NYK-Fil
MARITIME E-TRAINING, INC.

PJMCC

FAMILIARIZATION TRAINING IN MOORING EQUIPMENT FOR PJMCC SEAFARERS

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2. Introduction

2.1 Course Objectives:

Those who successfully complete this course should be able to:

- Understand the effect of environmental forces acting on the ship.
- Understand mooring arrangement and lay outs
- Understand Loads, Safety Factors and Strength
- Understand Winch Performance, Brake holding capacity and Strength requirements.
- Determine different types of Ropes and wire construction, design, Loads, Safety Factors and strength.
- Understand the importance used of PPE and Personal Safety procedures in handling the mooring lines to prevent injuries.
- Understand Snap-back zone and Danger areas.
- Know existing company circulars concerning mooring incidents.
- Enhanced and developed skills on proper line handling during Practical scenarios

2.2 Daily training activities:

0800 – 0830	House Rules/ Introduction	Safety Alerts & Circulars Communication Signals	Practical Mooring
0830 – 1000	Principles of Mooring	Safety Alerts & Circulars Communication Signals	Practical Mooring
1000 – 1015	Coffee Break	Coffee Break	Coffee Break
1015 – 1200	Principles of Mooring	Communication Signals Unified Operation	Practical Mooring
1200 – 1300	Lunch Break	Lunch Break	Lunch Break
1300 – 1500	Understanding Mooring Incidents / Mooring Practices	Familiarization with Mooring Equipment / Practical Mooring	Practical Mooring
1500 – 1515	Coffee Break	Coffee Break	Coffee Break
1515 – 1700	Safety Alerts & Circulars/Communication Signals	Practical Mooring	Assessment Evaluation

3. Principles of Mooring

Mooring refers to the system for securing a ship to a terminal.

The most common terminals are piers and Sea Islands. Other shipboard operations such as mooring at Single Point Moorings (SPMs), Multi-Buoy Moorings (MBMs),

Floating Production Storage and Offloading vessels (FPSOs) and offshore loading facilities, emergency towing, tug handling, barge mooring, canal transit, ship-to-ship transfer and anchoring may fall into the broad category of mooring and so require specialized fittings or equipment.

3.1 Effective mooring

What does mooring system do ?

How big are these forces?

Mooring Layout:

- Typical Mooring layout
- Typical Mooring set up forward
- Typical Mooring set up Aft

3.2 What does mooring system do ?

A mooring system prevents the ship from drifting away from a berth and holds the ship in place in relation to the loading or dis-charging arm.

The mooring system has to maintain the ship's position against the forces that will try to move it.

These forces maybe one or more of the following:

- Wind
- Current
- Surge due to passing ships
- Waves & Swell
- Change of Freeboard
- Ice

3.3 How big are these forces?

At a well sited berth, the major forces arise from *wind and current*, but to design a mooring system capable of resisting the extreme conditions of wind and current would create problems in both size and cost of equipment.

Because of the speed/force and speed/height characteristics of wind behavior, freeboard is a major and sometimes critical factor for safe mooring.

Both wind and current forces are proportional to the square of the wind or current speed, thus the force caused by a 60 knot wind is four times that caused by a 30 knot wind, and the force exerted by a 3 knot current is nine times that exerted by a 1 knot current.

Wind speed increases with height above sea level.

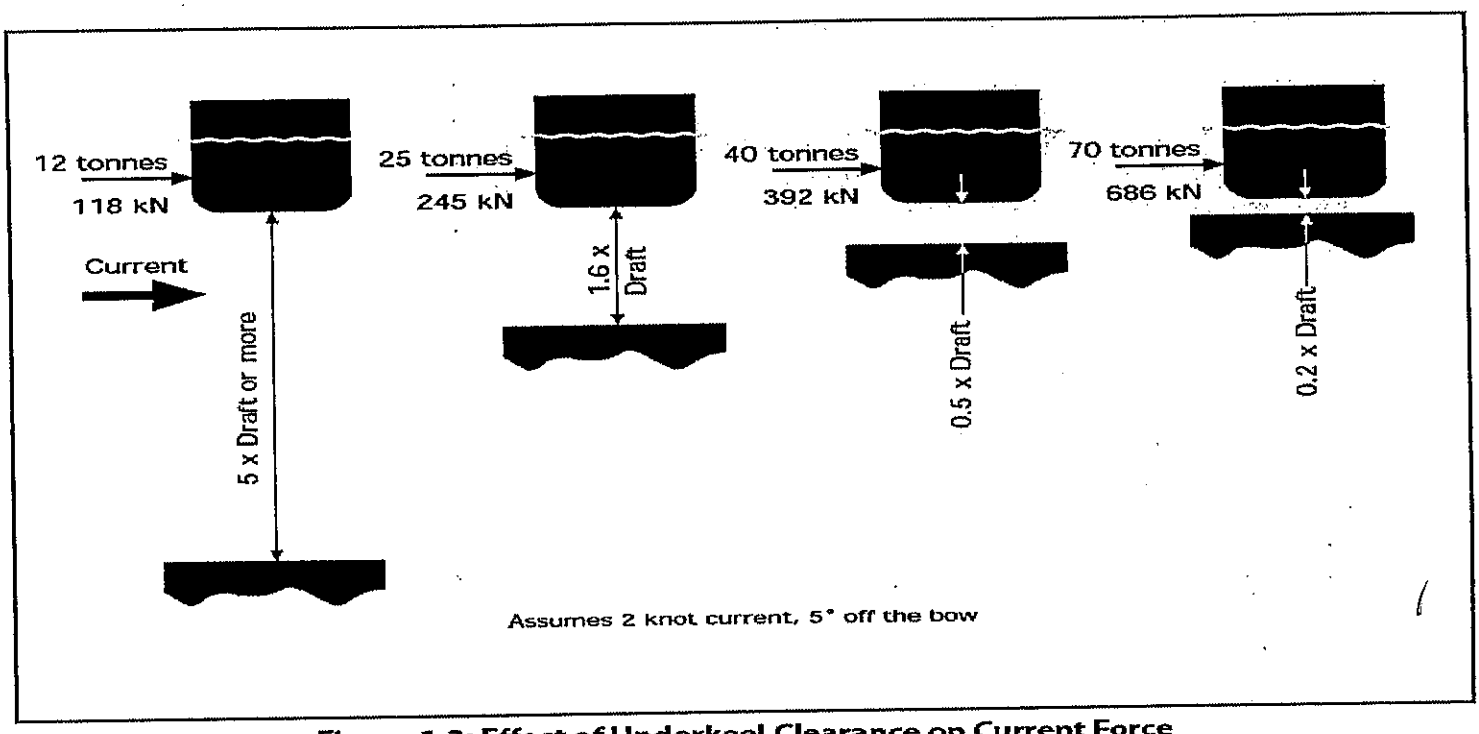


Figure 1.3: Effect of Underkeel Clearance on Current Force

For example, a wind of 60 knots at 10 meters will be more than 75 knots at 30 meters but only 30 knots at 2 meters (just above man-high). So that information from different sites can be compared, it is usual to correct all anemometer readings to an equivalent height of 10mtrs.

		Wind	Current	Wind	Current
18,000	Loaded	33	30	27	15
	Ballast	102	7	48	5
70,000	Loaded	72	62	37	35
	Ballast	220	8	52	13
200,000	Loaded	106	132	49	73
	Ballast	378	15	76	23

The table above gives some examples of the forces on various ship sizes due to wind (60 knots) and current (3 knots ahead or 0.75 knots abeam)

Ballasting the ship down will usually reduce the total forces acting on a ship as the wind gradient effect is greater than the under keel clearance effect. As the UKC of vessel decreases, the pressure of current on the vessel increases.

Apart from wind and current, the biggest forces that influences mooring, it is also known that a ship moves vertically up and down alongside a berth both with the tide as a result of cargo operations. It is perhaps stating that, obviously to see that as ship rises, the tensions in the mooring lines will increase. As the height above the jetty decreases, the lines will become slack and the ship will likely to move away from her proper position.

The only reliable remedy for this is regular line tending whilst the ship is moored at a jetty.

4. Recommendations for ship Design

The mooring facilities provided on the ship should permit the ship to remain safely moored under the standard Environmental criteria alongside a berth that is provided with a standard arrangement of mooring points

Loads in any wire mooring should not exceed 55% of the lines MBL. For synthetic lines, except Polyamide, loads should not exceed 50% of the lines MBL. For polyamide, Loads should not exceed 45% of the Lines MBL

5. Interaction between passing ships

With the increase of ship size and the planning of new terminals along waterways and port entrances, the effects of passing ships on the motions and the mooring loads of berthed vessels have become an important issue for planning, engineering and port operations.

To ensure up-time and safety of terminal and moored vessel and at the same time to allow a swift passage of ships in waterways and handling in ports, accurate tools to predict the effects of passing vessels and concepts to restrict vessel motions and peak loads are required.

When there is a passing vessel near the moored vessel, the low pressure amidships of the moving vessel draws the two ships towards each other as they come abeam, so the moored ship is pulled away from the jetty.

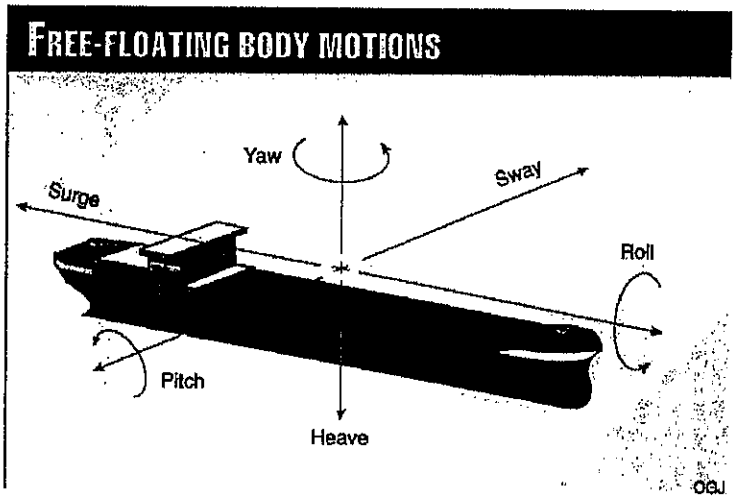
And then, High pressure at the stern of the moving vessel again repels the moored ship whilst pushing its stern into the jetty as the moving vessel passes clear.

Forces caused by passing ships, waves or swell are complex and continually varying, although at most berths they will not create problems for a ship that is using her equipment properly.

