

Pilotage pre-planning guide

PART 4 – MOORING AND UNMOORING



DanPilot

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Your Time, Your Safety – Our Commitment



DanPilot
Pilotage pre-planning guide
Part 4 - Mooring and Unmooring

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Pilotage pre-planning guide from DanPilot

Part 4 - Mooring and Unmooring

Your Time, Your Safety – Our Commitment

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Foreword by our Chief Pilot

Dear Reader

Firstly, I wish to thank you for selecting DanPilot as your service provider, we are honored by the confidence vested in us.

By working with DanPilot for your transit pilotage through Danish waters, I wish to assure you that you are in the most capable hands at all times, and that the Pilot boarding your vessel is a highly skilled and experienced master mariner, with an in-depth knowledge of the areas you will be navigating together.

Danish waters can be tricky to navigate, and are subject to intense traffic, crossing ferries, low and variable draughts and strong currents. This is why the IMO officially recommends making use of a Pilot when navigating through Great Belt for any vessel with a draft of 11.0 m or more, or through Sound for tankers with a draft of 7.0 m or more. Fortunately, many vessels make use of a Pilot even with less draft than the IMO Recommendation, in order to ensure themselves and their cargo a safe and smooth transit through the Danish waters.

When boarding, the Pilot will bring along a “PPU” – Portable Pilot Unit – which is a state-of-the-art navigation solution, ensuring that your vessel will navigate through the optimal routing during transit. All our pilotages (more than 20.000 per year) are stored, and the data is used for further education of our Pilots and optimization of the routings through Danish waters.

To ensure that we are capable of meeting the ever rising demands, DanPilot are continuously investing in upgrading of our fully-owned fleet of pilot boats, and the coming years from 2017-2019 will see delivery of a large number of new pilot boats, designed with the purpose of delivering maximum performance year round, regardless of weather and location.

As a Not For Profit organization, owned fully by the Danish State, our mission is to safeguard the environment, and all vessels and crews passing through Danish waters.

Being the only pilotage provider in Denmark having obtained ISO 9001 certification for quality, DanPilot is your guarantee for the highest level of professional services, and strict adherence to regulations regarding training, certification and resting hours – all with the sole purpose of giving our customers the optimal safety.

It is my hope that you will be fully satisfied with the services rendered onboard your vessel by our Pilot, and I invite any comments at any time as well as any suggestions on how DanPilot can continue to improve our services towards you – our customer. Please feel free to contact me anytime.

Thanking you again for choosing DanPilot, and I remain,

Yours Sincerely

Brian Schmidt Nielsen
Chief Pilot, DanPilot
bsn@danpilot.dk





About DanPilot

Established more than 450 years ago, pilotage is an ancient profession in Danish waters. In the beginning, many small providers were present in the market, which were later merged to 3 separate companies.

In 2006, the remaining 3 companies were merged into one; DanPilot, and in June 2013 DanPilot assumed the responsibilities of the Danish State Pilotage Service as directed by the Act on DanPilot (Parliament Act no. 600 of 12 June 2013), DanPilot is an independent state-owned company, responsible for pilotage in all Danish waters and ports.

With the primary mission of safeguarding the environment, and ensuring safe passage for all vessels operating in Danish waters, DanPilot conducts more than 20.000 pilotages each year and is highly regarded by our customers for our expertise and service.

Currently serving more than 60 ports and transit pilotage through all Danish straits and waters, DanPilot is a dedicated full service provider, capable of delivering Pilot anywhere in Denmark on a short notice and at a competitive cost.

Our 170+ highly skilled and experienced marine Pilots are all master mariners with extensive experience from the international merchant fleet, backed with a solid knowledge of the local waters and ports, delivering the optimal safety and efficient

operation of your vessel. Our Pilots are continuously subjected to extensive training and knowledge sharing to ensure that we are always up-to-date on the latest information. In addition, we operate our own fleet of capable pilot vessels, making certain that we can deliver a Pilot anywhere at any time, regardless of weather and sea.

Always available 24/7/365, we are always at the ready to assist your vessel, whether for port pilotage or transit pilotage.

Due to the above, we are confident in our vision to be the most reliable pilot service in Europe, and to promise to you that

Your TIME, Your SAFETY – is Our COMMITMENT.

We look forward to serve you.

