
Diepa®
DISCARD CRITERIA
www.diepa.de

INTRODUCTION

DIEPA Special Wire Ropes are designed to achieve longest lifetime and to provide best durability. And this in a huge variety of applications.

Nevertheless, running ropes are subject to different types of wear and other harmful effects. So, to ensure safe operation of a rope drive, it is mandatory to regularly check the rope's condition. The international standard ISO 4309 provides rules to judge the rope wear with respect to discard.

This brochure wants to give the user of DIEPA Special Wire Ropes an overview over the different types of wear and a guidance how to judge it according to ISO 4309. Naturally this can be only a rough overview.

If there are any uncertainties or questions left, please contact us.

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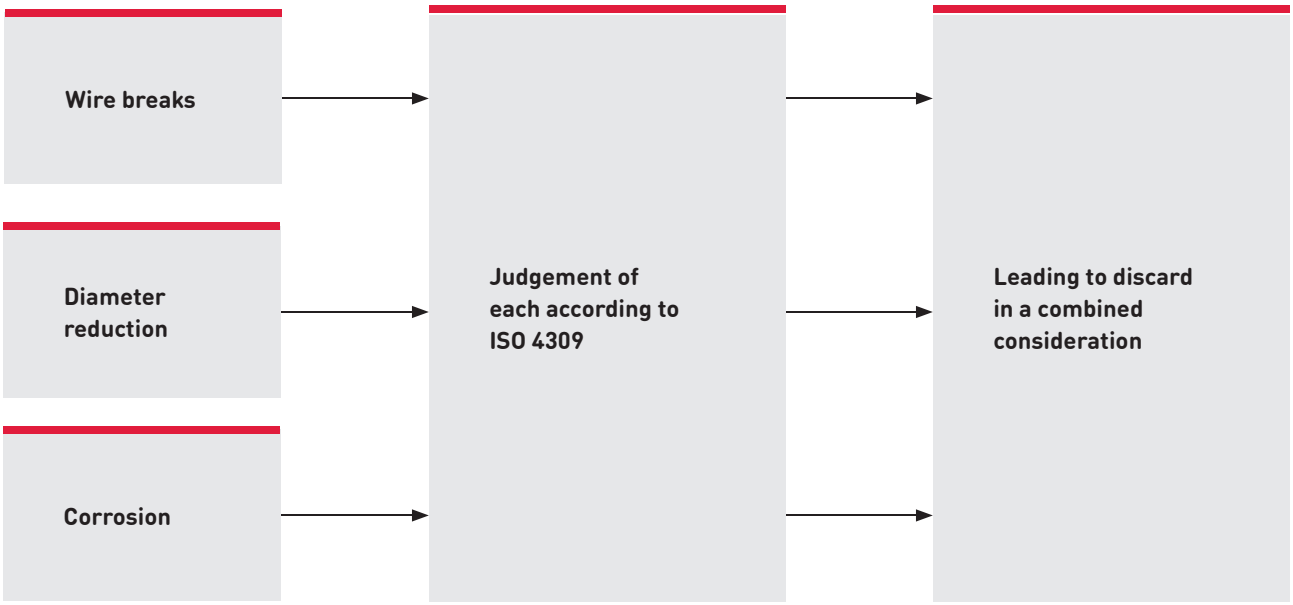
STEEL WIRE ROPES ARE ALWAYS SUBJECT TO WEAR **THUS, SERVICE LIFE NATURALLY IS LIMITED**

There are two main types of rope wear existing

REGULAR ROPE WEAR



IRREGULAR ROPE WEAR

⚠ **The safety of rope drives is highly depending on quality and frequency of rope wear monitoring!**

The following chapters give information how to deal with each of them.

WIRE BREAKS ARE THE MOST REGULAR WEAR **LOOK OUT FOR THEIR APPEARANCE**

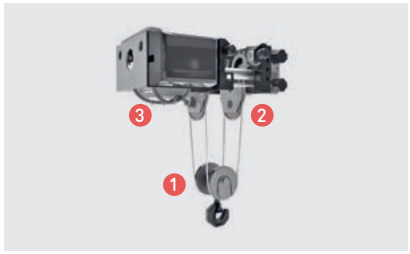
BASICALLY THE FOLLOWING TYPES OF WIRE BREAKS HAVE TO BE DISTINGUISHED:

Regular wear: **smooth wire breaks** on the outside due to mere bending fatigue, **see the following pages.**

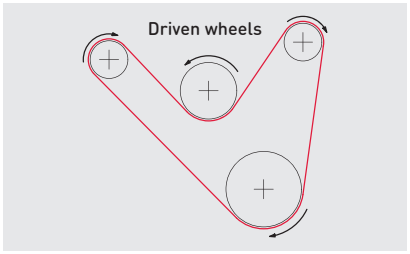
Lateral wire breaks due to internal rope wear. **Special attention is required – see page 13!**

DEFINE THE CRITICAL SECTIONS:

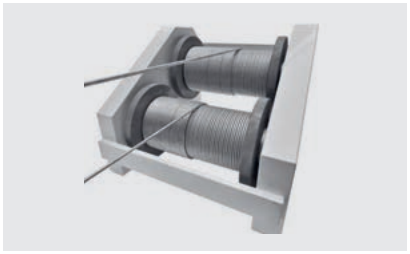
Before you start counting wire breaks think about the critical sections in your rope drive. These might for example be:



1. Sheaves of hook block
2. Compensation sheaves
3. Rope fixing point

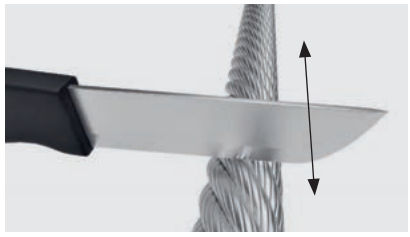


Sections of reverse bending

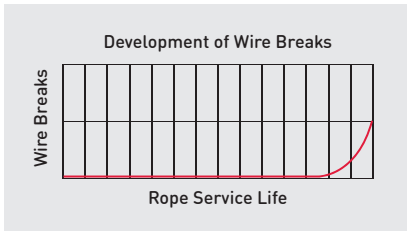


Sections of multilayer spooling
Special wear pattern, see page 11

FURTHER HINTS:



Use a knife to easily detect wire breaks by moving it alongside the rope.



