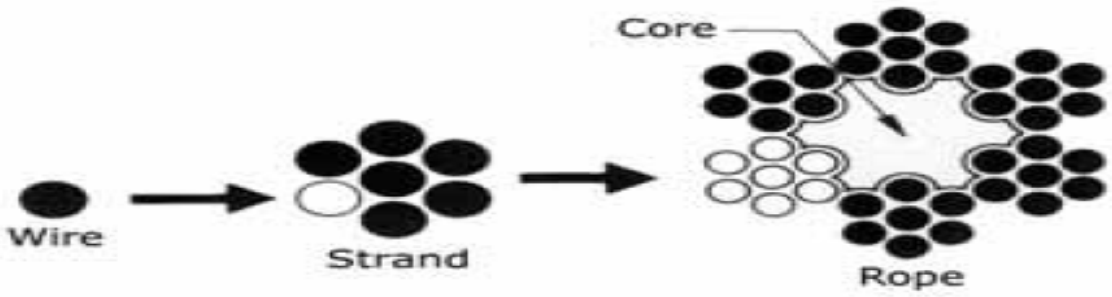
CONTENTS

CARGO CRANE WIRES AND SHEAVES

1. CONSTRUCTION OF A WIRE

Construction

The main components of a wire rope are shown below.



In the above example, each individual wire is arranged around a central wire to form a 7-wire strand. Six of these strands are formed around a central core to make a wire rope. The rope is specified as 6x7 (6/1) – i.e. six strands each of seven wires.

The size and number of wires in each strand, as well as the size and number of strands in the rope greatly affect the characteristics of the rope. In general, a large number of small-size wires and strands produce a flexible rope with good resistance to bending fatigue. The rope construction is also important for tensile loading (static, live or shock), abrasive wear, crushing, corrosion and rotation.

Hoisting wire provided on board are generally of 4 x 48 (4 strands of 48 wires) OR 4 X 39 (4 strands of 39 wires)

Luffing wires provided on board are generally of 6 x 29 (6 strands of 29 wires)

2. DAMAGE TO WIRES

There are many causes of damage to wires and ropes on board; these can be categorized as follows:

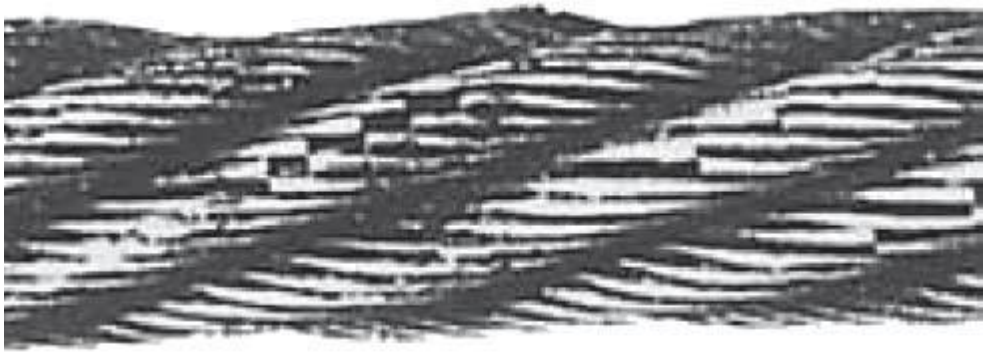
- **Abrasion**
  - Generally due to sheaves being seized or otherwise damaged.
  - Crane wires are frequently found to have the individual outer strands flattened due to non-rotating or under-sized sheaves or contact with other strands on the drum itself.

- **Corrosion**
  - Caused by unprotected wires being exposed to salt water and the elements.
  - Corrosion is prolific in the marine environment and diminishes the breaking strength of the wire by reducing the cross-sectional area of the individual wires, which increases the likelihood of fatigue, cracking and reduces the elasticity of the wire.
  - Internal corrosion is invariably the result of insufficient internal lubrication. General indications of internal corrosion include the appearance of fine brown powdery residue between the strands, where the wire bends around sheaves there is usually a reduction in diameter. In stationary wires there is sometimes an increase in wire diameter due to the build-up of rust, and wire breaks between or within the strands. Severe internal corrosion renders the wire unusable.