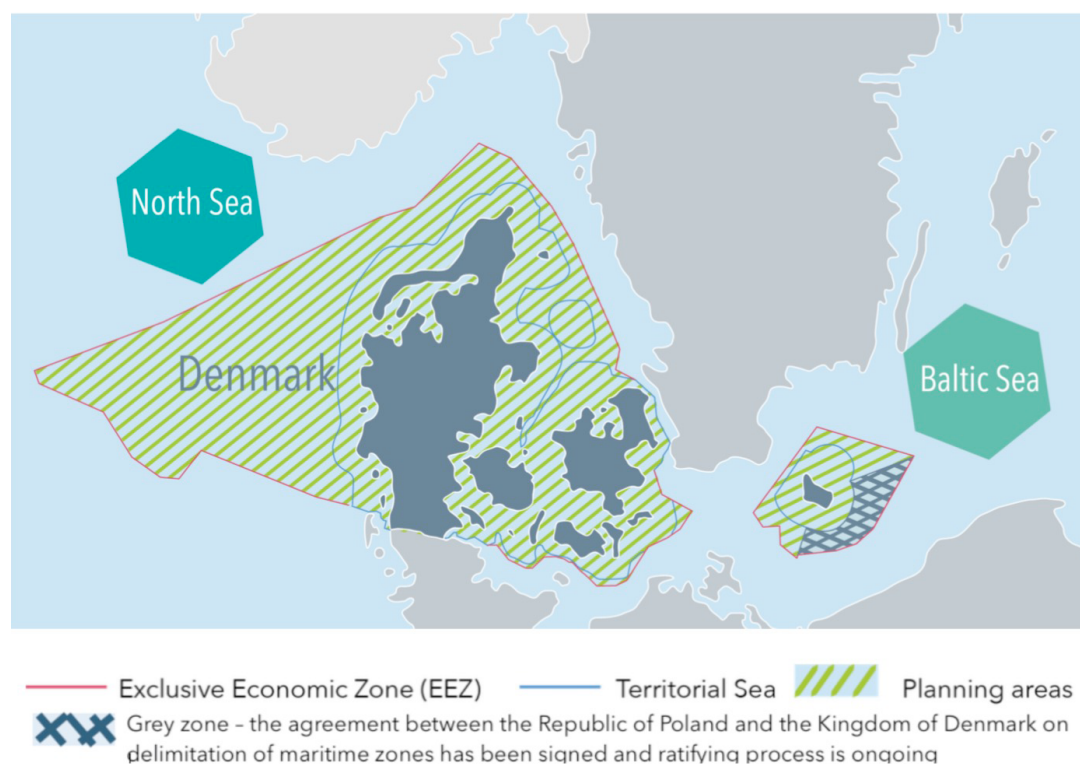


Figure 1. Danish maritime zones
Source: The European Maritime Spatial Planning Platform



1. Preface

With this guide, Danpilot wants to discuss various aspects of mooring operations seen from the perspective of the ship as well as the person ashore and in relation to the pilot's tasks during mooring, which include communication with external operators - in other words, all aspects of the mooring operation, the ship/quay/terminal, crew on board and mooring personnel ashore as a complete co-operation in connection with a mooring operation on arrival or departure from a given quay/terminal.

Despite improvement in material and training as well as technological progress, there are still many accidents in connection with mooring of ships, both on board and ashore. P and I clubs, insurance companies etc. describe this fact and it is therefore essential that pilot services/the pilots make an effort to be active within prevention of accidents during mooring operations.

The guide is primarily for internal use for port pilots, but it may also be used externally as inspiration for other interested parties. The guide should also be regarded as a guideline for the way in which we deal with the subject of "mooring" during pilotage operations, i.e. advice and recommendations for the master and crew and communication with mooring personnel on the quay/terminal.

The guide does not cover the entire subject of mooring since there are already a multitude of guides and material on the subject. Reference is made to all these

guides and regulations in the last section of this guide. OCIMF (Oil Companies International Marine Forum), P and I clubs, IMO and others have published comprehensive material on mooring. However, it should be mentioned that mooring operations are rarely seen as a combined operation where the ship/persons ashore carry out a joint task.

Quote from Foreword MEG4 Fourth Edition 2018, Steve Clinch MNM (MEG; Mooring Equipment guidelines, OCIMF)

“Each year many seafarers and terminals operators are injured, or worse, when mooring lines fail under tension. In the ten years between 2007 and 2016 the Marine Accident Investigation Branch (MAIB) received 37 such reports. In five years between 2009 and 2014, another major maritime nation recorded more than 90 accidents in its ports involving broken mooring lines, with two lives lost. That these statistics are reported by just two of the many maritime authorities around the world suggest a much larger problem, which has been reflected by recent extensive discussions within the industry and at the International Maritime Organization (IMO)”

Other guides

In addition to this guide, Danpilot has also prepared other guides, and reference is made to pre-planning guide I - Transit, and pre-planning guide II- Ports, which include a description of best practice for BRM, good communication and other mooring-related information.