Usually, the increase of bending fatigue wire breaks is not proportional to rope service life, see diagram. **Thus, inspection intervals may be defined according to the recent development of wire breaks.**

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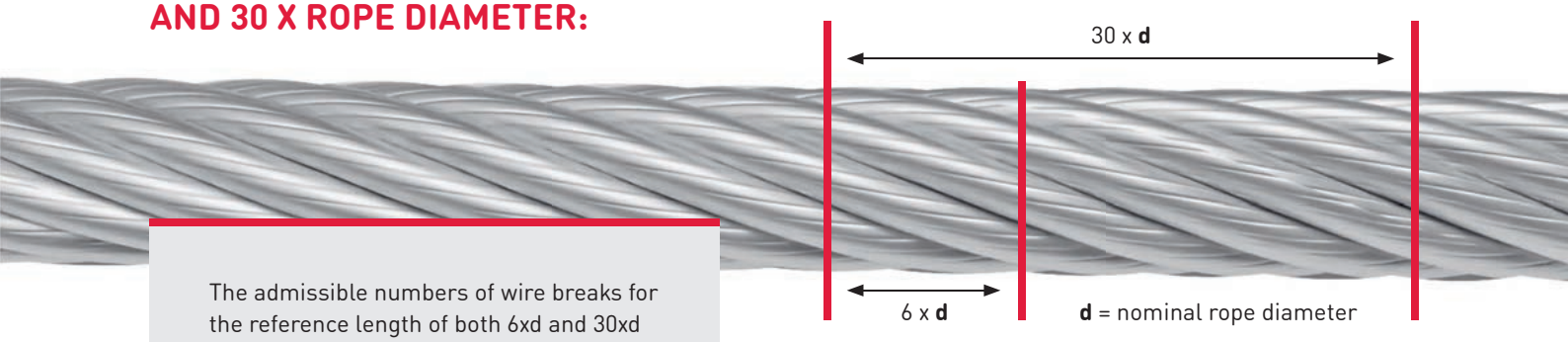
LENGTH DISTRIBUTION
OF WIRE BREAKS IS RELEVANT

CHECK FOR WIRE BREAKS ON A LENGTH OF 6 X ROPE DIAMETER AND 30 X ROPE DIAMETER:



The admissible numbers of wire breaks for the reference length of both 6xd and 30xd are given in the tables on the following pages. The reference sections can be placed independantly and do not need to overlap. If one of these two criteria is met, discard is reached!

HOW TO FIND OUT THE ADMISSIBLE NUMBER OF WIRE BREAKS:

For the classification of the admissible number of wire breaks, ropes are categorized by their **R**ope **C**ategory **N**umber (RCN) → see our catalogue or the DIEPA rope certificate.

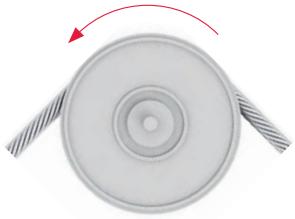
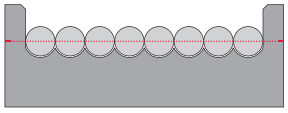
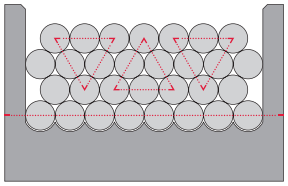
DIEPA rope certificate:

Seilkategorie nach ISO 4309 ..... : 23-2
rope category number / numero de categorie

152	Ø 4 – 14 mm	RCN.04
208	Ø 15 – 43 mm	RCN.09
288	Ø 44 – 65 mm	RCN.13
328	Ø 66 – 100 mm	RCN.13

The admissible numbers of wire breaks for DIEPA Special Wire Ropes in dependence of their Rope Category Number are listed on the following two pages.

ROTATION RESISTANT ROPES
ADMISSIBLE NUMBERS OF WIRE BREAKS

	Sections of rope working in steel sheaves and/or spooling on a single-layer drum		Sections of rope spooling on a multi-layer drum, see page 11	
				
	Smooth outer wire breaks, evenly distributed over		Outer wire breaks aggregate in crossing zones over	
Rope category number (RCN)	**6 x diameter**	**30 x diameter**	**6 x diameter**	**30 x diameter**
21	2	4	2	4
22	2	4	4	8
23-1	2	4	4	8
23-2	3	5	5	10
23-3	3	5	6	11
24	3	6	6	13
25	4	7	7	14
26	4	8	8	16
27	4	9	9	18
28	5	10	10	19
29	5	10	10	21
30	6	11	11	22
31	6	12	12	24
>31	6	12	12	24

⚠ If synthetic sheaves are used in combination with single layer spooling, the above values are not valid for discard judgement. Since rope wear in these cases shifts to the internal, **a reliable judgement of outer wire breaks is not possible!**

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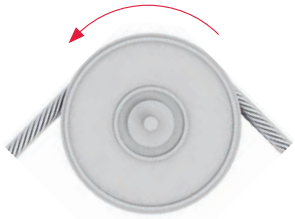
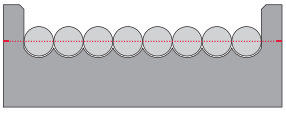
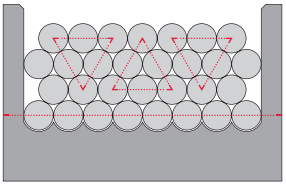
NON ROTATION RESISTANT ROPES
ADMISSIBLE NUMBERS OF WIRE BREAKS