6. Effect of waves in a moored ship

1. Waves crest at the bow:
   The Ship is surging astern and pitching bow up

2. Waves crest amidships:
   Headlines checked the astern surge whilst the ship bodily rises
3. Waves trough at the bow:
   The ship is surging ahead and pitching bow down
4. Waves trough amidships:
   Stern lines check the ahead surge whilst the ship bodily falls



7. **Mooring Layout**

No.	Name	Function
1	Bow line	Prevent backward movement
2	Forward breast line	Keep close to pier
3	After bow spring line	Prevent from advancing
4	Forward quarter spring line	Prevent from moving back
5	Quarter breast line	Keep close to pier
6	Stern line	Prevent forward movement

While it is often difficult in practice to achieve an ideal mooring layout, a typical mooring arrangement designed to resist environmental forces acting on the ship. These forces, particularly wind, can come from any direction, but when discussing mooring systems the forces are split into *longitudinal and transverse components.* A ship's equipment can always be employed to the best advantage if the following general principles are remembered:

a. Breast lines provide the bulk of the transvers restraint against off-the-berth forces.

Breast lines are effective in holding the ship against transverse forces. They also are most effective in restraining the yawing tendency of a ship, which is induced by forces such as wind and current acting on it. However, to be most effective in restraining the yawing tendency, issue points for breast lines should be as far forward and aft as possible. The lead from the winch drum to the shipside fairlead should be as direct as possible, preferably

avoiding the use of pedestal fairleads. If pedestal fairleads are used, the change in rope direction should be kept to a minimum to reduce the loads on the fairlead. To provide an efficient lead to the terminal bollards, spring line issue points should be as far forward and as far aft as possible. To avoid line chafing on the shell, the issue points must also be within the parallel body.

b. Spring lines provide the largest proportion of the longitudinal restraint.

To provide an efficient lead to the terminal bollards, spring line issue points should be as far forward and as lenient far aft as possible. To avoid line chafing on the shell, the issue points must also be within the parallel body. In practical terms this means that the shipside chocks serving the forward headsprings should be at the point where the upper deck starts to taper into the bow area. The shipside chocks serving the aft back springs are normally just forward of the aft accommodation house where a direct lead to the winch can be provided. This arrangement results in the aft spring winches and the winches serving the aft breast lines being too far apart for efficient manning during docking and undocking. To overcome this, at least one owner has attempted to locate the aft spring winches on the aft deck.

Example

Shipside chocks are aft of the parallel side area, which can result in line chafing at some terminals. Nevertheless, with proper coordination of hull shape and mooring arrangement at the early design stage, this concept may be workable and could contribute to reduced manning requirements.

c. Very short lengths of line should be avoided when possible; as such lines will take a greater proportion of the total load, when movement of the ship occurs. Short lines are also the ones most seriously affected by DIP.
   Whenever a line is unable to act in exactly the same direction as the force it is trying to withstand, its holding power is reduced. Hence a short line to a mooring hook substantially lower than the ship's fairlead will be of limited value. The effectiveness is proportional to the cosine of the angle the line makes to the horizontal, i.e. for 30 degrees the line is 87% effective and, for 45 degrees, 71% effective
d. Headlines and stern lines, because of their direction, have the effect of providing some restraint against both longitudinal and transverse forces; they actually contribute less to overall mooring strength than is commonly assumed.
   This is because the direction of the largest forces encountered is usually either nearly transverse or nearly longitudinal, i.e. along the lines of action of breast or spring lines respectively.

e. Elasticity of lines effect to mooring layout

The elasticity of a mooring line is a measure of its ability to stretch under load. Under a given load, an elastic line will stretch more than a stiff line. Elasticity plays an important role in the mooring system for several reasons:

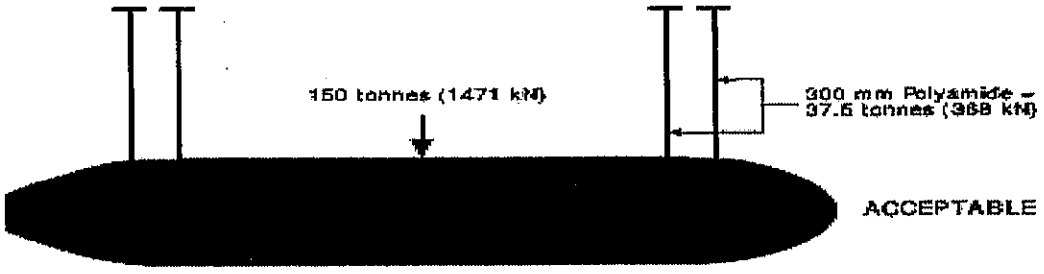
- High elasticity can absorb higher dynamic loads. For this reason, high elasticity is desirable for ship- to-ship transfer operations, or at terminals subject to waves or swell

- High elasticity also means that the ship will move further in her berth and this could cause problems with loading arms or hoses. Such movement also creates additional kinetic energy in the mooring system

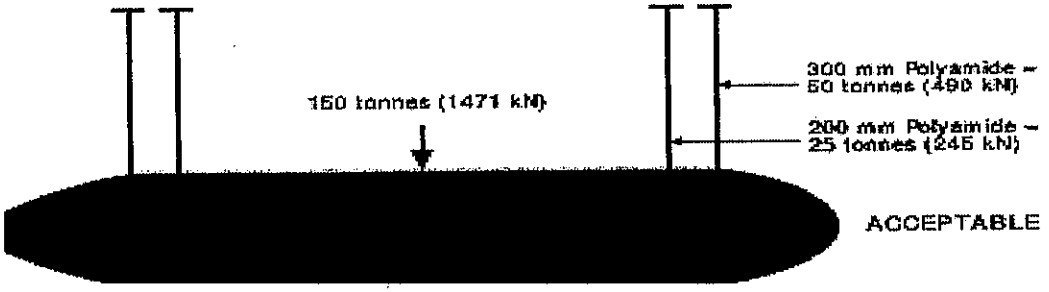
- A third and most important aspect is the effect of elasticity on the distribution of forces among several mooring lines. Larger ships require more lines resulting in load sharing and interaction between lines. This becomes more complicated as the number of mooring lines increases.

Optimum restraint is generally accomplished if all lines, except spring lines, are stressed to the same percentage of their breaking strength. Good load-sharing can be accomplished if the following principles are understood.

Following demonstrates the significance of each of the above factors on load distribution. The most important points to note are the appreciable difference in elasticity between wire lines and fiber ropes and the effect of line length on elasticity. ***Case A- shows an acceptable mooring where lines of the same size and material are used.***

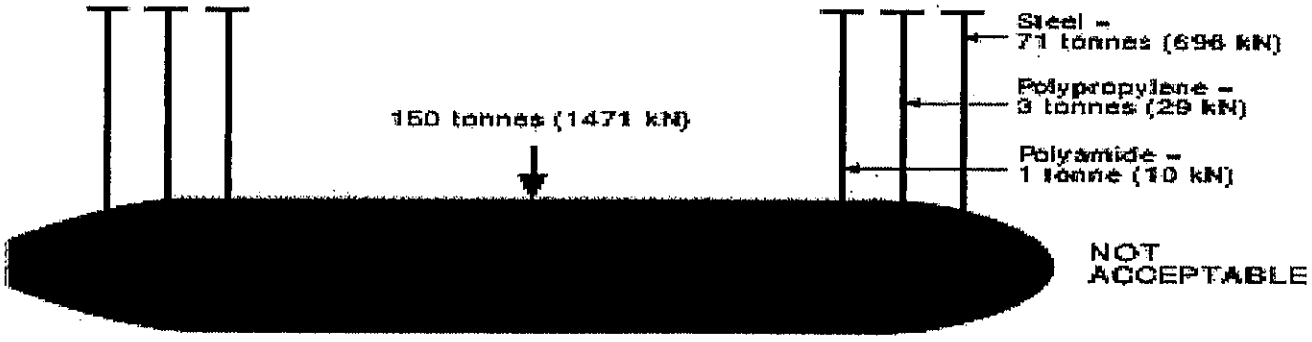


Case B indicates the sharing of loads between lines of the same material but of different size and each line is stressed to approximately the same percentage of its breaking strength. ***Different line size. (Acceptable as per calculation)***



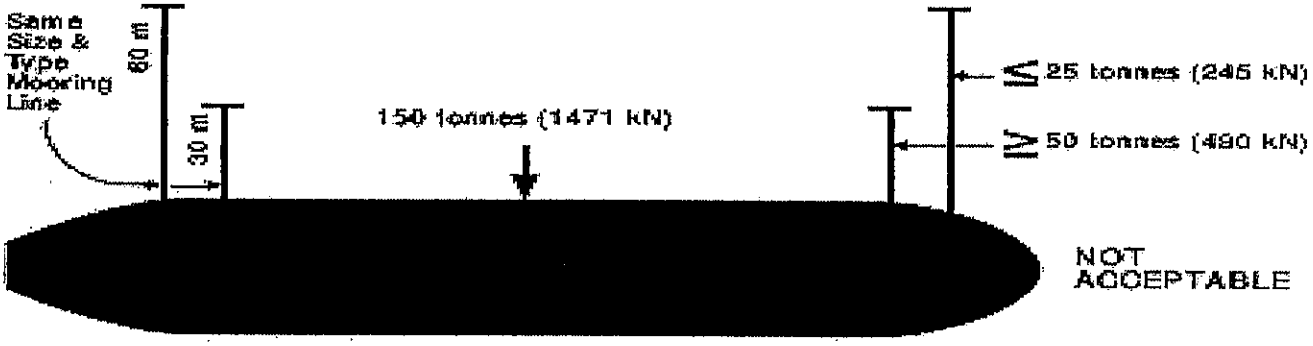
Case C is an example of mooring arrangement that should be avoided, *Different mooring line material.*

Never mix wire and conventional synthetic fiber lines leading in the same direction. Two or more lines leading in the same direction should always be of the same material.



Case D is an example of mooring arrangement that should be avoided.

Uneven mooring line length - If two or more lines of the same sizes and materials are run out in the same direction, pre-tensioned but of not the same length, the shorter one will take a greater load and most likely to break. Therefore if two or more lines leading in the same direction should as far as possible, be of the same length.