The overall purpose of Danpilot's guide is 1) to establish a more uniform approach to the subjects and 2) to reduce the occurrence of damage/injury/accidents and dangerous situations. When we analyse damage to for example the ship/quay, which is fortunately a one-in-a-thousand occurrence compared to the number of operations, there are often many elements that may result in damage.

These may be more or less hidden, but it is important to keep an eye on the many rather vague elements that may be a contributing factor to damage at a later time.

Pre planning I - Transit^I

pre planning II - Harbour^{II}



2. Danpilot's recommendations for Danish ports/terminals

Danpilot's 12 recommendations for Danish ports/terminals.

- 1) Danpilot's recommendation for ports and terminals is to establish requirements to be fulfilled by subsuppliers such as companies involved in the mooring of ships. Danpilot's recommendation is that persons carrying out mooring work must, as a minimum, fulfil the requirements described in Ship/port interface Guidelines on minimum training and education for mooring personnel - FAL.6/Circ.11/Rev.1 -20 April 2016
- 2) Danpilot's recommendation for ports and terminals is also to prepare a matrix for the minimum number of linesmen required by the individual port call (based on the size of the ship). Several terminals have such a well-functioning and safe system/matrix.
- 3) Danpilot's recommendation for ports and terminals is also that mooring on arrival and departure must not be carried out by the ship's crew but must be carried out by persons ashore so as to avoid dangerous situations where crew members have to 'jump' onto the quay.
- 4) Danpilot's recommendation that the port/terminal always ensures that access routes to/from the mooring areas are cleared and clean and safely lit.

- 5) All mooring bollards and hooks/winchies must bear clear indication of SWL and be in a good state of maintenance and fully functional.
- 6) Fendering on the quays must be designed to withstand the forces by which the types of ships that come alongside the quay impact the quay structure and by which the ship is exposed from current/wind etc.
- 7) The port must state the maximum permitted speed by which the ship must come alongside the quay with indication of ship size etc.
- 8) Berth length must be designed for the type of ship to come alongside/depart from the quay and, where required, maximum limitations must be stated.
- 9) The water depths at the quays and basin must be taken regularly and the official water depths in the nautical chart must be correct and must be used as a basis for calculation of max. draught on arrival/departure.
- 10) Danpilot's recommendation for ports/terminals to notify Danpilot well ahead of time of all relevant information on the port/terminal of importance for a pilotage operation to/from a port and mooring of a ship to/from a port.
- 11) Danpilot's recommendation for Danish ports/terminals not to place mobile cranes or other equipment that may be "hit" at the positions to which the ships have to manoeuvre.
- 12) Danpilot's recommendation for Danish ports/terminals to install equipment for measuring weather conditions such as wind/force/direction and a current meter when this is relevant. Equipment should be accessible electronically with the possibility of extracting data.



3. Danpilot's recommendations for companies carrying out mooring work

- 1) Danpilot's recommendations for companies carrying out mooring operations are that all employees participating in mooring operations ashore and from mooring boat must be trained in working with mooring of ships and that there must be a training guide, training course and procedure description within this work area.
- 2) Danpilot's recommendation that all personal safety equipment for mooring personnel must always be in order during the operations.
- 3) Danpilot's recommendation that mooring personnel must at least fulfil IMO/ FAL.6/Circ.11/Rev.1 20 April 2016 Ship/port interface guidelines on minimum training and education for mooring personnel.
- 4) Danpilot's recommendation to mooring personnel/company to always report to the master/pilot if anything extraordinary is observed before, during and after a mooring operation.
- 5) Danpilot's recommendation that it must always be possible to communicate with the team of linesmen through VHF.



4. Pilot's task and considerations in connection with mooring tasks

During the mooring operation on departure or arrival, the pilot will often act as a liaison between the ship's master/bridge team and the people on the quay. It is therefore important that the pilot creates good communication between the ship's crew and the people on the quay. As in all other situations involving bridge team, an effort must be made to ensure that communication is based on the theory of 'closed loop communication' in order to minimise sources of error and misunderstanding of a given notification/order.

4.1 On arrival

Before coming alongside a quay/terminal, the pilot must review any rules and practices that apply when coming alongside the specific quay/terminal with the ship's master/bridge team. In Denmark, the ports are obliged to prepare rules applicable to the port. In addition to the mandatory rules, most major ports also have other information on the port and the quays.

4.2 After completion of pre-mooring

On board many vessels, it is common practice for the number of turns on the working drum to be adjusted after berthing. When berthing in areas subjected to currents, it is crucial that the moorings are adjusted individually to avoid vessel drifting from the berthing position. The pilot will advise special requirements for mooring line rat guards, fire wires etc. Likewise, the pilot will advise the bridge team of weather conditions, change in currents, tide and standby tugs (where applicable).

