D. KORONAKIS S.A.
INSTALLATION & INSPECTION MANUAL
FOR SYNTHETIC FIBER MOORING ROPES
8, 12 & 24 STRAND

Demanding Ropes for demanding operations

MANUFACTURERS OF WIRE - SYNTHETIC AND COMBINATION ROPES • STOCKISTS OF ANCHORS - ANCHOR CHAINS - CARGO GEAR - ACCESSORIES
Main Offices & Stocks:
56, Gravias Str. 185 45 Piraeus-Greece
Plant - Factory: Eleonas 32200 Thiva, GR
Tel: +30 210 4060600
Fax: +30 210 4615211
www.koronakis.gr

 koronakis@koronakis.gr
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</tr>
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- EDITION 01/2018 -
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:


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 9001:008 certified by UKAS-B.V.Q.I
- ISO 14001:2004 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 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 ROPE
- LLOYD’S REG TYPE OF APPROVAL FOR UHMPE FIBRE ROPE
- LLOYD’S REG TYPE OF APPROVAL FOR MIXED FIBRE ROPE
- LLOYD’S REG TYPE OF APPROVAL FOR NYLON FIBRE ROPE
- LLOYD’S REG TYPE OF APPROVAL FOR POLYESTER FIBRE ROPE
SYNTHETIC FIBER MOORING ROPES - 8, 12 & 24 STRAND

D.KORONAKIS S.A is among the few top worldwide manufactures for the construction of SYNTHETIC FIBER MOORING ROPES known as:

“FLEX”, “FLOAT”, “STRONG”, “OCEANIC”, “SILVER FLOAT”, “KARAT MAXI”,

“NYLON”, “POLYESTER”, “POLYPROPYLENE”

Our company has been engaged and built the “KNOW HOW” for the construction of these ropes after great studies, experiments, investigations and various tests performed. Ensuring this way an extremely increased safe and economical solution and a great longevity using always high and prime quality certified materials.

The main advantage is that our ropes maintain their shape while under load and provide a very high abrasion resistance. They are tailor made and offer a high protection against various internal & external damages.

Designed with extremely high properties than other ropes in the market, they offer increased strength, less abrasion, minimum backlash and perform efficiently.

Furthermore, to the above additional protection, long performance is obtained by using our Chafe or Kapa Sleeve protectors.

Our production process is fully complying with International standards and is in accordance with OCIMF recommendations and mentioned ISO standards.

End users - Port Captains, officers and crew – are always welcome to our factory to follow up the production and tests, discuss with our technical personnel and take recommendations and explanations for any queries that they may have.

These ropes are produced and tested in accordance ISO 2307 and ISO 9554.
# KAPA MOORING ROPE
THE ULTIMATE MOORING CONSTRUCTION

**A ROPE CONSTRUCTION INVENTED BY D.KORUNAKIS S.A.**

The ultimate round rope construction easily spliced.

Ropes recommended in OCIMF guidelines to serve on OBO’s - OOC’S, TSH’S - ULCC’S and GC’S in a most effective way.

In these ropes polyester is combined with high density polyolefin to construct the "Kapa float - Kapa flex and Kapa strong", depending on the polyester percentage (25%-40% and 50%).

All three constructions have the same features, more or less, apart from the specific gravity that is different depending on the amount of polyester it contains - 0.99 for the Kapa Float, 1.10 for the Kapa Flex, 1.14 for the Kapa Strong. These ropes are produced and tested in accordance with ISO 2307 and ISO 9554.

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## KEY FEATURES

<table>
<thead>
<tr>
<th>Feature</th>
<th>Kapa FLEX 24 40% per weight polyester</th>
<th>Kapa FLOT 24 25% per weight polyester</th>
<th>Kapa STRONG 24 50% per weight polyester</th>
<th>Kapa OCEANIC 24 pure olefin</th>
<th>Kapa SILVER 24 custom-made</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPECIFIC GRAVITY</td>
<td>1.1</td>
<td>0.99</td>
<td>1.14</td>
<td>0.98</td>
<td>1.01</td>
</tr>
<tr>
<td>UV-RESISTANCE</td>
<td>Very good</td>
<td>Very good</td>
<td>Very good</td>
<td>Very good</td>
<td>Very good</td>
</tr>
<tr>
<td>ABRASION RESISTANCE</td>
<td>Very good</td>
<td>Very good</td>
<td>Very good</td>
<td>Very good</td>
<td>Very good</td>
</tr>
<tr>
<td>CHEMICAL RESISTANCE</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>ELONGATION</td>
<td>See graph</td>
<td>See graph</td>
<td>See graph</td>
<td>See graph</td>
<td>See graph</td>
</tr>
<tr>
<td>CONSTRUCTION</td>
<td>12 or 24 strands</td>
<td>12 or 24 strands</td>
<td>12 or 24 strands</td>
<td>12 or 24 strands</td>
<td>12 or 24 strands</td>
</tr>
<tr>
<td>COLOR</td>
<td>White with black tracer</td>
<td>White with blue tracer</td>
<td>White with black tracer</td>
<td>Blue</td>
<td>Other colors available upon customer's request</td>
</tr>
<tr>
<td>WATER ABSORPTION</td>
<td>max 1%</td>
<td>max 0.9%</td>
<td>max 1%</td>
<td>approx 1%</td>
<td>max 0.5%</td>
</tr>
</tbody>
</table>
KAPA MOORING ROPES
12 AND 24 STRAND (TWILL)

