INSTALLATION & INSPECTION MANUAL

FOR MOORING WIREropes
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- EDITION 08/2018 -
COMPANY PROFILE

D. Koronakis S.A. is the leading company in the manufacturing of ropes and wire ropes in Europe and one of the largest and most important companies in its field worldwide.

Established back in 1967 by the founders of the company Eleni and Dimitris Koronakis, the company continues to be 100% family owned serving the needs of the Shipping, Offshore Oil and Gas, Drilling and Towing, Yachting and Sailing, Fishing and Aquaculture Industries.

Our product range includes hi-tec synthetic ropes, wire and combination ropes, mooring ropes and specialized sailing and yachting ropes. Produced in Greece, all our products are globally recognized for their top quality and technical performance and comply with International Certification Organizations.

In recent years, the production units of the company have expanded, covering more than 40,000 m² of building areas on more than 100,000 m² of land where we keep large stock of anchors, chains and anchor chains, fiber slings, rigging gears and various accessories. The company operates a state of the art factory that is able to produce any kind of rope, of any size, quality, length or color.

The mission statement of the company is "to focus on customer satisfaction, worldwide coverage, custom-made design and development of unique products." To succeed in this, while also being able to respond 24/7 to our customer's needs all over the world, we have built a distribution network with our best selling products at the biggest ports worldwide: Piraeus, New York, Houston, New Orleans, Los Angeles, Panama, Dominican Republic, Singapore, Fujairah, Durban, Cape Town, Rotterdam, Antwerp, Hamburg, Livorno, Tarragona, Algeciras, Las Palmas.

The company is daily looking into new challenges and is equipped with machinery of latest technology. To guarantee top quality control for our products, we have established in our factory and operate the biggest Test Bench available in southern Europe.
OUR CREDENTIALS

- Member of ISSA, IMPA, Helmepa, Hemexpo & WIMA
- In Lloyd’s list as wire rope manufacturers since 1972
- ISO 9001:2015 certified by UKAS-B.V.Q.I
- ISO 14001:2015 certified by UKAS-B.V.Q.I
- Our 500 T & 150 T test benches – fully computerized – and other equipment, calibrated annually and acknowledged by all known registries. Included in Lloyd’s lists
- Sole representative of CASAR wire ropes in Greece.
- Sole representative of VEROPE wire ropes in Greece.
- Sole representative of GUNNEBO, lifting gear, chains and accessories.
- LLOYD’S REG FOR ANCHORING AND MOORING EQUIPMENT
- LLOYD’S REG FOR APPROVED TESTING MACHINE
- LLOYD’S REG FOR STEEL WIRE ROPES
- LLOYD’S REG TYPE OF APPROVAL FOR UHMPE FIBRE ROPES
- LLOYD’S REG TYPE OF APPROVAL FOR MIXED FIBRE ROPES
- LLOYD’S REG TYPE OF APPROVAL FOR NYLON FIBRE ROPES
- LLOYD’S REG TYPE OF APPROVAL FOR POLYESTER FIBRE ROPES
INTRODUCTION & MAIN TERMINOLOGY

As per MEG4/2018, section 5.5.5 (Specifications and procurement), there are currently no International standards for the wire ropes and specifically for their use as mooring lines.


There are many wire constructions, but the most recommended and commonly used for ships’ mooring operations is the 6x36 + IWRC. This denotes that the wire has one steel wire core and 6 wire strands, where each strand is made from 36 wires.

Depending on the wire’s steel grade, there are various wire tensile strengths, with the most commonly used for mooring: 1770N/mm², 1960N/mm², 2160N/mm².

The use of IWRC is recommended for mooring wires considering that this wire rope has a greater breaking strength from the same wire rope with FC. Same applies for the highest tensile strength.

As per MEG4 the wire’s breaking strength is called LDBF (Line design breaking force) expressed in tons. The LDBF equals to approximately 100%-105% of the MBL.

MBL refers to only mooring fittings.

Mooring wire’s safety factor = 1,82.

Winch drum diameter should be at least 16 times bigger than wire rope’s diameter.

