# INFORMATIVE PUBLICATION 10/I

## WIRE ROPES FOR LIFTING APPLIANCES.
## GUIDELINES FOR CONDITION ASSESSMENT

January
2022

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as guidance or explanatory notes to PRS Rules

GDAŃSK

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This *Informative Publication* replaces the *Informative Publication No. 10/I – Wire Ropes for Lifting Appliances. Guidelines for Condition Assessment* – 2016.



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Str.

# 1 INTRODUCTION

A wire rope on a lifting appliance is regarded as a wearing element, requiring replacement when the results of inspection indicate that its condition has diminished to the point where further use would be unwise from a safety standpoint. The rope lifetime depends on the lifting appliance workload, the rope technical condition and intended use, and on environmental operational conditions.

The safe handling of loads may be ensured through periodical examinations of ropes, so that they are removed from service in adequate time. The examinations of wire ropes apply, irrespective of operational conditions, the wear criteria, taking into account the number of broken wires, the rope abrasion, corrosion and deformation.

The mentioned criteria are described in this Publication, aimed at checking safety reserve of operated wire ropes and determining their safety margin, after transgressing of which the rope should be discarded. Failure to recognize them can be dangerous for the users of lifting appliances.

The below specified principles may be also applied to wire ropes used in appliances other than used for lifting, but with similar type of operation.

The new issue of *Publication 10/I* is based on the below standards:

– PN-EN 12385 – 1 Steel wire ropes – Safety – Part 1: General requirements 2008/2009.
– PN EN 12385 – 2 Steel wire ropes – Safety – Part 2: Definitions, designation and classification
– PN EN 12385 – 3:2021-5 Steel wire ropes – Safety – Part 3: Information for use and maintenance
– PN EN 12385 – 4 Steel wire ropes – Safety – Part 4: Stranded ropes for general lifting applications;
– ISO 4309: 2010 – Cranes – Wire ropes – Care and maintenance, inspection and discard;
– ISO 17558:2006(en) - Steel wire ropes — Socketing procedures — Molten metal and resin socketing

and reports:

– HSE OTH 341 – Wire rope offshore – review of wire rope endurance research affecting offshore applications;
– HSE OTO 2000 064 – Wire rope Non-Destructive Testing – Survey of Instrument Manufactures
– HSE OTO 2000 069 - Resin-Socketed Termination of Offshore Wire Ropes

# 2 WIRE ROPES EXAMINATION AND TETSTING

## 2.1 General examination

The wire rope shall be examined along its whole length, taking into account the following portions:

– sections at the ends of ropes – both the winding and the fixed ones (stays, preventer guys, shrouds);
– sections of wire ropes winding under load over pulleys or pulley blocks (See Attachment 1);
– sections of wire ropes wound over the compensating pulley;
– sections subjected to abrasion by contact with external elements (e.g. hatch coaming);
– sections particularly subjected to corrosion and fatigue (see Attachment 2);

The user shall maintain the *Wire rope examination record* and make there entries on the examination results (example of such *Record* is given in Attachment 3).

## 2.2 Close-up examinations

**2.2.1** Close-up assessment of technical condition of wire ropes for detection of invisible damages or corrosion may be performed with the use of NDT techniques able to detect internal damages in the rope (such as cracked wires), with the magnetic inspection (MRT) being the most frequently applied.

**2.2.2** The Magneto-Inductive Rope Testing (MRT) includes: generating strong magnetic field acting on structural material of rope for its magnetization to reach full saturation (> 1.9 Tesla), the measurement of magnetic field and its changes and processing of collected information into usable format. The testing is executed with a speed up to 4 m/s and the results may be currently visualized, documented and analyzed, in accordance with the requirements for the given supervision.

**2.2.3** Damages inside the rope result in the dispersion of magnetic field, which is measured for the whole rope or for its selected portions. The method enables detection of a number of damages at early stage of their occurrence and propagation, e.g.:
- internal and external broken wires
- internal and external corrosion
- clamping points
- grooves
- notches
- structural changes

**2.2.4** The method enables detection, analysis and monitoring of the condition of the rope structure both of small and large diameter, e.g. from 4 to 140 mm. The assessment methods include simultaneous visual assessment and are used for current assessment of wire rope technical condition for its safe operation. The MRT allows for defining the level of internal damage or wear of the rope and wires for prediction of their possible service time.

