NYK Maritime College

NYK SHIPMANAGEMENT

NMC-69
Safe Mooring Operation Training
(Advanced Course)

NYK SHIPMANAGEMENT PTE LTD
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1st Edition (Jun. 2013)

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Introduction

Ships enter and leave ports regularly. Tying up a ship when alongside a berth or another vessel is potentially a very hazardous operation unless simple and effective safety procedures are followed. Mooring accidents are always on the list of personal injury accidents, often resulting in severe injuries or even fatalities.

Always anticipate well ahead and expect the unexpected. Maritime Incidents are seldom the result of single event, they are almost invariably the result of the culmination of an error chain. Situational awareness is extremely important to recognize that an error chain is developing and to take action to break the error chain.

This training is a guideline that should be taken into account by Master and Senior Officer while performing mooring and anchoring operations.

This course has been developed in response to the prevailing incidents and accidents onboard ships related to mooring and anchoring operations. To minimize the risks, Senior officers on board vessels must have good knowledge and understanding about management of mooring operations safely.

Objective

This training course will equip officers who manage to plan, judge and control of mooring operation when engaging themselves in actual mooring on board.
Those who successfully complete this course should be able to:

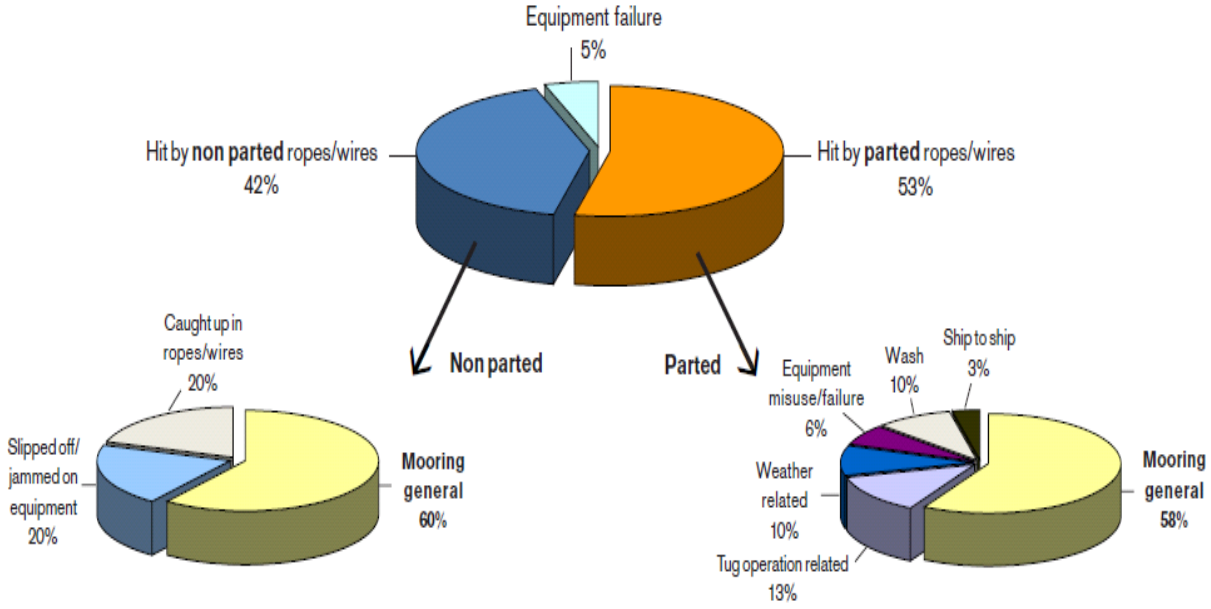
- Be aware of the risk involved.
- Relate and learn from the mooring accidents and incidents.
- Understand the management of safe mooring operations.
- Be familiar with applied characteristics of ropes and wires used in mooring operations.
- Understand the management of safe anchoring.
- Have applied comprehension about the mooring equipment.
- Be familiar with testing, inspection and maintenance of the mooring hawsers and mooring equipment.
- Handle mooring line & equipment properly with considering prevent injuries and incidents.

1. Understanding Mooring Incidents

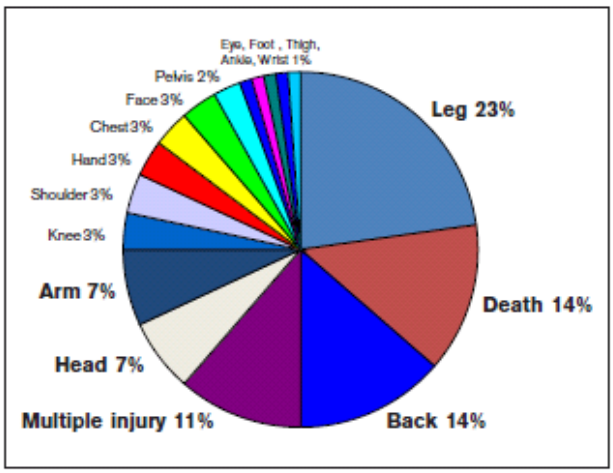
1.1 Statistics of Mooring Incidents *(UK P&I Club LP News, Jan. 2009)*

Many of these accidents have occurred during the handling of ropes/wires, where ropes/wires have parted (53%) or where ropes/wires have jumped/slipped off drum ends/bitts (42%) with 5% caused by actual equipment failure (see pie chart below centre).

Parted ropes/wires normally occur during general mooring, tug and ship to ship operations with equipment failure, misuse, wash damage and weather also playing a role. Injuries from non parted ropes/wires normally occur due to crew being caught up in ropes/wires and ropes wires slipping off and becoming jammed on drum ends during normal mooring operations (see pie charts).



Types of incidents resulting in personal injury



Injuries from Mooring Incidents

1.2 Mooring Incidents in NYK Fleet

(1) Parting of rope at Tanker Terminal

Description of Incident : 11th Jun. 2012

Vessel made fast portside along side with mooring 3+2+2 fwd & aft. Wind speed was 25 knots with swell about 01 meter. Due to strong wind and swell Master decided to send additional spring lines on 10 June 2012. On 11 June 2012, due to surging movement one aft breast line parted and subsequently one stern line parted.

Cause(s) & Contributing Factors :

① Chaffing of rope due to surging of vessel.

② Delayed corrective action from vessel.

③ Use of synthetic rope instead of wire/tail.

Lessons Learnt :

① Vessel shall get latest weather forecast, and plan corrective action if necessary.

② If all the wires are not permitted by terminal, request terminal to allow at least the springs (fore and aft) as wires.

③ Vessels shall continue monitoring the rope status. As soon as rope shows sign of damage due to chafing, terminal shall be informed to provide shore mooring crew to replace the rope.

④ Vessel shall confirm in pre cargo operation meeting regarding the notice required to mobilize shore mooring crew for replacing any rope.

⑤ In strong wind condition, vessel shall use 4+3+3 (04 head / stern line, 03 breast ropes and three springs) mooring configuration fore and aft.

Sea State Moderate to Rough with 25-30 kts wind speed from onshore, swell height is 1m and vessel rolling 0.5deg.

Aft Breast Lead where line parted

(2) Human Injury during Berthing Operation *(Safety Bulletin GEN 2012 014)*

Description of Incident : 11th Oct. 2012

There was a fatality during berthing operation. After investigation we found that the crew succumbed to his injuries due to slipping off of the messenger rope from the warping drum & not due to mooring rope.

When the accident occurred, crew were preparing for berthing. Aft mooring station team was picking up tug line, which was wire rope and very heavy, using messenger rope. The messenger line was improperly guided towards the warping drum and the messenger line was led to wrong side of pedestal roller. To make matters worse, two messenger lines were used for picking up the heavy tug line and rolled up on the same warping drum crushing each other.

The messenger line got entangled onto the warping drum, due to incorrect lead from the pedestal roller on the drum itself, and the messenger line sprang off the warping drum.

The 2/O was the designated officer in charge of the mooring operation at the aft station. Due to the unsafe condition of the messenger line, he stopped the winch operation. At this time the eye of the tug line was close to the ships side. Instead of reassessing the risk & readjusting the fouled messenger rope, 2/O instructed one of the crew members to push and guide the messenger rope on the warping drum. Upon heaving the winch, the messenger rope sprang off the warping drum & got entangled with the neck of the attending crew member.

[OBSERVATION]

As you can observe, there are several links of error chain.

One thing we would to highlight in this incident is improper usage of mooring equipment. In this casualty, the messenger rope was incorrectly lead from the pedestal roller to the warping drum. *(See Fig.1 and Fig.2)*

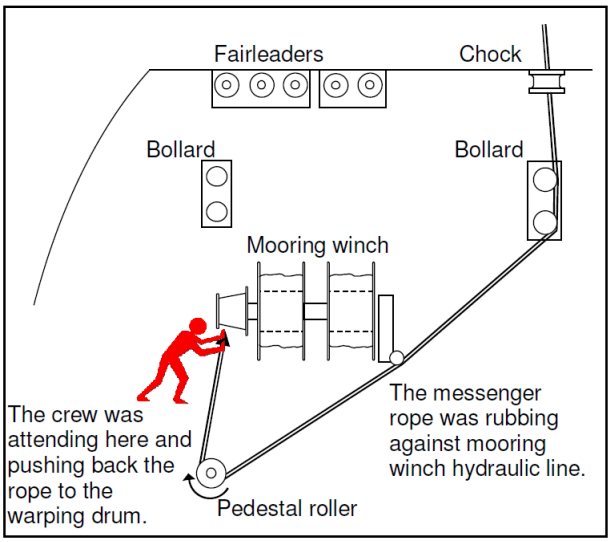


Fig.1 Path of messenger line when casualty occurred

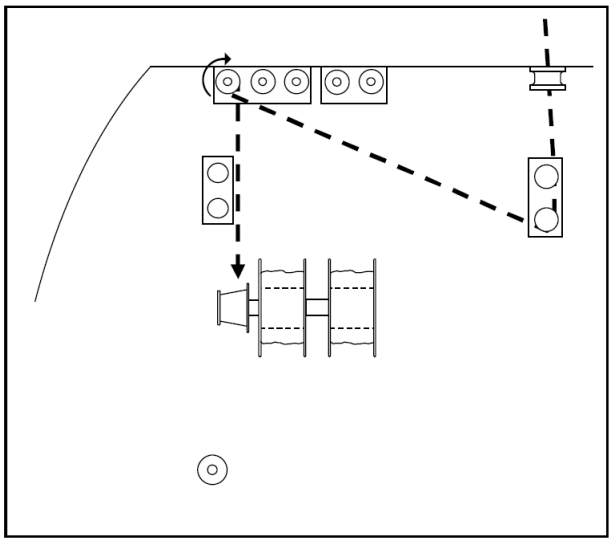


Fig.2 Preferable path recommended by the management company of the ship after the casualty

Normally, fairleaders or stand rollers are arranged so that ropes can be guided straight to the warping drum. On the other hand, if guiding direction is wrong, crush of the rope on the drum can happen easily.

(See Fig.3 and Fig.4)

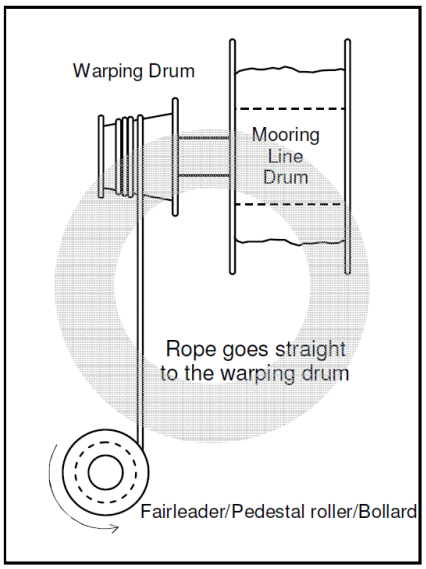


Fig.3 Proper usage

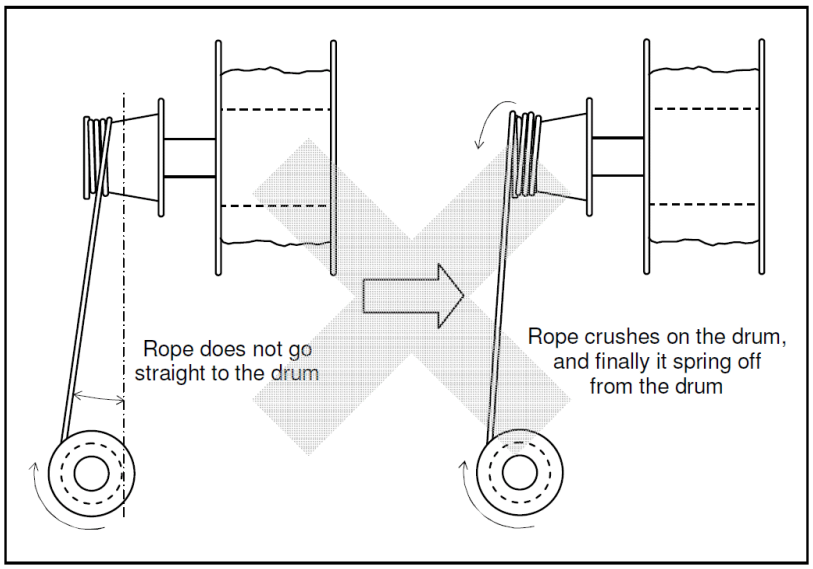


Fig.4 Improper usage

Other possible causes are as follows:

- Two messenger ropes were used: if single strong messenger rope was used, crush of the rope might not occur.
- The work was resumed without reassessing the risk: 2nd officer was aware of the dangerous situation and stopped the winch once. But tug line was almost onboard, then safety lost priority.
- The line was rubbing against hydraulic pipe: The messenger rope was rubbing against the hydraulic pipe near the mooring winch. It gives extra tension on the line and may cause damage on the line. I addition, it was a clear indication which shows the lead of the ropes were incorrect. However, those were overlooked.

