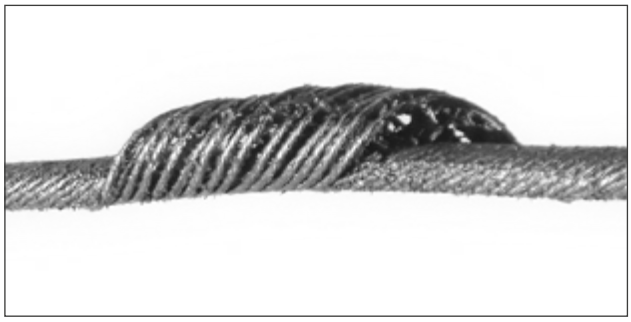


Fig.: Birdcage deformation

8.7.3. Protruding or deformed core or strand

This is a special form of basket deformation in which uneven loading or the twisting of individual strands or strand layers results in either the core (or, in the case of low-rotation ropes, the center of the rope) protruding between the outer strands or an outer strand of the rope protruding from the rope structure.

Ropes in which the rope core or a strand protrudes or is deformed must be discarded immediately.

Fig.: Protrusion of the rope core at a non-rotation resistant rope (top) and at a low-rotation rope (bottom)

8.7.4. Protruding wires in loops

The looping of wires can occur as a result of elevated internal friction between wires and strands due to high bending stresses acting on the rope. Ropes exhibiting such loops, i.e., wires protruding without visible broken wire ends, must be discarded immediately. In the case of looping, individual wires or groups of wires will often bulge on the side of the rope opposite the sheave groove, creating loops (bulges).

Fig.: Protruding wire loop

8.7.5. Local increase in rope diameter

A deformation of the rope core or swelling of the fiber core can lead to a local increase in the rope diameter during operation. Discard is recommended if this increase exceeds a value of 5% for ropes with a steel core and of 10% for ropes with a fiber core.

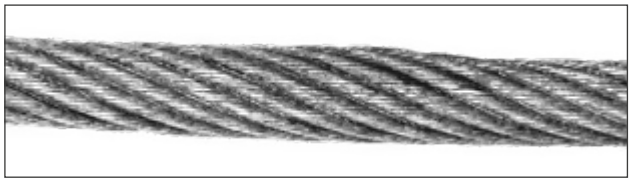


Fig.: Local increase in rope diameter due to deformation of the core

8.7.6. Flattened rope portions

Flattened rope portions cause damage to the wire rope earlier than usual, especially when running over sheaves. Wire breaks will occur, and the sheave can be damaged. Flattened rope portions tend to corrode more quickly, especially on stationary ropes. In such cases, depending on the severity of the flattening, it will be necessary to consider discarding the rope or to consult the rope manufacturer or rope supplier.

Ropes with flattened portions caused by adverse mechanical influences due to improper handling (e.g., clamping of rope) must be discarded or shortened immediately.
Flattened rope portions must be monitored at shorter intervals, in particular for the development of wire breaks and corrosion.

Assessment of flattened rope portions in multi-layer spooling systems:
Flattened rope portions in climbing zones in multi-layer spooling must be assessed in combination with other discard criteria, based on the rating of their degree of deformation:

- Measurement of maximum diameter d_{max} at the flattened rope portion
- Measurement of minimum diameter d_{min} at the flattened rope portion
- Calculation of the deformation V in relation to the nominal rope diameter:

$$V = \frac{(d_{max} - d_{min})}{d} \cdot 100\%$$

Deformation V ≥ 10 %	50 % severity rating
Deformation V ≥ 20 %	100 % severity rating – point of discard reached!

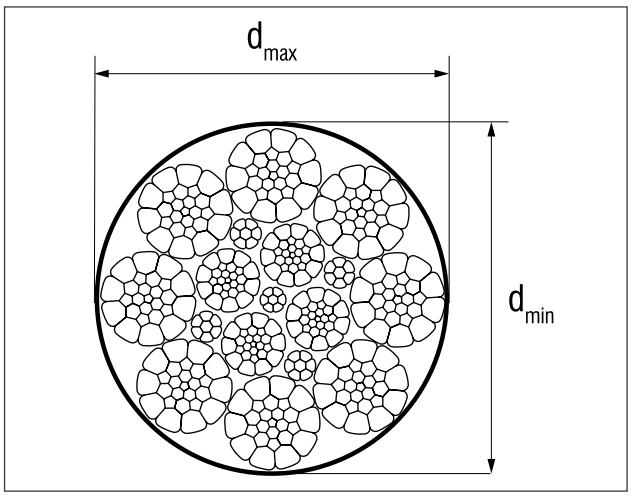


Fig.: Measurement of deformation

Fig.: Flattened portion

8.7.7. Kinks or pulled-tight loops

A kink or pulled-tight loop is a deformation resulting from a loop in the wire rope that was pulled tight without the rope being able to rotate around its own axis. This creates an imbalance in the lay length of the rope, resulting in excessive wear. The wire rope is deformed in such a way that it retains only a fraction of its original strength.

Fig.: Kink

Ropes with kinks or pulled-tight loops must be discarded immediately

8.7.8. Bends

Bends are angular deformations of the rope caused by external influences.