4.3 Master/pilot exchange (mooring/unmooring)

When carefully prepared, a mooring plan is an essential tool in the successful discussion of mooring works. The moorings of a ship must resist the forces due to some, or possibly all, of the following factors:

- Wind
- Current
- Tides
- Surges from passing ships
- Waves/swell
- Ice
- Changes in draft, trim or list.

Checklist of information to be discussed between master and pilot:

- Are the moorings rope or wire?
- Are all moorings on winches?
- Tension?
- Which manifold, hatch, port etc. is to be used for the cargo operations?
- Sequence
- Number of moorings simultaneously
- Timing
- Mooring line for throwing or mooring boat? (possibly messenger)
- Is the combination of loose moorings on winches permitted?
- Possible tension gauging ashore
- Problems with fenders on the quayside
 - Pilot to advise nature of quayside fendering

4.4 Danpilot General Recommendations on mooring

Moorings should be set symmetrically around the midship section of the vessel. The total number of spring and breast lines should be even, to ensure symmetry. Breast-lines must be set perpendicular to the longitudinal centreline to the extent possible, and as far fore and aft as possible. Spring lines must be set parallel to the longitudinal centreline to the extent possible. When making use of forehands on wire-type moorings, same type and size of forehands must be used on all moorings bearing load in the same direction. All moorings bearing load in the same direction should to the extent possible be of the same length, as elasticity is dependent on the length of the mooring, among other factors. All moorings must be tight while vessel is alongside – slack moorings may result in vessel movement and build-up of inertia, which will in turn affect the SWL of the moorings. It is recommended that all moorings used for mooring of a vessel are of the same material and construction. When alongside in ports where the moored vessel may be passed by other moving vessels, please note that suction from passing vessels may occur.

4.5 Risk assessment mooring – unmooring

Mooring is a high-risk task, which should be conducted in a calm and controlled manner. Prior to commencement of mooring, the master and the pilot should agree on the procedures to be employed to ensure a smooth and safe operation. Please refer to Seahealth Denmark (2013), Mooring – Do it safely, a guide to prevent accidents while mooring.^{III}

To the extent possible, mooring operations must be conducted in accordance with the guidelines set forth in “Mooring Equipment Guidelines, OCIMF Understanding mooring incident

Adapted from UK P&I Club’s Loss Prevention Bulletin January 2009:

Statistical evidence shows that in 53 per cent of all cases of personal injuries arising from mooring incidents, ropes (wire or fibre) have parted under load and personnel within ‘snap-back zones’ have been hit. In 42 per cent of cases, ropes/wires have not parted, but injuries have resulted from ropes jumping/slipping off drum ends or bitts, or personnel being caught or ‘dragged’ by ropes, fixtures coming off mountings and from other causes.

4.6 Prior to departure - Pilot should:

Agree with master the order in which the moorings should be cast off. Ensure adequate contact between Master and crew as well as mooring team ashore and terminal staff (where applicable).

Ensure contact to mooring team as well as mooring boat (where applicable). Inform mooring team of the order in which the moorings should be cast off. Ensure mooring team does not let go of any moorings until explicit instructions are given by the bridge of the vessel, even for moorings which are slack. Carefully monitor the tension on the remaining moorings when shortening the moorings when vessel is subjected to adverse currents and/or wind. Ensure that the moorings are shortened to allow the use of the vessel's propeller and thrusters (where available) when vessel is subjected to adverse currents and/or wind. This is of utmost importance. Ensure that adequate personnel are on standby ashore to manually release any automatic hooks in the event of equipment failure.

4.7 Danpilot's recommendations for linesmen

At DanPilot, we recommend that mooring personnel/linesmen are always hired for arrival and departure, regardless of the size of the vessel. Failure to meet this recommendation will result in the pilot issuing a DPR (Deviation From Pilotage Recommendation) to be signed by the master, certifying the decision to proceed against our recommendation. Further, DanPilot recommends that all mooring personnel/linesmen (and companies) should work according to the "Guidelines on minimum training and education for mooring personnel" as issued by IMO



5. Mooring in general

5.1 Types and designs of port areas

The design of port areas with respect to the tonnages calling on the individual port is of great importance for the safety and quality of the tasks. The ports in Denmark and also in other countries are often visited by ships with greater tonnages than what the port was actually built/intended for, which makes it even more vital that everyone involved in the arrival/departure of a ship knows exactly what to do and how to do it correctly.

The mooring operation depends greatly on the location of the port and its exposure to weather forces. Here are a few examples of port set-ups. Ports facing the open sea are particularly exposed. Quays located so that other ships pass by moored ships are also exposed to any suction from these passing ships.