- **Crushing**
  - Uneven spooling on a drum can result in wires crossing. With load on the wire, this can lead to the lower layers of wire becoming crushed, reducing the effecting breaking strain of the wire.

- **Cutting-in**
  - Occurs when a rope buries itself when under tension beneath poorly spooled lower layers, potentially leading to jamming which could result in the wire kinking, being crushed or even counter-rotation.

- **Fatigue**
  - Fatigue is the result of frequent bending of the wire under load, particularly round under-sized sheaves and due to kinking. Fatigue is exacerbated by poor lubrication and corrosion. Fatigue results in the individual strands cracking and eventually failing.
  - Fatigue-induced wire breaks are characterized by flat ends on the broken wires.



- **Stretch**
  - This will result in slight differences in diameter and/or elastic properties. Compensation mechanisms are usually fitted, but it can lead to wire slippage on the sheaves.

- **Reduction of Wire Diameter**
  - Deterioration of the core is a common cause of reduction of a wire's diameter, and can be caused by:
    - Internal wear and wire indentation
    - Internal wear due to wire bending
    - Deterioration of a fiber core

  - Fractured internal layers in a rotation-resistant wire.
- If these factors cause the wire's diameter to decrease by more than 7-10% of the wire's nominal diameter the wire should be discarded even if no broken wires are sighted.

- **Decreased Elasticity**
  - Under certain circumstances usually associated with a wire's working environment, it can sustain a substantial decrease in elasticity and would therefore be unsafe.
  - Decreased elasticity is difficult to detect, but is usually associated with the following:
    - Reduction in wire diameter.
    - Elongation of the rope lay length.
    - Lack of clearance between individual wires and strands due to compression.
    - Appearance of fine brown powdery residue between the strands.
    - Increased stiffness.

3. INSPECTION OF WIRES

Although the wire shall be examined throughout its length, particular care shall be taken at the following locations:

a. The termination points of both moving and stationary wires.
b. The part of the wire which passes over the block or over sheaves.
c. In the case of cranes performing a repetitive operation, any part of the wire which lies over.
d. sheave(s) while the crane is in a loaded condition.
e. That part of the wire which lies over a compensating sheave.
f. Any part of the wire which may be subject to abrasion by external features (e.g. hatch coamings, block cheeks).
g. Internals of the wire, for corrosion and fatigue.
h. Any part of the rope that is over the block sheaves when the grab is planned in the cargo.
i. Any part of the wire exposed to heat.

4. GREASING OF WIRE

Apart from the mechanical stresses placed on crane wires during operation, the factors most affecting their working life are: -[1]

- Weather Protection
- Lubrication

Regular correct application of good quality wire rope grease will fulfil both purposes. Vessel is to ensure that sufficient stocks of suitable grease are held on board.[2]

There are no circumstances which can excuse a vessel arriving in port, where the deck cranes are to be used, with the wires in a dry condition. However, it must be remembered that, especially in very warm weather, that if the crane wires have been over greased it is possible that the grease may begin to run and drop onto the cargo. This must also be avoided as it may result in cargo damage claims.[3]

Greasing wires, either by the use of a rags covered in grease or with brushes dipped in grease, is ineffective as the wire is not cleaned of the old grease and there is no grease penetrating to the core of the wire. By this method the new grease is only spread over the surface of the old grease, salt, soot and other contaminants and there is no effective lubrication.