	Sections of rope working in steel sheaves and/or spooling on a single-layer drum				Sections of rope spooling on a multi-layer drum, see page 11	
						
	Ordinary lay e. g. DIEPA X 43, X 53, H 43		Lang`s lay e. g. DIEPA X 55, H 45		All DIEPA rope types	
Rope category number (RCN)	Smooth outer wire breaks, evenly distributed over				Outer wire breaks aggregate in crossing zones over	
	6 x diameter	30 x diameter	6 x diameter	30 x diameter	6 x diameter	30 x diameter
01	2	4	1	2	4	8
02	3	6	2	3	6	12
03	4	8	2	4	8	16
04	5	10	2	5	10	20
05	6	11	3	6	12	22
06	6	13	3	6	12	26
07	7	14	4	7	14	28
08	8	16	4	8	16	32
09	9	18	4	9	18	36
10	10	19	5	10	20	38
11	10	21	5	10	20	42
12	11	22	6	11	22	44
13	12	24	6	12	24	48

⚠ If synthetic sheaves are used in combination with single layer spooling, the above values are not valid for discard judgement. Since rope wear in these cases shifts to the internal, **a reliable judgement of outer wire breaks is not possible!**

ℹ **Twice the number of broken wires listed may be applied to ropes on mechanisms where classification is known to be M5 to M8.**

MECHANICAL WEAR OF THE OUTER STRANDS
LEADS TO A REDUCTION OF THE ROPE'S DIAMETER.

USE A SUITABLE CALIPER TO MEASURE THE ROPE DIAMETER:

IF THERE IS NO SPECIAL CALIPER AVAILABLE, ENSURE TO MEASURE IN THE CORRECT WAY:

HOW TO DETERMINE THE SEVERITY GRADE OF THE DIAMETER REDUCTION

1. Define the reduction by subtracting the actual diameter from the diameter of the new rope.

ℹ If you do not have the real diameter of the new rope calculate it by 1,04 times the nominal diameter.

ℹ The diameter of the new rope can also be obtained from the rope certificate.

2. Relate the calculated reduction to the rope's nominal diameter by using the following formula:

$$\frac{\text{diameter reduction } \textbf{[mm]}}{\text{rope´s nominal diameter } \textbf{[mm]}} \times 100$$

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DIAMETER REDUCTION
CALCULATION AND LIMITS

EXAMPLE

Diameter of the new rope (mm) **20,9 mm** — Actual diameter by check (mm) **19,7 mm**

NEXT STEP

$$\frac{\text{Result [mm]}\ \mathbf{1,2\ mm}}{\text{Nominal diameter [mm]}\ \mathbf{20\ mm}} \times 100 = \boxed{\mathbf{6\ \%}}$$

Rope type	Uniform decrease in diameter (expressed as % of nominal diameter)	Severity rating	
		Description	%
Non-rotation resistant rope	Less than 3,5 %	–	0
	3,5 % and over but less than 4,5 %	Slight	20
	4,5 % and over but less than 5,5 %	Medium	40
	5,5 % and over but less than 6,5 %	High	60
	6,5 % and over but less than 7,5 %	Very high	80
	7,5 % and over	Discard	100
Rotation resistant rope	Less than 1 %	–	0
	1 % and over but less than 2 %	Slight	20
	2 % and over but less than 3 %	Medium	40
	3 % and over but less than 4 %	High	60
	4 % and over but less than 5 %	Very high	80
	5 % and over	Discard	100

⚠ The severity values given above are valid for a rope section spooling on a single layer drum and / or running through a steel sheave. Their rating can be combined with other discard aspects, see page 12.

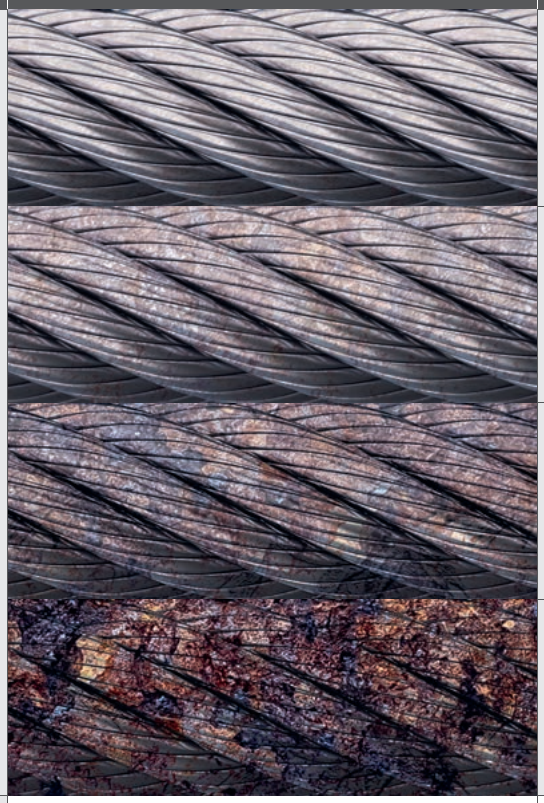
⚠ CAUTION: A **locally concentrated** decrease of rope diameter leads directly to discard!

CORROSION PROVOKES WIRE BREAKS, **REDUCED METALLIC AREA AND FRICTION**

Corrosion is a result of **lacking protection**, i. e. lubrication, in combination with certain ambient conditions like e. g. **humidity, sea climate, corrosive atmospheres**.