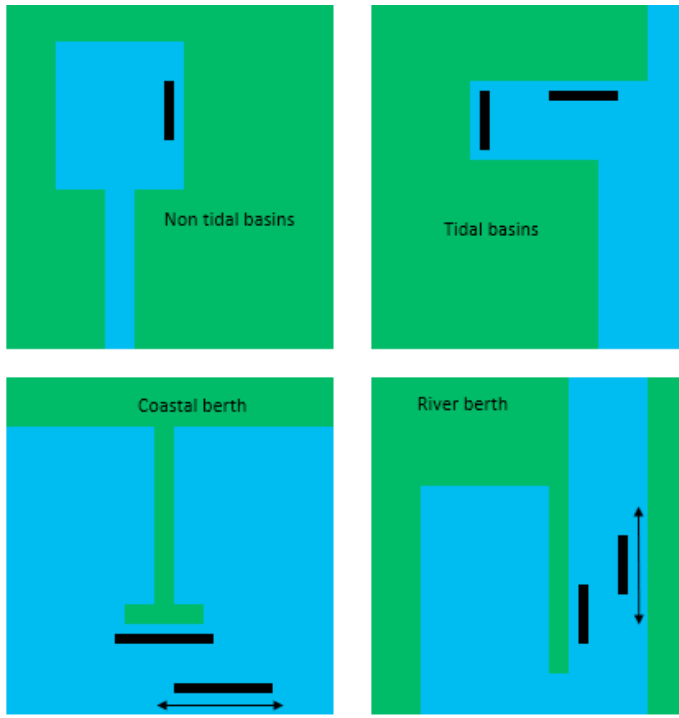


Figure 1 - Different types of port designs

5.2 Types and designs of quays

The types of quay are also very important, and their advantages and disadvantages should be known to masters/pilots/tugs/linesmen.

The current conditions in relation to the below examples of quays are markedly different, and it may be seen that the open structure and semi-closed structure are impacted by current in a very different way than the closed structure.

The following information should be available to ports and terminals via web access:

Wind direction

Wind force

Water level

Temperature

A current meter should also be available at ports where the current affects manoeuvring and mooring

(Wind direction)



113.5° (Sydøst)

(Wind speed)



Middel: 10 m/s / Max: 13.2 m/s

(Water level)



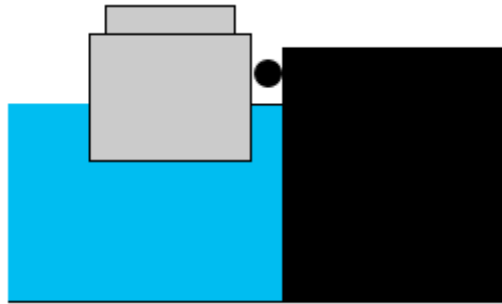
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(Temperature)

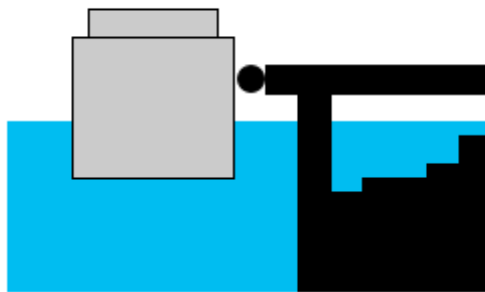


Luft: 1.9°C / Vand: 4.4°C

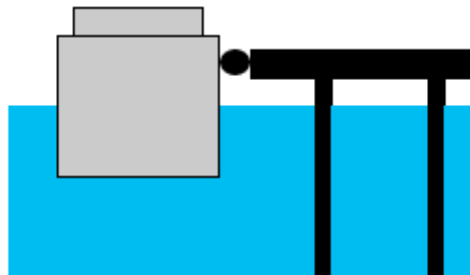
Figure 2 – Wind direction – Wind force – Water level – Temperature



Closed structure



Semi-Closed structure



Open structure

Figure 3 – Different types of quays

5.3 Tanker terminals

Reference is made to International Safety Guide for Oil Tankers and Terminals. It is comprehensive material on the safety of these terminals. In general, it may be said about oil terminals that they are described in detail with respect to mooring, ship sizes, fendering and SWL on hooks and winches. Furthermore, there are also drawings of mooring set-up for the respective ship sizes at a given quay. As a main rule, terminals require all persons with access to the terminal to attend a safety course specific for the Terminal.

5.3.1 Safety of moorings - Tankers

Any excessive movement, or the breaking adrift from the berth, of a tanker owing to inadequate moorings could cause severe damage to the jetty installations and the vessel. For all tankers above 16,000 tonnes deadweight intended for general worldwide trading, the mooring restraint available on board the ship as permanent equipment should satisfy the following conditions:

60 knots wind from any direction simultaneously with either:
3 knots current from directly ahead or astern (0 deg or 180 deg), or
2 knots current at 10 deg or 170 deg, or
0.75 knots current from the direction of maximum beam current loading.