KAPA ROPEs THE KORONAKIS WORLDWIDE INNOVATION

Designed by our company, this new rope was invented to combine the advantages of 8-strand and Double Braided ropes. Safe and easily spliced, KAPA is a well-accepted construction that very quickly dominated the marine world.

The Kapa Nylon, the Kapa Polyester and the Kapa Pelagos is a category of ropes designed with the user in mind, the crew member that makes the splices and above all the increased safety factor. With minimum elongation, the snap back danger zone is decreased significantly. These ropes have dominated the market, having established a name for themselves, “Kapa”. More and more companies prefer them over the old 8-strand ones. A wide variety of raw materials and colors ensure that the end user can select the most appropriate construction to meet his exact mooring expectations.

COMMON TECHNICAL SPECIFICATIONS FOR KAPA

- Non-rotating, torque free, hangs straight under load
- Superior abrasion resistance
- Non-kicking, non-hockling
- Excellent grip
- Longer service life (estimated lifetime 1:2, 25)
- Stay flexible, wet or dry, new or old
- Greater bearing surface
- Comfortable handling

KEY FEATURES

<table>
<thead>
<tr>
<th></th>
<th>KAPA PELAGOS</th>
<th>KAPA NYLON</th>
<th>KAPA POLYESTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra High Strength to Weight Ratio</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Working Elongation</td>
<td>8%-10%</td>
<td>10%-14%</td>
<td>8%-10%</td>
</tr>
<tr>
<td>Breaking Elongation</td>
<td>12%-14%</td>
<td>21%</td>
<td>12%-14%</td>
</tr>
<tr>
<td>Melting Point</td>
<td>Approx. 160º - 270ºC</td>
<td>Approx. 220ºC</td>
<td>Approx. 270ºC</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>0.99</td>
<td>1.14</td>
<td>1.40</td>
</tr>
<tr>
<td>Ideal for Auto Winches</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>0%</td>
<td>4% Approx.</td>
<td>4% Approx.</td>
</tr>
</tbody>
</table>
8 STRAND MIXED MATERIAL ROPES

ROPEs THAT MEET IN FULL THE OCIMF GUIDELINES

D. Koronakis S.A. has been producing mixed fiber ropes for more than 35 years. In recent years, OCIMF has included these ropes in the latest version of mooring guidelines.

Mixed ropes are preferred by end users as they are strong and flexible at the same time. The polyester surface fibers protect adequately the olefin fibers which in turn provide flexibility to the rope construction.

These ropes are produced and tested in accordance with ISO 2307 and ISO 9554.

TYPICAL ROPE CONSTRUCTIONS INCLUDE:

**FLOAT 8**: 25% polyester and 75% high density olefin per weight. Construction is used with the polyester covering 100% of the rope’s surface, yet constructing a floating rope.

**FLEX 8**: 40% polyester and 60% high density olefin fiber per weight. Construction is used. The ropes’ surface is totally covered by a thick polyester jacket ensuring increased abrasion and temperature resistance (Non floating).

**STRONG 8**: 50% polyester and 50% high density olefin fibers per weight. Construction. The rope, having all the qualities of the Flex construction, is really made to prove its name.

**OCEANIC 8**: The latest development of our factory is the mixed material 8 strand ropes. With 30% of the surface fibers being polyester and 70% high density olefins. This combination guarantees floatation and high breaking loads.

### KEY FEATURES

<table>
<thead>
<tr>
<th></th>
<th>FLEX 8</th>
<th>FLOAT 8</th>
<th>STRONG 8</th>
<th>OCEANIC 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPECIFIC GRAVITY</td>
<td>1.1</td>
<td>0.99</td>
<td>1.14</td>
<td>0.98</td>
</tr>
<tr>
<td>UV-RESISTANCE</td>
<td>Very good</td>
<td>Very good</td>
<td>Very good</td>
<td>Very good</td>
</tr>
<tr>
<td>ABRASION RESISTANCE</td>
<td>Very good</td>
<td>Good</td>
<td>Very good</td>
<td>Very good</td>
</tr>
<tr>
<td>CHEMICAL RESISTANCE</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>ELONGATION</td>
<td>See graph</td>
<td>See graph</td>
<td>See graph</td>
<td>See graph</td>
</tr>
<tr>
<td>CONSTRUCTION</td>
<td>8 strands</td>
<td>8 strands</td>
<td>8 strands</td>
<td>8 strands</td>
</tr>
<tr>
<td>COLOR</td>
<td>White with black tracer</td>
<td>White with blue tracer</td>
<td>White with black tracer</td>
<td>Blue</td>
</tr>
<tr>
<td>WATER ABSORPTION</td>
<td>max 1%</td>
<td>max 0.5%</td>
<td>max 1%</td>
<td>max 1%</td>
</tr>
</tbody>
</table>
KARAT® MAXI PLUS