Corrosion leads to **reduced metallic area** and forwards **superficial defects** which promote bending fatigue cracks. In a progressed state **internal rope friction** will be increased remarkably.

The judgement of corrosion to some extent remains subjective, thus the following examples may help.

Type of corrosion	Characteristics	Severity rating
External corrosion		Signs of surface oxidation but can be wiped clean **Superficial – 0 %**
		Wire surface rough to touch, surface not cleanable **Slightly – 20 %**
		Heavily corroded and surface very rough to touch **High – 60 %**
		Wire surface heavily pitted and slack wires **Discard – 100 %**
Internal corrosion	Obvious visible signs of internal corrosion – i. e. corrosion debris exuding from the valleys between the outer strands	Discard – 100 % or internal examination if feasible
Fretting corrosion	The process of fretting involves the removal of fine particles of steel from the wires due to dry wires and strands constantly rubbing together and then oxidizing and creating internal corrosion debris, which manifests itself as a dry powder, similar to a red rouge.	Evidence of such a characteristic should be further investigated and if there is any doubt about its severity, the rope should be discarded (100 %).

ℹ External corrosion can be prohibited by re-lubrication if necessary.

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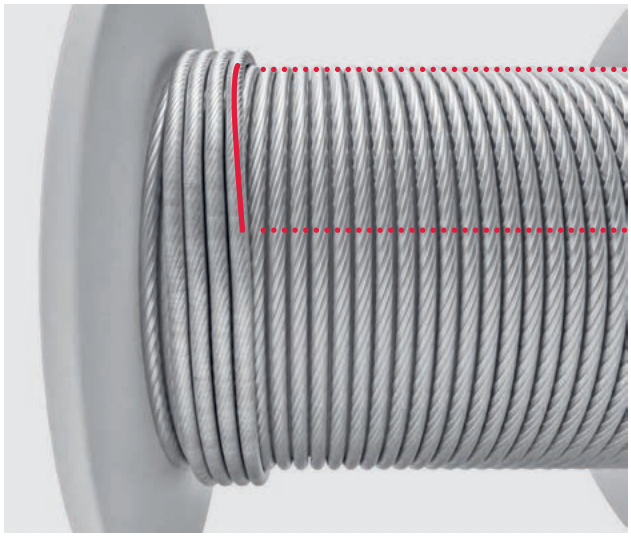
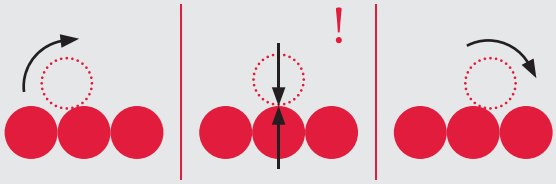
MULTILAYER WEAR
SHOWS A SPECIFIC CHARACTERISTIC

Ropes operated in multilayer systems usually show their predominant wear in the zones of rope layers crossing upon rope layers.

The crossing zones are most critical due to high local pressure.

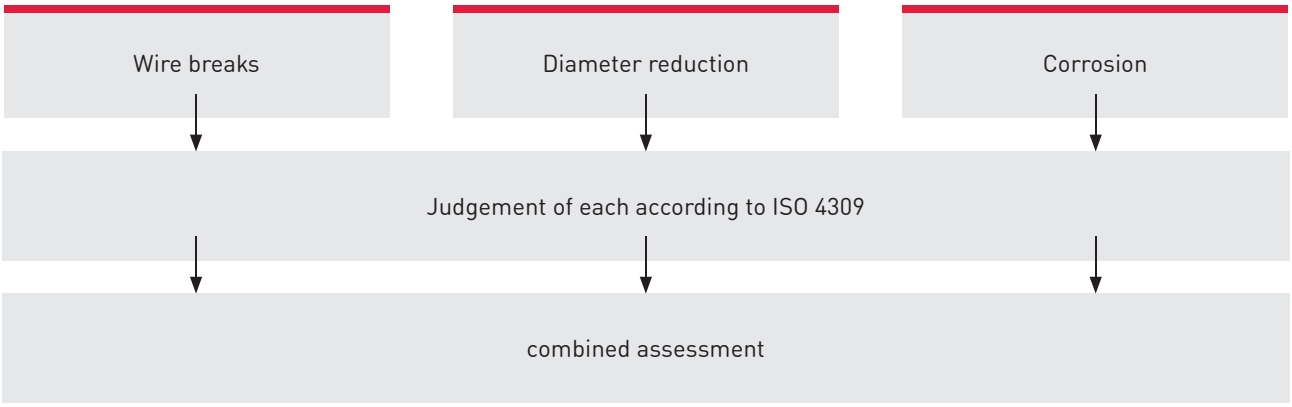
Linear single line contact leads to high pressure, slipping movements contribute mechanical abrasion. Both causing mechanical surface defects and wire breaks.





For the admissible numbers of wire breaks located in crossing zones, individual limits are existing.
See right columns on pages 6 and 7.

SIGNS OF REGULAR WEAR
ARE JUDGED IN A COMBINED CONSIDERATION



EXAMPLE 1:

Rope **DIEPA X53 diameter 30 mm (RCN.09)** running in an overhead hoist with single layer spooling, machine class unknown, ordinary lay

Result: The overall severity rating is 66 % to discard; the rope may remain in service. Closer attention shall be taken to further rope checks.

Admissible number of wire breaks according table page 7
- 9 wire breaks | over 180 mm
- 18 wire breaks | over 900 mm
- Actual rope diameter (mean value) 30,55 mm

ℹ No visible signs of corrosion on the outside, no red coloured powder from inside

Actually present
- 5 wire breaks | over 180 mm | 55 % discard
- 12 wire breaks | over 900 mm | 66 % contribution to discard
- Diameter reduction of 1,66% | 0 % contribution to discard
- Corrosion | 0 % contribution to discard

EXAMPLE 2:

Rope **DIEPA B55 diameter 21mm (RCN.23-2)** running in a mobile crane with multilayer spooling, machine class unknown examined rope section: multilayer crossing zones

Result: The overall severity rating is 70 % to discard; the rope may remain in service. Closer attention shall be taken to further rope checks.