[COMMENT]

a) We would like to emphasize, especially to team leaders of mooring stations, to check the mooring equipment on board your vessel. On some vessels the path of the messenger ropes from a specific chock / fairlead to warping drums may be complicated. If you could not find out a good path, please discuss with the master or vessel manager.

b) We would also like to draw your attention to use messenger lines of adequate strength whilst picking up mooring lines or tails. There is also a danger due to snapback from the messenger rope in case of parting of messenger rope.

c) Crewmembers who in engage mooring operations shall be familiar with operation of mooring equipment and signals used in the operation. Besides they shall have knowledge of potential risks of mooring operation.

d) Even if the operation is completed 90%, when unsafe condition is found, the operation shall be reviewed. If deemed necessary, the operation shall be restarted again from the beginning. Always keeping safety as a priority.

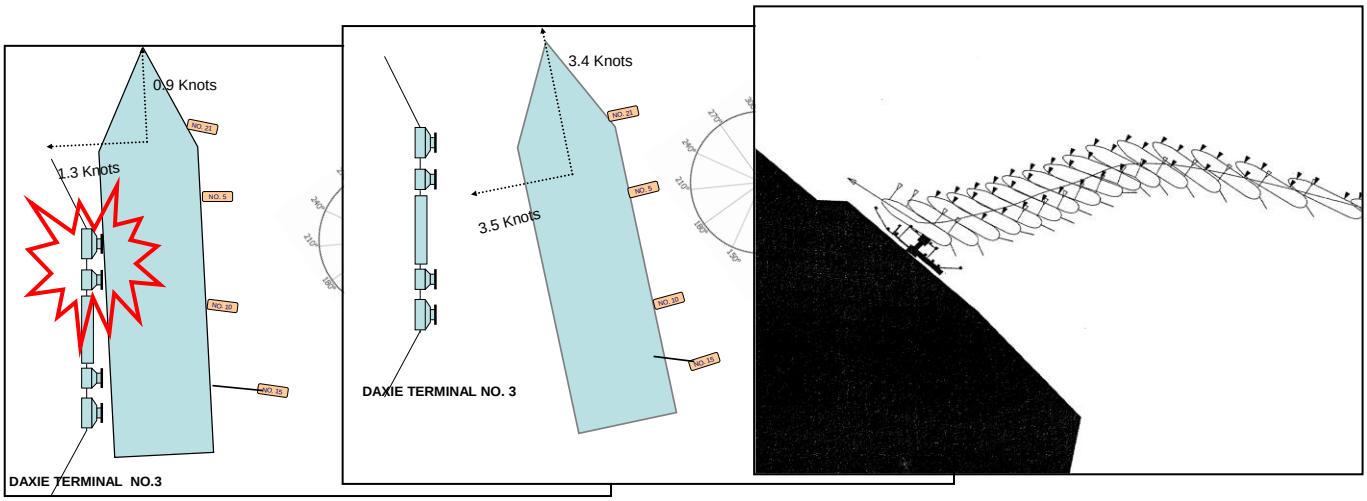
e) Needless to say, kindly keep safe distance from mooring ropes under strain, in case a rope needs to be held temporarily, kindly use correct rope stopper for the job.

(3) Heavy Contact with the Berth Fender

Description of Incident :

On 18th May 2012, a NYK operated VLCC made heavy contact with the fender of a dolphin while berthing at Daxie Shihua Crude Oil Terminal Berth #3, Ningbo, China, with a pilot on board, resulting in indentation to the vessel's hull and damages to the fender and jetty structure. Fortunately, no injury or oil spill was reported. Wind was ESE 9 knots (4.6m/s) and Tide was Ebb tide at the time of the incident.

The vessel was not allowed to sail out after completion of cargo operation due to the on going investigation resulting in delay to the vessel's schedule.



[OBSERVATION]

On investigation of SVDR data and Master's testimony, it was found that the vessel had excessive maneuvering speed (headway and lateral approach speed) throughout the berthing operation.

- 6 min prior contact: Appx. 250m to the berth, Headway: 3.4 kts, Lateral approach speed: 3.5 kts
- 4 min: Appx. 120m to the berth, Headway: 1.9 kts, Lateral approach speed: 2.0 kts (103cm/s)
- 2 min: Appx. 60m to the berth, Headway: 0.8 kts, Lateral approach speed: 1.2 kts (62cm/s)
- At the time of accident: Headway: 0.9 kts, Lateral approach speed: 1.3 kts (67cm/s)

Master advised the pilot to instruct the tugboats to pull. However Master was unable to confirm actual pilot's order to the tugs due to language barrier.

This terminal had been recently constructed. It was the first time for this vessel to call at this terminal and it was also the first call for the Master and officers.

During Master / Pilot information exchange, Master did not confirm the berthing speed.

[COMMENT]

To prevent a similar incident, Master and Officers are reminded to pay attention to the following points;

1. Master shall discuss the vessel's berthing plan with the Plot when he presents the Pilot Card and reach upon a mutual agreement regarding the planned maneuver.
2. Challenge or question the pilot's actions whenever in doubt about his intentions or actions.
3. If the vessel is calling at new Port or Terminal, Master shall contact the Local agents and try to obtain information in addition to the that available in the Guide to Port Entry and other publications, including the standard berthing procedures if available.
4. Company shall assist vessel in obtaining the required information, if deemed necessary.

2. Knowledge of Mooring Line

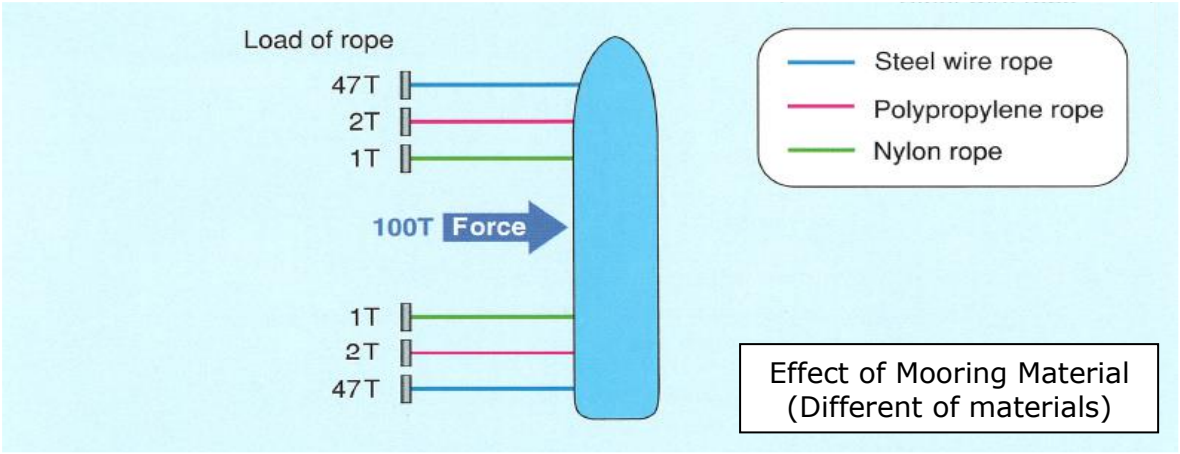
2.1 Type and Quality of Mooring Lines

All Mooring lines should be the same material, diameter and construction. Ropes with low elastic elongation properties are recommended for all tankers, as they limit the tanker's movement at the berth.

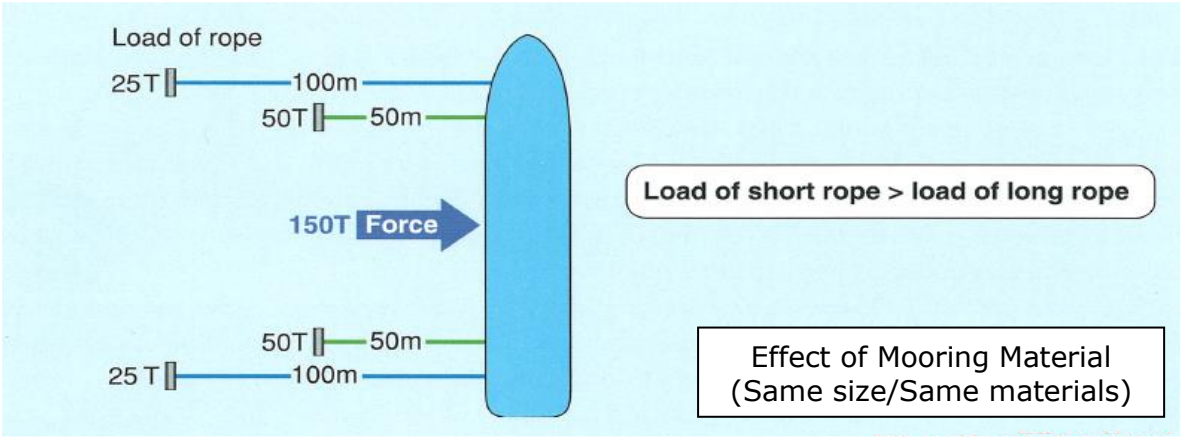
Moorings composed entirely of high elasticity ropes are not recommended as they can allow excessive movement from strong wind or current forces or through interaction from passing tankers. Within a given mooring pattern, ropes of different material (elasticity) should never be used together in the same direction. Never mix wire and synthetic fiber ropes leading in the same direction.

The elasticity of a mooring line primarily depends upon the Material, Condition, Length and Diameter.

Standard synthetic fiber ropes will deteriorate more rapidly than steel wires or high modulus synthetic fiber ropes.



Effect of Mooring Material
(Different of materials)



Effect of Mooring Material
(Same size/Same materials)

Therefore two or more lines leading in the same direction should, as far as possible, be of the same length.

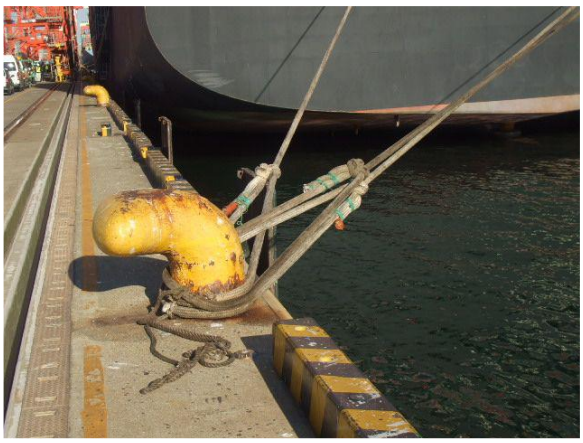
2.2 Proper Usage of Mooring Ropes

It is understood that an eye made by a bowline knot reduces the breaking strength of a mooring line because the mooring line loses elasticity at the knot. The manufacturer's test result shows that the breaking strength of such a mooring line is excessively, 50% or less of present strength, reduced. The result supports our general understanding. Thus, we should be reminded that making an eye from a bowline knot on mooring lines is not safe.

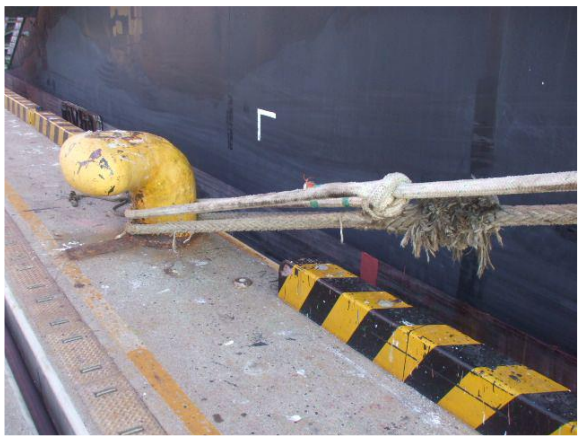
In addition, it is the general opinion that vessels should not use different kinds of mooring lines because the tensions of the lines can not be the same when vessel moor. *Mooring Equipment Guidelines 3rd Edition* by OCIMF states that "generally, mooring lines of the same size and type (material) should be used for all leads. If this is not possible, all lines in the same service, i.e. breast lines, spring lines, head lines, etc. should be the same size and type."

To conduct safe mooring, please ensure the following.