8. **Typical Mooring Set-up Forward**
   With the headlines leading at 45° degrees to the breast lines, the contribution of the headlines to the total transverse restraint is only about 26% of the whole. Even if the total resultant force aligns with a headline, the line takes only 41% of the load, with the breast line and spring line sharing the remaining 59%.
9. **Definition of terms:**
   a. *HEAD LINE* -There maybe two, three, en or even four ropes or wires should lead at least about 45^0 on the bow.
   b. *FORWARD BREAST ROPE* – Should lead as near 90^0 to the ships fore and aft line as possible.

c. FORWARD HEAD SPRING – It is usually a wire rope passed from the shoulder pipe
d. *FORWARD SPRING line* – It is usually a wire rope passed from the shoulder pipe and leads well aft.
e. *AFTER SPRING line* – It is usually a wire rope passed from the waist pipe and leads well forward.
f. AFTER HEAD SPRING – It is usually a wire rope passed from the shoulder pipe and leads well aft.
g. *AFTER BREAST ROPE* – It should lead as near 90^0 to the ship's fore and aft line as possible.
h. *STERN LINE* – Two, three or four ropes and wires leading about 45^0 on the quarter.
i. *"CHECK THE ROPE"* - This order is heard when the hawser is being slacked away. On hearing this order, take one more turn on the bitt or drum and pull on the inner part of the hawser. Let the hawser become tight but feed a little slack as soon as the hawser gets too tight.
j. *"MAKE FAST"*- At this order, make fast the hawser on the bitt. If the hawser is on the drum it has to be transferred to the bitts. this is done as follows: Pass a stopper on the hawser and when ready, slack a little hawser from the drum or walk the winch back a little so as to shift the strain gently onto the stopper. When the stopper has taken the strain, quickly remove the hawser from the drum and make it fast on the bitt, taking in all the slack. Unhitch the stopper.
k. *"SINGLE UP"*- It means that all lines should be cast off except those as advised by the master / pilot. When order "*let go*" is given, there are only one or two ropes to contend with. "*Single up to a line and back spring or single up to a slip wire*". Pls. Take note in LNG vessel when "SINGLE UP" is ordered there will be only one line remaining forward and aft.
l. *"SLACK AWAY"* - The order "slack away" means hawser should be paid out so that a longer length is outside the ship.
m. *"HOLD ON"* - It means that the hawser should not be slackened anymore and should be stopped wherever it is. Carry out this order by taking one more turn on the bitt or drum. Of course do not break the hawser and if you think that the strain is too much and the hawser is about to part, just slack a little.
n. RAT GUARDS – Circular plates used to prevent ship's rats going ashore and shore rats coming on board. All ropes leading ashore must have rat guards fixed on them.
o. *STOPPERS* – Are used to hold tight mooring ropes or wire ropes while it is being transferred from the warping drum to the bitts and vice versa. Rope stoppers are used on manila and nylon hawsers, and chain stoppers are used for wire ropes.
p. HEAVING LINE – Is a light thin rope, about 15 fathoms long. It may be either a 10 mm or 8 mm (dia.) vegetable fiber rope or a nylon rope. One end of it is weighted by making a monkey fist or a heaving line knot on it and the other end is just whipped.

q. MESSENGER LINE – It is a 16 or 20 mm (diameter) rope used for bringing on board a heavy hawser when a heaving line is not considered strong enough.

10. Mooring Winches & Equipment

1. Mooring Winches

a. Type of mooring winches:

Control type

- Automatic tensioning and Manual tensioning

Type of winches by drums

b. **Automatic Tension Winches**

The reaction of self -tensioning to changes in the ship's angle of list

- The set line tension holds the ship tight alongside the wharf when it is upright
- The winches pay out at the set tension as the ship heels away from the wharf
- The winches haul in at the set tension as the ship heels in towards the wharf

c. **Split and Undivided**

Split Drum Mooring Winches

The split drum winch was designed as a solution to the spooling problem encountered with undivided drum winches. When mooring lines are handled directly off drums, the final turns of the outer layer when under tension tend to bite into the lower layers. This could result in damage and difficulties when releasing the line.

Split drum should be wide enough to allow for 10 turns of the design wire rope on the tension section. A minimum of 10 turns is also required when using low friction unjacketed high modulus synthetic fiber ropes.

d. **Undivided mooring winches**

The undivided drum winch is commonly found on smaller ships and is preferred by some shipyards. The undivided drum avoids the need to transfer the mooring line from section to section as is required for a split drum winch when a poor estimate has been made of the spooling requirements. The undivided drum eliminates the potential for line damage and personnel injury that exist at the time of transfer on a split drum.

The brake holding capacity for these winches (non- split drum) will always be quoted for a specific number of layers, In order to minimize any reduction in brake holding power, the line should always be reeled on to the drum in a symmetrical pattern and not allowed to pile up on one side or in the center.

1st Layer	100%	say 55 tons
2nd Layer	88 %	48 tons
3rd Layer	80 %	44 tons
4th Layer	73 %	40 tons
5th Layer	67 %	37 tons
6th Layer	61 %	34 tons

Drive type
Mooring winches can be driven by:

Steam (w/ Turbine engine), Electric or Hydraulic motors.

Although steam is very common, many newer vessels are fitted with hydraulic equipment; electric winches are not common on board tankers.

Whatever the power source, all mooring winches will be affected to a greater or lesser degree by a characteristic known as the "Render/Heave Ratio".

Render is defined as the force required turning the winch in the opposite direction when set to heave with the driving force applied.

It should be noted that the heaving power is always less than the render force and it is thus impossible to heave in after a winch has rendered unless there is a change in the forces acting on the moorings.

With hydraulic and electric driven winches, the render value is constant but with steam winches the render value varies. This is because the torque available is dependent upon the position of the pistons. Winch manufacturers have endeavored to solve this problem in different ways, and for a given Render value the heaving power available varies as shown in the table below.

WINCH TYPE	RENDER	HEAVING POWER
Maker A (Steam)	35 tonnes	15-22 tonnes
Maker B (Steam)	35 tonnes	30 tonnes
Maker C (Hydraulic)	35 tonnes	22 tonnes

Many ships are equipped with self-tensioning winches with the intention of eliminating the need for line tending. These are designed so that a specified line tension can be pre-set, and the winch will render (pay out) when tension in the line exceeds this value, and will recover (heave in) when it is less than this value.

Number of drums associated with each drive

- Single Drum, double drum and triple drum

Winch Brake type and brake application

- Band brake, spring applied and disc brake

The brake is the heart of the mooring system, since the brake secures the drum and thus the mooring line at the shipboard end. A further important function of the brake is to act as a safety device in case the line load becomes excessive. It does this by rendering and allowing the line to shed its load before it breaks.

The winch brake should be designed to hold 80% of the line's MBL and have the capability to be adjusted down to 60% of the line's MBL at which level they should be set in service.

Since the winch brake is a vital part of the mooring winch system, there are two main types of brake system that are used on board:

- Band brake type
- Disc brake type

e. Winch brakes

Band brake - The brake linings are secured to the two halves of the steel brake band by brass rivets and so the linings must be replaced before they have worn down to expose the inner ends of the rivets.

As the brake resists the torque created by an increasing load on the mooring line, so the band and its linings stretch slightly in the payout direction, which pushes up the brake lever connecting the lower half of the band to the brake screw. This in turn relieves some of the tension in the threaded rod so the brake handle loosens slightly, as the brake bites. Torque is the force applied into a rotating shaft.

Band Brake Lining

Band brake lining to be properly fitted (all bolts or rivets in place).

Sufficiently thick? Note that thickness of the brake liner is not always a good indicator for brake lining efficiency, as new lining can also be inefficient through exposure to heat/ damp conditions, presence of oil on drum surface, inferior quality and corrosion of the drum surface.

In our OPM, the company request vessel to conduct;

1. Thickness of brake lining measure at every 6 month (end of Jun & Dec)
2. Annual Brake Test for Mooring Winch

Some hydraulic winches & most electric winches are provided with spring applied brakes at the drive motor They are automatically applied by springs when the control lever is in neutral & automatically released when control lever is in the heave or rendering position(when the motor is powered)

f. Winch in gear

Winches should never be left in gear with the mooring winch band brake on. Hydraulic or electric drives can suffer severe damage should the brake render. Mooring drums should always be left disconnected from the winch drive whenever the mooring line is tensioned and the band brake is fully applied.

Winch Brake Testing

Before testing a winch brake, it should be ensured that the brake and the brake drum are in a satisfactory condition. Any damage or failure should be rectified before any testing takes place. If the brake has not been in use for some time it should be applied slightly with the winch running in the payout direction, thereby cleaning the brake drum surface and the brake lining.

The main purpose of brake testing is to verify that the brake will render at a load less than the design rope's MBL. New ships are normally supplied with a brake test kit of the simplified type.

g. Winch Brakes Testing Specification

For each ship, a winch test specification is prepared incorporating specific instructions for setting up the test gear, preparation of the winch for testing, setting of the winch brakes, and application of the test load, revision of torque wrench or hydraulic pressure readings if required, and recording of test results.

h. Winch Brake Testing Equipment

- ❑ A Lever usually consisting of two pieces of bar. The lever is secured to the drum of the winch by means of bolts furnished with the test kit, and fitted through holes provided in the drum flange
- ❑ A Hydraulic jack with pressure
- ❑ A Foundation to be placed under the hydraulic jack for the purpose of distributing the load into the deck structure.

i. **Winch Performance terms**

The drum should be capable of stowing the total line length. The Table lists the drum capacities as specified in ISO Standard 3730. Two capacities, `normal' and high' are indicated. Winches with undivided drums could be more suitable for the `normal' capacity since this would reduce the number of layers required.

j. **Wharfing drum**

Drum ends

These are warping drums or rotating barrels which are spool shaped, mounted on a horizontal axle and frequently fitted to a winch or windlass. They are used to ease the handling of large/heavy mooring wires/lines which are secured on bitts once they are heaved tight.

Mooring lines should never be secured to the drum ends as the drum ends are not designed for holding the loads of the mooring ropes for a long period. The force exerted by the mooring lines (due to changes in the vessel's condition, and passing vessels) might result in line tension becoming excessive which might cause damage to the winch mechanism or slacking/slipping of the rope. Ropes tensioned by means of the drum end should always be properly belayed on the bitts as soon as possible.

Capstan- A vertically mounted warping drums for which the drive system is located below deck. As a result, capstans are frequently installed on decks where free space is limited.

Difference between capstan and drum ends - 'Drum ends' are driven by a horizontal axle that is usually shared by a mooring winch or the anchor windlass while 'capstans' are driven by vertical axles.

11. Types of ropes used in mooring operation

- ❑ Synthetic fiber rope
- ❑ Steel wire rope

1. Synthetic fiber hawsers

a. ***Polyester*** is the most durable of the common materials. It has high strength, both wet and dry. It has good resistance against external abrasion and does not lose strength rapidly due to cyclic loading. Polyester is therefore useful for large and small ropes where strength and durability are important and where moderate elasticity is required. It does not float. Specific Gravity 1.38.

b. ***Polyamide is better known as Nylon.*** Polyamide rope loses 10 15% of its strength when wet. It has the highest elasticity of regularly used materials with good temperature and abrasion resistance. It does not float. Specific Gravity 1.14. Melting Point 250 Deg. Centigrade.

c. ***Polypropylene*** has approximately the same elasticity as polyester rope. Has limited temperature resistance. Prolonged exposure to the sun's UV rays can cause polypropylene fibers to disintegrate. Polypropylene is lighter than water and can be used for floating messenger lines. The use of moorings from 100% polypropylene is not recommended.

d. High Modulus synthetic Fiber mooring line – These fiber are much stronger and stiffer than conventional synthetic fibers such as polyamide, polyester and polypropylene.

