

13.12.2005

## *Wire Damage on Ships' Cranes*

(Capt. Dipl.-Ing. U. Kreitz,)

On board sea-going vessels, rotation-resistant wire ropes with compacted strands are preferable for use in respect to ships' cranes with high-lifting capacity, e.g. for heavy-lift service.

At this point, the construction of individual wire types, or brands, as the case may be, will not be addressed in detail but rather the damage to hoisting wires which has recently been occurring.

### **In General**

Wire ropes are checked by the class society at the manufacturing plant according to their safe-working load (SWL) using a defined test load. During further operation, regular load tests with corresponding test loads (depending on the SWL) are performed in the presence of the class society.

The "standards for wire rope operation" and especially the "in-service-monitoring" are stated in the DIN 15 020, section 2. This norm specifies the safety regulations for the use and handling of wire ropes.

The class societies have not made any regulations to this respect.

### **Maintenance**

Wire ropes must be maintained regularly (e.g. every three months as stipulated by the crane manufacturer O&K) and must be greased at regular time intervals, which are dependent on the condition and frequency of operation, whereby this application is to be performed especially in the range of the bending area.

The lubricant used must be compatible with the existing lubricant on the wire rope, and it must be able to penetrate into the interior of the wire rope. By lubricating, potential corrosion can be reduced. Extremely fouled wire ropes should occasionally be cleaned.

It is highly recommended to rinse off wire ropes affected by sea water with fresh water before greasing, as salt binds moisture under the lubricant, which can then lead to corrosion.

The date of the greasing is to be entered into the cargo gear book.

## Wire Rope Check

Wire ropes are to be checked regularly in order to recognise damage in good time. These checks are then to be recorded in the cargo gear book.

The checks are to be performed according to the following criteria:

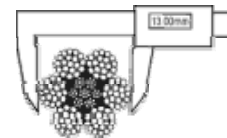
- a) wear and tear on the outer strands
- b) rust build-up
- c) twist loosening
- d) reduction in wire diameter
- e) wire- and strand fractures (the number of visible wire fractures are to be documented by means of sketches)
- f) location of the fractures
- g) chronological log of the wire fractures
- h) damage by pinches

To this end, the areas to be checked are to be cleaned of grease and dirt.

## Discarding Condition

In order to ensure operational safety, the wire rope must be discarded when the following characteristics are present:

- a) wear and tear beyond 10% of the original diameter



- b) significant build-up of corrosion



- c) deformation similar to that of a corkscrew



- d) the wire rope is buckled



- e) loosening of individual wires or strands



f) formation of knots

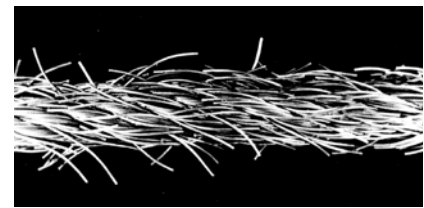
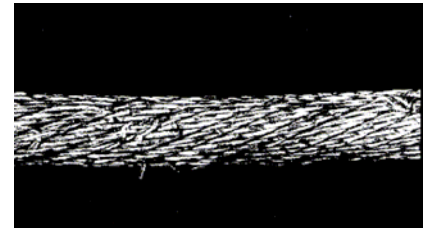


g) pinches

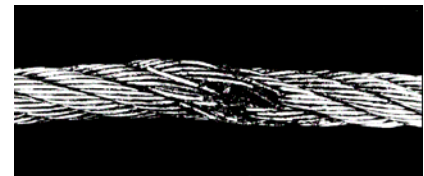


h) flattening by squeezing

i) visible wire- and strand fractures corresponding to the register (DIN 15 020, section 2, page 3)  
e.g.  
at a length of 6 x rope's diameter; 15 visible wire fractures  
at a length of 30 x rope's diameter; 30 visible wire fractures



local concentration of wire fractures



The replacement of a wire rope is to be recorded in the cargo gear book.

Unfortunately, there are no concrete rules or regulations regarding the timely discarding condition of wire ropes. Of course, some companies have published internal rules and regulations indicating when crane wires are to be discarded.

**Example:**

In regard to hoisting wires, a check of undersize and wire fractures is required to be performed quarterly.