The above criteria are intended to cover conditions that could readily be encountered on worldwide trade, but they cannot possibly cater for the most extreme combination of environmental conditions at every terminal. At exposed terminals, or those where for some reason the criteria are likely to be exceeded, the ship's mooring restraint should be supplemented with appropriate shore-based equipment.

Although responsibility for the adequate mooring of a tanker rests with the master, the terminal has an interest in ensuring that vessels are securely and safely moored. Cargo hoses or arms should not be connected until both the terminal representative and the master are satisfied that the ship is safely moored.

5.4 Types and design of fenders/bollards/hooks/winches on quays

5.4.1 Fender types

Cylindrical fenders
 Arch fenders
 Cell fenders
 Cone fenders
 Pneumatic
 Hydro-pneumatic fenders
 Foam elastomer fenders
 D fenders
 Square fenders
 Wing fenders
 Keyhole fenders
 Solid rubber fender
 Floating rubber fender

Energy to the fenders

The energy of the vessel when contacting the pier can be calculated with the following equation, and is proportional to the square of the speed of contact.

$$E = \frac{1}{2} W a V^2 C$$

E Contact energy (ton-m)
 W (displacement (tons) x Transverse additional mass *) coefficient (1.0 – 2.0)
 g Acceleration due to gravity (m/sec²)
 V Berthing Velocity (m/sec)
 C Energy diminution coefficient due to turning etc.

*) As a vessel makes contact with the berth and its movement is suddenly stopped by the fenders, the mass of water moving with the vessel adds to the energy possessed by the vessel. This is called “Mass Factor” and the weight of the water is generally called “Additional Weight”



Figure 4 – Showing the deflection of different fender types

Basic parameters of berth fenders are as follows:

- 1) reaction force as a function of deflection
- 2) energy absorption as a function of deflection
- 3) admissible deflection.

There are additional parameters:

- 1) fenders hardness
- 2) fender – ship hull area contact
- 3) ender dimensions (length, breadth, depth)
- 4) method of fixing to the berth.

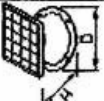
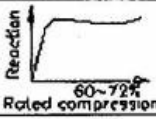
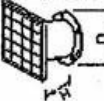
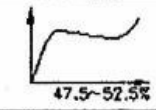
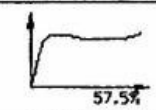
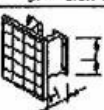
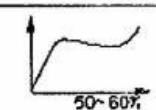
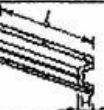
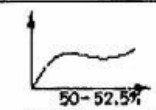
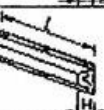
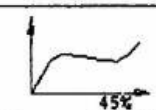
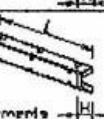
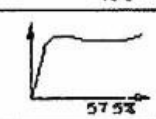
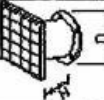
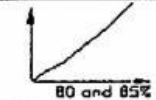
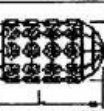
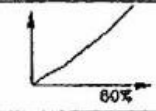
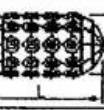
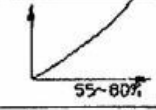
	Type	Fender shape	Sizes in mm	Reaction kN	Energy kNm	Performance curve
Backing type fender	Circular shape of the bucking fender with panel contact		D/H 500/300 ↓ 3200/2000	60 ↓ 4660	9 ↓ 4840	 Reaction 60~72% Rated compression
			D/H 650/400 ↓ 3350/3000	56 ↓ 5688	10 ↓ 6570	 47.5~52.5%
	Longitudinal shape of the bucking fender with panel contact		H/L 300/600 ↓ 1800/2000	66 ↓ 1708	9 ↓ 1260	 57.5%
			H/L 400/500 ↓ 2500/4000	140 ↓ 6900	22 ↓ 7000	 50~60%
	Bucking fender with direct contact		H/L 250/1000 ↓ 1000/2000	150 ↓ 2290	15 ↓ 940	 50~52.5%
			H/L 200/1000 ↓ 1300/3500	150 ↓ 3400	10 ↓ 1500	 45%
			H/L 300/600 ↓ 1000/2000	45 ↓ 646	6 ↓ 297	 57.5%
Pneumatic	Airblock		D/H 600/450 ↓ 3200/3200	138 ↓ 6210	15 ↓ 4990	 80 and 85%
	Pneumatic		O/L 500/1000 ↓ 4500/12000	50 ↓ 10570	4 ↓ 9080	 60%
	Foam filled		O/L 1000/1500 ↓ 3500/8000	200 ↓ 4050	41 ↓ 3000	 55~60%
Side loaded	Cylindrical		O/L 150/1000 ↓ 2800/5800	80 ↓ 6600	3 ↓ 5000	 50%