- Mooring-line eyes made by a bowline knot should not be used except in emergency. Any eye splice on a mooring line should be made in accordance with the attached instruction for double braid rope.
- Different sizes and types (material) of mooring ropes should not be used together; rather, the same sizes and types should be used, for this will keep tensions the same and in balance.



Mooring-line eye made by bowline knot



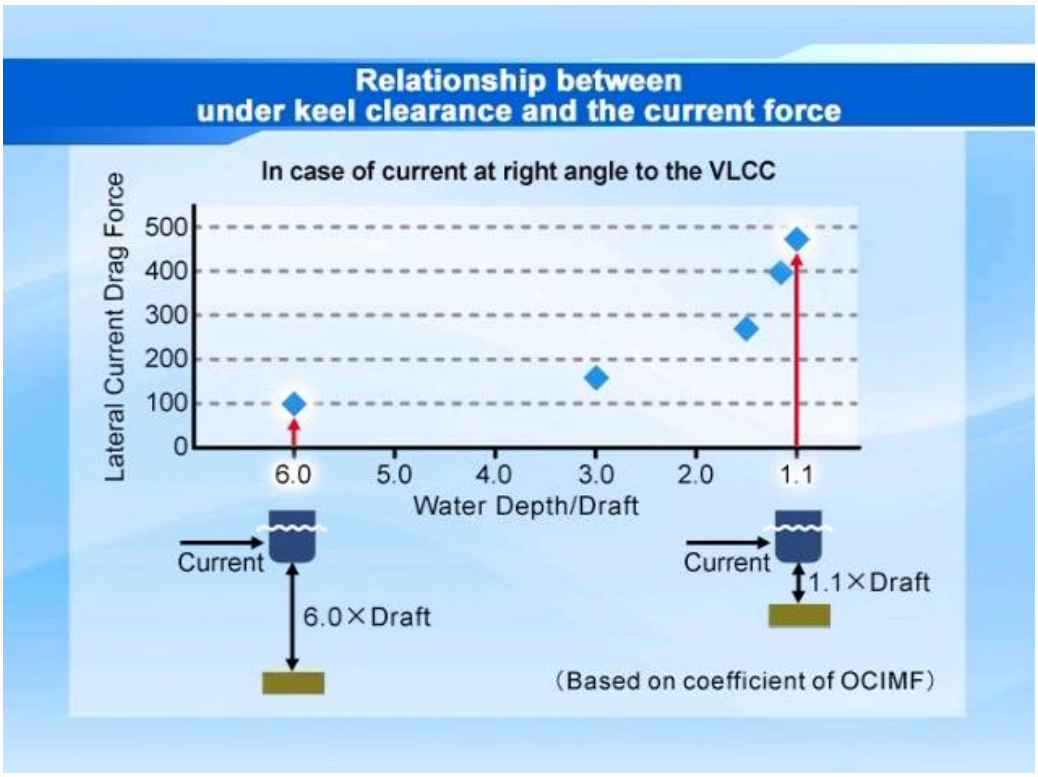
Different kinds of ropes were used, double braid rope and plaited rope

2.3 Current Effect

Current forces on the ship must be added to the wind forces when evaluating a mooring arrangement. In general, the variability of current forces on a ship due to current velocity and direction follows a pattern similar to that for wind forces. Current forces are further complicated by the significant effect of under keel clearance.

Bellow Fig shows the increase in force due to reduced under keel clearance.

Nevertheless, even a current with a small angle (such as 5°) off the ship's longitudinal axis can create a large transverse force and must be taken into consideration.



3. Knowledge for Management of Mooring Equipment

3.1 The Number of Layers of Wire on the Drum

The holding capacity of a winch brake is in inverse proportion to the number of layers of the mooring wire or rope on the drum. The designed holding capacity is usually calculated with reference to the first layer and there is a reduction in the holding capacity for each additional layer. This can be substantial - as much as an 11% reduction for the second layer.

If the rated brake holding capacity of a split drum winch is not to be reduced, only one layer should be permitted on the working drum.

No. of Layer	Theoretical holding capacity % Rated Holding Capacity	
1st Layer	55 tones	100%
2nd Layer	48 tones	89%
3rd Layer	44 tones	82%
4th Layer	40 tones	75%
5th Layer	37 tones	69%

3.2 The Direction of Reeling on the Winch Drum

On both single and split drum winches, the holding power of the brake is decreased substantially if the mooring line is reeled on the winch drum in the wrong direction. Before arrival at the berth, it is important to confirm that the mooring line is reeled so that its pull will be against the fixed end of the brake strap, rather than the pinned end. Reeling lines onto a drum in the wrong direction can cut its brake holding power by up to 50%. The correct reeling direction ("Heave In" and "Slack") should be permanently marked on the drum to avoid misunderstanding.

Winches fitted with disc brakes are not subject to this limitation.

3.3 The Condition of Brake Linings and Drum

Oil, moisture or heavy rust on the brake linings or drum can seriously reduce the brake holding capacity. Oil, moisture or heavy rust on the brake linings or brake drum can reduce holding load capacity up to 75%. Moisture may be removed by running the winch with the brake applied lightly, but care must be taken not to cause excessive wear. Oil impregnation cannot be removed so contaminated brake linings will need to be renewed.

3.4 The Application of the Brake

A band brake holding capacity of 80% MBL with the rope on the first layer is also required by Lloyds, DNV and ISO Standards 3730. If a brake of an undivided drum is set to hold 80% MBL on the first layer, it will hold approximately 60% MBL on the 4th layer.

Therefore brakes must be adequately tightened to achieve the required holding capacity. This is usually 60% of the line's Minimum Breaking Load (MBL). The use of hydraulic brake applicators or a torque wrench showing the degree of torque applied is recommended. If brakes are applied manually, they should be checked for tightness.

4. Planning and Briefing

4.1 Planning and Briefing with Crew

The key element for safe and effective mooring operation is planning and ensuring that appropriate procedure are followed.

Planning shall take into account not only the mooring layout of the vessel and the berth but the prevailing and expected weather conditions, tide, currents and any other factors affecting the moorings of the vessel.

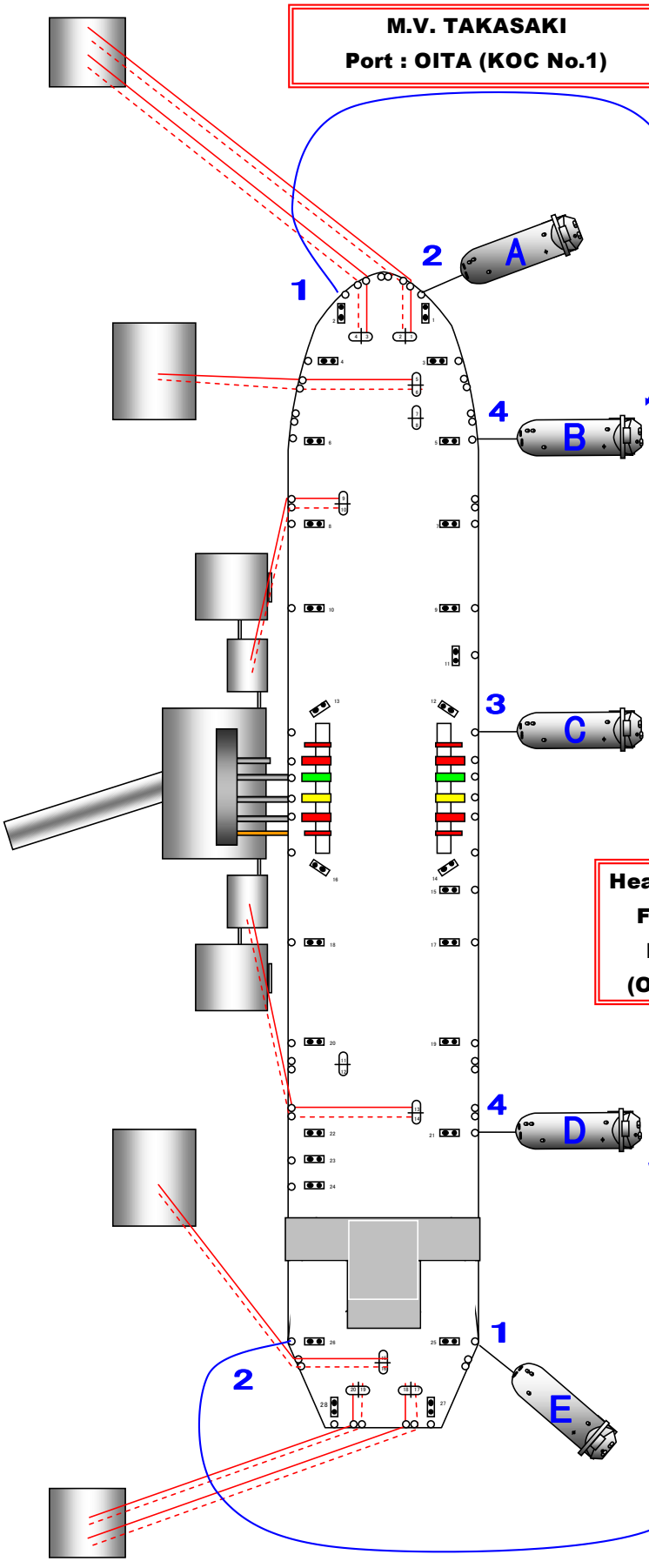
Before arrival at a port, all necessary mooring equipment shall be made ready for use and all mooring machinery shall be inspected and proved to be in good condition. Chief Officer must confirm that all preparation of mooring has been done.

The following items should be discussed during BRM/BTM meeting before arrival at Pilot Station. The practice of BRM/BTM talks to discuss the operation and hazards involved is an effective way to help reduce accident.

- Time Schedule: Estimated time of Pilot on Board, timing for Stand-by stations, Estimated Time of Berthing, notices to E/Room, call Master, etc.)
- Documentation: Working Instructions, Risk Assessments, SMS Check Lists and Standard Procedures, Pilot Card, Weather Forecast, Instructions from Agents, Sailing Instructions, etc.
- Manning, Work-Rest hours, Communication methods, preparation of pilot ladder, preparations of ropes and anchors, experience sharing.
- Expected lay-out of the berth and mooring arrangements, hawsers to be used, safety precautions.
- Expected number of tugs to be made fast, location to make fast, lines to be used (tug's or ship's lines).
- Reporting and communication flow Bridge / Fore / Aft – items to be reported, standard terminology, back-up arrangements.
- Speed management as per standard berthing maneuver.
- Expected traffic and other hazards to navigation.
- Emergency / Contingency Plans, any other related safety issues.

M.V. TAKASAKI
Port : OITA (KOC No.1)

SAMPLE
(Mooring & Tug Arrangement)



Line Arrangement
Fore : 4 - 2 - 2
Aft : 4 - 2 - 2

Head Lines & Stern Lines First
Followed by Breast Lines,
Lastly, The Spring Lines
(Outer Lines to Inner Lines)

NYKSM Maneuvering Standard

<Rev: 2012/03/31>

We seek your cooperation for adherence except in cases of emergency for avoidance of any imminent danger:-

- DO NOT DEVIATE **from CHARTED PASSAGE in channel/traffic route**
- COMPLY **with company's UKC Policy** *(Ref Pilot Card Section-D)*
- COMPLY **with company's AIR DRAFT Policy**
- COMPLY **with company's BERTHING / UNBERTHING GUIDELINES**

Note: All Bridge Team Members are expected to observe prudent seamanship and comply with applicable local and international rules & regulations and relevant company's navigation procedures.

NYK LOGISTICS A MEGACARRIER

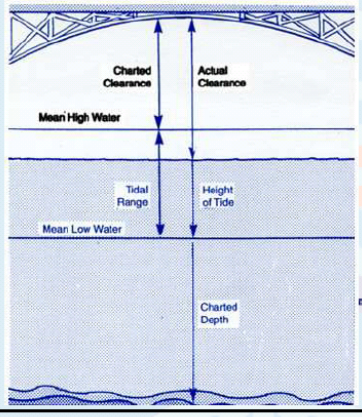
Notice to Pilot

We would like to request your active involvement in Bridge Team Management (BTM). Let us ask that you take part in information-sharing with the master.