The term 'High Modulus Fiber Mooring Lines' generally refers to ropes made from high modulus fibers such as:

- Aramid
- Liquid Crystal Polymer (LCP)
- High Modulus Polyethylene (HMPE).

Aramid fiber typically has high strength and low stretch. It does not creep and does not melt, but chars at high temperatures. Aramid ropes do not float. They are typically covered (jacketed) with some other synthetic fiber, such as polyester, to increase abrasion resistance and to protect against UV degradation.

LCP fiber has high strength and low stretch and excellent resistance to creep and flex fatigue. The fiber has a temperature resistance between HMPE and aramid.

HMPE is a fiber with high strength to weight ratio and low stretch characteristics. HMPE fibers have very good fatigue and abrasion properties, but limited temperature resistance having a maximum working temperature of 70°C.

HMPE has good resistance to axial compression, a low coefficient of friction and good abrasion resistance.

12. Rope Design and Construction

In general, five main types of assembly or rope construction are seen. These are:

1. Parallel lay (parallel yarns or strands, assembled together under an outer (braided) jacket). They are commonly used for regular mooring ropes and as SPM mooring hawser.

2. Laid - generally 3-4 strand constructions which have a considerable amount of twist.

- **Four strand or shroud lay**- provides the ropes with the greater bearing surface than three- strand rope of the same size. A core is generally place at the center of rope for stability. Both are normally made "RIGHT HAND"
- **Three strand or hawser** – it is sometimes called plain lay which is the general standard types of ropes for all ordinary purposes.
- **Cable lay rope (or water lay)** – this is made by laying three, three- strand ropes together. It is normally made " LEFT HAND" but can be made " RIGHT HAND" when required. When used in conjunction with wire rope as towing spring, it is essential that the lay of the rope is the same as that of the wire rope.

3. Stranded - Twisted strands arranged in one or more concentric rings around a central core strand (similar to wire rope construction).

4. Plaited – Also known as 'Square Braids' or the Eight Strand ropes(Octoplait) of a somewhat square cross section. Together with the twelve strand rope, they are constructed of left and right hand laid strands to give torque-free rope. They are easily spliceable and provide a good rope structure for mooring lines.

5. Braided - The braid consists of an equal number of interwoven clockwise and anti-clockwise strands. Includes the *Double braided* ropes sometimes called *braid-on-braid* are constructed of a core braided of many small strands and surrounded by a *cover that is also braided of many small strands*. The cover provides an integral component to the line's strength and neither the core nor the cover should provide more than 55% of the overall weight. They are commonly used for mooring hawsers at single point moorings (SPMs) and for tails on wire ropes.

12.1 Rope Inspection Checklist

- ✓ ***Abrasion Damage***
- ✓ ***Temperature Damage***
- ✓ ***Crushing / Pinching Damage***
- ✓ ***Stiffness***
- ✓ ***Pulled Yarns***
- ✓ ***Cut Yarns***
- ✓ ***Inconsistent Diameter***
- ✓ ***Kink, Hockle and Twist Damage***
- ✓ ***Discoloration***

Abrasion damage - look closely at both inner and outer fibers of the rope. When either is worn the rope is obviously weakened. Open the strands and look for powdered fiber, which is one sign of internal wear. Estimate the internal wear to estimate total fiber abrasion. If total fiber loss is 20%, then it is safe to assume that the rope has lost 20% of its strength as a result of abrasion.

Temperature damage - When using rope, friction can be your best friend or worst enemy if it is not managed properly. By definition, friction creates heat, the greater the friction the greater the heat buildup. Heat is an enemy to synthetic fiber and elevated temperatures can drastically reduce the strength and/or cause rope melt-through. Exposure to sub- zero temperature. Presence of ice will cause internal abrasion.

Crushing – pressing and squeezing with enough force to deform. Rope can be crushed from multilayer spooling

Stiffness - When rope becomes exposed to shock loads (jerks or sudden loads), they tend to become rigid and stiff which means an alteration of properties which will have an effect of the

ropes strength and behavior during handling. It will not therefore bend properly around bollards and warping ends. It can be inspected by manipulating the rope by hand or other means.

Pulled yarns - is often the result of the rope being caught or hooked behind an object on deck or ashore. Pulled yarns should be worked into the rope again in order to prevent possible aggravation.

Cut yarns - Apart from the type of material and construction method used, the number of yarns/strands in a rope determines the rope's strength, cut yarns and strands affect and reduce a rope's strength directly. Also, cut yarns result in greater stretch of a rope.

Kink, Hockles and twist damage - A kink is a sharp bend or twist in a rope that causes distortion of the strands. A hockle is a back turn (a twist against the lay) in a rope that cannot be corrected, which can occur when a rope under load is suddenly released or snaps. Kinks and hockles are an extreme form of bending which adversely affect the strength of a rope. Ropes can become twisted through improper handling and incorrect coiling. Coiling in figure of eight turns will prevent twisting of the rope.

Discoloration - Contact with chemicals such as paints might cause deterioration and degradation of rope. Fuel, diesel and lubricating oil as well as hydraulic oil when absorbed might affect rope properties.

12.2 Care and maintenance of ropes

The safety of the ship or an individual crew member is often dependent on the rope that is being used. ***(Code of Safe Working Practices for Merchant Seaman - COSWP)***

a. Proper stowage of rope

- ✓ Stow in a well-ventilated dry compartments away from chemicals.
- ✓ Do not store ropes on wet decks, even for short passage between ports
- ✓ Stow on gratings to avoid inadvertent contamination.
- ✓ In port, cover coiled mooring rope. Exposure to precipitation and direct sunlight is detrimental to ropes.
- ✓ Inspect regularly for internal and external wear and tear. Powdering will be visible between strands in case of excessive wear. Over worked ropes may become hard, stiff and hairy.
- ✓ Eye splice should have five tucks.
- ✓ Avoid overloading the rope around sharp angles.
- ✓ Wash ropes with fresh water in the event of being splashed by a corrosive.

- ✓ Where wire is to be joined by a rope, ensure that a thimble is used and the wire and rope are laid the same way.
- ✓ Keep wires and ropes in different leads.
- ✓ Sections of ropes which are vulnerable to abrasion like the eyes, should be protected with leather sheaths.
- ✓ Do not cross cut ropes on drums.
- ✓ Mooring ropes should be covered by tarpaulins or, if the ship is on a long voyage.

b. Degradation of Ropes

The following are the main causes of degradation (*Declining strength*) of ropes:

1. Outside abrasion - Wear by friction and cuts
2. Inner abrasion - Wear by repetition of loads
3. Ultraviolet rays
4. Heat (including frictional heat)
5. Chemical products

13. WIRE ROPES

a. Types of Steel Wire Rope

- ➢ Bare Steel wire
- ➢ Galvanized wire
- ➢ Stainless Steel wire

b. Tensile strength

The tensile strength of a wire is expressed in Newton /mm^2. The most frequent tensile strengths of wires used to make wire ropes Are 1560N/mm^2, 1770N/mm^2, 1960N/mm^2 and 2160N/mm^2.

Bare Steel wire (untreated, sometimes also referred to as 'black' wire)

This is a wire which is used in a corrosion lenient / low environment. Sometimes, the bare steel wire may be lubricated during the manufacturing process, as a result of which some corrosion protection is given.

Galvanized wire

This provides a superior quality of wire when compared with the previously commonly used process of galvanizing the wire after it was reduced to the required diameter. Wires can be galvanized or heavy galvanized.

The galvanizing process will protect the wires from corrosive action as a result of exposure to chlorides and contribute to an extended in-service life in a marine environment. Wires used for the manufacturing of mooring wires should preferably be of the preformed drawn heavy galvanized wire strand type.

Stainless Steel wire

Cables which might be exposed to high temperatures or corrosion can also be made of stainless steel. Stainless steel resists corrosion better than ordinary steel.
The tensile strength of a wire is expressed in Newton /mm^2.
The most frequent tensile strengths of wires used to make wire ropes are:

- 1560N/mm^2
- 1770N/mm^2
- 1960N/mm^2
- 2160N/mm^2.

c. **Fiber Core - The Disadvantages**

- Accelerated abrasion damage of the fibrous core due to the fact that internal wires are continuously chafing over the fiber core.
- Quick reduction in diameter, as a result of abrasion and wastage of the core material.
- Rotting - especially when the wire rope is used in wet/humid environments such as on board vessels and when the fiber core is lacking lubricant. Under such conditions, the fiber cores which are trapped inside the wires will start to absorb humidity which will trigger the rotting process.
- Corrosion - when the core is devoid of lubricant and saturated with seawater absorbed by the fibrous material, and when being compressed during service, the internal wires and strands will be exposed to corrosive action which is difficult to detect and which will invariably lead to failure when it remains undetected.

d. **Maintenance of Steel Wire Moorings**

- It is essential to grease or, oil steel wire mooring ropes at frequent intervals as rusting will reduce the strength of the wire in a very short time.
- It is important that periodically the whole wire is physically removed from the drum for inspection and greasing.
- Investigations have shown that deterioration of the wires can occur, undetected on the bottom layers, especially when a wire has seen some service and has been turned "end for end.
- Regular visual inspection is vital, particularly around eyes which are shackled to nylon tails, as the shackle tends to increase wear on the wire at this point.

- If "dry" or darkened patches are observed, the depth and degree of corrosion should be checked. An effective way to do this is to place the wire on a solid surface and strike it with a hammer. This will cause the rust to fall away and will part the weakened strands, exposing the severity of the corrosion.
- Snags in a wire also indicate a reduction in the strength
- Wires must be replaced if the number of broken strands (snags) exceed 10% of the visible strands in any length of wire equal to 8 diameters.

14. Mooring Practices

a. Wire to rope

Rope mooring line should never join a metal line without the use of a thimble or fiber rope tail. The condition of the rope and wire in this example is poor and the lack of a thimble increases the likelihood of the rope breaking

TAILS: The length of a tail should not exceed 11 mtrs, in order to keep the additional elasticity to the minimum to prevent wire failure. Because tails are likely to deteriorate more rapidly than wire, they should be at least 25% stronger than the wire to which they are attached.. They should be inspected frequently, or replaced at regular intervals. The use of 'D' or bow shackles should be avoided.