Severe deformation results in excessive wear of the wire rope. Ropes with bends must therefore be discarded immediately.

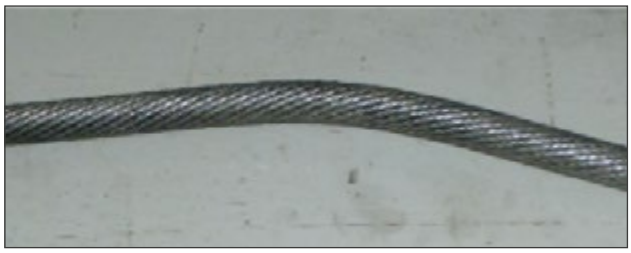


Fig.: Bend

8.8. Damage caused by exposure to heat or arcing

Wire ropes that have been exposed to exceptionally high temperatures must be discarded immediately. Visible signs on the rope's exterior include discoloration (to tempering colors) and/or a significant loss of lubricant.

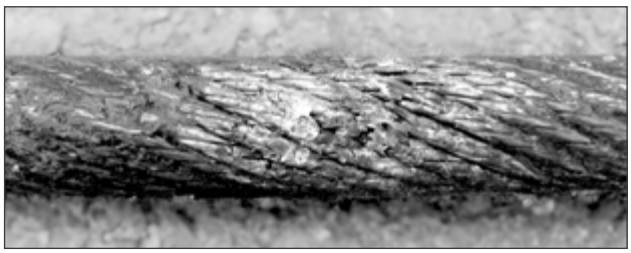
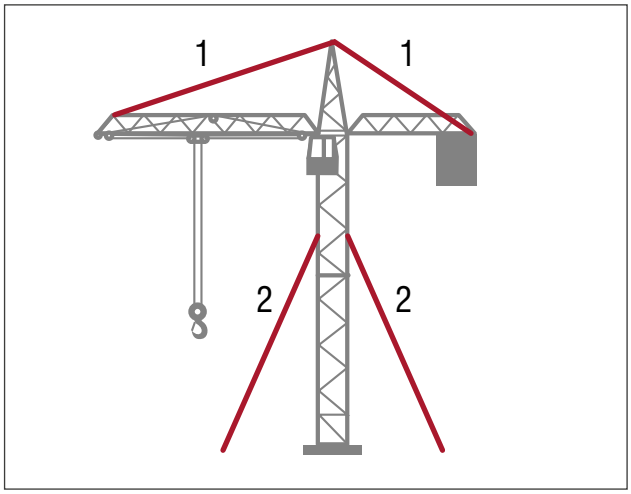


Fig.: Contact with high-voltage line

9. Inspection and point of discard of stationary ropes

Definition

As used herein, the term Stationary Ropes refers to installed stationary wire strand ropes which are not guided over pulleys or drums and on which no pulleys run. Essentially, they are pendants and guy ropes.



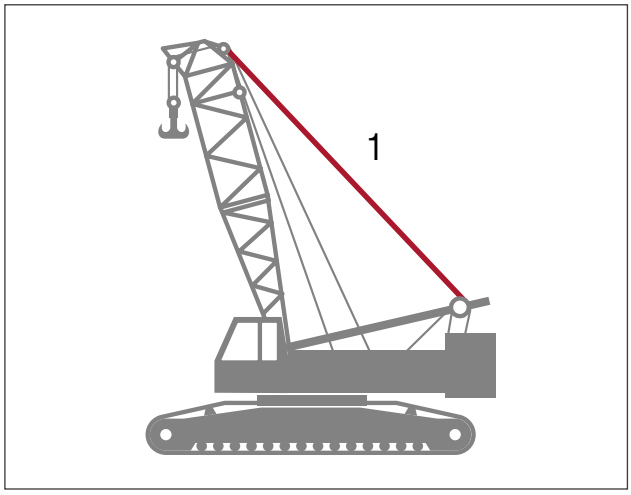


Fig.: Typical examples of stationary ropes in crane applications

9.1. Inspection and discard

9.1.1. General information

Generally, the safe use of stationary wire ropes is governed by the guidelines set forth in Chapters 7 + 8. Absent any instructions to the contrary in the system manufacturer's manual, the general principles for inspection according to Chapters 7 + 8 and the recommendations specified herein must be observed.

9.1.2. Frequency of inspections

In view of the way in which stationary ropes are installed, they are often not or only partially accessible. Therefore, performing daily visual inspections as well as regular inspections in accordance with Chapters 7 + 8 will be difficult and/or only possible after partial disassembly.

It is therefore recommended to specify operation-based inspection intervals, depending on the type of system or machinery, the usage and ambient conditions, and the frequency of use (e.g., based on rope operating hours), which define the time interval between regular inspections, and additionally, if necessary, an operation- and time-based discard criterion which results in the general discard of a rope, even without externally visible defects.