- ✓ **Passage planning (intended course, speed, approach)**
- ✓ **Anticipated disturbances (weather conditions, currents, etc.)**
- ✓ **Traffic congestion**
- ✓ **Local regulations, rules, and navigational warnings**
- ✓ **Information from any ships around or traffic control**
- ✓ **Instructions for tugs or escort boats**
- ✓ **Any alteration in your plan; any unanticipated situations**

NYK Line

Air Draft Policy



Maximum Air Draft shall be limited such that a MINIMUM NET CLEARANCE OF 0.60M is maintained at all times during the voyage

NET CLEAREANCE =
Charted Clearance
– Air Draft
– Wave Allowance
– Accuracy of Chart
± Other Corrections / allowances for various factors

<Rev: 2012/03/31>

NYKSM Maneuvering Standard

Standard Berthing Procedure:

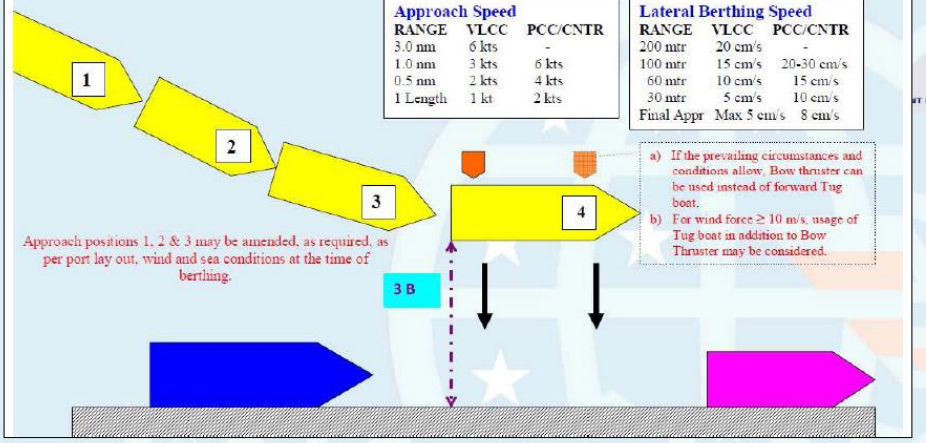
a) Vessel should be parallel to the berth and stopped at a distance of approximately 3 beam lengths from the Berth.

Approach Speed

RANGE	VLCC	PCC/CNTR
3.0 nm	6 kts	-
1.0 nm	3 kts	6 kts
0.5 nm	2 kts	4 kts
1 Length	1 kt	2 kts

Lateral Berthing Speed

RANGE	VLCC	PCC/CNTR
200 mtr	20 cm/s	-
100 mtr	15 cm/s	20-30 cm/s
60 mtr	10 cm/s	15 cm/s
30 mtr	5 cm/s	10 cm/s
Final Appr	Max 5 cm/s	8 cm/s

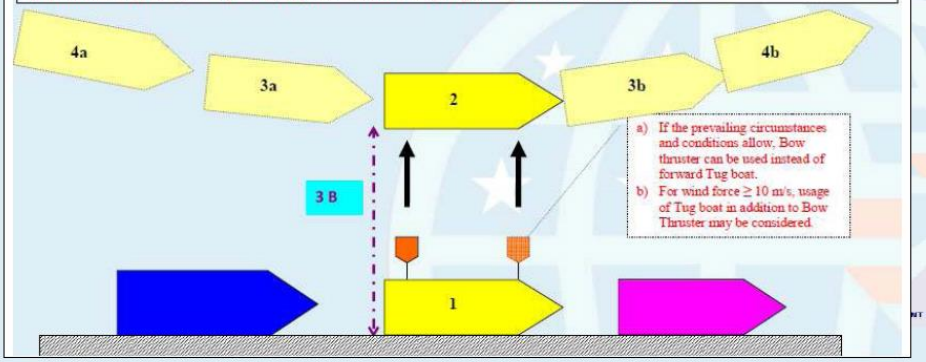


STANDARD BERTHING PLAN

Standard Un-Berthing Procedure

[For On Shore Winds, Beaufort scale, Force > 4]:

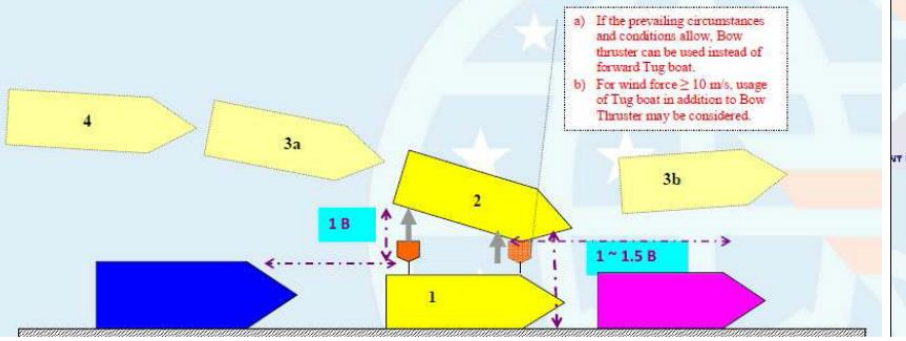
a) Vessel should be pulled off the berth to a distance of approximately 3 Beam lengths.
b) It is recommended that Main Engine should be used only after vessel is at position No.2.
c) Position no. 2's aspect may not necessarily be parallel (considering departing route/currents/wind/port layout etc)
d) Positions 3 (a or b) & 4 (a or b) may be amended as per port layout / wind / current etc.



STANDARD UN-BERTHING PLAN (A)

Standard Un-Berthing Procedure [For On Shore Winds, Beaufort scale, Force ≤ 4 and Off-Shore winds of any force]:

a) Vessel should be pulled off the berth to a distance as mentioned in the figure, where "B" is beam of own vessel.
b) It is recommended that Main Engine should be used only after vessel is at position No. 2.
c) Positions 3 (a or b) & 4 may be amended as per port layout / wind / current etc. however shall not be closer to berthed vessel than 1B.



STANDARD UN-BERTHING PLAN (B)

4.2 Master and Pilot Information Exchange

The Master shall discuss and confirm with the pilot the necessary matters among the following and shall properly convey them to the Deck Officers.

a) Information about the passage from the point where the pilot boarded the ship up to the final guiding point of pilotage;

b) Number and horsepower of tugboats and their positions;

c) Name of the berth, side of the ship to be berthed, the method of berthing and how the mooring lines will be strung;

d) Which side of the ship the pilot ladder is to be rigged when the pilot disembarks, its height from the surface of the water, the ship's speed, etc;

e) The prevailing tide, effect of current and vessel speed;

f) The effect of squat, maximum speed and resultant UKC. In case of Tankers and Gas carriers vessel compliance with company UKC policy;

g) Approach or departure plan for mooring and unmooring;

h) Contingency plan in case of failure of Main engine, Bow Thruster or Steering;

i) Cautionary positions where special care may be required;

j) Thoroughly exchange necessary information with the pilot regarding the ship operation when entering and leaving port, On that occasion, the Master shall confirm the following items and require the pilot, if necessary, to implement the following items;

i) Method of use and engine output of tugs.

ii) Method of main engine maneuvering

iii) More specific use and adjustment method of engine power of tugs and specific use method and plan for the main engine in a situation where there is the possibility that the ship may move at the same time when the mooring ropes are released. Carefully operate the ship considering the characteristics and the proper use of the main engine to prevent black smoke.

5. Practical Exercise of Mooring Operation

Before carrying out any practical exercise, make sure that all personnel involved have been properly briefed and have the appropriate Personal Protective Equipment (PPE).

5.1 Conning Position

Mooring Operation area has some blind zone by ship structure or equipments. During mooring operation, leader of each station should identify blind zone with consider the following.

(1) General

① Review the mooring operation of your vessel and check if there are any unsafe acts or conditions.

② To maintain safe conditions, hardware modifications shall be considered if necessary. The master should discuss the necessity of such modifications with the manager before taking measures.

③ Clearly identify dangerous places and apply safety markings where necessary.

④ Appropriate numbers of crewmembers shall be assigned in consideration of workload, difficulty, and crew experience.

⑤ Tool box meetings should be held and involve all concerned crewmembers.

(2) During a mooring operation

① Officers on-site should properly supervise the safety work of crew.

② Conning positions should be considered. An on-scene director must take the proper place for managing crew and equipment.

③ Maintain good oral and visual communication with each other.

④ Crewmembers should take action only in compliance with clear orders from the director, and should not take any action based on uncertain information or guesswork.

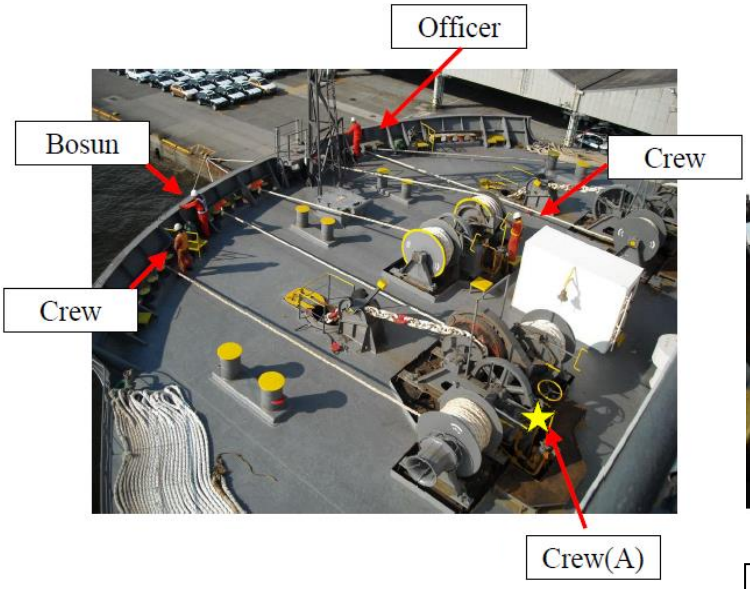


Photo #01 : Allocation

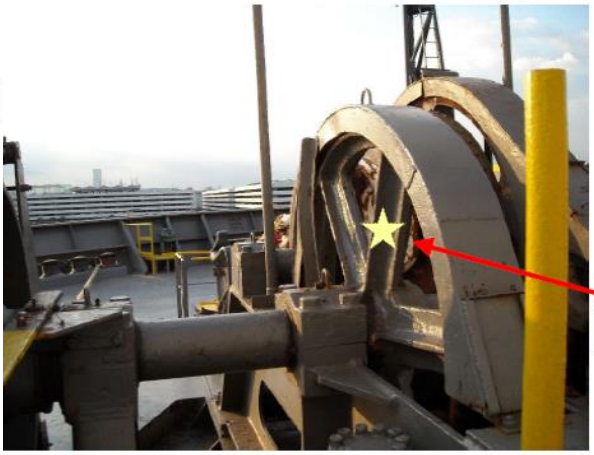


Photo #02 : View from winch control stand (Port Side)

6. Anchoring Incidents in NYK Fleet

(1) Anchor chain entanglement due to improper anchoring procedure *(Ref : Safety Bulletin GEN 2010 006)*

Description of Incident :

When the container vessel was heaving up her port anchor at Koje anchorage, the chain was observed to be entangled with itself. About two shackles-length of chain was bundled on the anchor. (Please see the attached photo.) The ship was planning to leave Koje anchorage for Pusan. Because the chain could not be disentangled by ship's crew, a shore service company was arranged to clear the entangled chain.

[OBSERVATION]

The following can be considered as the causes of these incidents:

- Just after letting go, quite a lot of anchor chain was dropped underneath and resultantly became bundled.

- The anchor chain was left as it was and brought up without clearing the bundle.
- Both vessels stayed 28-30 meter-depth anchorage with 7 shackles for 5-6 days.

  They turned around several times due to semidiurnal tide, which might have led to entanglement of the chains.
- Some unusual bottom topography, such as a depression, irregular gradient etc., existed.

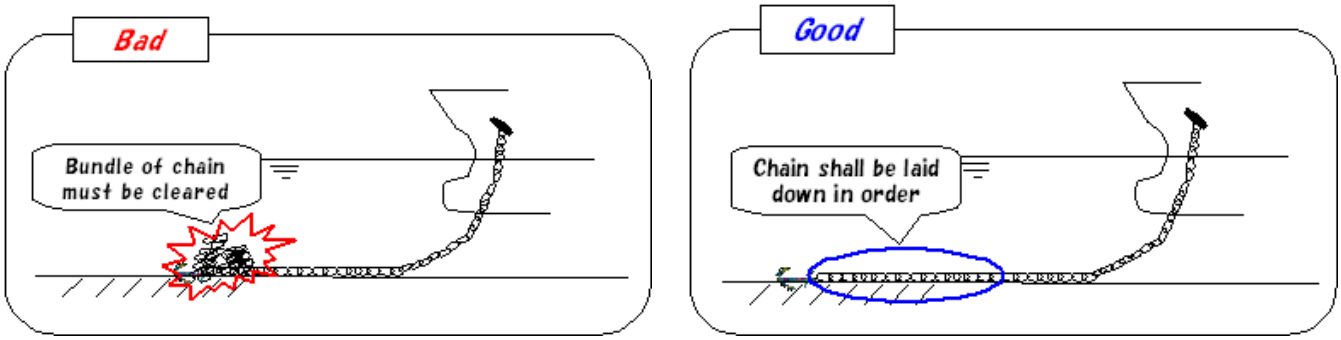
  Then, anchor chain slid and bundled on the anchor when dropped.

[COMMENT]

You are well aware of the below anchoring procedure when you carry out single and sternway anchoring.