Admissible number of wire breaks according table page 6
- 5 wire breaks | over 126 mm
- 10 wire breaks | over 630 mm
- Actual rope diameter (mean value) 19,05 mm

ℹ No visible signs of corrosion on the outside, no red coloured powder from inside

Actually
- 2 wire breaks | over 126 mm | 40 % discard
- 7 wire breaks | over 630 mm | 70 % contribution to discard
- Diameter reduction | not relevant, see page 9
- Corrosion | 0 % contribution to discard

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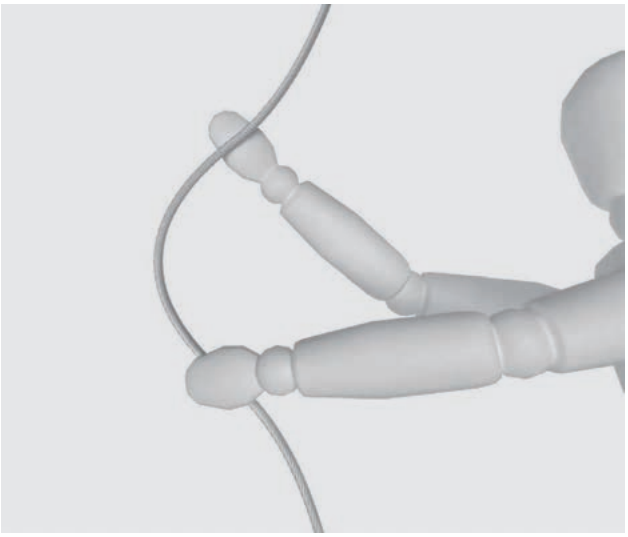
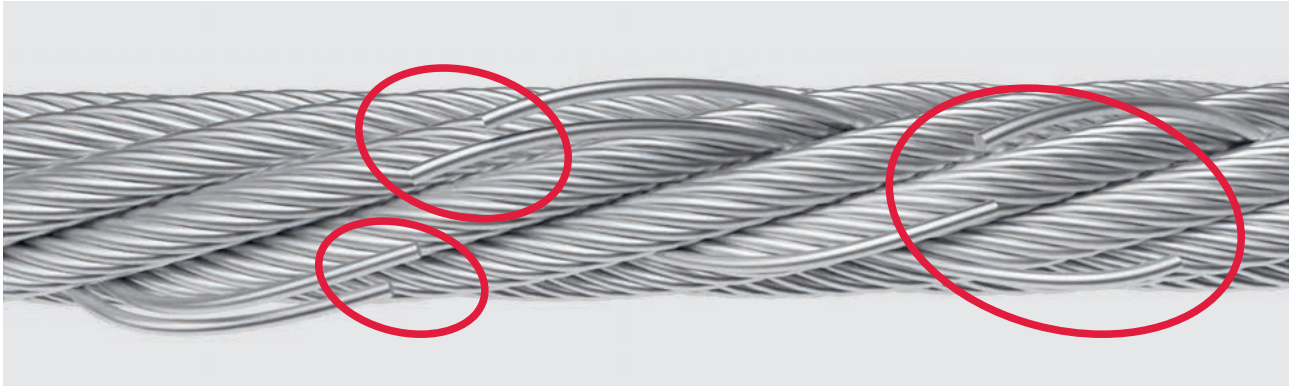
LATERAL WIRE BREAKS
NEED SPECIAL ATTENTION

Lateral wire breaks are a malicious type of wear. They are not necessarily obviously noticeable. The grade of wear within the rope may be much more higher than what is visible from the outside.

Bending a rope helps to detect lateral wire breaks.



Also, a **seemingly intact** rope can show **lateral wire breaks** when being bent.



If two or more wire breaks in a rope lay length (approx. a length of 6xd) are present, the rope has to be discarded immediately!

WIRE BREAKS AT THE TERMINATION
MAY NOT BE LEFT OUT OF CONSIDERATION

Wire breaks at end terminations like e. g. poured sockets are bending fatigue induced. If lateral vibrations of the rope are stopped at the end termination, bendings with a relatively small D/d-ratio are the result at the edge where the rope enters the socket. This results in acceleratd appearance of bending fatigue wire breaks.

The presence of water may support corrosion which supports the development of wire breaks.

⚠ **If two or more wire breaks at the end termination are present, the rope has to be discarded immediately!**

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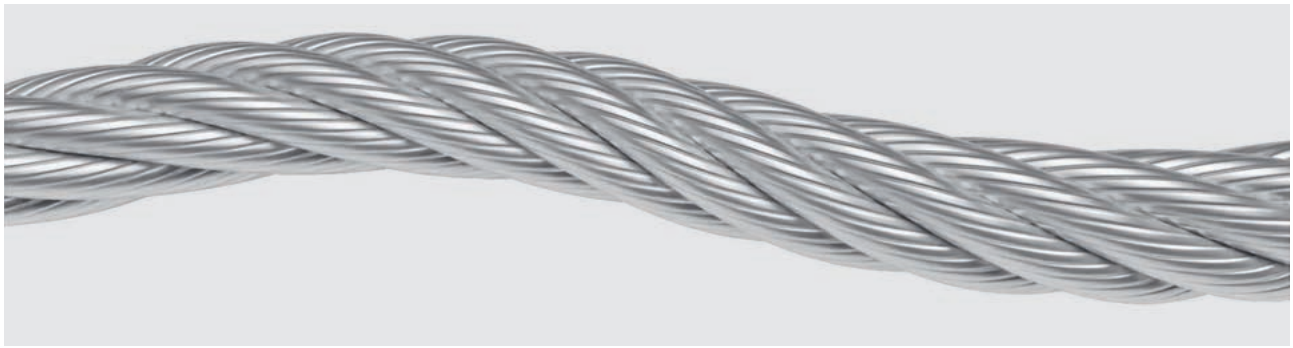
WAVINESS AND CORK SCREW
STRUCTURAL DEFECTS CAUSED BY TWIST