**2.2.5** Detailed guidelines for the application of selected methods and assessment of testing results shall be subject of a separate agreement with PRS.

## 2.3 Testing of rope terminations

**2.3.1** Testing of rope termination made by metal or resin socketing shall be conducted according to ISO 17558 std.

**2.3.2** The rope shall be examined in the area where it passes out from the termination, as this position is critical for the onset of fatigue damages (e.g. wire breaks) and corrosion. The terminal fittings themselves shall be examined for signs of distortion or wear.

**2.3.3** Terminations involving pressed or swaged ferrules shall be similarly examined, and the ferrule shall be checked for cracks in the material and possible slippage between the ferrule and the rope.

**2.3.4** Detachable terminations (wedge sockets, grips), shall be examined for broken wires within and under the termination and at its rim to ensure the tightness of wedges and screwed grips.

**2.3.5** Eye splices made by hand shall be served only over the tail of the splice so as to protect the hands from protruding wire, while at all times allowing the remainder of the splice to be inspected for wire breaks. When broken wires become evident close to, or within, the termination, it may be possible to shorten the rope and re-fix the terminal fittings. However, the remaining length of the wire rope shall be sufficient to allow for the minimum required number of rope turns on the drum.

2.3.6 In case of detection of any abnormalities in the wire rope detected, the rope is to be immediately removed from service and relevant details are to be included in the survey report created.

## 3 CRITERIA FOR THE ASSESSMENT OF WIRE ROPES WEAR

The assessment of wire rope wear is performed considering the following criteria:

- the number of broken wires in the rope,
- broken wires at rope end terminals,
- localized grouping of wire breaks,
- the rate of increase of the wire breaks,
- the fracture of strands,
- reduction of rope diameter resulting from core deterioration,
- decreased rope elasticity,
- external and internal abrasion,
- external and internal corrosion,
- rope deformation,
- damage due to heat radiation or electric arc,
- the rate of increase of rope permanent elongation.

### 3.1 Number of cracked wires in the rope

The level of rope wear may be defined on the basis of the number of broken wires in the external layer (irrespective of the number of layers in the rope). The filling wires do not carry loads, therefore they shall not be considered. In steel core ropes, the core is regarded as internal strand and it is not taken into account. In the case of 6- and 8- strand ropes, broken wires occur mainly at the external surface, while in multi-strand ropes majority of breaks occurs internally, and are therefore non-visible fractures. This is considered in the wear criteria, given in Table 3.1.

**Table 3.1**

| No. of load bearing wires in outer strands *n* | Typical examples of rope structure | Group of work intensity of the crane | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0 | | | | I – IV | | | |
| | | Kind of rope and length of examined portions *L* | | | | | | | |
| | | ordinary lay | | langs lay | | ordinary lay | | langs lay | |
| | | 6*d* | 30*d* | 6*d* | 30*d* | 6*d* | 30*d* | 6*d* | 30*d* |
| | | Number of visible broken wires on the length *L* qualifying the rope for replacement | | | | | | | |
| Up to 50 | 6 × 7 /6/1/ | 2 | 4 | 1 | 2 | 4 | 8 | 2 | 4 |
| 51 to 75 | 6 × 19 /9/9/1/*<br>12 × 6/3 × 24 | 3 | 6 | 2 | 3 | 6 | 12 | 3 | 6 |
| 100 to 120 | 8 × 19 /9/9/1/*<br>6 × 19 /12/6/1/<br>6 × 19 /12/6+6F/1/<br>6 × 25F8 /12/12/1/*<br>34 × 7 /17 ext. strands/ | 5 | 10 | 2 | 5 | 10 | 19 | 5 | 10 |
| 121 to 140 | – | 6 | 11 | 3 | 6 | 11 | 22 | 6 | 11 |
| 141 to 160 | 8 × 19 /12/6+6F/1/ | 6 | 13 | 3 | 6 | 13 | 26 | 6 | 13 |
| 161 to 180 | 6 × 36 /14/7+7/7/1/* | 7 | 14 | 4 | 7 | 14 | 29 | 7 | 14 |
| 181 to 200 | – | 8 | 16 | 4 | 8 | 16 | 32 | 8 | 16 |
| 201 to 220 | 6 ×41 /16/8+8/8/1/* | 8 | 18 | 4 | 9 | 18 | 36 | 9 | 18 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 221 to 240 | 6 × 37 /18/12/6/1/ | 10 | 19 | 5 | 10 | 19 | 38 | 10 | 19 |
| 241 to 260 | – | 10 | 21 | 5 | 10 | 21 | 42 | 10 | 21 |
| 261 to 280 | – | 11 | 22 | 6 | 11 | 22 | 45 | 11 | 22 |
| 281 to 300 | – | 12 | 24 | 6 | 12 | 24 | 48 | 12 | 24 |
| Above 300** | – | 0.04$n$ | 0.08$n$ | 0.02$n$ | 0.04$n$ | 0.08$n$ | 0.16$n$ | 0.04$n$ | 0.08$n$ |