However, please let us remind you of the following so as to prevent a recurrence of these incidents:

- <u>The astern engine shall be applied before dropping anchor. And it should be let go when the vessel is at almost 0 kt over-the-ground.</u>
- <u>After the anchor is dropped to a length a bit longer than water depth, the officer responsible for the forward station should stop paying out and monitor the chain movement to confirm that the chain is being laid on the bottom in order.</u>
- <u>Then, the chain should be veered out properly, following the ship's sternway.</u>
- Sighting anchor should be carried out with an appropriate interval if duration of lying at anchorage gets longer.
- The bottom topography of anchorage should be checked with charts and echo-sounder, other available means



(2) Loss of Anchor while Anchoring *(Ref : Casualty Report 2012 009)*

Description of Incident :

A laden LPG carrier with a pilot on board was approaching Sudong Anchorage "B" (Singapore) to bunker. The master ordered the forward station to walk back the starboard chain further to about 10 meters in water and keep it ready for letting go. The charted depth at the anchoring position (01-10.4N, 103-42.3E) was 22 meters. The master ordered that the anchor be let go at 2154LT when the vessel arrived at the planned anchoring position, but the ship's speed was still 1.8 knots headway over the ground. The forward station kept opened the brakes because the cable was being paid intermittently, and the cable was paid out as weight came on the chain.

After five shackles, the cable started paying continuously and gained speed due to excessive headway. The crew at the forward station tried to tighten the brake, but the brakes could not be tightened quickly because the brake controlling wheel was very hard to operate. Shortly thereafter, the end of the chain was observed to be passing over the gypsy and going overboard through the hawse pipe. Fortunately, no injuries were reported.

The weather was fair, winds were easterly at 3 kts, and visibility was good.

[COMMENT]

You are kindly requested to remain mindful of the below points to avoid a similar accident.

Bitter end in the Chain Locker

- The ship's speed should be reduced enough before letting go the anchor.
- If the ship's speed is excessive for the anchoring operation, the anchor should not be let go.
- Brakes should be applied intermittently to keep the speed in check and thus ensure that the chain is paid out in a controlled manner.
- Brakes for the windlass, in addition to other movable parts, should be well maintained and free of rust.

7. Guideline for Safe Anchoring

7.1 Prior Anchoring

(1) Risk Assessment (RA)

Master shall carry out Risk Assessment based on existing and predicted weather conditions, duration of stay etc (as listed bellow). The RA shall be reviewed prior every anchoring operation and record result of review in an appropriate log.

a) Weather conditions, Direction and Strength of wind and current

b) Conditions affecting visibility, weather and currents

c) Anchoring location, Nature of sea bed, Location of lee-shore, shoals or hazards such as submarine cables and other obstacles

d) Depth of water at the anchorage

e) Anchor holding power

f) Condition of the hydraulic gear, windlass motor, anchor, cable and brake linings

g) Duration of expected stay

h) Maneuvering room for approach, Swinging room after anchoring

(2) Making Plan in advance

Approach and speed reduction plan shall be prepared prior arrival at the anchorage. Anchoring method and length of cable to be used shall be decided in advance, basis critical wind velocity.

(3) Pre-communication with Officers and the Company

It is recommended to discuss the result of the Risk Assessment and Master's anchoring plan, with Officers (BTM members) and the company if applicable, prior every anchoring and confirm that it is safe to anchor.

Following information shall be included;

a) Name of Port

b) Expected Date/Time of Anchoring and duration of stay at Anchorage

d) Prevailing Weather condition. Wind Direction/Force and Sea state

e) Weather forecast

f) Estimated depth of water

g) Vessel draft

h) Anchor holding factor calculation

i) Which Anchor and No of shackles expected to be used

j) Dropped by gravity or walked back

For the vessels which are managed NYKSM following procedure should be done.

Prior every anchoring the Master shall report the result of Risk Assessment to Vessel Manager by phone and shall discuss with the Vessel Manager and confirm that it is safe to anchor. In a situation when Master is requested to anchor at short notice due to change in schedule, emergency or other specific reasons where detailed RA may not be possible, master's discretion shall prevail. Vessel Manager shall be informed after anchoring.

(4) Calculate Maximum Anchoring Depth

Master should grasp the capacity (Liftable Load) of the windlass by referring to the Vessel's plans and the operation manual.

Master shall calculate the Maximum Anchoring Depth, basis Liftable Load of the windlass. This shall be done in order to ensure that the vessel's Windlass will be able to lift the weight of the anchor and cable, at the time of heaving anchor.

*Since nowadays there are high-spec windlasses available, which are capable of hoisting the entire anchor cable, each company shall determine the procedures and restrictions based on the equipment fitted on board.

In order to prevent incidents wherein the anchor and cable could not be heaved up in deep water, kindly refer to the following procedures;

a) As far as practicable, vessel's shall avoid anchoring in depths greater than the maximum Anchoring depth, based upon 80% of the Lifting Load of the Windlass

b) If no suitable location is available for anchoring, basis above, vessel shall anchor in depths not greater than the max. Anchoring depth, based upon 90% of the Lifting Load of the Windlass

c) If vessel is unable to comply with the above, Company shall be advised immediately

After calculation, following information shall be readily available on the bridge, for easy reference and as a reminder: (Please refer to attached sample placard)

- Maximum anchoring depth, based upon 80 % of the Liftable Load of the Windlass.
- Maximum anchoring depth, based upon 90 % of the Liftable Load of the Windlass.

SAMPLE

Maximum Anchoring Depth Guidelines & Calculation

As far as practicable, vessels shall avoid anchoring in depths greater than the Maximum Anchoring depth, calculated basis 80% of the Lifting Load of the Windlass.

Maximum Anchoring depth, based upon

80 % of the Liftable Load of the Windlass = 104.6 metres

90 % of the Liftable Load of the Windlass = 126.8 metres

Contact Vessel Manager immediately if vessel is unable to obtain suitable anchoring position with depth less than 126.8 metres
(basis 90 % of the Liftable Load of the Windlass)

(5) Entry of information on the relevant charts

Following Entries related to essential / useful information shall be made on the relevant charts (Paper and ECDIS) in order to share information among Bridge Team members and to enhance safe anchoring,

- Planned anchor position,
- Speed reduction plan, planned engine movements, target speed,
- Position to start Echo Sounder Recording
- Position to man forward stations
- Anchoring method and length of cable to be used, etc

7.2 Anchoring Operation

(1) Criteria of Anchoring Method (extract from SMS manual)

Master shall be guided by the following criteria and decide the anchoring method in advance.

a) Depth of the water is less than 25 meters:

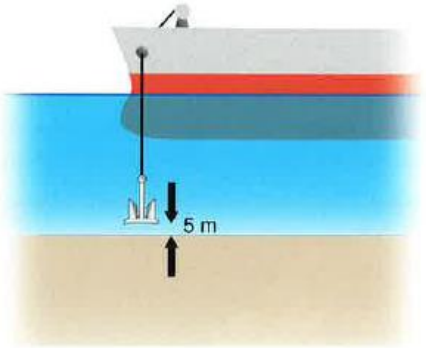
Walk back the anchor until it is "cock-bill" (hanging vertically just outside the hawse pipe) and then let it go

In case the hawse pipe is located at a height from the water level due to type of vessel or due to vessel being in light condition, Master should consider walking back the anchor until it is just above the water level, before letting go.

*Application of the brake for controlling cable speed after letting go the anchor shall be in accordance with (3) (4) mentioned below.

b) Depth of the water exceeds 25 meters and up to 50 meters:

Walk back the anchor under water close to the sea bottom (10 to 5 meters) and then let it go



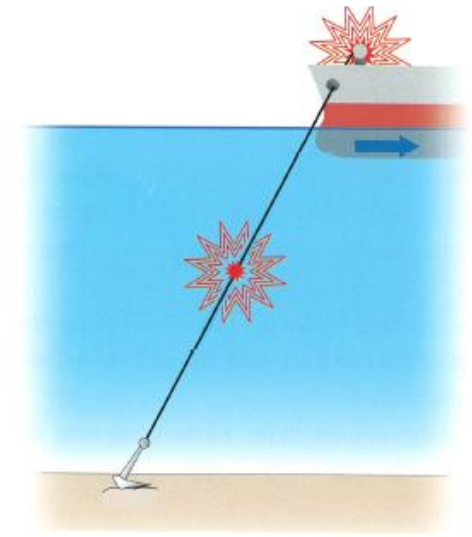
*Application of the brake for controlling cable speed after letting go the anchor shall be in accordance with (3) (4) mentioned below.

c) Depth of the water exceeds 50 meters:

Walk back the anchor until it reaches the sea bottom and pay out the anchor chain under power

In large ships, sternway over the ground should not exceed 0.5 knot after the anchor has been embedded in the bottom.

This is because if the ship's sternway is greater than the walk out speed of the cable, painting the cable or damage to the windlass may occur due to excessive strain on the cable.



(2) Ship's Speed

The ship's speed should be adequately reduced before letting go / walking back the anchor.

It is recommended to carry out anchoring using a single anchor while the vessel has a slight stern way (instead of head way). Astern engine shall be applied before dropping the anchor. The anchor shall be let go when the vessel is at almost stopped or going slightly astern.

When the cable is walked back, ship's speed shall be determined by taking into consideration the veering speed of the windlass.

Vessel shall maintain ship's speed within 0.1 to 0.5 knots over-the-ground taking into consideration depth of water, anchoring method, length of cable to be used and veering speed of windlass.

When strong wind or currents are encountered when anchoring, main engine shall be used (ahead or astern engine) as required to maintain ship's speed within above range.

(3) Control of the cable speed

While lowering the anchor, brakes should be applied intermittently to keep the speed in check and thus ensure that the cable is paid out in a controlled manner.

When the anchor is let go, it should be stopped by applying the brake after every 2 shackles are paid out and as far as practicable cable speed shall be less than one shackle per 5 seconds [330mtr/min] (This is an empirical figure which has been provided as a guidance for safe anchoring).

7.3 Anchor Watch

Maintain anchor watch as per company's procedures in SMS manual.

Master should instruct OOW criteria of anchoring condition and when to call Master, by written instructions.

Critical wind velocity for dragging anchor shall be calculated as per SMS ZZ-S-P-07.20.02 1.1.6 and result of the calculation shall be readily available on the bridge so that the OOW is able to refer to it at any time.

OOW shall keep a close watch for sudden changes in weather, signs of dragging anchor, signs of cable fouling and dangerous behavior of other ships in the vicinity. Master should immediately be informed when anything unusual is observed.

Type of ship		Critical wind velocity [m/sec]	Calculation conditions			
			Frontal area of windage [m²]	Anchor Type Weight	Anchor chain Dia. Weight	Others
Container (3800TEU)	Ballast	17	1108	AC-14 9.27 t	87mm 0.166 t/m	
	Full load	18	979			
Container (6300TEU)	Ballast	16	1620	AC-14 12.08 t	97mm 0.206 t/m	
	Full load	17	1490			
Bulk Carrier (200,000DWT)	Ballast	18	1207	AC-14 11.60 t	97mm 0.206 t/m	
	Full load	23	761			
PCC (6000RT)	Ballast	12	1060	AC-14 8.43 t	81mm 0.144 t/m	T=5×R
	Full load	13	980			
VLCC	Ballast	17	1875	AC-14 16.13 t	114mm 0.285 t/m	
	Full load	22	1125			
LNG Carrier (Moss type)	Ballast	15	1762	JIS 21.50 t	114mm 0.285 t/m	
	Full load	15	1684			

Fig. 1 : Critical wind velocity for dragging anchor for typical types of ships

In consideration of the above, if wind velocity is expected to reach the velocity shown in bellow table, the vessel should take action to avoid dragging, such as standing by its main engine and bow thruster, adjusting the ship's draft, enhancing the anchor watch, and escaping to a safe offing.

Vessel Type	Warning Wind Velocity Boding Dragging
PCC	Ave. 10 m/s
VLCC, Cape-size Bulker (Ballast)	Ave. 15 m/s
VLCC, Cape-size Bulker (Fully Loaded)	Ave. 20 m/s
Others	Ave. 15 m/s

(For reference only. Regardless of the above data, appropriate action should always be taken.)

7.4 Detecting Dragging Anchor

Anchor dragging occurs in two stages. It is important to make full use of the GPS, ECDIS, and radar to detect dragging in the first stage, "swing dragging."

A dragging anchor could lead to drifting and result in a vessel colliding, capsizing, or grounding. It is therefore important to detect a dragging as early as possible to quickly regain control of the vessel.

Anchor dragging occurs in following two stages.

- 1st Stage: Swing Dragging

  The swinging body of the vessel results in pressure on the vessel's lee side. This condition is indicated by the "B" section of Dia. 2. If the vessel can detect dragging at this stage, heaving up the anchor and regaining control of the vessel is relatively easy.

- 2nd Stage: Pressurized Dragging

  The ship's body is pushed by the wind, resulting in constant pressure on the vessel's lee side. This condition is indicated by the "C" section of Dia. 2.

Time is needed to heave up the anchor chain if the vessel detects dragging at this stage. In addition, in most of cases, maneuvering is difficult until the anchor is heaved up.