HIGHEST STRENGTH OF THE CONVENTIONAL PERMANENTLY FLOATING MOORING ROPES

KARAT® MAXI Plus has become standard terminology in high quality mooring applications. Very high strength-to-weight ratios allow substantial size reductions and ease in handling, as well as providing excellent cost/economy.

The KARAT® MAXI PLUS is DNV Type approved.

ADVANTAGES OF KARAT® MAXI Plus

- Water repellent
- Highest strength of the conventional permanently floating mooring ropes
- High abrasion resistance
- No loss of strength when wet
- High energy absorption
- Very low back-up effect
- Manufactured according to ISO and DNV
- EStalon™ is a polyester/polypropylene melt
  mixture
- Euroflex™ in the outer yarns

KEY FEATURES

<table>
<thead>
<tr>
<th>SPECIFIC GRAVITY</th>
<th>UV-RESISTANCE</th>
<th>MELTING POINT</th>
<th>CONSTRUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.96 (tested)</td>
<td>Very Good</td>
<td>105°C</td>
<td>8 strands</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ABRASION RESISTANCE</th>
<th>CHEMICAL RESISTANCE</th>
<th>ELONGATION</th>
<th>BENDING RATIO: DYNAMIC ISO 3720</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Good</td>
<td>Good</td>
<td>10% new rope-11% Used rope</td>
<td>9.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WATER ABSORPTION</th>
<th>REDUCTION OF MBL WHEN WET</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
8 STRAND PLAITED ROPES

The 8 strand constructions are plaited ropes made to eliminate the tendency twisted ropes have to rotate under weight / load.

They are produced on machines containing 8 camers in groups of 2 'twells', revolving around each other in pairs to form the 8 strand plaited construction.

The 8 strand rope, developed after the World War II, is still widely used even today in a broad range of applications. Depending on the use and on the experience of the user, many man made materials and even combinations of them are used in this construction. The materials normally used and treated during manufacturing are the same as in the 3-strand ropes and as far as WLL is concerned, it is the same, for the same diameter ropes.

These ropes are produced and tested in accordance with ISO 2397, ISO 9554, ISO 11417 and ISO 11420.

### KEY FEATURES

<table>
<thead>
<tr>
<th></th>
<th>POLYESTER 8</th>
<th>NYLON 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPECIFIC GRAVITY</td>
<td>1.36</td>
<td>1.4</td>
</tr>
<tr>
<td>UV-RESISTANCE</td>
<td>Excellent</td>
<td>Very good</td>
</tr>
<tr>
<td>ABRASION RESISTANCE</td>
<td>Very good</td>
<td>Excellent when dry</td>
</tr>
<tr>
<td>CHEMICAL RESISTANCE</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>ELONGATION</td>
<td>See graph</td>
<td>See graph</td>
</tr>
<tr>
<td>MELTING POINT</td>
<td>Approx. 270°C</td>
<td>Approx. 260°C</td>
</tr>
<tr>
<td>CONSTRUCTION</td>
<td>8 strands</td>
<td>8 strands</td>
</tr>
<tr>
<td>COLOR</td>
<td>White, Silver. Other colors upon customer's request.</td>
<td>White. Other colors upon customer's request.</td>
</tr>
</tbody>
</table>
INSTALLATION PROCEDURE

Initial preparation:
To avoid chaffing damages all contact surfaces on winch drums, stand rollers and roller fairleads, universal fairleads and/or Panama chocks, should regularly be inspected and be free of any rust scale, grooving or cuts.

Smooth and clean surfaces should be maintained with free chafe points. Where possible should be highly polished to at least RA 10 standard. This in practice may be difficult to be achieved or maintained unless stainless steel is used. In any case the use of chafe and/or Kapa sleeve protectors along with a Kapa lubricant for the protection of the ropes against the rollers and chocks is recommended.

Even if chocks are new, it is still recommended to place a synthetic "Kapa Protection Sleeve" or "Chafe protection tube" to avoid the contact of the mooring ropes with the metal surfaces and minimize abrasion and temperature increase.
Must assure that on Pedestal and or universal side Fairlead rollers there are no rough edges, bolts or other obstacles that the synthetic rope can touch on, and should be well maintained and kept free to rotate.