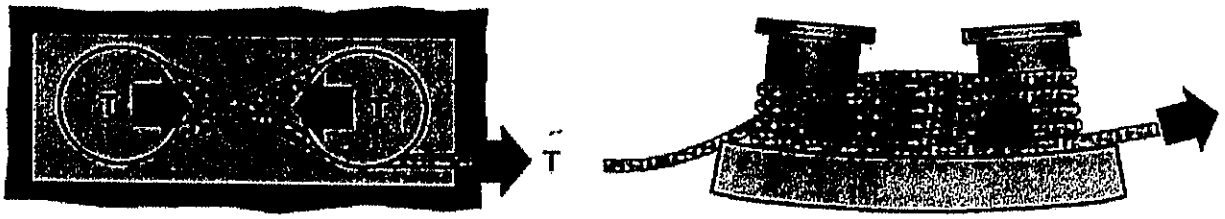
b. *Securing to the bitts*

Gypsy heads or drum ends are not designed for taking the weight of mooring lines for a long period of time. If gypsy heads are used for this purpose then over a period of time they will suffer damage and be in need of repair.

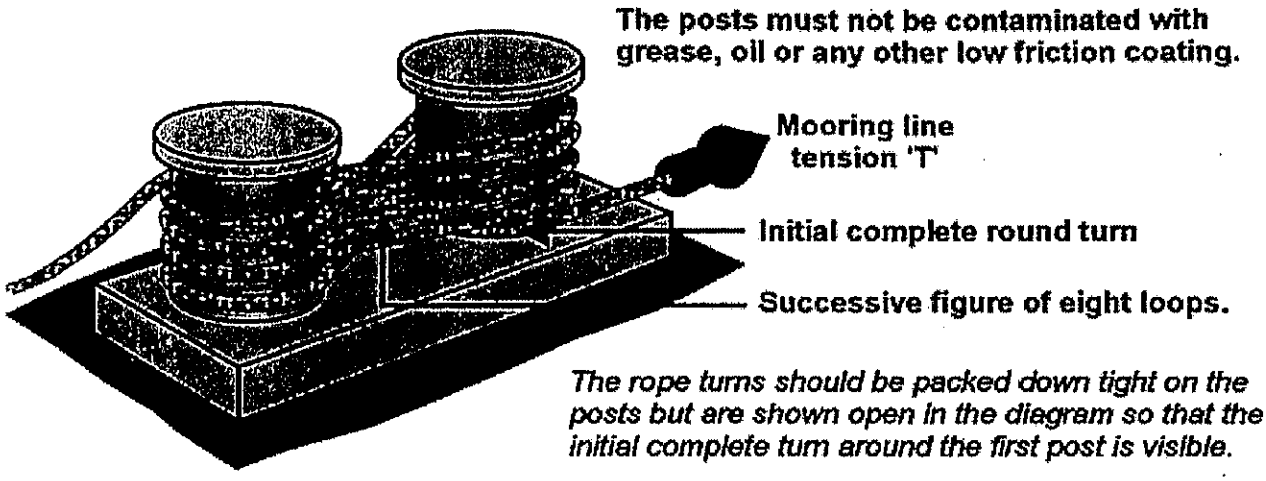
Once ropes have been hauled tight they should be secured to the bitts.

Making a fibre rope secure by turning it up on a set of twin bollard bitts

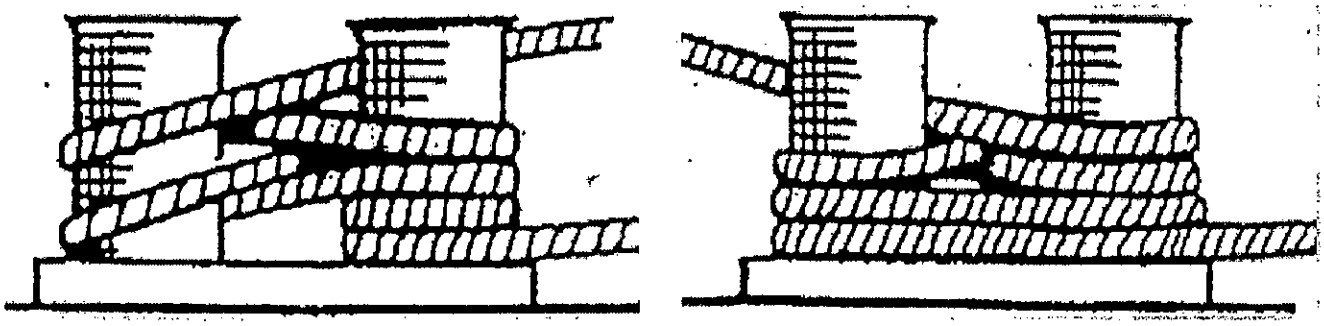
The mooring line is criss-crossed as figure of eight loops between the two posts, so it acts like the parts of a pulley system to pull the two posts together. However, the line tension is progressively reduced to nothing by the accumulated friction between the loops of rope and the two posts, so the forces pulling the two posts together are concentrated in the lower figure of eight loops.



The distorting effect shown above can be reduced by taking at least one complete turn in the rope around the first post before making the figure of eight loops, as the round turn (or turns) will bear a greater proportion of the load on the bitts than the successive criss-crossing loops.



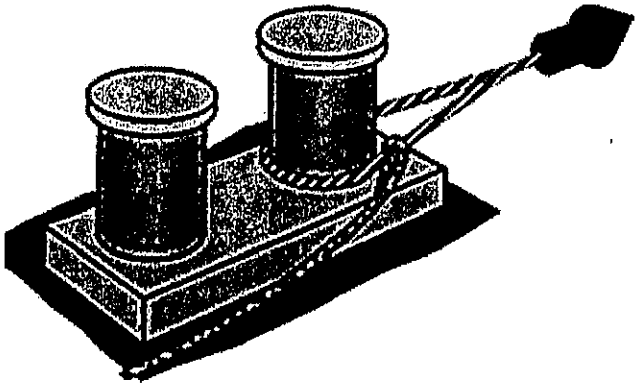
- First you should make *two round turns (but not more) around the leading post* of the bollard before making the figure of eight for large size bollards,
- Or make *two round turns around both posts* before the figure of eight for bollards with smaller circumference posts. This method can control synthetic fiber ropes successfully, and it is safe and easy to use. As shown in the figure below



The correct method of securing a tug towline for berthing operation:

A towline should always have a fiber line of sufficient strength attached to it to allow ship's crew to handle a towline and if necessary to heave in onboard with capstans or drum ends. A towline is looped over the single post of the twin bollard set of bitts, as the bitts is stronger when used in this way.

The crew should then stand well clear of the towline until ordered to release the tug.



To the over side fair lead

The pull is in line with the posts of the bitts

c. **Correct Use of Stoppers**

Holding the mooring line is dangerous especially when the tension of the rope is transferred to the stopper. What are the different types and methods of using a stopper?

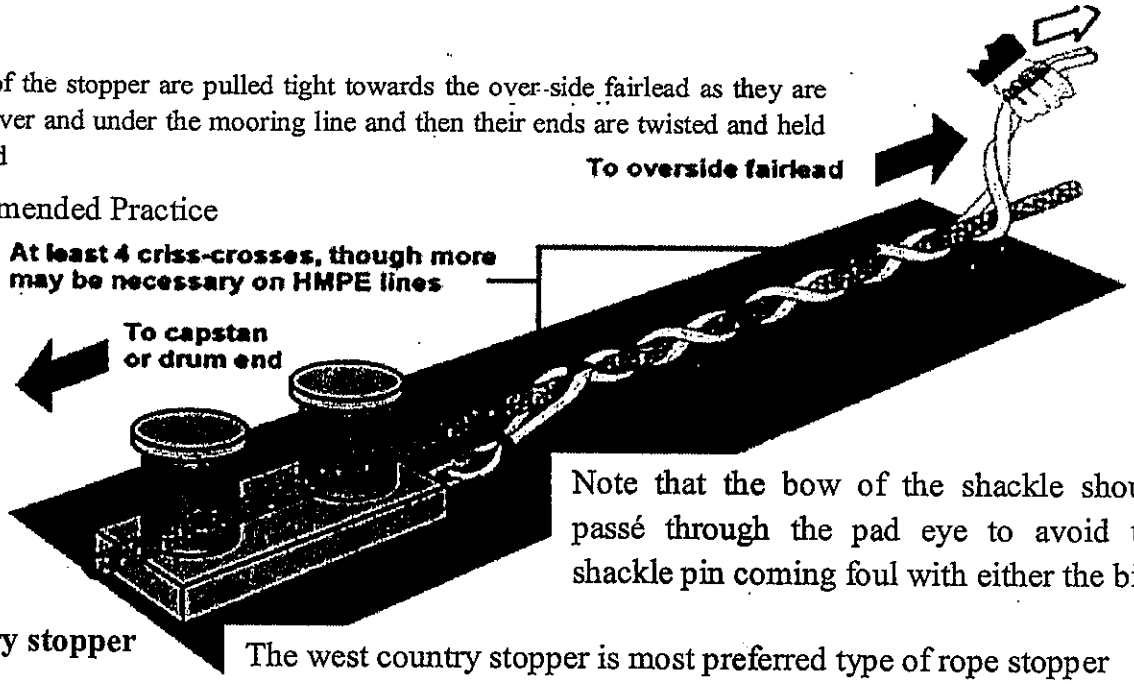
1. **Different types of Stopper**

   What is a Stopper? A short length of rope with one end firmly secured to a stopper eye or a bollard. Used for temporarily holding a rope under tension and transferring of the weight in the mooring rope from the windlass drum end to bitts (bollards).

   Stoppering is the term used for holding a rope under stress by means of a stopper.