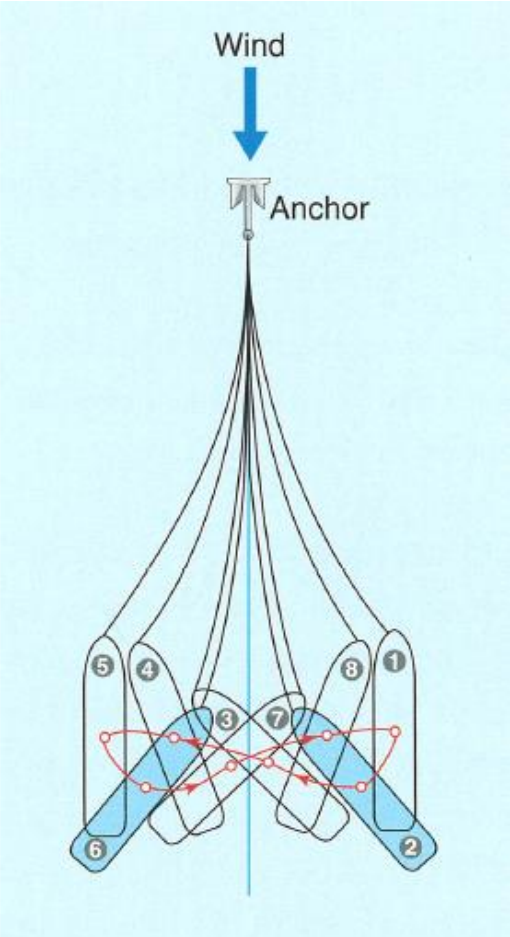
It is therefore important to detect a dragging as early as possible — i.e., the first stage — to quickly regain control of the vessel.

The common ways to detect a dragging anchor are as follows:

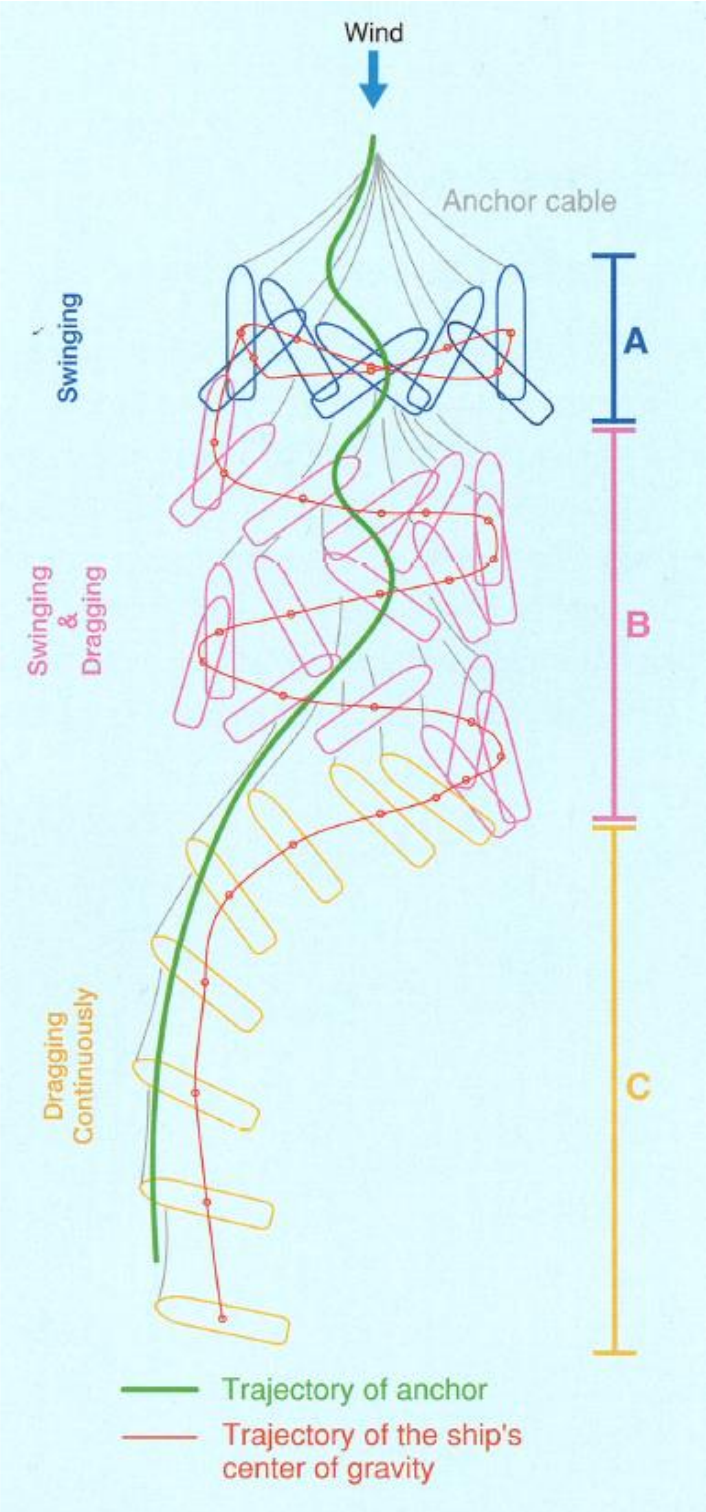
- The ship is not positioned where it should be inside the "Bridge Turning Circle". To check the speed OG by Doppler Log.
- The ship's heading is not directed windward. The anchor might be dragging when the Course Recorder stops drawing a steady sine curve.
- The ship is receiving wind from only the starboard side or the port side. The anchor might be dragging when the ship stops making steady swings and remains in one posture against the wind.
- Anchor cable remains tight even when the side of the ship receiving wind changes.
- Anchor cable has unusual vibration.

Even though these ways to detect dragging are widely known, it is difficult to use methods to detect dragging in the first stage because they normally appear in the second stage.

To detect dragging in the first stage, it is important to have an accurate understanding of the ship's position and grasp vessel movement through use of the GPS, ECDIS, and rader.



Dia.1 Swing Motion in Wind

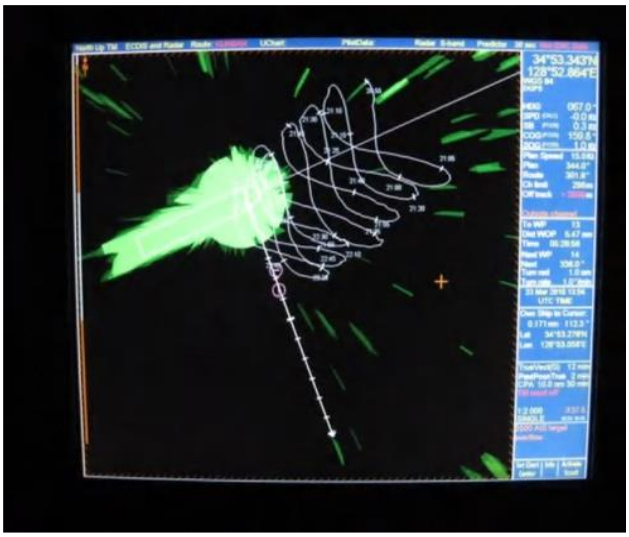


Dia.2 Stage of Anchor Dragging

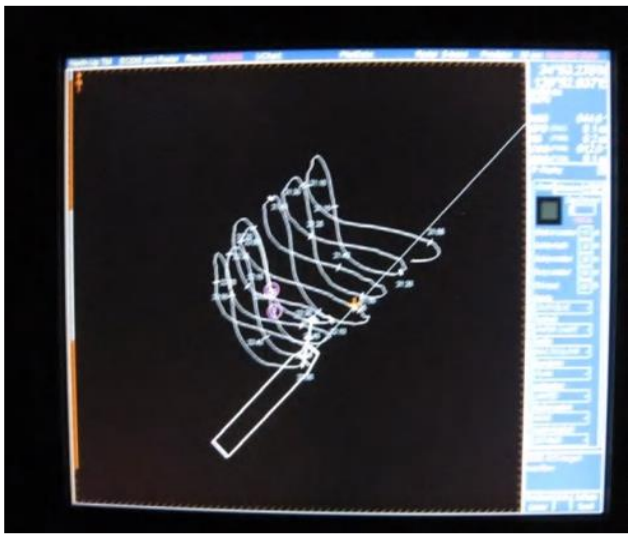
Dia. 3 shows a vessel's GPS track on radar while the PCC was dragging. We can easily identify the first stage of dragging.

Dia. 4 shows vessel's GPS track on ECDIS while the PCC was dragging. We can easily identify the first stage of dragging, as we did in Dia. 4.

To avoid a marine accident caused by dragging anchor, it is important to detect dragging during the first and take prompt action as early as possible.



Dia.3 GPS Track of Vessel Dragging Anchor (Radar)



Dia.4 GPS Track of Vessel Dragging Anchor (ECDIS)

7.5 Actions to be taken in case of Dragging Anchor

Under situations when cable is slipping or the anchor is dragging, Vessel shall review the situation. Consider paying out extra length of chain to avoid dragging or heave up anchor and drift at a safe location. At the time of anchoring, it is recommended that sufficient cable is available as reserve, which may be paid out later if deemed necessary.

Vessels with a large windage area (for eg. PCC) shall avoid paying out long lengths of cable, as it may not significantly prevent anchor from dragging and may pose additional risk of damage to machinery and equipment, if it is required to heave up anchor later.

When the Master detects signs of dragging anchor, the following countermeasures shall be taken (depending on the situation)

a) Paying out an extra length of cable.

b) Keeping the ship's head to the wind and easing tension on the cable by using the main engine, rudder and bow thruster (if applicable).

c) Consider shifting anchorage or drifting off shore.

7.6 Holding Power by Length of Anchor Chain veered out

We will now consider the holding power by length of anchor chain veered out. For the calculation of holding power, formulas shown in bellow are used.

To determine the length of the anchor chain veered out, the below formulas are commonly used.

① In normal weather : $L = 3D + 90m$

② In rough weather : $L = 4D + 145m$

(D: Depth(m), L: Deployed length of anchor chain (m))

Formula ① and ② are given in Japanese ship-handling booklets. A ship-handling booklet from the U.K. provided formula ③ below.

③ $L = 39 \times \sqrt{D}$ m

Bellow table shows the length of anchor chain veered out, calculated using formulas ①, ②, and ③ for a water depth of 30 m.

	① 3D+90 m	② 4D+145 m	③ 39x √D m
Meters	180 m	265 m	214 m
Shackles	Abt. 7ss (6.5ss)	Abt. 10ss (9.6ss)	Abt. 8ss (7.8ss)

Length of Anchor Chain Veered Out in Water Depth of 30 m

Bellow table shows the length of anchor chain veered out using formulas ① and ②, which are widely used in the NYK fleet.

And it shows that If an additional three shackles of anchor chain are veered out, the critical wind velocity increases by only 1 m/s. Thus, additional anchor chain increases holding power only slightly.

Type of Ship		①7ss	②10ss	Diff.
		[m/sec]	[m/sec]	[m/sec]
Container (3,800 TEUs)	Ballast	16.3	17.3	1.0
	Full Load	17.4	18.5	1.1
Container (6,300 TEUs)	Ballast	15.4	16.2	0.8
	Full Load	16.1	17.0	0.9
Bulk Carrier (200,000 DWT)	Ballast	17.5	18.5	1.0
	Full Load	22.3	23.7	1.4
PCC (6,000 RT)	Ballast	12.3	13.0	0.7
	Full Load	12.8	13.6	0.8
VLCC	Ballast	16.5	17.3	0.8
	Full Load	21.4	22.8	1.4
LNG Carrier (Moss Type)	Ballast	14.2	15.5	1.3
	Full Load	14.6	15.9	1.3

Comparison of Critical Wind Velocity at an Anchor Chain Length of 7ss and 10ss

7.7 Use of Second Anchor

There have been many reported cases of a vessel being unable to clear by itself a fouled anchor and of the hull being damaged by the anchor fluke when a fouled anchor is being cleared.

Both anchors would be lost if the vessel was using a second anchor and the anchors were slipping. It would then be difficult to take further action if two anchors were lost. Therefore, use of a second anchor is not recommended.

(1) Hammer lock

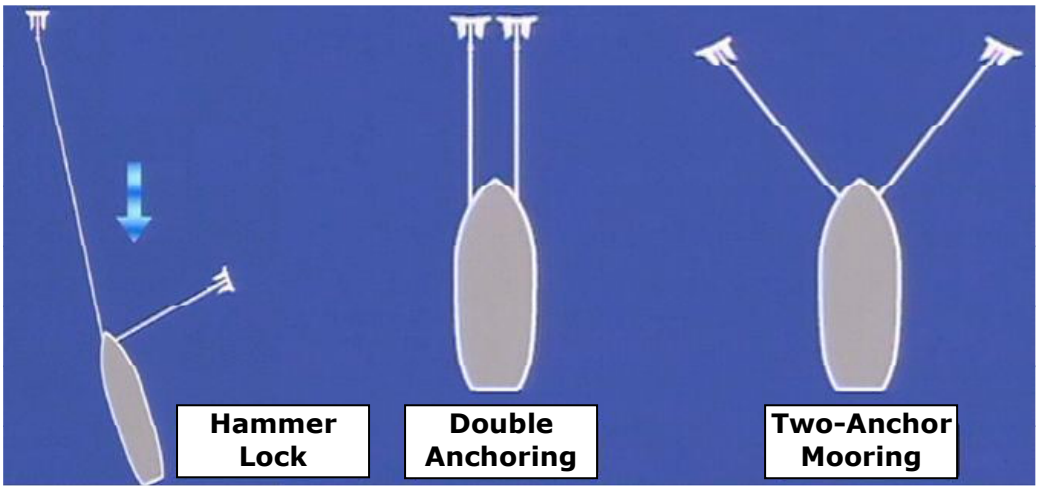
The second anchor is often used as a "hammer lock" to ensure the safety of single anchoring. The best way to use a hammer lock is for the vessel to drop two anchors and extend both anchor cables to a direction that matches the wind direction at the time when the maximum wind speed is predicted.