*d* – rope diameter

* Rope structures in service, having outer wires in the strands of larger diameters than required in obligatory standards.

** Calculated values shall be rounded off to a whole number.

### 3.2 Broken wires at rope termination

Broken wires at, or adjacent to, the termination, even if few in number, is an indication of high stresses at this position, which may be caused by incorrect fitting of the termination. Investigation of the cause of this deterioration shall be made and. After cutting the damaged length, the rope termination may be fixed again if sufficient length remains for further use.

### 3.3 Localized grouping of broken wires

Where broken wires are very close together, constituting local grouping of such breaks in a length less than 6d or is concentrated in any one strand, it will be safer to discard the rope even when the number of wire breaks is smaller than the maximum number given in Table 3.1.

### 3.4 The rate of increase of broken wires

In applications where the predominant cause of rope deterioration is fatigue, the commencement of broken wires will begin after a certain period of usage, but the number of breaks will progressively increase at ever-shortening intervals. In such cases, it is recommended that careful examination and recording of the increase of broken wires should be undertaken with a view to establishing the rate of increase of the breaks. It shall enable to approximate the date of the rope discard.

### 3.5 Fracture of strands

If a complete strand fracture occurs, the rope shall be discarded.

### 3.6 Reduction of the rope diameter due to core deterioration

If deterioration of a fibre core or fracture of a steel core (fracture of internal layers in a multi-strand construction) cause reduction of rope diameter, the rope shall be discarded.

Small deterioration may not be so apparent from normal examination, particularly if the rope stresses are well balanced throughout the individual strands. However, the condition may result in a high loss of the rope strength, therefore it is recommended that any suggestion of such internal deterioration should be verified by internal examination. Where such deterioration is confirmed, the wire rope shall be discarded (see Attachment 2).

### 3.7 Decreased rope elasticity

Under certain circumstances usually associated with the working environment, a rope may sustain a substantial decrease in elasticity and will be unsafe for further use.

Decreased elasticity is difficult to detect directly; usually it brings the following symptoms:

– reduction of rope diameter, not result of wires abrasion,
– elongation of the rope lay length,

– lack of gap between individual wires and between strands, caused by the compression of the component parts against each other (tendency to protrude wires or strands out of the rope),
– the appearance of fine, brown powder within the strand gussets,
– while no wire breaks may be visible, the wire rope will be noticeably stiffer to handle.

This condition can lead to abrupt failure under dynamic loading and is sufficient justification for immediate discard.

### 3.8 External and internal wear

The wear is caused by two kinds of factors:

– abrasion of the crown wires of outer strands in the rope in result of rubbing contact, under pressure, with the grooves in the pulleys and the drums. It is particularly evident on moving ropes at points of pulley contact when the load is being accelerated or decelerated, and shows itself as flat surfaces at places subject to chafing,
– internal wear and occurrence of notches is a result of rubbing between individual wires and strands – in particular in sections subjected to bending around pulleys or drums.