   Depending on the mooring line that is used, the following types of stoppers are employed:

The two parts of the stopper are pulled tight towards the over-side fairlead as they are crises-crossed over and under the mooring line and then their ends are twisted and held together by hand

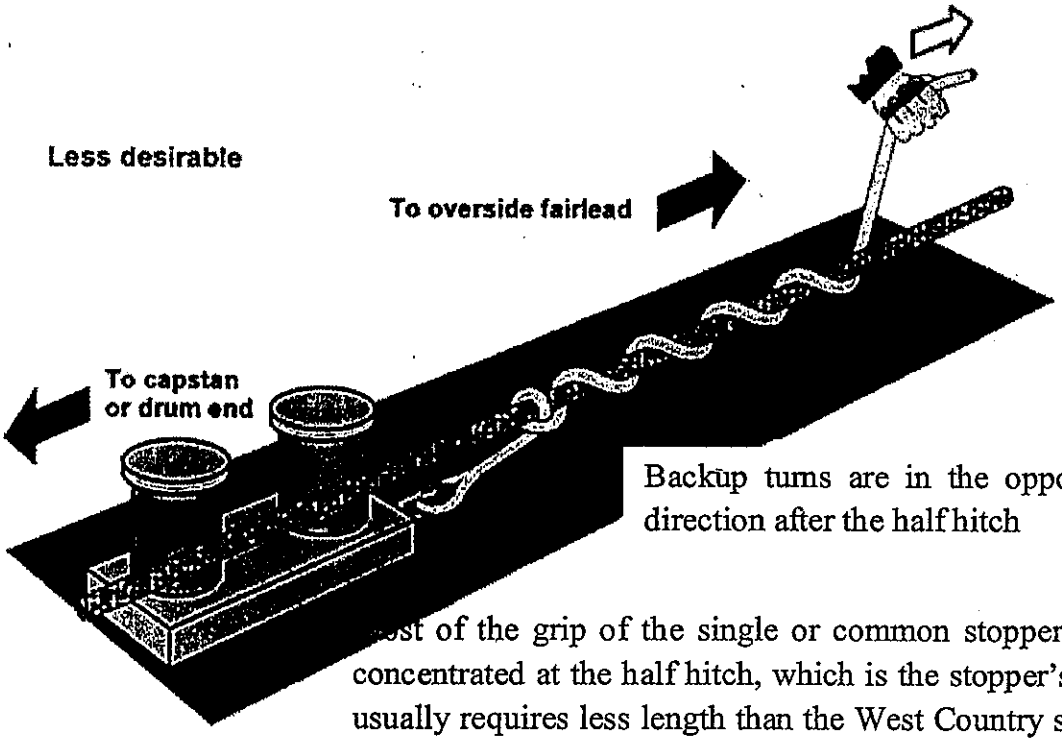


Recommended Practice

Note that the bow of the shackle should passé through the pad eye to avoid the shackle pin coming foul with either the bitts

The West Country stopper

The west country stopper is most preferred type of rope stopper as this grip on the mooring line is spread over much of the stopper's length and only gradually decreases the hand held



Backup turns are in the opposite direction after the half hitch

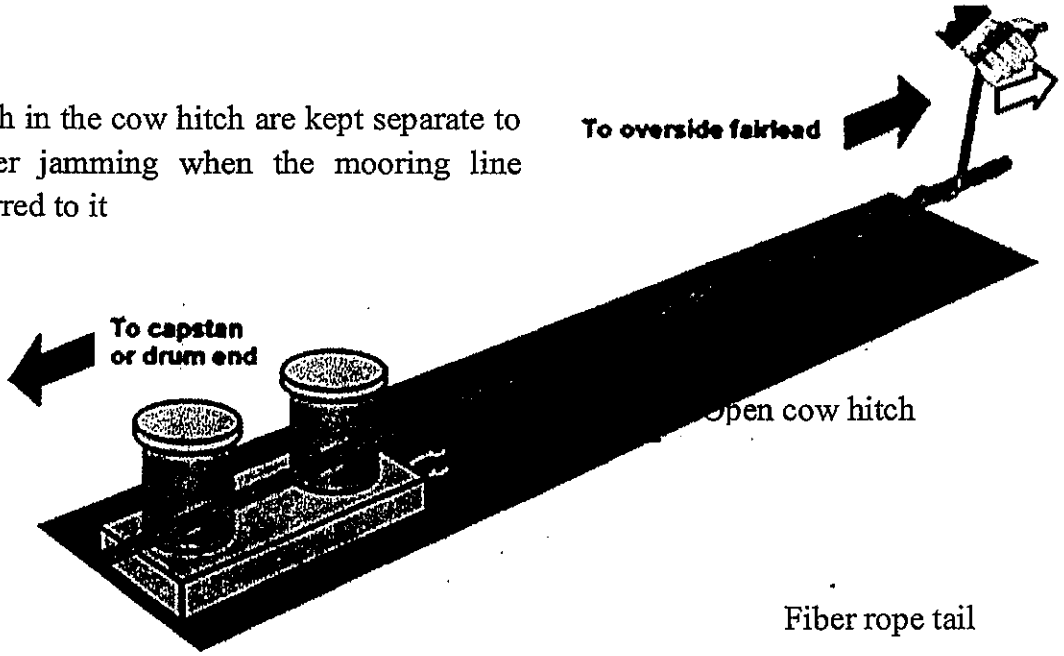
ost of the grip of the single or common stopper on the mooring line is concentrated at the half hitch, which is the stopper's weakness. However, it usually requires less length than the West Country stopper so it can be used when the bitts are very close to the fairlead fair lead

The single stopper or common stopper (Less desirable)

The stopper is pilled tight towards the fairlead whilst making a half hitch around the mooring line, and then taken around the mooring line in a series of turns in the opposite direction with the end being held by hand

Applying a chain stopper

The two half hitch in the cow hitch are kept separate to avoid the stopper jamming when the mooring line tension is transferred to it

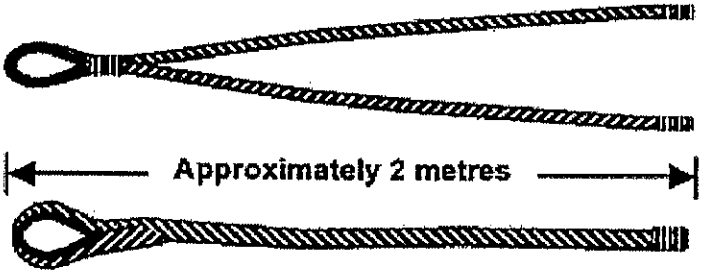


pen cow hitch

Fiber rope tail

Mooring ropes will use a rope stopper, either the common stopper or the West Country stopper. Depending on the type of lay of the material of the mooring ropes, it is important to note that the type of rope used for the stopper is critical and the following points should be considered:

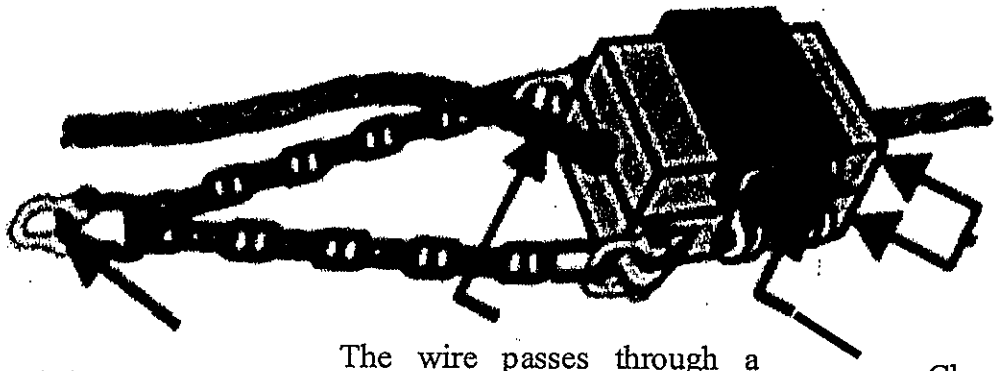
a) The rope stopper should be of synthetic fiber rope.
b) The stopper should be of natural fiber rope.
d) The rope stopper should be flexible.
e) Should of low stretch material.



Double, or 'West Country', rope stopper
Stopper dia. = 0.25 x mooring line dia.

Single rope stopper
Stopper dia. = 0.4 x mooring line dia.

The carpenter's Stopper



The two halves of a hinges steel box

Chain bridle and shackles secured to the pad eye on the bitts

The wire passes through a grove inside the box and is held fast by a steel wedge when the box is closed

Claps for closing and securing the box

Often noticed on board vessels are, *that stoppers have been left on lines after they have been secured.*

This is a bad practice that puts unnecessary strain on the stopper as the line continues to tighten on the bitts. It may also result in the stopper rope tightening to the point where it can't be released.

15. Mooring at Buoys

Single Point Mooring

- Catenary Anchor Leg Mooring

- Single Anchor Leg Mooring
- Exposed Location Single Buoy Mooring

Multi Buoy Mooring
Conventional Buoy Mooring

1. Single Point Mooring or 'SPM', (sometimes referred to as a 'single buoy mooring', or 'SBM') is used to secure tankers carrying out cargo loading and discharging operation offshore. The SPM is attached to a swivel mechanism which allows the ship to swing around the buoy in response to wind and tide.
2. SPM provides a berth for tankers to load or discharge cargo in sheltered locations as if they were at anchor. The SPM is anchored to the seabed and the tanker moors to it by either one or two strong fiber
3. A Catenary Anchor Leg Mooring (CALM) - The chafe chain and hawser are supplied by the terminal but the tanker must be fitted with a chain stopper and fairlead on the centerline aligned with a winch to bring the chafe chain onboard. Rope hawsers (depending on the terminal and the vessel's size) shackled to a chafe chain secured to the ship's foredeck.
4. Single Anchor Leg Mooring (SALM) - The 'SALM', system is normally used in deeper water than the 'CALM' buoy. Oil flows up from the terminal pipe-line through a riser pipe that is connected to the sea-bed anchor by a universal joint and with a fluid swivel at the connection to floating cargo hose.
5. Exposed Location Single Buoy Mooring (ELSBM) - The 'ELSBM' system consists of a large anchored buoyancy body through which the oil flows up to a swivel joint below a raised helicopter deck on a turntable that is above the height of the waves.
6. Multi-Buoy Mooring - Multi-Buoy Mooring (MBM) consists of mooring a ship to several permanently anchored buoys in conjunction with the ship's own anchors. It is also called Conventional Buoy Mooring or `CBM'.

   The Conventional Buoy Mooring (CBM) system includes multiple buoys that are fixed to the seabed by means of mooring lines and marine anchors. The three to six buoys are permanently installed in a rectangular pattern that allows safe mooring of a vessel which is positioned between the buoys with tug assistance.

   The buoys provide the strong points to which the vessel's on-board mooring lines can be attached. These are the same lines that are also used for mooring the vessel along a quay.

   The CBM system is especially valuable when no quay sites are available. It can also be combined with a fluid transfer system that enables connection of (subsea) pipelines to the mid-ship manifold of a conventional tanker. When no tanker is moored, the submersible hose or hoses are stored on the seabed.

Some mooring buoys are off-the-shelf products, while others have been specially designed to include features like quick disconnection couplings. The mooring system and layout of the buoys are always specifically designed to match the vessel's requirements and local environmental conditions. Typically these systems are designed for near shore applications with water depths starting from six meters.

7. Mooring to Buoy - Standard method to moor the ship to Buoy is to utilize the ship's anchor chain. Following is the most popular way of the mooring to buoy.