However, use of the second anchor is not recommended for the below reasons.

- There have been many reported cases in which a vessel has been unable to clear by itself a fouled anchor chain.
- There have been many reported cases in which the hull has been damaged by the anchor fluke while clearing a fouled anchor.
- Both anchors would be lost if the vessel was using a second anchor and the anchors were slipping. It would be difficult to take further action if two anchors were lost.

(2) Double anchoring / Two-anchor mooring

For large vessels, it would be very difficult to form the intended angle using two sets of anchor cables when the second anchor is dropped. In particular, if wind direction were to change, the risk of anchor cables becoming fouled would increase. Double anchoring / two-anchor mooring is thus recommended only for small vessels, which can more easily clear a fouled anchor, and is not recommended for large vessels.



8. Maintenance and Inspection

8.1 Windlass and Mooring Winch

(1) Maintenance

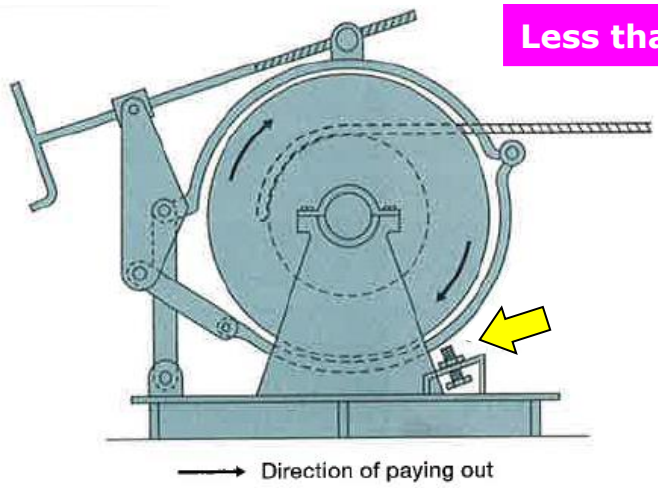
- Check all grease nipples on mooring equipment to ensure the nipples remain usable. It is a good idea to highlight these items in order to prevent them from being overlooked.
- Oil, moisture or heavy rust on the brake linings and the drums be checked as it reduces the brake holding capacity.
- The brake lining thickness should never be less than 9mm. Always check the wearing out state of the brake band, brake drum, and the hole and pin of the break link.
- Check the safety pin on winch clutch lever. Risk of causing the operational mistake of the winch due to the clutch lever not positioned appropriately. Safety pins should be kept with chains or wires connected to the lever.
- Apply the grease to the gears and bearing bushes of the windlass properly.

- Confirm that the working/operation area are not slippery and damaged
- Check the condition of Bollard, bitts and fair-leader and ensure that the fair-leader is working well
- Ensure that the strength, materials and shape of stoppers are appropriate
- Confirm that the mooring has a handling rope
- Adjust the brake band 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 due to lower by own weight.

  Proper clearance between the brake band and the bolt should be less than 2mm. If the clearance is much wider, only upper brake band will work by own weight even loosing the brake.

<How to adjust of brake band support>

1) Tighten Band brake to braking position.
2) Loosen lock nuts and support screws.
3) Tighten screws until they touch the band brake (clockwise).
4) Turn the screws back one turn (counter clockwise).
5) The clearance should now be 1-2mm, check.
6) Test opening function of brake. The band brake should be free from drum surface all way round.



(2) Cautions against the Cold latitudes

In winter, The icing of mooring equipment often invites the risk of injury and accidents. For prevention of risk following precaution should be taken.

In carrying out de-icing, the chief officer in charge of the task should pay sufficient attention protecting his assigned team against chill and slipping on the iced surface, among other things; keep good command of the team in the extremely cold environment; give appropriate orders at the right time; and endeavor for highly efficient work, while giving top priority to safety.

- When sailing in a cold area, always keep the brakes of mooring winches tightened. If the brake of any mooring winch is loose, water may permeate into the gap between the rim and the brake lining, and the freezing of the latter might deprive the mooring winch of braking power when the ship enters the port.
- Swinging out of hawsers in preparation for port entrance should not be done too early in cold waters. If hawsers swung out onto the upper deck in preparation for port entrance freeze and firmly stick to the deck surface, they will prove extremely difficult to handle. Also, hardened hawsers would obstruct smooth rope handling and expose personnel to risks both on board and on shore.
- Before entering after sailing cold waters, if the bridge wing is frozen, an anti-freezing agent should be applied with a view on preventing the pilot and the master from slipping and falling so that they can concentrate on their duties.

8.2 Brake testing of Mooring Winch

(1) General Instruction

For vessels fitted with undivided drums the brake holding capacity is affected by the number of layers of wires on the drum. It is therefore important that the operator of an undivided drum winch, knows the number of layers of wires on the drum that the manufacturer states will develop the design brake capacity. The brake of mooring winch is generally designed to hold the 80% of minimum breaking load of a specified mooring rope or wire, at its first layer on winch, which is specified to be used on the mooring winch. In practice the brake is adjusted to render the rope/wire at load equal to 60% of minimum breaking load of wire/rope. Therefore, Brake holding Capacity and Brake rendering capacity of winch are designed as 80% of MBL with the ability to adjust down to 60% of MBL of wire respectively. It could be expressed in Tonnes or in KN.

Vessels fitted with split drum winches should have the brakes set to hold a minimum of 60% of the minimum breaking load (MBL) of the rope on the first layer of the working drum.

Care must be taken to ensure that brakes are kept in good condition and clean. Oil, moisture or heavy rust on the brake linings or brake drum can reduce the holding capacity by up to 75%. A careful record shall be kept of all mooring equipment onboard. Each wire and rope must have a record when put into service and on which particular winch and when wires were end for end. Each rope tail must have an identification tag to indicate for which particular winch it is used for. The number of times each rope tail is used must be logged in order to affect the replacement date. Certificates must be available for all wire ropes, synthetic lines, links and tails.

(2) Brake Holding Test of Mooring Winch

The mooring winch brake shall be tested at least once in a year on Tankers & Gas Carriers and during every docking (2.5 years) on all other vessels (For the Tankers & Gas Carrier, As a rule it shall be tested in the month of April every calendar year, other than exceptional circumstances related to weather or operation).

In practice the brake is generally adjusted to render at the load equal to 60% of MBL of wire/rope designed to be used on the winch.

If over strength line is used on the winch, the rendering of the brake must not be altered from the original calculation.

Brake holding test on mooring winches should also be performed after any maintenance, modification and repair is carried out on mooring

winches e.g. after changing of brake lining and/or upon any evidence of premature brake slippage or related malfunctions.

(3) Procedure for Testing the Brake

The Brake Holding Capacity test kit comprises of various parts including hydraulic pump. The brake holding test shall be conducted as per the manufacturer's instruction.

The hydraulic jack pressure, for achieving equivalent brake rendering weight, should be carefully calculated for the first layer of the mooring winch.

All the safety precaution shall be taken while performing the test including following

a) The brake test should be conducted in fair weather when vessel is not rolling or pitching.

b) The job should be planned after holding meeting with Chief Engineer. The testing shall be conducted under the direct supervision of Chief Engineer.

c) The hydraulic pressure, which is to be applied by the pump for achieving equivalent weight of Brake Holding and Brake rendering loads, should be carefully calculated referring to manufacturer's instruction.

d) The location on deck, where hydraulic jack is planned to place, should be carefully examined for sufficient strength so as it could withstand the concentrated thrust of the hydraulic jack.

   Position of hydraulic jack on deck should be painted marking clearly, so as to place right position.

e) Confirm that brake lining and brake drum is free of rust and oil stain, presence of rust and oil may reduce the brake holding capacity of winch.

f) The excessive pressure shall not be applied by hydraulic pump as it could result in structural damage to winch.

g) During brake testing the pressure on the brake should apply slowly and to be build up gradually.

h) Fix up the test kit as per manufacturer instructions and apply the hydraulic pressure gradually to achieve the equivalent load of BHC.

i) If slippage of brake occurs at less than designated pressure brake should be tightened or repaired and jack pressure reapplied.

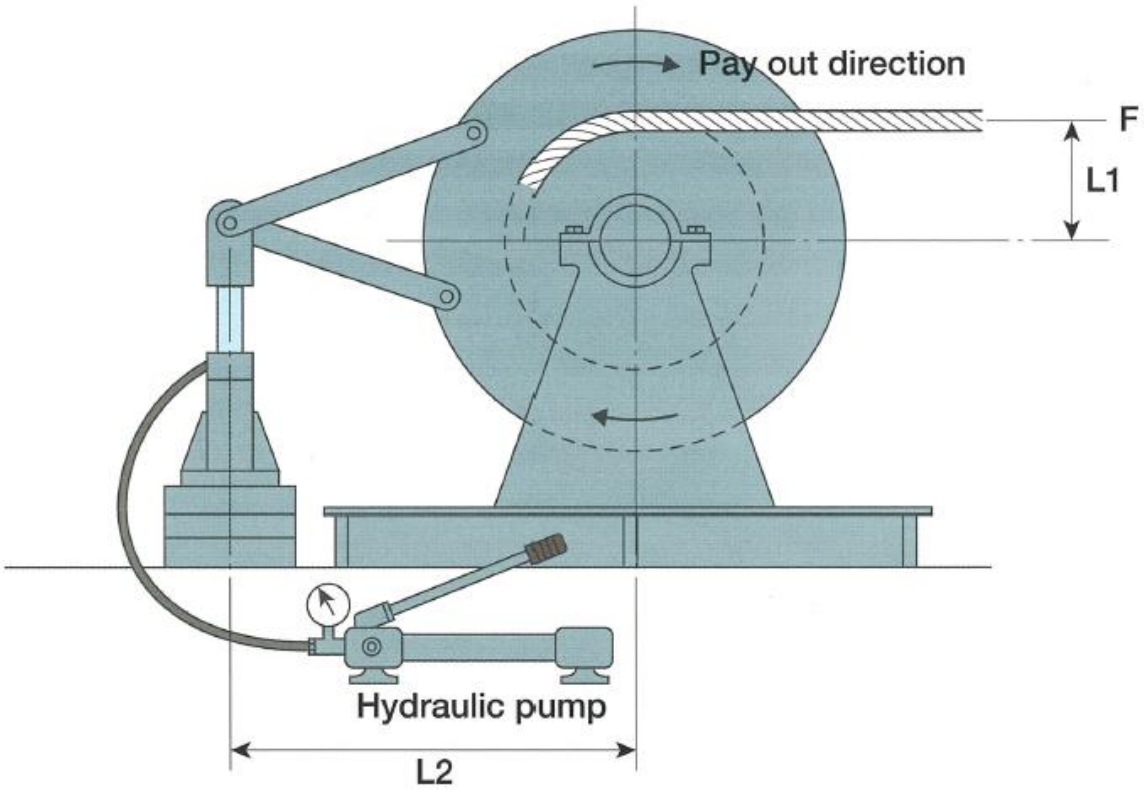
j) If brake slips at designated pressure the test gear shall be removed.

k) If slippage does not occur at the designated pressure, the brake setting should be adjusted and pressure reapplied so as the brake slips at the designated pressure.

l) Once brake are tested and calibrated, the proper setting should be recorded.

m) For further detail regarding brake testing, OCIMF publications Effective Moorings and Mooring Equipment Guidelines should be referred.

The record of the brake test shall be maintained in the format as provided by manufacturer otherwise the form shall be used to maintain operational record of the test . shall be used as sample for calculating the required pressure of hydraulic Jack.



As per maker, Brake force for 1 layer of rope (wire) on drum is given by

$$\text{Required Jack Force} = F \times \frac{L1}{L2}$$

8.3 Criteria for Changing End to End (Reversal) and Replacement

(1) Mooring Rope

All hawsers on board shall be changed end to end every 18 months. However, before discarding a rope, the following two criterions shall be taken into account.

(1) Hawser: All mooring hawsers shall be discarded after 5 years (on wood chip carrier after 4 years) from the date taken in use or even earlier if visible condition of hawsers is observed as described as follows.

(2) Tail rope: Ropes shall be replaced every 18 months. However, if safe usage is verified as follows then the tail rope may be used for a longer period. In any case the tails shall be replaced within 36 months.