The rope wear process may be accelerated in result of incorrect lubrication or lack of it and in result of presence of dust or grit. The process reduces the strength of ropes by reducing the cross-sectional area of the steel. When owing to external wear the actual rope diameter is reduced by 7% or more of the nominal diameter, the rope shall be discarded, even if no wire breaks are visible.

### 3.9 External and internal corrosion

Corrosion occurs particularly in the marine and industrial polluted atmospheres. It will not only diminish the breaking strength of wire rope by reducing its metallic area but will also accelerate fatigue by causing the irregular surface from which stress cracking will commence.

**3.9.1** Guidance on identifying corrosion:

– the corrosion of outer wires is identified directly by visual examination,
– the internal corrosion (which frequently accompanies the external corrosion) is more difficult to detect. It may be suspected based on ascertained changes of the rope diameter and loss of gaps between the strands in the outer layer.

**3.9.2** In positions where the rope bends around pulleys, a reduction in diameter usually occurs. However, in stationary ropes (stays, preventer guys) it is not uncommon for an increase in diameter to occur due to the build-up of rust under the outer layer of strands. Loss of gap between the strands in the outer layer of the rope is frequently combined with wire breaks in the strand gussets.

**3.9.3** If there is any suggestion of internal corrosion, the rope shall be subjected to internal examination, as indicated in Attachment 2, to be carried out by a competent person. Confirmation of severe internal corrosion is justification for immediate rope discard.

**3.9.4** Prevention corrosion present in wire ropes utilized in lifting appliances used in marine offshore and underwater works requires additional supervision. The relevant supervision procedure shall include the application of appropriate inspection technique (such as VT and MRT) and shall be adapted to the method of wire ropes service and be agreed with PRS prior to tests accepting the rope for service in the lifting appliance. Based on the results of performed testing, supervision principles and methods of further monitoring of the rope condition and periodical testing shall be defined, to ensure safe operation of wire ropes used in exploitation of marine resources.

### 3.10 Wire rope deformation

The wire rope deformation means visible distortion thereof from its normal formation. Stresses have uneven distribution at the deformation position. Below are presented most often types of wire rope deformations:

**3.10.1 Waviness** (Fig. 8 in Attachment 4 ). It is a deformation where the longitudinal axis of the rope takes the shape of a helix. While not necessarily resulting in any loss of strength, such a deformation, if severe, may transmit a pulsation resulting in irregular rope drive. After prolonged working, this will give rise to wear and wire breaks. The wire rope shall be discarded if (see Fig. 3.10.1):

$$d_1 \geq 4/3 \times d$$

where:

$d_1$ – the diameter of a cylinder circumscribed on the deformed wire rope;

$d$ – the nominal diameter of the wire rope

and the length of the rope under consideration does not exceed 25 × $d$

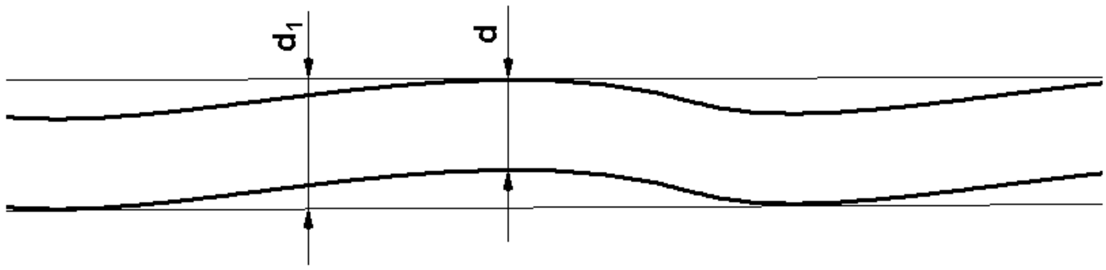



Fig. 3.10.1

**3.10.2 Birdcage (basket deformation)** (Fig. 9 in Attachment 4). The deformation occurs when outer wires in strands separate from the core wires. The birdcaging occurs mostly in result of abrupt loading of the rope from a slack condition. The deformation justifies immediate discard of the rope.