The whole surfaces of the winch must be absolutely smooth, if possible, painted with strong epoxy paint. The minimum drum diameter is recommended to be at least 16 times the nominal diameter of the rope.
It is recommended to have at least 8-10 turns on the tension drum. It is not recommended and should be avoided to have more than one layer of turns, limiting rope’s tendency to “bury” under tension, while any additional layer weakens the brake holding capacity of the winch (about 7%-10% for each layer).

To avoid chafing in the transfer section between the storage and tension drum, it is very important to pay attention to the fairing of the edge.
Packing, Identification & Unpacking:

All coils of ropes are dispatched from our premises properly packed for sea or road transportation. Carefully placed on wooden or plastic pallets are always covered with plastic sheet, wrapped to maintain coil’s shape, free of any kind of damages, labelled with rope’s main characteristics.

Each Coil has its own metallic ID tag which should remain intact for the whole rope’s life. It is used to indicate the onboard working position, as well as any reference kept to the booklet of “record keeping” for visual inspection results, number and time of operations, repairs made by the crew or manufacturer, any destructive test by manufacturer.

Upon the receipt of ropes, ensure that all are received intact without any transportation damage(s), and if any, you should immediately report it to your company. Depending the damage, your company along with the manufacturer, will evaluate the rope’s condition and decide whether the rope(s) can be used, be repaired by crew or to be sent back in our factory for examination and proper repairs.

Carefully unpack them near the winches, place each coil on the turntable, then start uncoiling the rope from the external layer to avoid twisting (never from the internal layers).
Secure the eye to the storage drum with extreme attention to avoid any damages if “U bolt(s)” are used. Alternatively you can use a pig tail (weak link) of a common use rope with half diameter to the mooring line and secure it to the “U-Bolt”. In case of emergency where the vessel has to let go the whole mooring line, you can cut this pig tail without damaging the line.

Remember that after years this eye will be the new working eye when rope is turned end for end.
During storage to the drum, please ensure that the rope is under a specific constant tension of approx. 40-60 kgs in order to avoid burying/diving into the previous lower layer.

During storing process to the storage drum, make a “cross winding” with 2 crossing layers of 1 or 2 wraps starting from left to right, and back right to left, then repeat again after 2 layers of full length winding.
OPERATION & HANDLING OF SYNTHETIC FIBER ROPES

The end user should take into consideration following concurrently with mentioned in INSTALLATION section.

Line design break force (LDBF) is referred to spliced ropes (as per MEG4 recommendations) and mostly has a positive allowance.

The ropes are properly hand under the proper handling and precaution will last for a very long period of time without a considerable deviation from their initial strength and its properties.

The rope’s longevity can be extended if they are used along with mooring tails.

Tails should have at least a length of 11 meters (sheltered ports with normal weather-sea conditions), can be of mixed synthetic materials (polyester and olefin) or 22 meters Nylon for STS operations or when vessel operates to open ports under abnormal weather, sea and tide conditions.

Tails of medium or high elasticity reduce and distribute evenly the mooring rope’s dynamic loads. The end user will decide which kind of tails have to be used for each case, to ensure the proper tenacity and elasticity characteristics applied to the mooring arrangement.

Consider tails’ elongation for mixed synthetic 15% and for nylon up to 37% of their initial length and bear in mind that it is proven that nylon material loses certain amount of its dry strength when wet (about 12%).

Therefore, when you place new orders for nylon tails, mention both dry and wet breaking force.

Longer tails are recommended for breast lines, i.e 25% longer than the others of 11 Mtrs.

We always can assist you for the proper selection of mooring tails.
Synthetic fiber ropes may be connected to tails with a proper ‘cow hitch’ as indicated below.

Correct way

Wrong way

Ensure that the rope remains straight when under load, same when collecting the rope to storage and tension drums. Twists reduce the strength and damage the fibers and strands construction.

Ensure that you are using the ‘chafe protector’ or ‘kapa sleeve’ for the ropes passing through your vessel’s chocks or stand rollers and side fairlead rollers.

Pay an extreme caution to spring lines and ensure that they are not touching the side shell and the rope’s angle at the chock is not very large. Change of the shore bollard if this is permitted and accepted for your mooring arrangement.

When re-directing a mooring rope which has to pass from a stand roller, ensure the roller is freely turn, the groove of working surface is clean and smooth with proper dimensions (usually groove diameter should be 10%-15% larger than rope’s diameter), and only one rope is passing through the roller, never two ropes of same or opposite direction.

It is recommended that after usage of the rope in dirty environment conditions and before storage to the drum, to clean it with fresh water.
Mooring team should always remember that they are working in an area where dangerous situation may occur, if they are in line with ropes under excessive tension and the line or tail will break.