(3) Visible Condition

The ropes shall be discarded if the following conditions are observed.

a) External abrasion and fusion:

If the diameter worn down more than 5% by external abrasion and fusion

b) Eye condition:

If significant abrasion or fusion has occurred to the eye

c) Cuts

(i) If 25% of the area of one or more strands are broken by cuts. Applicable to Eight Strand rope only (Example 1)

(ii) If 10% of the entire cover strands are broken by cuts. Applicable to Double braid only

d) Internal abrasion (Eight Strand rope only)

If the Internal abrasion has progressed to the extent that some yarns are worn out

e) Hockling (Eight Strand rope only)

f) Tight strands (Nylon Eight Strand rope only)

In case it is hard to insert a spike between strands of a Nylon eight rope, it is a sign to discard the rope as tight strands greatly reduce the structure's strength of the Nylon eight strand rope.

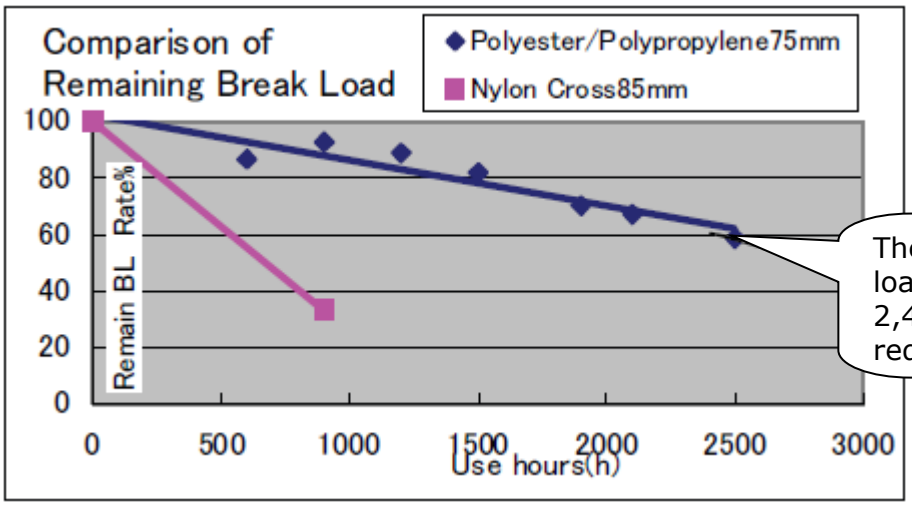
g) Broken core (Double braided only)

Example 1: Eight Rope1/4 cut

Example 2: Eight Rope1/2 cut

Reference Information

While berthing, the load of each mooring line must not exceed 50% of the breaking load of the mooring line (OCIMF-Mooring Equipment Guidelines). However, because regular usage gradually reduces the breaking load of mooring lines, it is necessary to consider the line's age when determining the reversal and replacement standard. For example, if 5,400RT class PCC uses new mooring rope made of mixed polyester / polypropylene yarn, the limit velocity of wind is 18m/sec, with a breaking load of 100% (840kN). But, when 2,400 hours of use have passed, the limit velocity of wind is down to 13m/sec, with a breaking load of 58% (496kN). Thus, when the reversal and replacement standards are made, it is necessary to consider the remaining breaking load of the mooring line like this.



The remaining breaking load is about 60% at 2,400hrs used. OCIMF requires more than 50%.

Result of remain BL Test

(2) Mooring Wire

If a wire develops a defect or deterioration, the wire shall be cut-off or replaced. In addition of Tanker and Gas Carriers, the maintenance schedule of mooring wires shall be carried out as follows;

(a) Mooring wire shall be turned end to end every 2.5 years.

(b) The mooring wires shall be renewed not exceeding 10 years from the date when taken in use.

(c) To facilitate renewal, the wire replacement shall be staggered.

8.4 Visible Condition Reference Tables

All ropes shall be inspected every three months to confirm the deterioration. Hawsers shall be laid out to its ordinary length of use and checked for the External abrasion / fusion, Eye condition and Cuts etc.

(1) The wear and tear level of the outside layer of yarn

Judging standard: Any case equivalent to the level 2 should be judged as meeting the standard for reversal or replacement.

Check the condition of the yarn, and determine which level corresponds to. Even though level 2 still has 55%～65% of the remaining breaking strength, it is desirable to make this condition for reversal or replacement,

＜The wear and tear level＞

Level	Condition	Picture
5	The outside layer of yarns is not broken. There is no wear and tear at all.	
4	The outside layer of yarns rubs, and there is a wear and tear.	

3	About ten yarns are broken.	
2	**The yarns of the 1/4 to 1/2 strand equivalent are broken.**	
1	The yarns of the 1/2 strand equivalent are broken.	

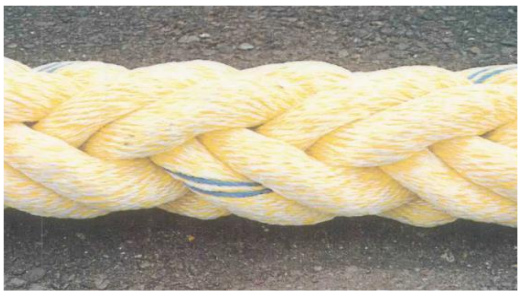
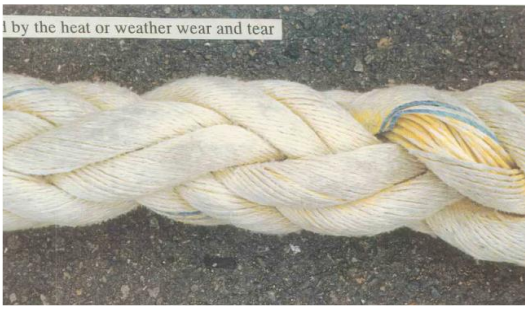
(2) Deterioration caused by the heat of weather or due to abrasion

Judging standard: Any case equivalent to level 1 should be judged as meeting the standard for reversal or replacement.

Check the condition of dissolution and discoloration by frictional heat.

Discoloration is an important standard for judging deterioration due to weather. Discoloration can be used to judge the effect of ultraviolet rays. Although deterioration also causes discoloration, the primary cause is ultraviolet light. Any case equivalent to level 1 should be judged as meeting the standards for reversal or replacement.

＜Deterioration caused by the heat or weather wear and tear＞

Level	Condition	Picture
5	The complete discoloration isn't seen, though the line looks slightly dirty.	
4	The yellow color has faded with the dirt a little.	
3	The yellow color has completely faded, and partial dissolution is seen due to the frictional heat and so on.	
2	The yellow color has almost completely faded, and serious dissolution due to frictional heat is seen.	
1	**The yellow color has completely faded, and the outside layer of yarn can be cut with a fingernail. Or, severe dissolution is seen.**	

8.5 Inspection and maintenance of Mooring Wires

(Reference : ZZ-S-P-10.30.05)

(1) Grease Up & Protection

Regular application of good quality wire rope grease will fulfill the purpose of corrosion prevention, weather protection and lubrication.

The wire on board shall be lubricated periodically. During maintenance following shall be followed.

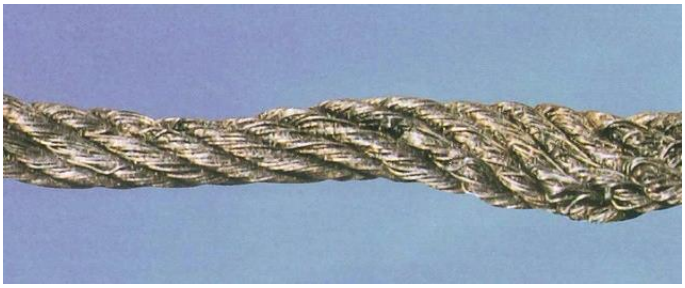
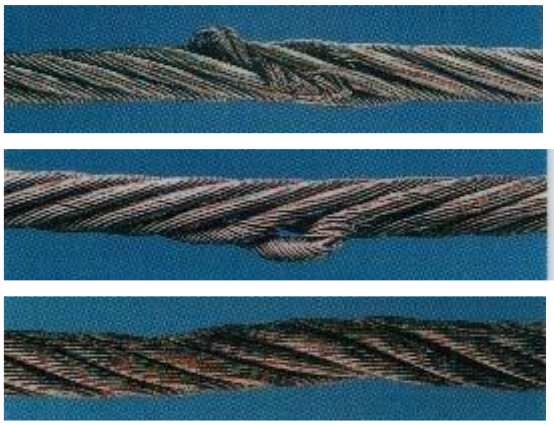
- The rusty parts on the wire shall be removed by wire brush or sand paper / emery paper.
- The wire shall never be allowed to dry. The wire shall be greased up using adequate grease as per vessel lubricating chart.
- The un-accessible part of the wire such as wire under the sheave, anchoring point etc, shall be paid careful attention while greasing.
- Wire Ropes which are stowed on drum, when not in use, shall be kept covered with canvas or other material to avoid exposure to the ultraviolet rays from sun.
- All the spare ropes and wires shall be stowed inside a store and shall be stored on wooden gratings to allow air circulation and encourage drainage.

(2) Criteria of prohibition of using and replacement

Standard Evaluation and Inspection of mooring wires shall be inspected every 3 months.

The wires must be cut-off or replaced, if the wire comes under any of following conditions. ("Cut-off" means removing the part which has the following conditions up to the end of the wire.)

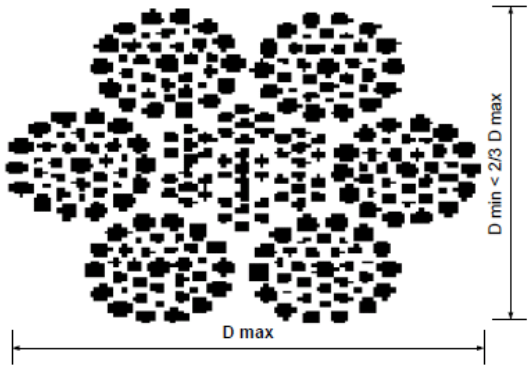
- ***Deterioration of Shape of Wire***

	
Collapse of shape, Collapse of Strand	Protrude of Core, Cave in, Protrude of Core

- ***Flattening Out and Bending***

  If wire rope has flattened out to the extent that minimum diameter of rope is less than 2/3 of maximum diameter of wire.

  If wire has developed permanent bent.

	
Dmin < 2/3 Dmax.	Remarkable Bending

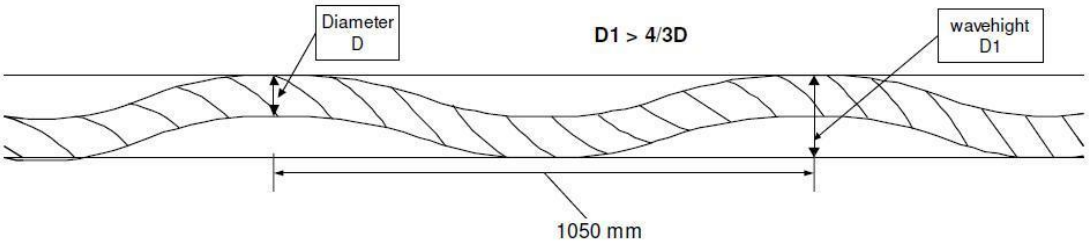
- ***Kink***

  If wire has developed a prominent kink as illustrated below

- ***Undulation***

  If Wave-height of undulation becomes more than 4/3D, within the length of 25xD of wire rope.

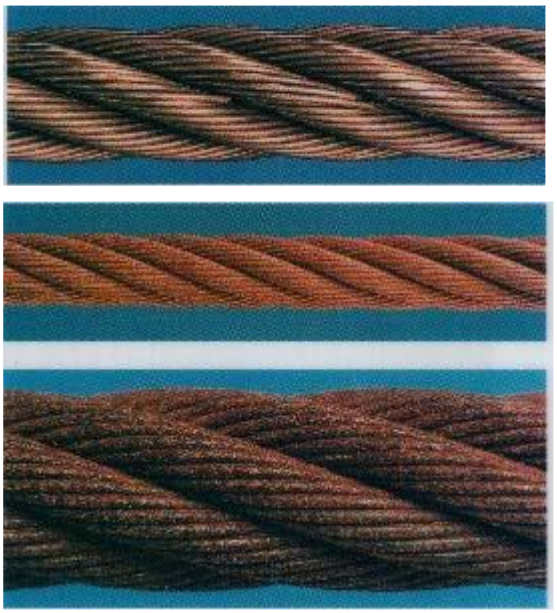
  Following illustration is showing 42mm diameter wire.



- ***Abrasion / Corrosion***

  If abrasion or corrosion of wire is as follows:

  - Reduction of diameter becomes more than 7% of its original diameter
  - Pockmark is existed on the wire face.
  - Strands are loosed due to hard corrosion



- ***Cuts***

  The wire shall be replaced if strands of wire exceed the condition as detailed below:

  - 10% of strand is cut in one ply (Lay).

  - 20% of strands in 5 plys.

  <Example>

  Ex. 6X37 wire

  Total number of Face layer; 222 strands

  10%=222X0.1=22 strands

  OR

  i.5%=222X0.05=11 strands