**3.10.3 Strand extrusion** (Fig. 10 in Attachment 4 ). The deformation is often associated with basket deformation (birdcage), which causes uneven distribution of stresses in the rope. Such wire rope shall be immediately discarded.

**3.10.4 Wire extrusion** (Figs. 11 and 12 in Attachment 4). In this condition, certain wires or groups of wires rise up, when the wire rope rests in a pulley, in the form of loops – this usually results from shock loading. If the deformation is severe, this is a justification for rope discard.

**3.10.5 Local increase in the wire rope diameter** (Figs. 13 and 14 in Attachment 4). The deformation is usually a result of distortion of fibre core (in some environments, the core can swell up owing to the effect of moisture), and that causes uneven distribution of stresses in strands and their incorrect orientation. If the deformation is severe, this is a justification for rope discard.

**3.10.6 Local decrease of wire rope diameter** (Fig. 17 in Attachment 4). The deformation is frequently associated with fracture of a core. Positions close to rope terminations shall be carefully examined for such deformations. If the deformation is severe, this is a justification for rope discard.

**3.10.7 Flattened portions** (Figs. 18 and 19 in Attachment 4). The deformation is a result of a mechanical damage. If the deformation is severe, this is a justification for rope discard.

**3.10.8 Kinks of tightened loops** (Figs. 15 and 16 in Attachment 4). The deformation is created by a loop in the rope which has been tightened without allowing for a rotation about its axis. It results in the change of the rope lay length and earlier wear of wires. More severe cases of rope kinking result in loosing rope strength and are justification for immediate discard.

**3.10.9 Rope bend** (Fig. 20 in Attachment). It is an angular deformation of the rope caused by external factors – justifies immediate discard of the wire rope.

### 3.11 Damage due to heat or electric arcing

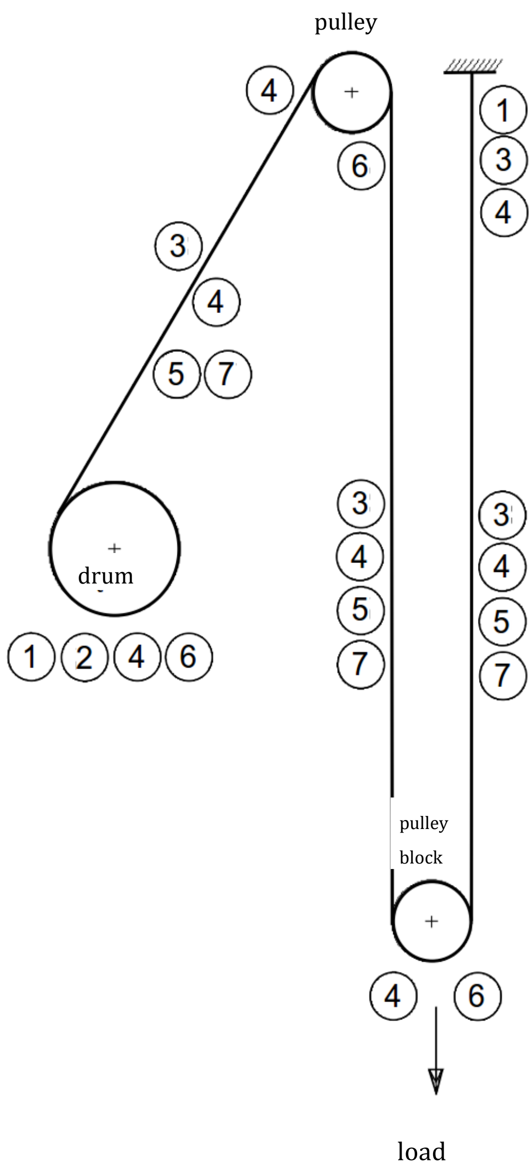
Wire ropes, which have been subjected to heat radiation or electric arcing, externally recognized by the colors produced, shall be discarded.