If there is no exterior damage to the hoisting wires, or if there are no alterations to the required timely changing of hoisting wires, they are to be replaced according to the following time-spans:

Wire diameter	After the following Hours of Operation	After the following Years of Use
Ø 20 mm	1,500	or 3.5
Ø 31 mm	2,200	or 3.5
Ø 32 mm	2,500	or 4.0

**Damage:**

Despite the previously mentioned maintenance and wire rope checks, time and time again the wire ropes fail during operation.

Even if a wire rope may visually appear to be in an intact condition, it may still fail.

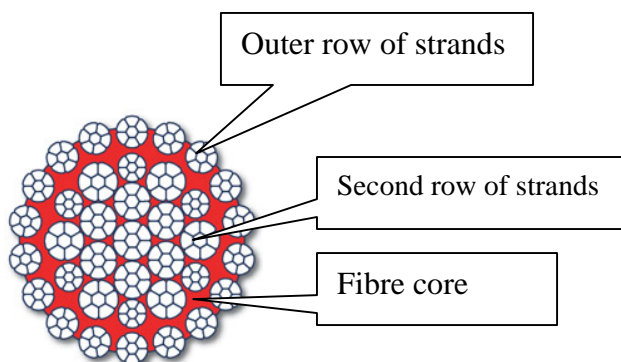
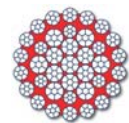
**Example of Damage:**

One of the most commonly used hoisting wires for ships' cranes is the **CASAR Powerplast**, a rotation-resistant hoisting wire made from compacted strands using a fibre core.



The instance of damage that is being considered here concerns a

- **CASAR Powerplast** rope: Ø 58 mm, rotation-resistant, galvanised, lubricated, MBL 3.190kN for a ship's crane with **SWL 200 t**.



Design of the CASAR Powerplast wire rope (cross-section of the wire rope)



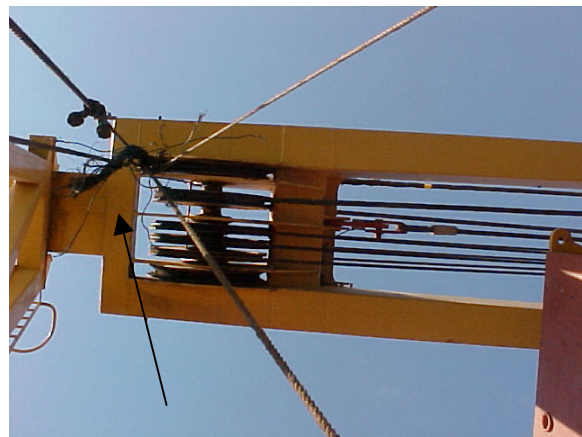
The hoisting wire is reeved into the ship's crane twice.

According to the cargo gear book, the maintenance and checks were documented regularly.

During a lifting process with a pay load of approx. 200t, the hoisting wire suddenly broke.

### **Inspection of the Damage:**

The hoisting wire on the jib's port side has broken between the deck and the resting crane jib.



Broken crane wire on the resting crane jib.

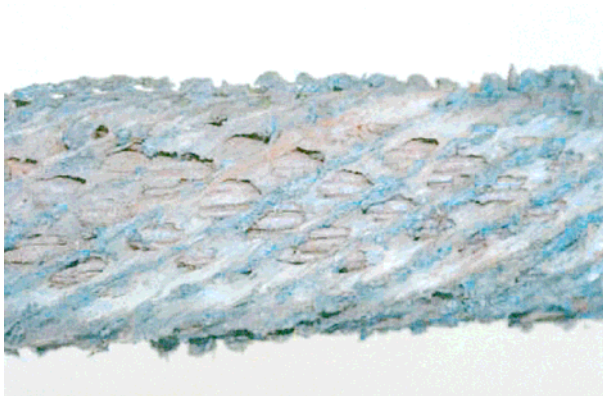


Pictures of the point of breakage on the wire rope.

It appears to be about a clear-cut rupture; that means that the broken strands occur within a short, locally-limited region on the wire rope. There are recognisable traces of corrosion existing on all wires. As a result of the corrosion, one can recognise, in part, heavily scarred and acute, broken wires.