For the construction of wire ropes and depending on the wire strands orientation/direction either to the right hand lay or to the left hand lay, there is in short a reference of Z,z S,s (DIN6890) where:

Z strands that follow the RIGHT direction.

z strand wires that follow the RIGHT direction.

S strands that follow the LEFT direction.

s strand wires that follow the LEFT direction.
Any combination to the above directions can be made as below picture shows.

The size of the wire ropes is defined by the diameter usually expressed in mm.

D. Koronakis S.A. is one of the leading companies worldwide in the production of the wire rope. All types and constructions of wire ropes are available, such as: Galvanized, hot deep galvanized, Bright, Normal and/or non-rotating for Shipping, Fishing, Machinery Cranes, Industry, Mining etc.
SPECIAL WIRE ROPES

For special wire ropes D. Koronakis SA is:

- Sole representative of **CASAR** wire ropes in Greece, considered as the highest quality for all types of cranes.

- We also represent **VEROPE AG** special wire ropes for crane applications at very high technical level.

- **VEROPE AG** (Non rotation resistant wires)
For your reference you can see below table showing the correct wire ropes suited for your intended use. In the meanwhile, you may contact us for any further assistance and selection.

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WIRE ROPE’S DIAMETER MEASUREMENT

| Diameter          | Wrong Measurement | Correct Measurement |

Upon the receipt of a new wire rope, the diameter \( d \) should always be measured the correct way by a caliper (preferably digital), as illustrated above and to be compared with manufacturer’s initial and certified one.

Any diameter differences exceeding manufacturer’s positive or negative allowances should be immediately reported to operators and then to manufacturer in order to verify if the received wire rope is suitable or not for the intended use.

After the first use of the wire rope for a certain period of time, a minor reduction in diameter is expected due to the strands and wire strands arrangement/ alignment. The small reduction is also caused due to stretch/elasticity from the exposure to various low or high loads.

Elongation cannot be calculated, but when the wire rope has reached a certain point of stretch/elasticity then no other extend is expected.

This diameter should be recorded to the vessel’s record keeping booklet for any future reference and comparisons during the wire rope’s service life.

Mooring wires mostly are exposed to non-standard and possible rough marine environmental conditions, resulting to a series of various damages.

Apart from the contact with the radius surfaces (drum, rollers, chocks, fairlead rollers, bitts etc), where the wire rope is subject to bend damages, except the abrasion damage, it suffers also a distortion by and lateral loads, which adversely affect wire rope’s strength in due time.
All people involved with wire ropes’ mooring operations, handling, maintenance, storage, inspections etc should take all necessary safety precautions of good seamanship and practice.

Beyond manufacturer’s recommendations for the proper handling/maintenance and safety use of mooring wires, crew has to understand always that the surveyed/inspected and evaluated condition of the wire rope is always subject to changes and in general it is in a past to present condition. Additional damages are added to the past condition, therefore it is obligatory not to extend/overcome residual limits of strength and replacement criteria. Wire rope has to be retired before it is parted with possible unpredictable fatal accidents.

The main objective and purpose of this manual is to support all personnel involved (operators and ship’s crew) with our company’s knowledge and the high experience factor we bear the last decades with mooring wires.

Communication of manufacturer D.KORONAKIS S.A with ship’s operator(s) and crew should be established for any query which may be raised during wires service life, as well as any other advice.
SELECTION OF MOORING WIRE ROPES

Although there are many tables presenting various wire rope types and specifications/properties, we consider that following steps should be followed for the proper selection of the mooring wire rope.