**Literature:**

– EN 12385-3:2020 Steel wire ropes – Safety – Part 3: Information for use and maintenance
– ISO 4309: 2010 – Cranes – Wire ropes – Care and maintenance, inspection and discard;
– ISO 17558:2006(en) - - Steel wire ropes — Socketing procedures — Molten metal and resin socketing
– HSE OTH 341 – Wire rope offshore – review of wire rope endurance research affecting offshore applications;
– HSE OTO 2000 064 – Wire rope Non-Destructive Testing – Survey of Instrument Manufactures;
– API Specification 2C – Offshore Pedestal-mounted Cranes – Machinery and Wire Rope Duty Cycles

**ATTACHMENT 1**

## DIAGRAMMATIC ILLUSTRATION OF POSSIBLE DEFECTS TO BE CONSIDERED DURING EXAMINATION




1. Termination of rope at drum and at permanent fixing.
2. Correctness of rope coiling on the drum.
3. Examination for wire breaks and rope wear.
4. Examination for corrosion.
5. Examination for deformations due to snatch loading.
6. Examination of portions which wind over drum, pulley and pulley blocks.
7. Examination for changes of rope diameter and other deformations.

Defective rope coiling on the drum causes the rope flattening and wires abrasion. Also the rope portions which are wound around compensating pulley, or the one adjacent thereto, shall be examined for wire breaks and corrosion.

**ATTACHMENT 2**

# INTERNAL EXAMINATION OF WIRE ROPE

## 1. General guidelines

Internal corrosion and fatigue cracking of wires are the prime reasons of the loss of rope strength. External examination may not reveal the extent of internal deterioration, even to the point when fracture is imminent. Internal examination shall therefore be carried out.

All types of stranded wire ropes can be opened up to permit assessment of their internal condition. Majority of ropes fitted on cranes can be examined internally, provided that they are at zero tension.

## 2. Examination method

Opening ropes may be performed with use of clamps (see Fig. 1) with jaws suitable for the rope diameter. The clamps are positioned on the rope at both ends of the examined portion to ensure that the jaws do not slip and then forces shall be applied to the jaws in the opposite direction to each other.

Fig. 1

The strands shall not be displaced excessively. When the wire rope opens, a screwdriver or other small device may be used to remove grease or debris which could hinder observation of the interior of the rope.

During examination, the following shall be taken into account:
– the state of the internal lubrication,
– the degree of corrosion,
– indentation of wires caused by pressure or wear,
– presence of broken wires (these are not necessarily easily visible).

After the examination, a service dressing provided by the rope manufacturer shall be inserted into the opened part and rotation of the clamping jaws shall be effected with moderate force to ensure correct replacement of the strands around the core. After removal of jaws, the outer surface of the rope shall be greased.

In examining the rope portion adjacent to termination, it is sufficient to use a single jaw, since the end anchorage system or a bar located through the end portion of the termination, will ensure the necessary immobilization of the other end.

## 3. Portions which should be examined

Since it is impracticable to examine the interior of the wire rope over the whole of its length, suitable sections most susceptible to damage shall be selected:

– wire rope portions which wind onto the drum or pass over pulleys or rollers when the crane is in a loaded condition;
– portions in which shock forces are arrested (caused by rapid lifting cargo without rope pretension), i.e. adjacent to drum and jib lead pulleys;
– portions close to rope terminals, what is particularly important in the case of fixed ropes (stays, pendants, etc.).

**ATTACHMENT 3**

## WIRE ROPE EXAMINATION RECORD

Data sheet for rope ........................................ Machine: ........................................
Application: ........................................

Construction: ........................................
Direction of rope lay: **RH/LH**
Type of lay: **ordinary/langs**
Nominal diameter: ........................................
Tensile grade of wire: ........................................
Quality: **galvanized/ungalvanized/stainless**
Type of core: **steel/natural/synthetic textile**
Preformation: ........................................
Length of rope: ........................................
Type of termination: ........................................