Waviness is a disturbance of the rope structure mainly generated by twisting the rope along its longitudinal axis. Up to a certain limit the rope may remain in operation. In a stronger extent of this phenomenon the rope's longitudinal axis takes a helical shape of a cork screw. In this state the equal load distribution among the rope elements is seriously disturbed thus leading to local overload.

MODERATE EXAMPLE

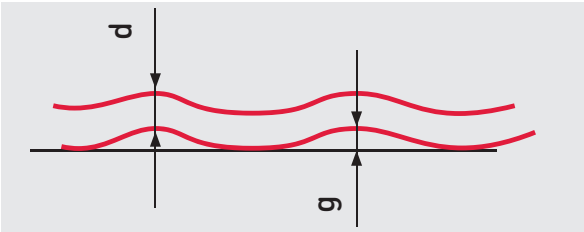
SEVERE EXAMPLE



DICARD CRITERION:

- Rope section **not running through** sheaves or onto drums: g_{max} = 1/3 x d
- Rope section **running through** sheaves or onto drums: g_{max} = 1/10 x d

⚠ **Ropes exceeding above limits have to be discarded immediately!**

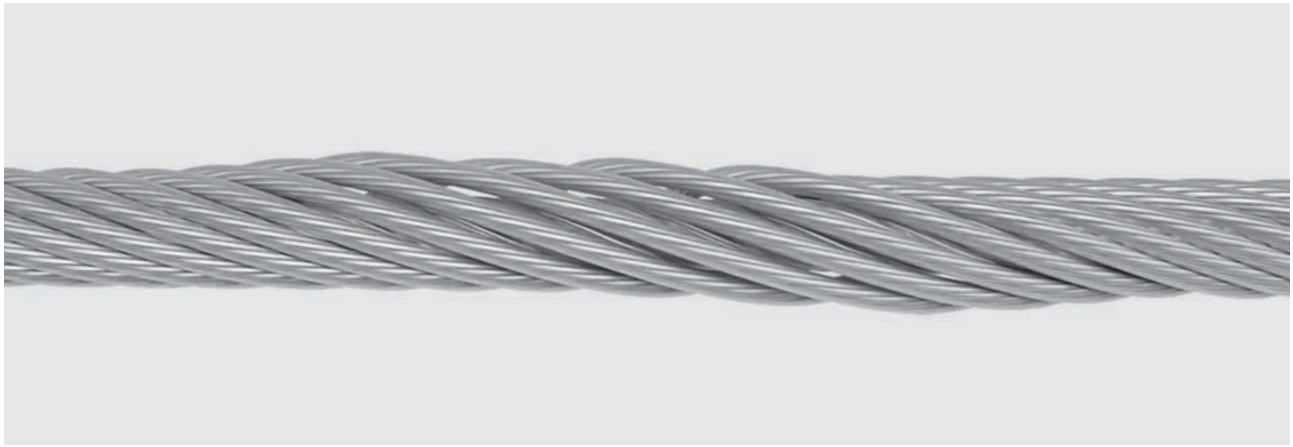


Key: d – nominal rope diameter | g – gap

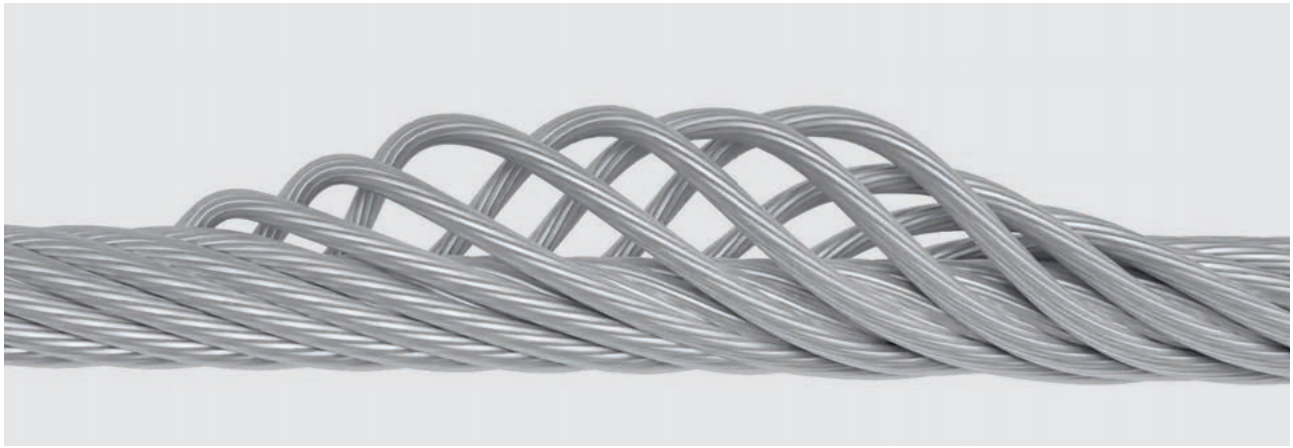
BIRD CAGEING
MAINLY AFFECTS ROTATION RESISTANT ROPES

Bird caging is a phenomenon where wires of outer strands are displaced and protruding the outer rope surface due to surplus length. This can predominantly be found on rotation resistant ropes. Bird caging mainly is a result of twist. Like for waviness, the equal load distribution in the rope section is disturbed with the **risk of overloading** single elements. Furthermore, passing through sheaves can provoke further mechanical damage!