Preparation for Mooring to Buoy

1. Prepare the tools & equipment.
2. Hanging off the anchor.

This allows sufficient space in the hawse pipe for the buoy chain to pass through smoothly.

   a. Connect the heaving-in wire to fluke of anchor
   b. Lower the anchor and simultaneously start heaving in the above wire afterward.
   c. Make fast the above anchor, then secure adequate length of chain to the deck.

3. Walk back the anchor chain lay down on deck until the first joining shackle (kenter shackle) is reached.
4. Uncouple the joining shackle (kenter shackle). Utilize a taper-pin punch and a shackle-pin punch; remove the taper-pin and then cut (split) off.
5. Connect a buoy shackle with end link to the anchor chain.
6. Fix the hanging off wire of the anchor chain to the 6th or 7th link from the end link.
7. Lower the chain adjusting the hanging wire of and to ensure no tangling.
8. Secure the hanging wire to bollard after being lowered to within a few meters above the water.
9. Secure the anchor chain with a bit of slack (windlass brake on and clutch off).
10. Lower the shackle pin immediately before connecting the buoy shackle to buoy.
11. Prepare the buoy rope (hawser).
12. Preparation of the slipping wire.

Mooring to Buoy

1. Send the buoy rope (hawser) to the Buoy and heave in the rope until the buoy is right under the ship's bow.
2. When the buoy is under the ship's bow, lower the hanging wire with Buoy hackle adjusting and connect the Anchor-shackle to the Buoy.
3. Lower the anchor chain to an adequate distance from the buoy.
4. Cast off the buoy rope (hawser).
5. Send the slipping wire to the buoy.

Releasing the buoy Chain

1. Heave in the Buoy chain until the buoy comes under the ship's bow.
2. Heave in the slipping wire simultaneously until the same condition of the above and secure it to the bollard.
3. Slack the buoy chain slightly and release the buoy shackle.
4. Heave in the anchor chain to the deck.
5. Cast off the slipping wire.

Connecting the Anchor

1. Confirm the chain not being twisted, connect the anchor chain again with a kenter shackle which was removed.
2. Resume heaving in the anchor chain slowly and simultaneously slack the heave-in wire rope for anchor.
3. Connect the anchor.

16. Emergency Release

Means should be provided to permit the quick and safe release of the ship in case of need in an emergency. The method used for the emergency release operation should be discussed and agreed, taking into account the possible risks involved.

Emergency Towing Off Wires (Fire Wires)

Except at terminals where no tugs are available, towing off wires of adequate strength and condition should be made fast to bollards on the tanker, forward and aft, and their eyes run out and maintained at, or about, the waterline.

Emergency Towing

All tankers of 20,000 DWT and above are to be provided with an emergency towing arrangement at both ends. For tankers over 20,000 DWT but under 50,000 DWT, the fairlead (chock) arrangement should have a minimum SWL of 1,000 KN.

For tankers of 50,000 DWT and above, the fairlead (chock) arrangement, with suitable reinforcement should have a minimum SWL of 2,000 KN. The fairlead (chock) should have a minimum diameter of 600mm and a minimum height of 300mm

17. Personal Safety During Mooring and Unmooring

REMEMBER, you stand a greater risk of injuring yourself or your shipmate, during mooring and unmooring operations than at any other time.

- STAND CLEAR of all wires and ropes under heavy loads even when not directly involved in their handling.
- When paying out wires or ropes, watch that both your own and shipmate's feet are not in the coil or loop.
- BEWARE THE BIGHT!

- Always endeavor to remain in control of the line.
- Anticipate and prevent situations arising that may cause a line to run unchecked. If the line does take charge, DO NOT attempt to stop it with your feet or hands as this can result in serious injury.
- Ensure that the "tail end" of the line is secured on board to prevent complete loss
- WHEN OPERATING A WINCH OR WINDLASS, ensure that the man (or yourself) understands the controls and CAN SEE the officer or person in charge for instructions
- DO NOT leave winches and windlasses running unattended.
- DO NOT stand on the machinery itself to get a better view.
- DO NOT use a wire direct from a stowage reel that has been designed only for stowing, but do make sure you have enough wire off the reel before you put it into use.
- When using a Double Barrel Winch, ensure that the drum not in use is clear.

Gloves protect the hands against abrasion and also give insulation against very hot or cold conditions, both of which could affect a person's handling of equipment.
Wire should not be handled without leather or similar heavy protective gloves. These can prevent wounds caused by "snags" (broken wire strands).Such wounds may become infected and may bring about medical complications.
Loose fitting gloves are more liable to become trapped between wires and other equipment such as drum ends or bollards and do not give the necessary degree of protection
In any event, it must always be remembered that gloves cannot be relied upon to give complete protection against snags in the wire, Also that such snags may catch in the material and endanger life and limb through trapping

18. Safe Handling of Tugs

- When tugs are used to assist maneuvering the ship, additional care is required by the ship's crew.
- The condition of the tug's lines is unknown, and the crew on mooring stations will not normally be aware of when the tug is actually heaving or what load is being applied to the line., It is therefore important to stay well clear of the tow line at all times.
- When the tug is being secured or let go, the person in charge of the mooring should monitor the operation closely to ensure that no load comes on to the line before it is properly secured, or whilst it is being let go.
- Never let a tug go until instructed to do so from the bridge; do not respond to directions from the tug's crew,
- If the tow line has an eye on it, heave this past the bitts so that there is sufficient slack line to work with, stopper off the line, then put the eye on the bitts. Do not try to manhandle a line on to the bitt if there is insufficient slack line, if the line

has no eye and is to be turned up on the bitts then it should always be stoppered off before handling it.

- Do not try to hold a line in position by standing on it just because it is slack if the tug moves away so will you!
- When letting go do not simply throw the line off the bitts and let it run out; always slack it back to the fair-lead in a controlled manner, using a messenger line if necessary to avoid whiplash.

19. Mooring Incidents

Types of Incidents resulting in personal injury

❑ What are the major accidents involving mooring equipment that has injured many seafarers over the years?

Accidents that have occurred during the handling of ropes or wires:

a) Where ropes or wires have parted *(53%)*

b) Where ropes or wires have jumped or slipped off drum ends/bitts *(42%)*

c) Caused by actual equipment failure *(5%)*

Injuries from Parted ropes or wires - This normally occur during: general mooring, tug operations, ship to ship operations, equipment failure or misuse, wash damage and weather also playing a role.

a. Wash (10%), Ship to ship (3%)
b. Equip 't. Misuse/failure (6%)
c. Weather related (10%)
d. Tug operation related (13%)
e. And Mooring General (58%)

Injuries from NON - parted ropes or wires - normally occur due to: general mooring, crew being caught up in ropes or wires, ropes or wires slipping off and becoming jammed on drum during normal mooring operations.

a. Caught up in ropes/wires (20%)
b. Slipped off or jumped on equipment (20%)
c. Mooring General (60%)

Injuries caused by Equipment Failure – Failure to follow the proper operational procedure in handling the equipment will lead to its failure thereby causing injuries. Inexperienced personnel, who are to be involved in mooring operations, should not be allowed to operate a windlass or capstan or equipment which he is not familiar at. Or an experienced personnel however doing a two person job would most likely find himself committing procedural errors leading to an equipment failure.

Mooring injuries is the seventh most frequent cause of personal injuries on board. They are the third most expensive per claim indicating how horrific some of these injuries can become.

20. Risk Assessment of mooring Station

How do we assess the mooring areas such that risk of accident or damage to equipment's can be avoided?

a. Risk assessment of mooring stations

A risk assessment should be made of all mooring areas on board; looking at the space with a view of purposely searching for hazards that may cause injury. Mooring areas naturally contain many trip hazards, and highlighting these is a good starting point.

- Hazard highlighting
- Injuries from mooring incident
- Poor and potentially unsafe mooring area

b. **Hazard highlighting**

- Physical hazards to be highlighted.
- It should not be limited to bulkhead frames, mooring bits, pedestal fairleads and cleats.
- It includes structures such as platforms at the windlass and hawse pipe covers.

c. **Injuries from mooring incident**

Mooring is a routine operation frequently performed on ships. Due to the number of people involved, moving machinery, ropes under tension etc., there is the potential for an accident if the operation is not:

1. Properly planned
2. Supervised and
3. Good communication maintained throughout.

The individuals involved must be alert at all times and take responsibility for their personal safety.

d. **Poor and potentially unsafe mooring area**

There is some sight that sometimes experienced on board. Not only are the windlasses rusty and poorly maintained, but the mooring area as a whole suggests poor safety andmaintenance standards on board:

Highlighting hazards is particularly important for the safety of crew that is new to the vessel, cadets and other trainees, and visitors.

It is also important for the benefit of experienced crew who easily become complacent, tired, or too busy in their work to not notice a hazardous situation developing.

21. *ANCHORING, MOORING AND TOWING OPERATIONS of the Code of Safe Working Practices for Merchant Seaman (COSWP)*

a. Maintenance of mooring equipment

All equipment used in mooring operations should be regularly inspected for defects. Any defects found should be corrected as soon as possible.

Particular attention should be paid to the risk of oil leaks from winches, and surfaces of fairleads, bollards, bitts and drum ends should be clean and in good condition. Rollers and fairleads should run smoothly and a visual check be made that corrosion has not weakened them.

The most important facet of maintenance must be *preventive maintenance*. This is maintaining of the equipment in good operating condition by the necessary continuous assessment and action. The old adage prevention is better than cure is extremely important because of the lack immediate repair time and spare facilities. Systematic maintenance should mean fewer breakdown and repairs.

b. ***Proper maintenance ensures the following:***

- Fewer hazards to crew.
- The equipment will last longer and so reduce expenses.
- It should be ready for inspections anytime by appropriate authorities thereby record is important.
- The rate of deterioration of the equipment is continually monitored, assessed and perhaps controlled.
- The reliability of the equipment. The equipment operates efficiently when required to do so and can be relied in an emergency.
- That the crew is working to maximum efficiency and working in most weathers and conditions.

Proper maintenance of the mooring equipment follows a plan which should be broken down into various time phases. Each schedule will be tailored to fit each particular ship but it should be on the following three categories:

1) ***Short term maintenance***
2) ***Long term maintenance***
3) ***Due to operational requirements***

The following is a basic maintenance schedule.

1) **Short term maintenance:**

a) ***Weekly inspection.*** When possible inspect visually the winches, windlass, fairleads and rollers.

b) ***Monthly inspection and greasing where necessary.***

Visual inspection to be conducted, greasing of winches, windlass, fairleads, rollers and movable parts.