Date fitted: ........................................
Date discarded: ........................................
Minimum breaking load: ........................................
Working load: ........................................
Diameter measured: ........................................
Under a load of: ........................................

| Visible broken wires (number in length of 6*d*) | Abrasion of outer wires (Degree of de-terioration)* | Corrosion (Degree of de-terioration)* | Reduction of rope diameter (in %) | Positions measured | Overall assessment (Degree of de-terioration)* | Damage and deformations (nature) |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
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| | | | | | | |
| | | | | | | |

Date: Signature:

Rope supplier: ........................................
........................................
Other observations:
........................................

Number of working hours: ........................................
Reasons for discard: ........................................
........................................

* In the columns **„Degree of deterioration"** describe it as **„slight", „medium", „high", „very high", „discard".**

**Notes:**

**Guidance and useful hints for the wire rope examination:**

1. Verify the source and manufacturer of all wire rope, and if purchased carefully observe the specifications of the rope to ensure it matches the product that was purchased (i.e., construction (number of wires per strand and number of strands) and wire rope lay);
2. Visually examine wire rope terminations for abnormalities that may indicate improper installation. These ridges or abnormalities COULD be indicative of over-crimping, but any abnormalities need to be verified based on the type of crimp and manufacturing die used in the crimping process (i.e., some manufacturers' dies have chambers for excess material that is then removed and can leave lines that appear similar to ridges);
3. Compare all fitting dimensions against the approved documents and certificates comparing with manufacturer's specifications/tolerances for the completed fitting (i.e. verify whether the wire rope length and diameter fall within fitting manufacturer specifications);
4. Verify that the wire rope termination type does not reduce the safe working load of the inspected wire rope below the minimum safety factor for the relevant usage and service conditions;
5. If any abnormalities in the wire rope are detected, immediately remove the wire rope from service and make an appropriate replacement

**ATTACHMENT 4**

## TYPICAL EXAMPLES OF DEFECTS THAY MAY OCCUR IN WIRE ROPE

For emphasis, some of figures show exaggerated deterioration and the ropes depicted should have been discarded at an earlier stage.

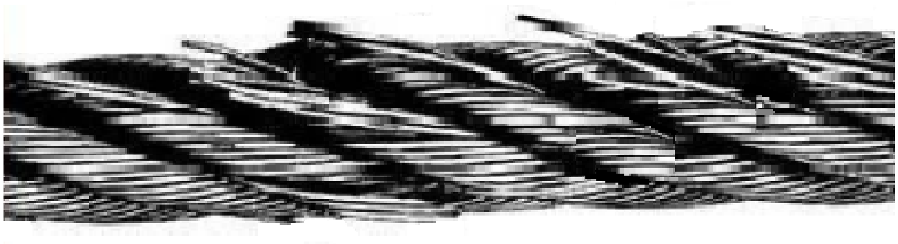

Fig. 1.
Wire breaks and wire displacement over two adjacent strands in an ordinary lay rope – justification for discard.

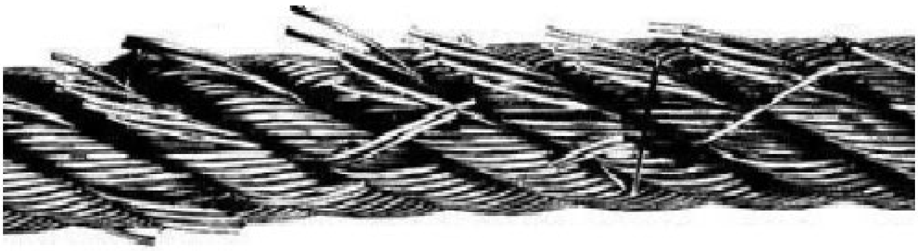

Fig. 2.
A large number of wire breaks, associated with heavy wear in an ordinary lay rope – justification for immediate discard.