- While the purchase order is placed to manufacturer by the operator, operator have to advise manufacturer with all mooring data supplied by the shipyard and included into the vessel’s mooring arrangement
  - winch drum---single drum
  - tension and storage drums
  - drum grooved or not
  - drum storage capacity
  - wire rope diameter
  - length
  - required strength (LDBF)
  - drum diameter
  - pedestal roller / fairlead rollers and bitts diameters
  - size of mooring chocks,
  - SWL of all these mooring fittings
- If yard has recommended a certain type of mooring wire, operator(s) and manufacture to confirm suitability and to consider and study all factors affecting wire rope’s safe use and service life longevity.
- Manufacturer can offer and propose the appropriate wire rope, but may advise operator if he has any concern or disagreement. The decision is on the operator(s).
- D.KORONAKIS S.A as manufacturer will supply the vessel exactly the correct wire rope type as requested and if any differences, then the approval from operator(s) to be obtained.
- D.KORONAKIS SA confirms that:
  All supplied mooring wires have been properly made/constructed and checked to be free from any defect and or damage prior leaving the factory. They are reeled/packed, each wire has its own metallic ID tug, and covered with plastic or other sheet properly labelled for transportation by truck or sea to destination.
  They are made to fully comply with the agreed specifications and dimensions (or any agreed deviations, if any) and supported with their relevant certification.
RECEIPT AND INSTALLATION

Upon receipt of the ordered mooring wires, crew should check all of them initially for any external damages to the reels/packing/covers which may have been done during transportation. First external checking has to be made at berth side and then when wire reels are placed on board by the crane.

All remarks, if any for any damage found, immediately to be reported to the operator(s) with copy to manufacturer. Not rarely we have seen external damages made during transportation or when lifted onboard (damaged reels/packing or torn and dirty covers with missing labels, etc).

When mooring wires have to be stored onboard for long periods (all main lines or spare ones) and especially in hot climates, reels have to be turned by 180° (at least once every month) avoiding draining/loss of initial manufacturer’s lubricant. In addition, crew to ensure that into the storage area there is sufficient ventilation to avoid humidity creation and corrosive conditions.

It is preferable for initial supplies the wires to be placed to their winch drums when they are received onboard, enabling the crew to verify their good condition, as when left the factory. Any kind of damages to be reported immediately to operator and manufacturer for further actions and recovery, if these damages do not permit the safe use of the mooring wire.

**Installation:**

When installation has to be made by the crew it is very important that a competent person/officer will guide them by taken all precautions and necessary steps to avoid any undesired conditions as accidents or injuries.

When installation is made by shipyard’s labors, all the work should be supervised by ship’s competent person/officer or company’s representative(s).

All personnel involved to this operation has to wear the correct protective clothing and safety gloves/shoes.
Unpack the wire reel and with **great attention** set free the wire’s secured end (eye).

**Remember that the wire end is secured to the reel or a fiber rope is wrapped to prevent looseness and uncoiling. When you free the wire end, due to wire’s stored energy and torque, possibly the wire end will move by force and suddenly to any direction.**

You can start uncoiling the reel in an horizontal position by inserting to the reel’s center holes an iron tube or iron bar, permitting the free rotation of the reel by using two base stands (one left, one right).
For other smaller wires in diameter and length which are not stowed into a wooden reel, you can use a turn table.

Attention to be paid to avoid any possible damage when you are using as lifting equipment your crane or forklift (the forklift nails not to touch the wire rope but only the wooden flanges or the center axis of the reel).

Wrong way  Correct way
When you have to store a wire rope to winch drum and the wire rope is not stored on a reel but is coiled, then uncoiling has to be done on deck in a vertical position with the deck covered by a plastic sheet or burlap.

In all cases as above the crew should pay extreme attention and follow the responsible officer’s instructions and orders.

Next installation step is to ensure that the wire end or the eye will be secured to the winch drum on top or down, left or right, according to mooring arrangement drawing and wire’s construction. You can use below pictures for the correct storage to the drum.

<table>
<thead>
<tr>
<th>Right Lay wire rope</th>
<th>Left Lay wire rope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top wrapping</td>
<td>Top wrapping</td>
</tr>
<tr>
<td>Under wrapping</td>
<td>Under wrapping</td>
</tr>
</tbody>
</table>

Use your Right hand

INDEX on top
THUMB on left

Use your Left hand

INDEX on top
THUMB on right

INDEX on bottom
THUMB on left
The drum has to be greased in its total surface by the appropriate or recommended by manufacturer or operator(s) grease.

Attention to be paid to avoid any wire damage(s) during the spooling into the drum, and while unreeling or unwinding ensure to apply a certain pressure where the wire will not be stowed slack on the drum.