Company has provided Viper wire rope lubricator to all vessels which shall be used for greasing wires.[4]

Operational and safety procedures as per the makers operational manual shall be complied with while greasing wires.[5]

Refer to SHEQ/MEMO section for the makers operational and safety manual[6]

[1] W 22 / 2019
[2] W 22 / 2019
[3] W 22 / 2019
[4] W 22 / 2019
[5] W 22 / 2019
[6] W 22 / 2019

5. DISCARD CRITERIA

Deterioration frequently is the result of a combination of factors, including:

- The nature and number of broken wires
- Broken wires at the terminations
- Localised grouping of wire breaks
- The rate of increase of wire breaks
- The fracture of strands
- Reduction of rope diameter
- Decreased elasticity
- Wear
- Corrosion – internal and external
- Deformation, including 'bird cages', kinks, etc.
- Damage due to heat or electric arcing
- Rate of increase of permanent elongation.
- Company specified hours of usage has been reached

A single layer 6x19 wire core rope should be discarded if 3 or more wires are seen to be broken over a length equivalent to 6 diameters, and a single layer 6x36 wire core rope should be discarded if 9 or more wires are seen to be broken.

6x19 wires are general purpose wires, used on sheaves, reels, hoists, etc. and 6x36 wires are commonly used as lifeboat falls, on davits and cranes.

Broken wires at terminations are indicative of high stress loadings at the termination, sometimes associated with incorrect fitting of the termination.

Where broken wires are grouped very close together, the wire should be discarded. If this grouping occurs in a length less than 6 x diameter or is concentrated in any one strand, it may be necessary to discard the wire even if the number of breaks is less than the maximum number allowed for that size / type of wire.

Crane wires should also be discarded based on running hours.

Recommended interval for renewal of crane wires is mentioned in form 2.3.22[7]

[7] W 36 / 2019

Running hours for the crane shall be recorded in form 2.3.22.[8]

Reference should also be made wire rope replacement criteria mentioned in the crane manual.[9]

5.1. Running hours shall be determined by the Hour meter on the Hydraulic motor of the crane.

6. REPLACING NEW WIRE

Should a wire be found to require replacing, it is essential that the specifications of the new wire are at least equal to those of the wire being replaced. The certificate for the new wire should replace that of the wire being discarded. Cargo gear register should be updated whenever wire is replaced. Condemned wire shall not be thrown overboard. It should be marked and disposed ashore at convenient port.

Reference should be made to the crane manual for the correct procedures of renewing the wires.[10]

New wires should not be removed from a coil by laying the coil flat on deck and pulling the end – this introduces twists into the wire.

When stored on a reel, the reel should either be placed on a turntable, or a shaft placed through the centre of the reel and the wire pulled as the reel rotates.

[8] W 22 / 2019
[9] W 22 / 2019
[10] W 22 / 2019

Incorrect method of unreeling a wire, this method induces twists, which could lead to kinks in the wire

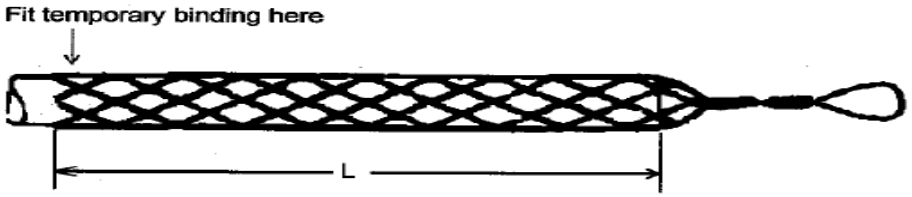
Correct method for unreeling a wire, either using a turntable (vertical) or centre spindle (horizontal)

Note:

- **All vessels should have wooden reels for unreeling wires.**
- **Supramax vessels shall maintain four HOISTING wire and two LUFFING wires at all times.**
- **All other vessels shall maintain two HOISTING wire and two LUFFING wires at all times**
- **New wire must be inspected prior putting in use.**

7. USE OF PULLING AND JOINTING SOCK FOR WIRE RENEWAL

PULLING & JOINTING SOCKS

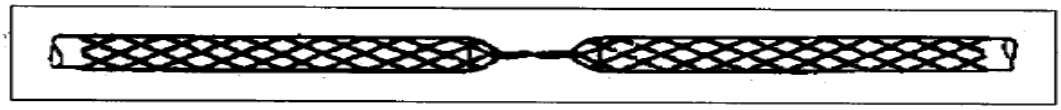


The simplest attachment that can be fitted to the end of a wire rope to pull it from a drum is to use a pulling "sock".