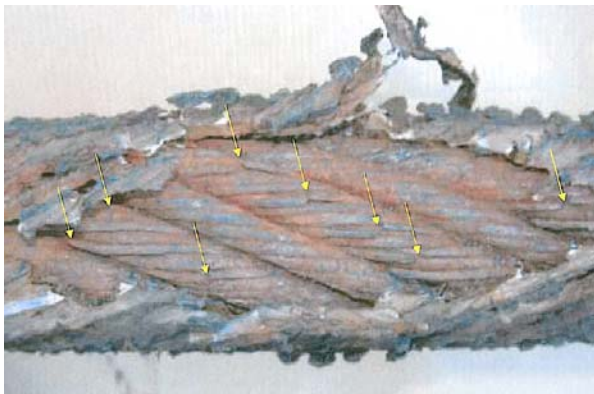


Detached wire rope structures with a perforated fibre core and corrosion on the wire strands.



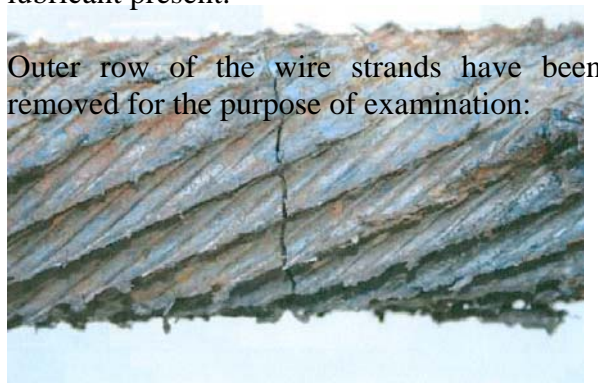
Outer row of the wire strands have been removed for the purpose of examination:

Finding: Heavily perforated fibre core. The perforation of the fibre core could have occurred through wear and tear as a result of internal rope friction.



Outer row of the wire strands have been removed for the purpose of examination:

Finding: A steel core with considerable traces of corrosion. There is no recognisable lubricant present.



Finding: A transverse fracture in the plastic layer. Such a fracture could only have occurred as a consequence of the sudden impact on or the overstress of the steel core of the wire rope at the breakage.



An intact rope structure with a relatively thick lubricant layer on its' surface.



An intact surface of the wire rope is recognisable. The lubricant film is sporadically broken, and corrosion has built up on the surface.

### **Possible Causes of the Damage:**

The bottom hook block is lashed with an approx. 6 m long rope on the port-side forecastle deck.

According to the on-site findings, the area of damage on the wire rope is the area that leads under the crane jib through the bottom hook block. The damaged area (position of the rip) extends over 6 m long. There are, in several places, recognisable areas of corrosion under the lubricant layer.

The wire rope has had constant exposure (since 1997 = 8 years) to the sea (spray water and sea wash) particularly between the crane jib and the bottom hook block. The sea water can then eat at the wire rope's lubricant, and, respectively, wash it away and penetrate into the space between the individual wire strands and wires. In theory, when the wire is re-greased after a sea voyage, the lubricant does not penetrate deeply enough into the individual wire strands and wires, and it also does not repel the remainder of the sea water. Therefore, corrosion originating from within the wire rope may occur.

In addition, there is also the fact that wires in the jib's stow position (the bottom hook block is firmly tight) are exposed to particular stress that comes from the movement of the ship in heavy sea conditions. These refer to intermittent loads from the vibration of the jib ("nicking" of the jib), which lead to prematurely accelerated fatigue.

### **Preventive Measures to Avoid Wire Rope Damage:**

During his on-site inspection, the owner's superintendent should allow himself to be convinced by the visual condition of the crane wire and not only by entries in the cargo gear book. Especially if there are constantly different crews on board who have different levels of knowledge and experience in dealing with ship's cranes, the following items, in particular, are to be given special attention:

- Wire ropes must be maintained regularly in accordance with the specifications of the manufacturer; (see operating instructions)
- Contingent upon operating conditions, wire ropes must be lubricated in regular intervals, especially in the bending zone;
- The lubricant that is applied must be compatible with the existing lubricant on the wire rope and be able to penetrate into the inside of the rope. A viscous lubricant should not be used;
- It is recommended to rinse off wire ropes, which have had heavy contact with sea water, with fresh water as the salt keeps moisture under the lubricant, and, thus, damage from corrosion may develop. Areas that are exposed to heavy sea wash should be lubricated all the more often;
- Wire ropes are to be checked regularly in order to recognise damage in due time;