Secure the eye as required, if wire clips are used to be stainless steel to avoid corrosion while this eye will be used after a certain period time (end for end) and should be as new.

Use a wooden mallet in order each wrap to be in touch with the next one till the first layer is completed without any blank spaces or gaps among the wire’s first layer.

When the first layer is completed to the whole drum width, continue wrapping for the next layer, but from now on, the wire rope will be put into the valleys (space between 2 adjacent wire wraps) of the previous layer.

It is very important in case you have any wire turns during unreeling/uncoiling, to remove them immediately.

During this process avoid the wire to touch the deck or other surfaces, and use a plastic sheet or canvas to avoid oiling it.

On completion join the wire end (eye) to synthetic tail with the appropriate Tonsberg or Mandal mooring link.
Mooring wires connection:

a) Connection with Tonsberg link

b) Connection with Mandal shackle

c) Cow hitch or any other knot to connect a mooring wire with synthetic tails is **not safe** and is **not recommended**.
Mooring wires during their service life are subject to various damages more or less same as all other synthetic mooring ropes. Of course they have few great differences, but is acknowledged that these damages route the wire ropes to the loss of strength and finally to retirement or repair if possible.

Depending the cause that has generated the damage, our factory has improved its technics to minimize the extend of them by selecting prime steel materials and construction techniques and tests complying to ISO, CI and MEG4 guidelines.

While mooring wires are working in different environmental conditions and mooring operations, they have damages in different extend.
**Abrasion:**

Abrasion is one of the very common wire mechanical damage. It occurs while is pulled to mooring fittings surfaces of pedestal rollers, fairlead rollers, winch drum flanges (wrong fleet angle), chocks and bitts/bollards.

Abrasive wear reduces wire’s cross sectional area, which is determined as a decrease in wire rope’s diameter.

Regardless of the presence of wire cuts, if diameter is decreased more than 10%, the wire is discarded.

Initially when external abrasion is observed, some flat wire areas of outer strand crowns. Wires with a greater tensile strength will resist more to abrasion, but they will offer a harder wire with less flexibility subject to other damages.

If the damaged area is in a short length the wire may be repaired by cutting/removing this part. **Resplicing is under question, making a new mechanical eye is recommended.** Turning the wire rope “end for end” is a good practice.

In every inspection the measured % abrasion area has to be recorded and followed up till or before will reach discard criteria.

*It is safe to act and take precautions before reach or overpass max permitted damage limits. This is a general rule for all damages affecting wire ropes.*

Wire’s abrasion with few wire breaks

Strand crowns wire breaks
Valley wire breaks

When you have abnormal and/or in excess abrasion which is located in certain lengths of the wire, then you should suspect that there is the possibility that the fittings are freezed (rollers), the winch flanges have sharp edges, the chocks have rough surface and grooves, the wire rope is dry or improperly lubricated.

**Wire breaks:**

Wire breaks is the result of many possible fatigue failures such as abrasion, corrosion, bend fatigue, overloading, which depending on their extend are reducing the wire’s strength proportionally.

It is recommended, the wire rope to be discarded if visible wire breaks are over than 4 in a length of 6 wire nominal diameters and/or oven than 8 in a length of 30 wire nominal diameter.

Also, if you have wire breaks in the end eye, then proceed to the construction of a new one (Mechanical or Hand splicing).

Record the condition of the broken wires, as more breaks are expected to appear at the next use of the wire rope. Adjust by your own the inspection frequency.

Attention is paid when you are carrying out hand greasing with or without protective gloves.
The other case of wire breaks is when they are not external, but hidden and underneath the wire strands and wire valleys, mostly generated by bend fatigue. This can be verified only by opening the strands, but it has to be done with caution when opening the strands with a marline spike. Only experienced personnel/crew can do it.

**D/d ratio & Bending fatigue:**

Bending fatigue normally is generated when mooring wires are bent when passing over stand rollers, fairlead rollers, chocks, bitts and on the drum. When the bending angle is sharp/very sharp and the ratio D/d (D=fitting diameter, d=wire diameter) is low, the wire is subject to bend fatigue with all consequences of deformation and wear.