The sock consists of a length of steel braid, which is fitted over the end of the wire rope. A temporary binding is then made around the open end of the braid, to hold it against the wire rope. When the loop on the other end of the sock is pulled, the braid tightens around the wire rope and forms a secure attachment.

So that the correct tightening occurs, it is important that the size of pulling sock is matched to the diameter of the wire rope. The sock attachment length "L" must not be less than the minimum specified by the sock manufacturer.

When the pulling tension is released from the loop, the sock can be taken off the end of the wire rope. The temporary binding must first be removed, and then the braid can be slid off the wire rope.



A temporary jointing sock uses two pulling socks, which are directly connected together. Each end is attached to the wire rope in exactly the same way as for a single sock.

Note A temporary jointing sock can only be used between two wire ropes with similar diameters. When a small diameter pulling rope is being used, this should be attached to the loop of a single pulling sock.

8. SHEAVES

Sheave is subject to wearing at its groove and flange due to constant contact to the wire. The wearing limits is specified in the maker manual.

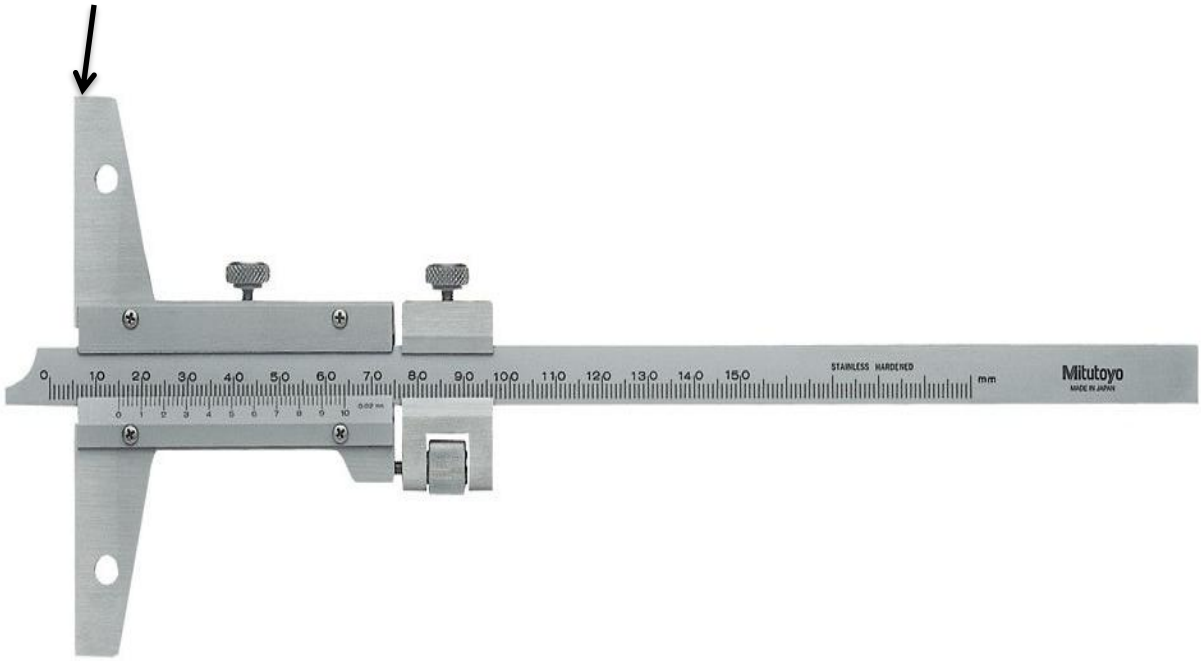
All sheaves shall be thoroughly inspected during renewal of wire and entered in form 2.3.6 A or B depending on crane manufacturer.