Fig. 3.
Wire breaks in one strand, associated with slight wear in a langs lay rope – further operation is acceptable if this condition represents the worst condition (fractured wires shall be cut out so that the end is at the strand gusset; this prevents further abrasion of the adjacent wires).

| Wear | | External corrosion | |
|---|---|---|---|
|  | Slight flats on outer wires. |  | Beginning of surface oxidation. |
|  | Flats on individual wires longer, affecting all crown wires in each strand. Considerable reduction in wire diameter (other rope damages shall be checked carefully). |  | Wires rough to touch. General surface oxidation. |
|  | Flats on individual wires almost continuous, strands slightly flattened and wires are noticeably thin (serious damages could be justification for rope discard, other damages shall be checked and the frequency of examination increased). |  | Surface oxidation more advanced. |
|  | Flats touch each other, wires becoming slack with an estimated reduction in cross-section of 40% (justification for immediate discard). |  | Surface of wire greatly affected by oxidation. |
| | |  | Surface heavily pitted and wires quite slack (justification for immediate discard. |

Fig. 4.
Examples of progression of wear and external corrosion in an ordinary lay rope

Fig. 5.
Wire breaks in several strands, local to a compensating pulley (often hidden by this pulley) – justification for immediate discard.

Fig. 6.
Wire breaks in two strands, local to a compensating pulley, caused by jamming of the pulley – justification for immediate discard.

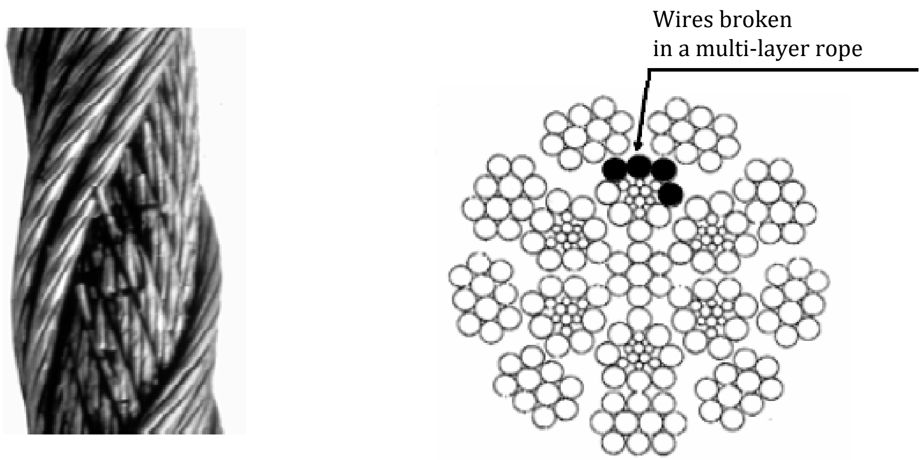


Fig. 7.
Wire breaks in the internal layer of an ordinary lay rope, due to abrupt load – justification for immediate discard

Fig. 8.
Rope waviness (the longitudinal axis of the rope takes the shape of a helix).
If the deformation exceeds the value indicated in 3.10 – the rope shall be discarded.

Fig. 9.
Basket deformation (bird cage) – deformation of a multi-strand construction –
justification for immediate discard.

Fig. 10.
Extrusion of a steel core, generally associated with a basket deformation (bird cage) –
justification for immediate discard.

Fig. 11.
One strand only affected by wire extrusion, examination over a length of rope shows that deformation is visible at regular intervals, normally of one lay length.

Fig. 12.
One strand only affected by wire extrusion (aggravation of the previous fault – Fig. 11),
typical of a hoist rope on a pilling machine – justification for immediate discard.

Fig. 13
Local increase in rope diameter due to protrusion of the fibre core in a degraded condition between the outer strands.

Fig. 14
Severe kink or tightened loop – note the screwed-up lay causing the extrusion of the fibre core – justification for immediate discard.

Fig. 15
A wire rope which has been kinked during installation but which has been placed in operation, and is in result subject to localized wear and to wire slackness – justification for immediate discard.

Fig. 16
Local decrease in rope diameter, as the outer strands take place of the fibre core, which has disintegrated – justification for immediate discard.

Fig. 17
Flattened portion due to local crushing, creating imbalance in the strands and associated with broken wires – justification for discard.

Fig. 18
Flattened portion of a rope caused by miscoiling on a drum.
Note how the lay length of the outer layer has increased due to local mechanical crushing and with imbalance of the strands associated with broken wires – justification for discard.

Fig. 19
Example of severe bend – justification for discard.