**Bend Limits:**

a) The bend angle should be as possible less than 10°

b) The D/d ratio greater than 15

Bending wear consists of wire’s abrasion (internal and external), wire breaks, flattened wire rope. If the wire rope is using the same mooring pattern frequently, then this part of the wire rope (see yellow area) shortly will be damaged. Specific attention and follow up to the extend of seen/unseen damages is required. See also previous sections mentioned remarks and recommendations (Abrasion, wire breaks).

It is safer this part of the wire to be cut and new eye to be made (provided that the length of the wire rope is not much shortened). Otherwise turn the wire rope “end for end” or discarded.
Corrosion:

Corrosion of the wire ropes is the result of the non-well maintained and or not properly greased wire ropes. Corrosion is considered as the most common reason for certain wire rope deterioration and damages. It is an environmental cause where mooring wires have to work under humidity and salt water. Corrosion is observed both to external and internal parts of the wire rope and the core.
The selection of a properly galvanized wire rope along with frequent and correct greasing will eliminate this effect.

Corroded wire ropes will indicate in addition to the mentioned damages and fatigue, an increase in diameter along with surface irregularities.

If the reduction of diameter is more than 10%, the wire rope should be discarded or repairs to be done if this is possible and permitted.

Depending on the extend of corrosion, maintenance by the crew can be done, otherwise the wire rope has to be discarded.

Corrosion is reducing wire rope’s cross section metallic area and is also reducing the wire rope’s strength. Service life is also shortened.

Maintenance includes the removal of the external/internal corrosion by hand or power brushing, and immediate hand or power greasing.

The use of an environmental grease is obligatory. The grease should conform to existing standards and must have all characteristics and properties for the wire rope and environmental protection.

The operator can select from market the type of grease which is the most suitable for the vessel.

**Crushing:**

Crushing is the effect observed when the wire of the working layer is coming into the previous layer loose wraps and is buried among them.

Remember the importance of the correct back tension when you install or spool the wire to the drum.

In this case we have to correct it immediately and avoid wire damages and shock loading as the drum continuously rotates.

Another crushing effect is observed when the wire rope is trapped between ship’s side and the berth.
**Fleet angle:**

**Tension drums** should be properly aligned to pedestal rollers or to universal side rollers, fairleads and or chocks, in order to maintain the fleet angle to the best working limits. OCIMF recommends that the **Fleet angle** is limited $a^\circ \leq 1.5^\circ$

**Very Small** fleet angles result to the wire rope’s over wrapping (over-laying) on the tension drum.

**Greater** fleet angles result to the rub of the wire rope against the surface of separation or side drum flanges, resulting to considerable abrasion with possible cut of strand wires.

The distance $(L)$ between the drum center line to the vertex point $(A)$ should be at least: $19 \times \text{drum width (W)}$

Therefore redirection of wire ropes to meet the limits of D/d and Fleet angle is recommended if it is possible and workable.
Birdcages, Kinks:

Mooring wire ropes are subject to un-laying twists due to sudden release of tension and/or when tails break. Usually the outer strands and their wires will open and most probably they will not return at their position as indicated below (birdcage).

Kinks are wire loops coming from the wire rope’s wrong coiling or uncoiling. If the wire rope is pulled tight then kink(s) are generated.
Hard kink

The damage is considered serious due to wire rope deformation and the replacement is the best action. Meanwhile if the deformation is limited and the damaged area is short, we can cut it and use the rest wire provided that we have to recoil it in the correct way.

**Temperature:**

Wire ropes for standard environmental conditions are not affected seriously as they can withstand to a great temperature range.

Values of -30° C up to +90° C are considered normal and do not affect wire rope’s performance. Meanwhile the freezing & melting point of the anticorrosive lubricant has to be taken into account.

Temperature damage has a discoloration appearance and if the wire rope seems to be dry and non-flexible with the expectation of further deterioration, then most probably the damaged part affecting the strength, has to be removed or the wire to be retired.

Exceeding these values we can see freezing or melting of the anticorrosive grease, this is why a prime quality anticorrosive lubricant should be used.

For any further information, please contact our company

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