- In order to ensure operational safety, the wire rope must be discarded when the following characteristics are present:
  - a) wear and tear beyond 10% of the original diameter
  - b) significant build-up of corrosion
  - c) deformation similar to that of a corkscrew
  - d) the wire rope is buckled
  - e) loosening of individual wires or strands
  - f) formation of knots
  - g) pinches
  - h) flattening by squeezing
  - i) visible wire- and strand fractures as listed in DIN 15 020, section 2, page 3  
e.g. at a length of 6 x rope's diameter; 15 visible wire fractures  
e.g. at a length of 30 x rope's diameter; 30 visible wire fractures

There are no clearly defined rules and regulations as to when a wire rope is to be discarded. According to the DIN 15020 (Standards for Wire Rope Operation), there are recommendations for the discarding of wire ropes in respect to visible damage, however, not in respect to operating time.

**According to the maintenance directives from shore-crane operators, a hoisting wire above Ø 32 mm after 2,500 hours of operation or 4.0 years is to be discarded. This directive is likewise recommended to ship's crane operators.**

### **Electro-Magnetic Testing Method**

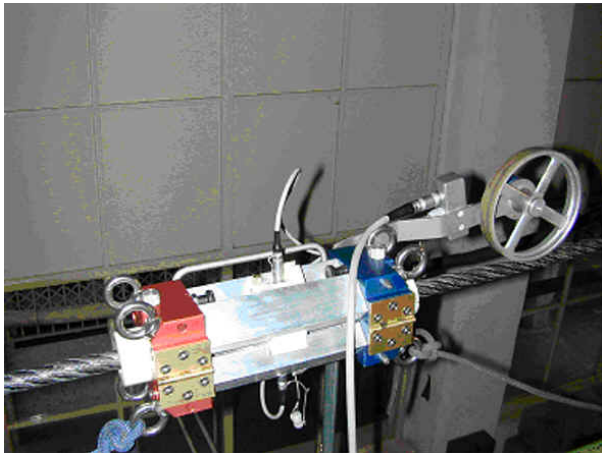
The optical appraisal of wire ropes, particularly the determination of the number of fractions for discarding a wire rope (see pg. 3, discarding conditions, item "i"), is limited to only, as a rule, the external visible surface of the rope. The steel core, the interior wires of the outer strand, and the areas, in which the outer strands lie in the rope's interior, are not accessible when performing an optical check.

After a certain amount of time, wire ropes begin to show deterioration from wear and tear, and wire fractures begin to appear on the surface of the wire rope. Under certain operational conditions and stress, wire ropes may begin to develop fractures and, thus, the reduction of cross-section in the interior of the rope (resulting from friction in the interior of the rope). Wire ropes that are dynamically charged (through vibration, and, respectively, through the "nicking" of the crane jib) or that are subject to twisting during operation are prone to interior wire fractures because of the excessive stress on the interior rope elements.

Electro-magnetic test methods allow for a non-destructive test and ascertainment of the interior condition of the wire rope.

The electro-magnetic testing devices available on the market allow for, according to type of device, a gauge or a continuous list of local wire rope damage such as single wire fractures, strand fractures, brazing- and welding joints, or pitting corrosion. The ascertainment of the

alteration of a cross-section resulting from corrosion and metallic reduction of a cross-section from wear and tear throughout the entire accessible wire rope length is likewise possible.



Electro-magnetic testing device CMRT 40

The measured data received and the evaluation, thereof, by specially trained personnel provide information about the entire condition of the wire rope.

The choice of a suitable type of device, the appropriate operation, and the interpretation of the measurement results received all require considerable technical knowledge and experience. Colleges, testing institutes, and commercial businesses offer electro-magnetic testing of wire ropes.

Electro-magnetic testing can and may not replace the optical test, as it provides additional information concerning the condition of the wire rope and is considered to be a supplement.

#### Special Note:

Further beneficial and detailed information can be viewed and downloaded from the homepage of **CASAR Powerplast** crane wire manufacturers **CASAR Drahtseilwerke Saar GmbH, Kirkel** ([www.casar.de](http://www.casar.de)).

...ooOoo...