Snap back zones indicate possible dangerous areas after a rope’s failure, but they are not limited. **The movement of a parted rope it is not predictable especially for the outboard side.**

Tension drum should always have 8-10 wraps, while a second layer of wraps is not permitted as long as this is unavoidable.

Inspection of the ropes after each mooring operation is compulsory. Any kind of possible external-internal damages, any local reduction or increase of rope’s diameter, deformation, stiffness, or twists should be recorded into your vessels “RECORD KEEPING” booklet for future reference to each rope’s life performance.

“Record keeping” booklet will guide us whether a rope will be fit for further use or will be rejected if repairs are not possible or costly.

Working hours should be kept for all mooring ropes. Each rope should be identified by its mooring position and metal ID tag.

Splices should always be inspected to ensure that remain intact and/or in acceptable condition free of any damages.

Avoid dragging the rope over rough surfaces (antislapping deck area), but in any case dragging will result the rope to develop initially a fur which is normal.

While berthed please ensure that all your mooring lines are properly tensioned to get the same strain and load. Some ropes fast to quay side bollards in a long distance, usually have a small sag, do not confuse it as a slack rope.

If slack rope(s) are observed, tension must be applied in order to prevent the vibration that might be developed in the rope. Slack may cause internal yarn on yarn fatigue that results to the premature loss of strength, temperature increase and generally harm the rope’s condition.
GLOSSARY AND KNOWN FAILURES FOR MOORING ROPES

(Few extracts are taken from OCIMF and other bibliography)

**Abrasión:**

Abrasión is a very common failure of synthetic ropes wear, which pending the severity adversely affect the rope’s service life.

**External abrasion,** is the wear to the rope caused by the contact with sharp surfaces and edges, contact with non-properly maintained surfaces of rollers, fairlead rollers and chocks, contact with winch drum side and separating flanges, contact with rough surfaces on a rusty deck and cargo remnants/prit etc.

In addition tension angle sliding of the rope against to certain surfaces is caused by repeated use of the same certain length of the rope against to the chocks, rollers, winch drum sections, bitts.

External abrasion is eliminated by using of Protection with synthetic sleeves and chafe guards.

When a synthetic fiber rope initially is put under service, outer filaments have a furry appearance. This is quite normal and should not be confused with the external abrasion. This furry surface is a protection for the underlined fibers.

**Internal abrasion** is referred as the wear to the strands/fibers/yarns caused when rope is subject to many and continuous bending and/or to cyclic tension.

Both External and Internal abrasion should be carefully evaluated, as the rope is losing strength proportionally. In addition, for each rope, abrasion observations should be recorded for further future reference, before a decision is taken to repair or retire the rope.

**Breaking strength:**

It is the tensile strength (force) required to break the rope under certain test procedures.

a) Actual breaking strength: This strength is the one obtained when the rope is under a destructive test.

b) Theoretical breaking strength: This is the maximum stress that the rope can get, based on manufacturer’s product properties with certain formula calculations.

c) Minimum breaking strength: MBL is the force that a given rope is required to meet or exceed when it is new and unused. It is the most common term for mooring rope’s strength value.

According to MEG4 the MBL is replaced by the term LDBF, which is approximately 100-105% of the MBL and always refers to spliced ropes. It is compulsory the residual strength to remain 75% above the initial LDBF. MBL is referred only to vessel’s mooring fittings.
**Critical temperature:**
Is the temperature at which the properties of a fibre begin to deteriorate.

**Cyclic loading:**
Repeated loading of rope or fibre in service, or on a test machine.

**Diameter nominal:**
The approximate diameter of the rope as declared by the manufacturer for reference purposes.

**Dynamic load:**
Any rapidly applied force that increases significantly the load on a rope above the normal static load.

**Elongation:**
The ratio of the rope’s extension under an applied load to its length prior to the application of the load. It is expressed as a percentage.

**Elastic elongation:** The temporary change in length of a fibre or yarn under tension which is reversed when the tension is removed.

**Elasticity:** the elastic (non-permanent) elongation of a unit length of an element caused by a unit load.

**End-for-end:**
The process of rotating a rope on its stowage drum so that the working section is changed. This involves removing the rope from the drum and re-stowing it with the previous end next to the drum.

**Extension:**
The deformation (change in length) of a rope when a load is applied.

**Laid ropes:**
Ropes made by twisting of three or more strands together with the twist direction opposite than of the strands.

**Plaited ropes:**
A rope structure consisting of two pairs of strands twisted to the right and two pairs of strands twisted to the left, braided together in such a way that pairs of strands of opposite twist alternatively overlay one on another.
Pretension:
Additional load applied to a mooring line by a powered winch over and above the one required to remove sag from the main run of the line.

Size number:
A nominal designation of a rope size, determined from the approximate circumference measured in inches.