9.1.3. Scope of inspection

When inspecting stationary ropes, it is recommended that, in addition to the free rope length, special attention and appropriate care be accorded to the below-mentioned rope areas:

Rope areas close to the end terminations

The rope must be inspected in the vicinity of the end termination, especially at its point of entry into the termination, as this area is particularly susceptible to wire breaks caused by vibrations and other dynamic effects. The rope should be checked for loose wires, possibly suggesting the existence of wire breaks in the end termination.

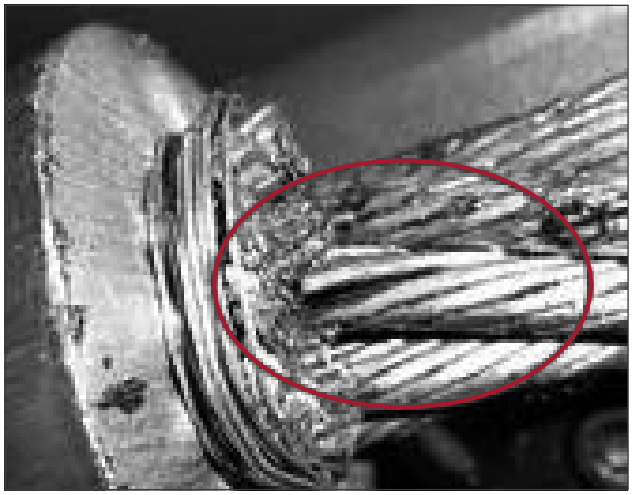


Fig.: Difficult-to-detect wire break at the exit from an aluminum ferrule

Especially ropes used in aggressive environments (salt water, industrial vapors, etc.) must be inspected for corrosion directly at the exit from the end termination. In view of the position of the end terminations (e.g., overhead), this is where a corrosive medium can accumulate and lead to corrosion.

End terminations

End terminations must be inspected for deformations, cracks, corrosion with pitting (no flash rust), and other distinctive flaws.

Distinctive flaws of typical end terminations:
In the case of cast end terminations, any possibly existing seizing must be removed for inspections. Furthermore, the socket basket must be checked for excessive slippage out of the socket body ("seating").

Note: A small amount of "seating" is normal for cast rope ends and is absolutely necessary for load transmission.

Swaged end terminations with aluminum ferrules or steel fittings must be checked for cracks in the swaging area of the ferrule or fitting and for slippage of the wire rope.
Rope ends with detachable end terminations (e.g., rope sockets, or wire rope clips) must be checked for wire breaks and corrosion in the clamped rope area, slippage of the rope, and loosening of the fastening screws.

Fig.: Excessive slippage of the socket basket out from the cast socket body

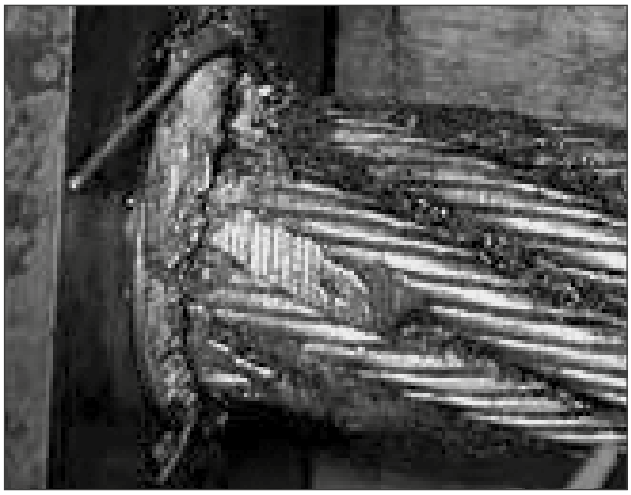


Fig.: Normal "seating"

Fig.: Cracks in a solid thimble

Fig.: Crack in the swaging area of an aluminum ferrule

Parts of the rope that are in contact with other components (e.g., rope saddles)

Stationary ropes must be checked for wire breaks, external mechanical wear, and corrosion, particularly in areas in contact with external components (e.g. rope saddles). It may be necessary to remove the ropes for this purpose.

9.1.4. Discard criteria

Generally, the discard criteria described in Chapters 7 + 8 shall apply.

However, contrary to the discard criteria listed in Chapters 7 + 8, it is recommended that stationary ropes be discarded when a wire break occurs at the exit from an end termination due to the rapid propagation of wire breaks.

10. Dismounting of wire ropes

The instructions given in Chapter 4 "Rope installation" must be observed accordingly.

11. Disposal of wire ropes

NOTE! Exercise caution when handling worn wire ropes or ropes with damaged (protruding) wires. Protruding wires pose an injury risk.

NOTE! Keep discarded wire ropes in a safe place, and clearly mark them as dismounted and worn ropes that must no longer be used.

Steel wire ropes can be disposed of as normal scrap steel. National regulations must be observed.

12. Normative references

The following standards must be applied to ropes according to DIN EN 12385-4 and be taken into account in connection with this User Manual:
DIN EN 12385-1/-2/-3/-4
DIN EN 13411-1/-2/-3/-4/-5/-6/-8/-9
DIN ISO 4309
as amended from time to time.

Other specific standards or national regulations must also be observed

13. Report templates

See templates acc. to DIN ISO 4309, Annexes E1/E2/E3

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