MODERATE EXAMPLE



SEVERE EXAMPLE



⚠ Ropes with signs of bird caging must be discarded immediately!

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PROTRUDING ELEMENTS
DISTURB THE ROPE STRUCTURE

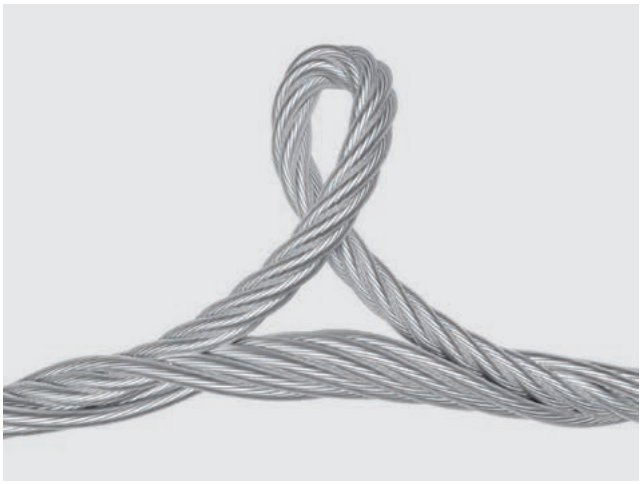
PROTRUDING STRANDS

MAINLY ON ROTATION RESISTANT ROPES DUE TO

- Torque imposed into the rope
- Sudden load relief

Severe structural defects naturally lead to unequal load distribution between the rope elements.

PROTRUDING ROPE CORE

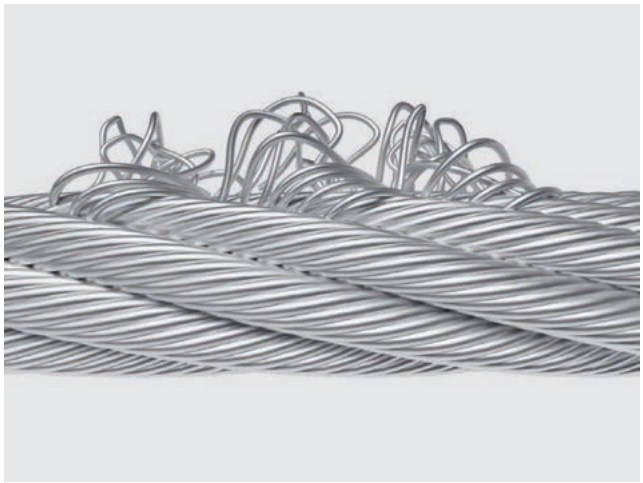


MAINLY ON ROTATION RESISTANT ROPES DUE TO

- Torque imposed into the rope
- Sudden load relief

⚠ **Ropes with protruding inner elements have to be discarded immediately!**

WIRES FORMING LOOPS

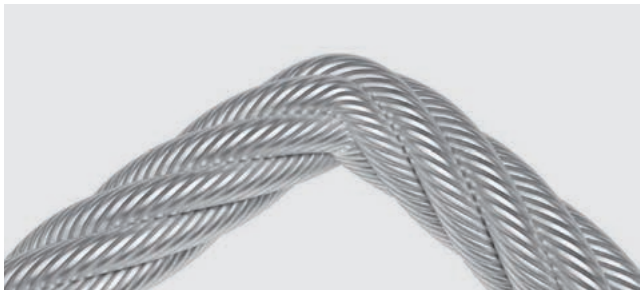


Protruding wires are a result of increased friction within the rope, which hindering the relative sliding movement of the wires.

⚠ **Ropes with protruding wires have to be discarded immediately!**

WIRE ROPE DAMAGES
CAN APPEAR IN VARIOUS SHAPES

SEVERE BEND



The judgment of bends is somehow subjective. With a light deformation in a section not running over a sheave, a rope might stay in service. Otherwise discard is necessary - in case of doubt please contact us!

⚠ **Ropes with severe bends like shown above have to be discarded immediately!**

TIGHTENED LOOP

A tightened loop most often is a result of wrong rope handling. Mechanical deformation leads to imbalance of load distribution. Hence rope strength can be reduced seriously.

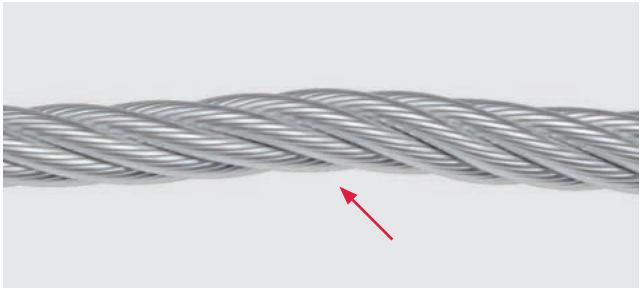
⚠ **Ropes with tightened loops have to be discarded immediately!**

MECHANICAL DAMAGE OF SURFACE

Mechanical damages of the rope surface often are a result of interference with rigid structures, like e. g. edges. Accelerated development of wire breaks is the result. Hence discard is necessary.

⚠ **Ropes with mechanical damages on the rope surface have to be discarded immediately!**

LOCAL DIAMETER DECREASE



Local diameter decrease most likely is a sign for a broken inner rope element, like a broken rope core. Rope strength is considerably decreased.