Tail:
A short length of synthetic rope attached to the end of a mooring line to provide increased elasticity, absorb the dynamic loads and ease the handling.

Twist:
A rotation induced in the rope during service.
ROPE INSPECTION – ROPE REJECTION CRITERIA

Before a rope is used, the entire length, including eye splices, should be inspected for the following:

c1) External-Internal wear: When a rope is first put into service the outer filaments will take on a slightly furry appearance. This is a normal occurrence as the surface filaments break due to abrasion in service. This surface abrasion needs to be examined visually regularly to ensure what is a normal occurrence is not mistaken for more serious damage being caused to the rope by other means. Internal abrasion is caused by the yarns that rubbing against one another, or by the ingress of grit or any kind of solid dirt into the braid of the rope.

The effect of abrasion on the residual strength of the rope is difficult to be assessed visually. The below figures can help for a visual estimation.

![FIGURE D1: NEW ROPE](image1)

![FIGURE D2: USED ROPE](image2)

![FIGURE D3: DAMAGED ROPE](image3)

Except of the visual examination a maximum material loss of 20% through abrasion is critical for removal the rope from use.

If this material loss appears only to a certain length of the rope, another solution is to cut this part of the rope and splice the two rope parts. The cut to be made by the crew if possible, otherwise by the manufacturer. If this is not possible the rope has to be retired.
c2) Inconsistent diameter: Visually detected as localized reduction in diameter and localized increases of diameter as in the figure below. Probably have been caused by shock loadings and/or cut yarns inside the rope. Normally this part of the rope has to be removed and splice the two rope. The cut to be made by the crew if possible, otherwise by the manufacturer. If this is not possible the rope has to be retired.

![Image of rope with inconsistent diameter]

C3) Glazed-Compressed areas: Normally occurs on bend surfaces (like winch drums) when the rope is under radial load. These areas are quite stiffer than usual but by flexing the rope reverts to its normal stiffness.

Usually no other corrective action needs to be taken.

![Images of glazed rope](GLAZED, NO FIBRE DAMAGE (BENT ROPE)
GLAZED, NO FIBRE DAMAGE (FLAT ROPE)
SAME ROPE AFTER FLEXING-NO PERMANENT DAMAGE)
c4) Heat fusion-Melted yarns: Visible detected as charred and melted yarns. Normally in these areas the rope is very stiff and cannot revert by flexing. This may be caused when rope sustained to extremely high load on to a bending surface or has been exposed to excessive heat. Normally this part of the rope has to be removed and splice the two rope parts. The cut to be made by the crew if possible, otherwise by the manufacture. If this is not possible the rope has to be retired.

![Figure D12: Actual melting damage, often black hardened yarn end that can not be flexed back. In this picture approx. 50% of one strand is actually melted away.]


c5) Cut strands: It may be caused by operating the rope over sharp edges and surfaces, more rarely from wear caused by extreme abrasion during operation. If 2 or more strands are cut this part of the rope has to be removed and splice the two rope parts. The cut to be made by the crew if possible, otherwise by the manufacturer. If this is not possible the rope has to be retired.

c6) Pulled yarns or strands: this may be caused during rope snagging somewhere to the equipment during operation. If there is not any cut or damage it can revert through working back the pulled yarns or strands into the rope. No other corrective action is needed.
RECOMMENDED MAIN D/d RATIOS

SPLIT DRUM WINCHES
MEG4 recommends the minimum drum diameter should be at least 16 times the design rope diameter.

PEDESTAL–STAND ROLLER–CHOCKS–BITTS
Synthetic fiber ropes lose strength when are bent over a radius such as pedestal rollers, universal side rollers or chocks, bits etc.

As per OCIMF, the recommended D/d ratio is 15, but 10 is also acceptable.

Apart from the contact with the radius surfaces and expected abrasion, rope operating under a bend will result in a distortion of the distribution of longitudinal and lateral loads, which adversely affect rope’s strength at a certain period of time.

The loss in efficiency of the rope is given by the formula:

\[
\text{Efficiency} = 1 - 0.5 \times \frac{1}{\sqrt{D/d}}
\]
Diameter:

It is clear that the largest “D”, the less loss of rope’s breaking strength.

Photo 2 indicates a pedestal roller where D=450mm with rope’s diameter d=44mm, a ratio of over than 10 is obtained, but where the stand height is an obstacle to other fittings, smaller stands and rollers are fitted with a roller diameter of 350mm fitted, presenting a ratio of about 8 which is close to acceptable.

Photo 1

Photo 2

Roller’s and chocks bend Angle:

Independently from the roller diameter and although synthetic fiber ropes ropes have very good bending properties, attention should be paid when re-directing the rope from tension drum through the pedestal roller to other mooring fitting as side universal side rollers, fairleads, or chocks. Especially when angles become very large there is a considerable loss of rope’s breaking strength and fatigue, but due to vessel’s mooring arrangement in some cases this is unavoidable.

bend angle $\vartheta < 10^\circ$
**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 rope’s over wrapping (over-laying) on the tension drum.