Figure 5 – different types of fenders and their energy absorption ability. Source: PIANC
 Different types of energy absorbing elastic deformation rubber unit. Source: PIANC

5.4.2 Examples of fenders

Single Cone



Dual Cone

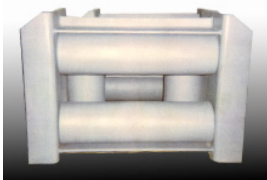


Cylindrical



5.4.3 Examples of ships bollard, Bits and rollers

Roller Chocks



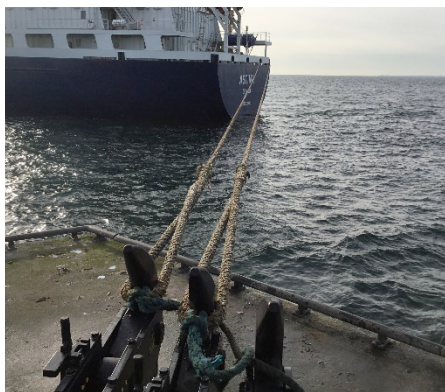
Panama chocks



Roller Fairleads



Hooks and winches ashore



Mooring points



Common bollard ashore



Types:

T head

Stag horn

Single Bitt

Double Bitt

Single Bitt 360°

Kidney

Tricorn

Cleats

5.5 Forces impacting the ship; wind, current and passing ships

The forces impacting the ship are wind and current and places where ships are alongside the quay and are passed by other ships at “small” distances. These also impact moored ships.

The wind impact depends on the wind force and the wind direction in relation to the total surface of the ship. This is called the ship's total wind area. Below are some theoretical and static examples. The current impact also depends on force and direction in relation to the ship/quay. Furthermore, the relationship between the water depth and the ship's actual draught is also a significant factor – the smaller the distance, the greater the force.

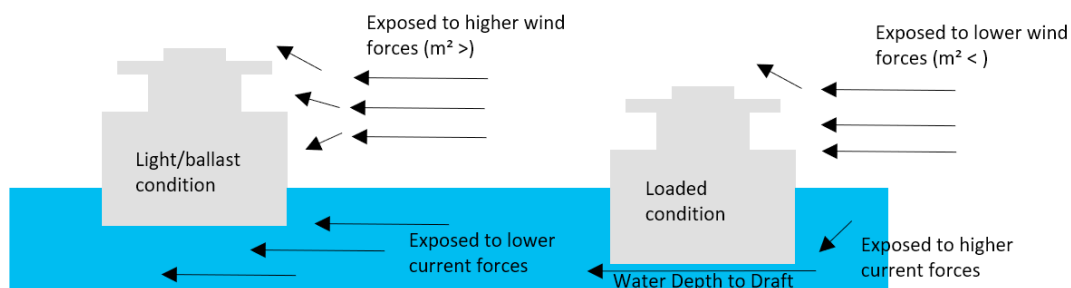


Figure 6 – Forces impacting the ship

The table below (figure 7) includes some 'rough' guidelines for impact caused by wind (60 knots and current 3 knots ahead or 0,75 knots abeam).

Summer dwt		Transverse Forces (ts)		Longitudinal Forces (ts)	
		Wind (ts)	Current (ts)	Wind (ts)	Current (ts)
18.000	Loaded	33	16	17	6
	Ballast	84	9	21	4
30.000	Loaded	50	42	23	16
	Ballast	112	21	26	9
70.000	Loaded	67	78	25	30
	Ballast	168	21	34	18
150.000	Loaded	98	107	34	42
	Ballast	213	29	46	23
300.000	Loaded	156	171	51	67
	Ballast	336	48	72	25
LNG Carrier	125.000 cbm	396	76	78	30

Wind 60 knots

Current 3 knots ahead or 0,75 kt abeam

Figure 7 – Impact caused by wind

The wind is stronger at altitude than on the surface of the water and increases logarithmically.