2) Long term maintenance:

a) ***Six months inspection-*** Strip and overhaul all mooring rollers. Grease all moving parts, wasted metal to be replaced.

b) ***Yearly maintenance.***

Strip the mooring winches and windlass. The winch break holding capacity should be regularly tested. It is recommended that test is made, and results recorded, at least once a year.

3) Operational maintenance:

a. Check all grease nipples on mooring equipment to ensure the nipples remain usable. It is a good idea to highlight these items in order to prevent them from being overlooked.
b. Oil, moisture or heavy rust on the brake linings and the drums be checked as it reduces the brake holding capacity.

3) Operational maintenance:

a. Whenever the brakes are opened for some reason, the brake drum should be examined for the buildup of rust or worn out break material. De-rust if necessary. The link mechanism of the brake must be free up and greased (remove old as well as the extra grease and apply new grease).
b. Always check the wearing out state of the brake band, brake drum, and the hole and pin of the break link. Adjust the support appropriately. This is installed in the lower part of the brake to prevent abrasion or wearing out of the upper part of the brake band (see diagram), following the equipment instructions.
c. **Hydraulic operated (hydraulic assist/hydraulic operated spring type) system:**
    - Free of hydraulic oil leakage.
    - Hydraulic piping/hoses in good condition.
    - Control/ settings operational/ in good condition and checked/calibrated.

22. Identifying Snapback Zones and other related hazards

The majority of serious accidents in mooring areas involve parting lines of which the result is a backlash or commonly known as Snapback.

a. Snapback & Snapback Zones

Line handling during mooring operations poses a great danger to personnel if not done properly. Handling of mooring lines regardless of whether wire or synthetic has a higher potential accident than other shipboard activities. Even long wire lines under tension can stretch sufficiently and breaks with considerable energy.

Synthetic lines are much more elastic, and thus the danger of snapback is more severe. Unlike wires, they do not give audible signs of pending failure and may not exhibit any broken elements before completely parting. ***In short, the larger the elasticity of a rope the more severe is the danger of snapback***

a. What is a Backlash or commonly Snapback?

Snapback: *is the sudden release of energy stored in a stretched mooring line when it breaks. When a line is loaded, it stretches.* Energy is stored in the line in proportion to the load of the stretch. When the line breaks, this energy is suddenly released. If the end of the line snaps back it will strike anything in their way with tremendous force.

The most serious danger during mooring is the snap back and line handlers must operate well clear of the potential path of the snap back.

b. The effect of a Snapback

A mooring line that is jammed on a bollard under another vessel's lines, and is therefore obstructed in a way, is suddenly cleared under tension. What will be the effect on the free end of the rope?

Since the tensioned line is suddenly cleared, there is the sudden release of energy stored in the stretched mooring line. The *free end of the rope tends to fly and 'whip' or oscillate violently striking anybody in the way* and thereby creating the snap back zone.

c. Snapback Zone

Snapback Zone: is the potential path of snapback of a broken line that extends to the sides of and far beyond the ends of the tensioned line.

As a gen rule, any point within about a 10° cone around the line from any point at which the line may break is dangerous.

If the line was bending on a roller, a broken line will snap back beyond the point at which it is secured, possibly to a distance almost as far as its own length. If the line passes around a fairlead, then its snap-back path may not follow the original path of the line. When it breaks behind the fairlead, the end of the line will fly around and beyond the fairlead to whip in a bigger arc.

d. Identifying Snapback Zones

If snap-back zones are painted on deck then crew will be alerted to the danger when they notice they are standing in a highlighted zone.

e. Snapback Zones and other related hazards

Avoiding the danger of a Snapback

- ✓ Stand well clear of the potential path of snapback whenever possible. Synthetic lines normally break suddenly and without any warning. The path of snapback extends to the sides of and far beyond the ends of the tensioned line.
- ✓ When it is necessary to pass a line under tension, do so as quick as possible. If it is a mooring hawser and the ship is moving about, time your passage for a period during under which the line is under little or no tension.

- ✓ If possible DO NOT Stand or pass near the line while the line is being tensioned.
- ✓ If you must work near a line under tension, do so quickly and get out of the danger zone as soon as possible and plan your activity before you approach the line.
- ✓ It is not possible to predict all the potential danger zones from snapback. When in doubt, stand aside and well away from any lines under tension.

23. Personnel at the Mooring Station - ***Who will man the mooring areas. How important is the availability of sufficient crew at the mooring station?***

Mooring operations are dangerous to crew on board because of the great loads that the mooring lines will carry, and the danger of them breaking while taking up this tension.

- A competent person should be in charge of the mooring operations and ascertain that there are no persons in a dangerous position during the operation.
- Only personnel involved in mooring operations should be present at mooring stations during mooring operations.
- Inexperienced personnel such as cadets in the early stages of their training, who are to be involved in mooring operations, should be under the supervision and direction of an experienced seafarer.
- Effectively, someone should be appointed to ensure the safety of the inexperienced person, and both should be aware of who is undertaking that duty.
- This is best done with safety notices and implementation into on board policies.
- The number of crew found on board is often the minimum required to safely operate the vessel. Although some ships may find themselves stretched for manpower, mooring operations should never be undertaken with less crew than is considered necessary to do the job safely.
- There should always be a minimum of two people to each mooring station throughout the operation. Even where automatic mooring systems are installed, a second person should always be present in case something goes wrong.
- Crew should not be allowed to operate a windlass or capstan and handle the rope at the same time. This is a two person job. Fixing a lanyard to an operating lever and pulling on it from the rope-handling position should strictly be forbidden. If only two crewmembers are on deck for mooring operations then they should work together on the lines at one end of the vessel and then the other.

24. Personal Protective Equipment (PPE)

The safety of the crew is the utmost concern during mooring. What is your personal protective equipment needed for the operation?

- When struck on the head by a parting mooring line, the wearing of a *hard hat* will be the life or death deciding factor. A hard hat should be worn at all times when involved in mooring operations, as well as appropriate *safety footwear* and *boiler suit.*
- It has been the general opinion on some vessels that the wearing of gloves when handling mooring ropes is an unsafe practice. This is due to concern that loose gloves may become trapped under a line on a windlass drum and hauls the crewmember over it. Gloves should be worn but crew need to be aware of the dangers associated with ill-fitting gloves when handling ropes.

a. Safe working practice for mooring operation

Here are some the typical guidance provided by MCA (Marine and Coastguard Agency, UK) to assist good manner for safe Operation on board in respect of mooring operation as follows.

(1) During mooring and un-mooring operations a sufficient number of personnel should always be available at each end of the vessel to ensure a safe operation. A responsible officer should be in charge of each of the mooring parties, and a suitable means of communication between the responsible officers and the vessel's bridge team should be established. If this should involve use of portable radio, then the ship should be clearly identified by name to prevent misinterpretation. All personnel involved in such operation should wear suitable protective clothing.

(2) If you use vessel's heaving lines, it should be constructed with a "monkey's fist" at one end. To prevent personal injury, the "fist" should be made only with rope and should not contain weighting material.

(3) Areas where mooring operations are to be undertaken should be clutter free as far as possible. Decks should have anti-slip surfaces provided by fixed treads or anti-slip paint coating, and the whole working area should be adequately lit for operations undertaken during periods of darkness.

4) All equipment used in mooring operations should be regularly inspected for defects. Any defects found should be corrected as soon as possible. Particular attention should be paid to the risk of oil leaks from winches, and surfaces of mooring chock, fairleads, bollards, bitts and drum ends should be clean and in good condition.

(5) Mooring wires, ropes and stoppers that are to be used in the operation should be in good condition, Ropes should be frequently inspected for both external wear and tear between strands. Wires should be regularly treated with suitable lubricants and inspected for deterioration internally and broken strands externally. Splices should be inspected regularly to check they are intact.

24. Terminology during Berthing and Un-berthing

General:

Bridge: Is / are the propeller(s) clear?

Yes, the propeller(s) is / are clear
Mooring station: No, the propeller(s) is / are not clear
Bridge: Keep the propeller(s) clear
Bridge: Are fenders on the berth?
Mooring Station: Yes, fenders are on the berth
No, fenders are not on the berth
Bridge: Have fenders ready forward and aft.

Berthing:

Bridge: We will berth port side / starboard side alongside
We will moor - to buoy(s) (ahead and astern)
- alongside
- to dolphins

Bridge: Send out
- The head / breast / stern line
- The … spring(s) forward / aft
-Have the heaving lines ready forward and aft
-Send the heaving lines / head / stern / breast line(s) ashore
-The lines men will use shackles / lashings for securing the mooring

Use
- The center lead / panama lead
- The bow lead
- The port quarter / starboard quarter lead

Heave on the... line(s) /... spring(s)
Have the heaving lines ready forward and aft
Pick up the slack on the … line(s) / … springs
Heave Away
Stop Heaving
Slack Away/Check the…lines(s) / …spring(s)
Hold on the …line(s) /… springs(s)
Heave in easy
Heave alongside
Keep the … line(s) /… spring(s) tight
Report the forward / aft distance to …
The forward / aft distance to… is … meters
We have to move … meters ahead / astern
We are in position
Make fast forward and aft
Finished with maneuvering stations

Un-berthing:

Bridge: Stand by engine(s)

Are you ready to get underway?

Yes we are ready (to get underway)
No, we are not ready (yet) (to get underway)
We will be ready to get underway in … minutes

Standby for letting go
Single up the … lines and …springs forward and aft
Slack away / hold on / heave on the
- Head / stern line
- Breast line
- Forward /aft spring

Let go
- The head / stern line
- The breast line
- The forward /aft spring line
- All (forward / aft)

Let go the towing line(s)
Standby bow anchor(s)
Finished with maneuvering stations

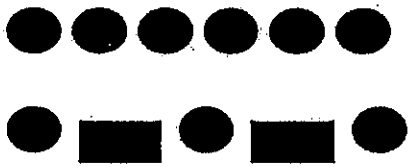
Close Loop Communication

- ❑ **Repeat the message**
- ❑ **Execute the instruction given on the message**
- ❑ **Report that the instruction has been complied with.**
- ❑ **"Short and concise"**

Whistle Signals

●	**Attention!**	**Workers *pay attention* to the order.**
● ●	**Hoist! Go Ahead! Heave! Stretch! Close!**	**The operator or driver starts to do as indicated.**
● ● ●	**Lower! Go Astern! Slack! Stretch! Close!**	**The operator or driver starts to do as indicated.**
▬	**Stop!**	**The operator or driver *stops* the operation.**

Whistle Signals



Danger!
Cancelation!
Emergency Stop!

This signal is used when as against the whistle order, the signalman feels danger, fails to make a correct order, cancels his order, and for emergency stops.

Finished operation!

Emergency!

The occurrence of an accident! Crew members shall rush to the scene at once. (This signal can be used by a person on duty for security reasons)