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

The distance (L) between the drum center line to the vertex point (a) should be at least: 19 x drum width (W)
12 STRAND SYNTHETING MOORING ROPE

SPlicing PROCEDURE OPTION 1

LOCKED BRUMEL BURRIED SPlICE

(MEDIUM DIFFICULTY TO PERFORM ON BOARD)

TOOLS REQUIRED

✓ Masking Tape
✓ Felt Tip Marker
✓ Splicing Fids
✓ Sharp Knife
✓ Measuring Tape

PROCEDURE

1) From end of rope measure back 1 FID length equal to 80 times the diameter of the rope in expressed in mm and make Mark "A". Measure Eye size and mark point B opposite to point A.

From the end of the rope measure a length equal to 10 times the diameter of the rope expressed in mm and using a cutting tool and beginning from this point cut the 1st pair s-z strand leave the second cut the third etc., till the end of the rope.

It is too critical to have a certain conical shape so the finishing of the splice will end as smoothly as possible. Then using masking tape place 2 wraps of tape on above length.

2) Pass end through Center of rope at Mark A.

3) Pull end up tight.
4) Pull end hard to roll "inside out" at Mark A.
5) Now pass end through center of rope at Mark B.
   (in same direction as before)
6) Pull A all the way through and pull tight.

7) You now have points A & B rolled inside-out.
8) Now un-roll point A working rope up and through point A in direction shown.
9) Pull point B all the way through A.

10) Now un-roll Point B working short end up & through Point B.
    (in direction shown)
11) Pull short end up- while pulling the standing end down as shown.
12) Continue to close-up locked Brummel Splice.
13) Finally, bury tail into standing end.

14) The following photos show the burring steps.

After 3 pairs of s-z strands open the body of the rope and pass through the rope end very carefully.

Be very careful not to carry any twist to the rope end!
When the total rope end is buried and after 3 pairs of s-z strands we pull out the conical tappered end and we remove carefully the tape.
Then holding from the top of the splice we start milking the rope body from the end of the splice loop towards the rope body and for the whole length of the splice.

In the following photos you can see the uniformly tapered spliced area.

Now the splice is ready for use.
12 STRAND SYNTHETING MOORING ROPE

SPLICING PROCEDURE OPTION 1

SIMPLE BURRIED SPLICE

(QUIET EASY TO PERFORM ON BOARD)

TOOLS REQUIRED

✓ Masking Tape
✓ Felt Tip Marker
✓ Splicing Fids
✓ Sharp Knife
✓ Measuring Tape

PROCEDURE

1) From end of rope measure back 1 FID length equal to at least 80 times the diameter of the rope expressed in mm and make Mark "A". Measure Eye size and mark point B opposite to point A.

From the end of the rope measure a length equal to 10 times the diameter of the rope expressed in mm and using a cutting tool and beginning from this point cut the 1st pair s-z strand leave the second cut the third etc., till the end of the rope.

It is too critical to have a certain conical shape so the finishing of the splice will end as smoothly as possible. Then using masking tape place 2 wraps of tape on above length.

2) Pass end through Center of rope at Mark B.
3) Pull the rope end carefully until the mark A meets mark B.
   Be very careful not to carry any twist to the rope end!

4) After 3 pairs of s-z strands open the body of the rope and pass through the rope end very carefully.
   Be very careful not to carry any twist to the rope end!
5) When the total rope end is buried and after 3 pairs of s-z strands we pull out the conical tapped end and we remove carefully the tape.

6) Then holding the 2 Marks A, B in touch we start milking the rope body from the marks and for the whole length of the splice.
Pay special attention during 'milking' the 2 marks A, B must be in touch.

7) For safety reasons to anew unused splice, in order to avoid that somebody will pull the buried end out due to a wrong operation, you can put 5 or 10cm of lock stitch seizing using a polyester or nylon yarn starting from A, B marks towards the splicing body.

8) Now the splice is ready for use.
24 STRAND SYNTHETING MOORING ROPE

SPlicing PROCEDURE

These ropes consist of 2x6 S-twist strands and 2x6 Z-twist strands arranged in a way that the S-twist pairs of strands alternate with Z-twist strands covering 1 or more laid or braided cores.

**Step 1.** From the end of the rope we count 15 tucks of Z or S pairs of strands. This is mark a, and we tightly put tape around the rope to mark a (photos 1&2).

---

**Photo 1**

**Photo 2**

**Step 2.** Measure eye size and mark point b opposite to point a. Cut the tape to the rope end and start securing with red tape the 6-z pairs of strands and blue tape the 6-s pairs of strands (photos 3,4,5,6).