Wear down of the crane sheaves shall be measured with the Vernier depth gauge provided.

(Picture indicating how to measure the groove depth of sheave)

Vernier depth gauge 0-150mm

Base should be 150mm in length



(Vessel shall carry Vernier depth gauge 0-150mm. Base should be around 150mm - width of sheave is 120mm.)

In case wearing is in excess of makers recommended limits or if sheave is deformed or damaged, it shall be renewed.

9. CARGO CRANES

Any breakdown or substandard operation of the ship's cranes will inevitably result in a claim for off-hire time from the Charterers. This always proves to be very expensive for the Owners and, if regular breakdowns of cargo cranes occur, the vessel's reputation will become tarnished, and may eventually be reflected in the vessel's future earnings.[11]

[11] W 22 / 2019

Any defects which affect their operation or efficiency are to be reported to the company immediately, who will decide what course of action is to be taken. In most cases however, repairs and maintenance are to be carried out by the ship's Officers and crew.[12]

Time has been lost in the past through vessels arriving in a port where cargo is to be worked, using ship's cranes, and the stevedores have refused to drive them due to dirty windows, untidy and dirty cabs, broken seats and operating levers, faulty ventilation and/or heating, slippery oily accesses and ladders and handrails in poor or unsafe condition. It is the duty of the Chief Officer to inspect the cranes prior to arrival with respect to the above items, and it is also his responsibility to ensure that any such defects are rectified before the stevedores come on board. During cargo operations it is the responsibility of the OOW to ensure that the cranes remain in good condition throughout the load/discharge and any subsequent defects are brought to the attention of the Chief Officer.[13]

The S.W.L. of the cranes must be clearly marked in a conspicuous position on the crane jib, and it must be ascertained by the Chief Officer that all parties concerned with the load/discharge operation are aware of the maximum capacity of cranes, and that this is not exceeded. The weight of grabs, spotters, or other cargo handling equipment attached to the hook must always be taken into account.[14]

9.1. General Precautions[15]

- Cranes must not be operated outside their design limits regarding safe working load, wire speed, list, trim or dynamic movement of the vessel. All these limitations are to be clearly marked on the appliance.
- Controls are to be permanently and clearly marked with their function and operating directions and instructions. Where special instructions are applicable to securing and unsecuring of the equipment these shall be separately detailed in a clear manner. Controls must not be modified in any way from their original specification.
- All fitted safety devices limit switches, cut-offs or pawls are to be kept in good working order and tested regularly. Safety devices must never be isolated or overridden.
- Crane override keys are not to be left in the cab or passed to stevedores.
- Crane hydraulics are to be switched off whenever there is no crane driver in the cab i.e. during breaks tea breaks, lunch breaks etc.
- Chief engineer shall ensure greasing of grab as per maker manual is carried out during cargo breaks. Chief Officer shall provide deck crew for assisting in greasing operations.
- Pulling and jointing socks is recommended to use for wire renewal.

[12] W 22 / 2019
[13] W 22 / 2019
[14] W 22 / 2019
[15] W 22 / 2019

- Grabs will be used with spill plates as per the grab manufacturer's guidance.
- OOW shall ensure that stevedores are operating the crane and grab in proper manner during cargo operations. The OOW must always be on the lookout for bad practices by crane operators and stop any abuse of the ship's equipment. The Chief Officer must be informed immediately if such bad practices have been witnessed in order that an appropriate claim can be made.
- Pre-cargo operation crane and deck fittings checklist (Form 2.3.7) has to be completed jointly by ship staff and stevedore foreman / surveyor prior commencement of cargo in each port.
- Laminated copy of the Crane, wire and grab checklist (Form 2.3.7 A) shall be maintained in ships office and compliance will be recorded in deck log book

10. MAINTENANCE

PMS and company guidelines related to crane / sheaves and other loose gear shall be strictly complied with.