⚠ **Ropes with local diameter decrease must be discarded immediately!**

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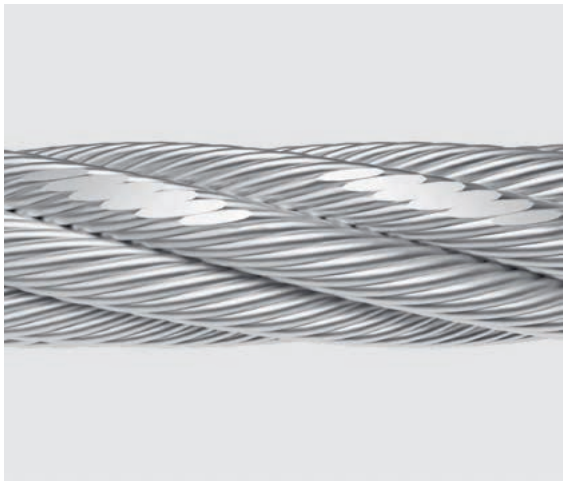
FURTHER DEFECTS
BUT NOT TO BE OMITTED

FLATTENED ROPE SECTIONS



Flattened rope sections are a result of mechanical impact:

Progressing wear e. g. in form of wire breaks is favored in these areas. Hence a more frequent inspection of these rope sections is advised if kept in service.

Depending on the extent of the disturbance, discard may be considered.

If the flattened sections are resulting from multilayer use, then the admissible number of wire breaks for this are the discard criterion.

LOCAL DIAMETER INCREASE

A local diameter increase might happen due to a disturbed rope core. The reason for this shall be investigated.

⚠ **If the local increase in diameter exceeds more than 5% related to the rope's actual diameter, discard should be considered.**

EXCESSIVE HEAT OR ELECTRIC ARC

The following phenomena indicate the influence of excessive heat or an electric arc:

- **blue discolouring** of the wire surface like temper color on local area give the hint for an **electric arc**, maybe due to welding operations
- **dry rope** and **complete loss of lubrication** are a typical appearance of a rope surface from applications with **extraordinary heat exposure**. High friction and overload of single rope elements may be the result

⚠ **In case of signs of heat influence the rope shall be discarded immediately!**

ADMISSIBLE NUMBER OF WIRE BREAKS **FOR DIEPA ELEVATOR ROPES**

ACCORDING TO EN 12358-5 "Stranded ropes for lifts"

	diameter		number of visible broken outer wires[1] over a length of	
rope type	from	to	6 x d^2	30 x d^2
DIEPA A 160 S	8	24	3	6
DIEPA A 190 S	8	24	3	6
DIEPA S 819 P	6	24	6	13
DIEPA A 139	6	20	6	12
DIEPA A 106	4		4	8
	5	6,5	6	12
DIEPA A 160	7	16	6	12

[1] Given numbers of wire breaks are based on DIN 15 020, mechanism group 2_m bis 5_m.
[2] d = nominal diameter of rope

⚠ In addition to the number of visible wire breaks, all other discard criteria according to ISO 4344 and ISO 4309 in their respective valid versions apply for determining discard limit.

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INSPECTION RECORD TEMPLATE
FOR SUBSEQUENT ROPE INSPECTIONS

ACCORDING TO ISO 4309


Information

Inspection Record Template
for subsequent **rope inspections** according to **ISO 4309**

General Data
Crane reference
Rope application type
DIEPA rope type
Nominal diameter
Direction and type of lay
reference diameter
permissible numbers of broken outer wires
RHOL
LHOL
RHLL
LHLL
RCN
6d
30d
date of installation
remark: see **DIEPA rope certificate**
remark: see **ISO 4309**

Inspection results

No	Date	Visible broken wires: number in length of 6d	30d	position in rope 6d	30d	severity rating 6d	30d	Diameter: actual diameter mm	decrease from reference mm	position in rope m	severity rating %	Corrosion: position in rope m	severity rating %	Other damage / deformation: position in rope m	severity rating %	Combined severity rating (overall assessment) %
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																

Signatures

	Name of competent person	Signature of competent person
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

DIEPA DRAHTSEILWERK DIETZ GMBH & CO. KG

Download your Inspection Record Template!

As of 09/2024 – We can accept no liability for mistakes and printing errors. Binding for discard judgement are always the actual versions of the DIEPA operating manual and ISO 4309.

FOR A DEEPER INSIGHT
BELOW PUBLICATIONS MAY BE HELPFUL

[1] Original Operating Manual for DIEPA Special Wire Rope acc. MD 2006/42/EC

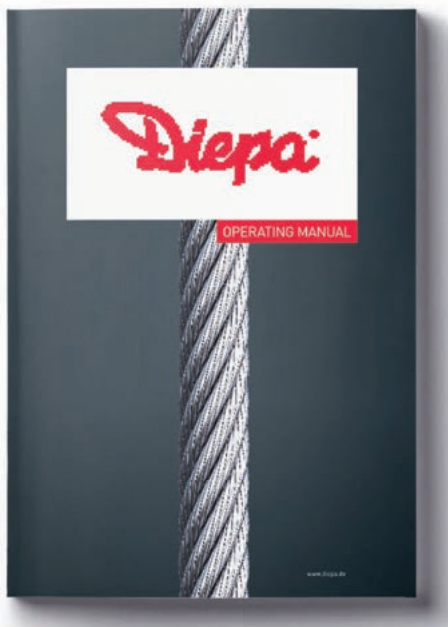
[2] ISO 4309, Cranes – Wire ropes – Care and maintenance, inspection and discard

[3] ISO 16625, Cranes and hoists – Selection of wire ropes, drums and sheaves

[4] EN 12385 – 3, Steel wire ropes – Safety; Part 3: Information for use and maintenance

[5] VDI 2358, Drahtseile für Fördermittel

[6] Feyrer, Klaus: Wire Ropes – Tension, Endurance, Reliability, Springer Verlag 2007



Download the "Operating Manual" brochure

Download the "Installation and Maintenance" brochure

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09/2024