---

**Photo 3**

**Photo 4**
Step 3. Secure tightly with tape the rope behind the marks a,b. Before this securing you have to be sure that the rope from the cutting edge to mark b has to be not twisted to its axis.

Then pull out of the rope end the 1st z-pair just after the mark a and bury it under the 1st & 2nd s-twist pairs just after the mark b, following the route of the below z-pair. Pay attention: each strand pair must pass through in parallel, with no twist between them (photos 7,8,9).
Continue burying the other five z-twist pairs 1 by 1 in the same way (photos 10,11,12).

Photo 10

Photo 11

Photo 12

**Step 4.** Continue burying the z twist pairs one more time under the s-twist pairs, following the route of the z-twist pair underneath (photos 13,14,15,16,17).

Photo 13

Photo 14
Step 5. Pull the s-twist pair that passes between the 2\textsuperscript{nd} and 3\textsuperscript{rd} z-twists pairs and bury it underneath the 2 z-twist pairs just after mark b. Continue burying one by one the next 2 spairs (photos 18,19,20,21).
Step 6. Pull slightly the core of the rope and cut it using a sharp knife. Continue burying the other 3 s-twist pairs (photos 22,23,24).

![Photo 22](image)

![Photo 23](image)

![Photo 24](image)

Step 7. Continue burying the s-twist pairs one more time under the z-twist pairs, following the route of the s-twist pair below (photos 25,26,27,28).

![Photo 25](image)

![Photo 26](image)
Step 8. Continue burying the s twist pairs 2 more times under the z-twist pairs, following the route of the s-twist pair underneath. Now the tucking of the s-strands is finished (photos 29,30,31,32).
Step 9. Continue burying the z twist pairs 2 more times under the s-twist pairs, following the route of the z-twist pair underneath (photos 33,34,35,36,37).
Step 10. The tucking of all the strands is finished. Pull smoothly each pair of strand to stabilize the tuckings of the splice. Then tape tightly 3 pairs of strands together (photo 39), and cut the remains with a sharp knife or with an electrical knife to melt and stick the yarn ends together.

Photo 38       Photo 39

Now the splice is ready for use (photo 40).

Photo 40
## EXAMINATION CRITERIA FOR REPAIRS OR RETIREMENT

<table>
<thead>
<tr>
<th>Stage</th>
<th>Condition</th>
<th>Remarks</th>
<th>Actions to be taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>New rope</td>
<td></td>
<td>Ensure upon unpacking that the rope is free of any transportation damages and dirt, install it on the storage drum as per the manufacturer's standard guidelines with great caution to the applied force during storage. Make sure that the rope is free of any twists or turns like when the rope left the factory. Ensure that ID tags are attached and all relevant documentation / certification is received onboard.</td>
</tr>
<tr>
<td>3</td>
<td>First use</td>
<td>After a few mooring operations, the rope’s diameter will be slightly decreased due to yarns and strands proper alignment, especially within the working length. This diameter should be recorded to enable future comparison measurements. A fur or fuzz may be seen as a result of dragging the rope over rough surfaces. This is normal and does not affect the rope's strength. It actually protects the external jacket strands from early abrasion.</td>
<td>Rope diameter after a few operations should be recorded as a baseline for future measurements. In case any oil or grease noted, wash in mild detergent. In case heavy surface fuzz is noted, remove the source of the abrasion. If needed, proceed to Stage 2.</td>
</tr>
<tr>
<td>2</td>
<td>External damages</td>
<td>Usually the first damages to the rope consist of: - Light to moderate abrasion - Melting with fused fibers due to rope slippage on the drum or chocks and high temperatures created during slippage or due to overloading at bend surfaces</td>
<td>Abrasion should be evaluated to ensure that it is only to the outer surface. As long as no other damages are observed, the rope still maintains its original strength. If outer strands are cut, patronizing should be made. If any reduction in diameter is noticed, then a measurement should be made to evaluate the degree of reduction and to decide whether this part of the rope can remain in service or needs to be properly spliced by the manufacturer. If necessary, turn the rope end-for-end to continue mooring operations. Ask manufacturer’s or expert’s advice before the rope will be repaired/re-spliced.</td>
</tr>
</tbody>
</table>
|   | Severe rope damage | This includes very heavy abrasion, visible internal damaged yarns, or a great number of twist/turns. | A rope should be considered significantly degraded if:

- More than four consecutive outer strands are pulled (and cannot be reincorporated into the rope)
- More than three outer strands are cut
- There are multiple cut yarns or filaments within distance of one pitch length

Depending on the extend of the damages:
- you can cut the damaged part and properly re-splice
- the rope can be cut turned end-for-end to continue mooring operations
- if cannot be repaired by crew or manufacturer, the rope should be downgraded. |

For any further information, please contact our company

**D. Koronakis SA**

T: +30 210 4060 600

E: koronakis@koronakis.gr