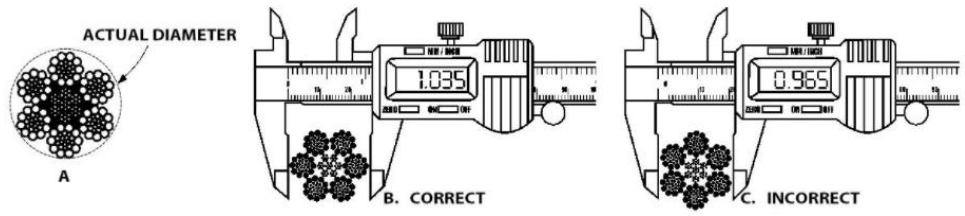
If vessel carries corrosive cargoes like coal, sulphur etc. which could deteriorate the condition of wire, it is recommended that greasing of wire is done after each discharge (in consultation with ship manager)

While greasing wires, ship staff shall check for broken strands, rope diameter is not 7% less than original and ensure that complete wire is properly greased. Also ship staff shall check the condition of the dead end of the wire (mechanical splice/ferrule) for cracks or uneven crimping.

While greasing sheaves, ship staff shall check the condition of sheaves and ensure that greasing is done until all the old grease is out and the new grease is visible at the bearing. They should also visually inspect the sheave for cracks, visible bearing wear and evidence of grooving of the working surface.

Master has the overriding authority to enhance the maintenance regimes like greasing of wires and sheaves as deemed necessary so that safety of equipment is not compromised.

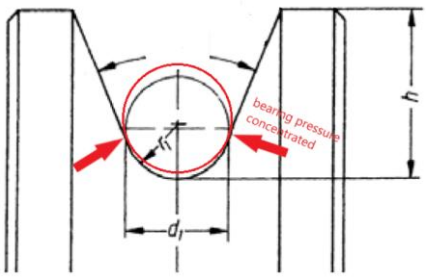
The actual diameter of the wire rope is the diameter of a circumscribed circle that encloses all the strands. It is the largest cross-sectional measurement as shown here correct and incorrect methods:[16]



[16] W 48 / 2021

The wire rope actual diameter is slightly larger than its nominal diameter allowable tolerance is up to 5% for wire rope of nominal size 8mm or more.[17]

The sheaves are designed for a specified wire diameter for the uniform weight distribution on its surface. If oversized wire is used for which sheave is not designed, it may cause premature failure of the wire, sheave and bearing, refer following figure:[18]



The wire ropes nominal diameter in use should be as specified by crane manufacturer. However, when a wire rope of exact nominal size is not available, a slightly oversized wire can be used with following maintenance:[19]

- Grease the wire well with patent greaser, and not by hand
- Inspect and monitor regularly after 200 running hours. If you notice some broken constituent wires during inspection, take photos and send the photos to the Office.
- Refer to the deck crane manual for the criteria for replacing wires.
- Make a plan to replace the wire.
- Consult with ship manager when ordering new wires.

11. WIRE INFORMATION RECORD

All crane wires are supplied along with a test certificate which pertains only to that wire. The certificate must be kept on file, and ready for inspection by the appropriate authorities at all times. The certificates must be marked the following:[20]

- position of the wire, i.e. on which crane the wire is situated and its use, e.g. luffing or hoist wire [21]
- date wire received and date put in use.[22]

[17] W 48 / 2021
[18] W 48 / 2021
[19] W 48 / 2021
[20] W 22 / 2019
[21] W 22 / 2019
[22] W 22 / 2019

If the wire is held on board as a spare, the certificate must be marked with:[23]

- the date received[24]
- hoisting or luffing wire and[25]
- stowage position of the wire. The wire itself is to be tagged and marked with the applicable certificate number.[26]

Details of all wire information along with the running hours has to be entered in form 2.3.22.

This form has to be maintained in conjunction with cargo gear register.

Chief Officer is responsible for maintaining this form in the Shared Drive[27].

[23] W 22 / 2019
[24] W 22 / 2019
[25] W 22 / 2019
[26] W 22 / 2019
[27] W 09 / 2024