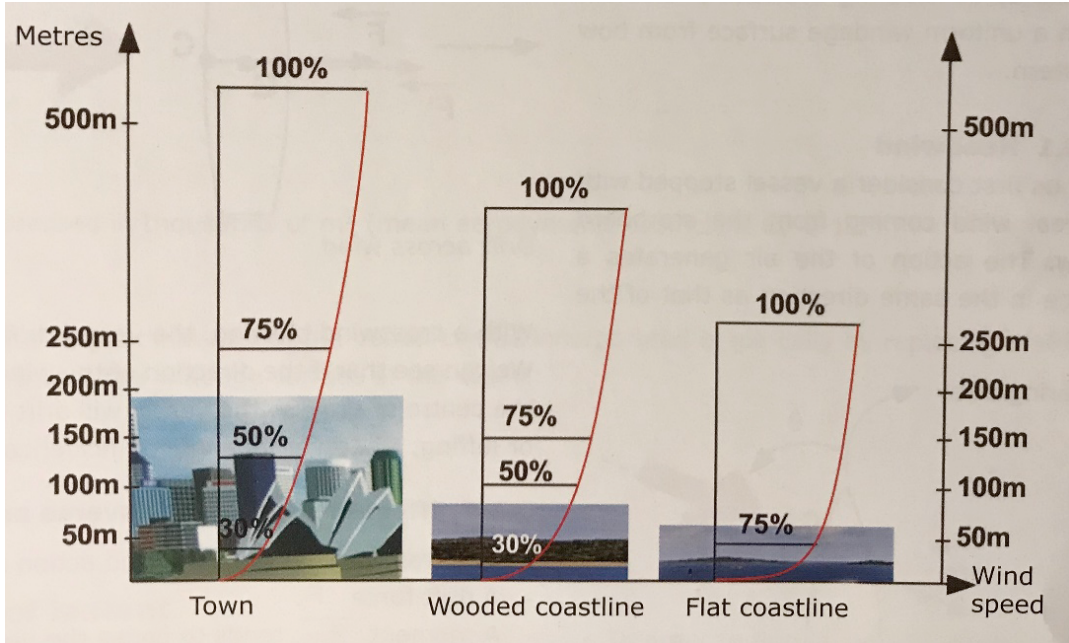


Figure 8 – Velocity of the wind as a function of the altitude and the relief

Of course, ports that are surrounded by buildings etc. have some protection with respect to wind impact – this correlation may be seen above in figure 8.

5.5.1 Example showing calculation of wind impact

The example is a ship lying still in the water with the wind coming right abeam. The ship has a total wind area of 6,000 m² and the wind speed is 15.4 m/sec. The total impact due to wind is 108 tons pressure (*highlighted in Figure 9*). In theory, this means that it would require 2 tugs of 54 tons each to prevent sideways movement of the ship. However, it also means that, for ships moored under the same conditions, the mooring lines would have to be able to withstand a total force of 108 tons.

		Wind area in sq m											
		1000	2000	4000	5000	6000	8000	9000	10000	12000	13000	14000	16000
m/sec	2,06	0,3	0,6	1,3	1,6	1,9	2,6	2,9	3,2	3,8	4,2	4,5	5,1
	5,14	2	4	8	10	12	16	18	20	24	26	28	32
	8,23	5,1	10,2	20,5	25,6	30,7	41	46,1	51,2	61,4	66,6	71,7	81
	10,3	8	16	32	40	48	64	72	80	96	104	112	128
	13,4	13,5	27	54,1	67,6	81,1	108	122	135	162	176	189	216
	15,4	18	36	72	90	108	144	162	180	216	234	252	288
	18,5	25,9	51,8	104	130	156	207	233	259	311	337	363	415
	20,6	32	64	128	160	192	256	288	320	384	416	448	512

Figure 9 – Examples of wind impact on a given wind area on a ship

Influence of Wind (Calculation)

$$K_{Wind} = k * A * V^2$$

K = Wind force in tonnes

k = Constant depending on the ship and direction of the wind

A = Windage area in sq.meters

V = Relative velocity of the wind in m/sec

Average k

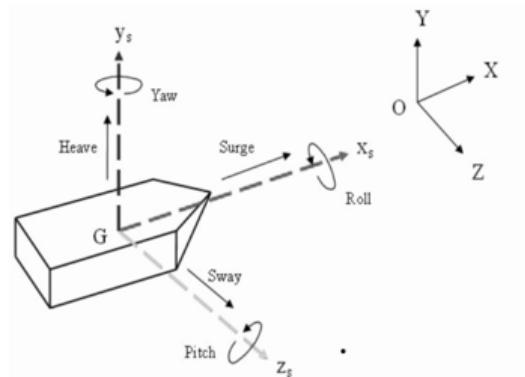
k = $0,52 * 10^{-4}$ for a beam wind and

k = $0,39 * 10^{-4}$ for a longitudinal wind

Example of % rising of wind effect from 8 m/sec to 11 m/sec

$8^2 = 64$ and $11^2 = 121 = 89\%$ increasing

Movement of the ship when the ship is along the quay, the moorings must withstand / keep the ship's possible movements. As you know, the ship can move in 6 directions.



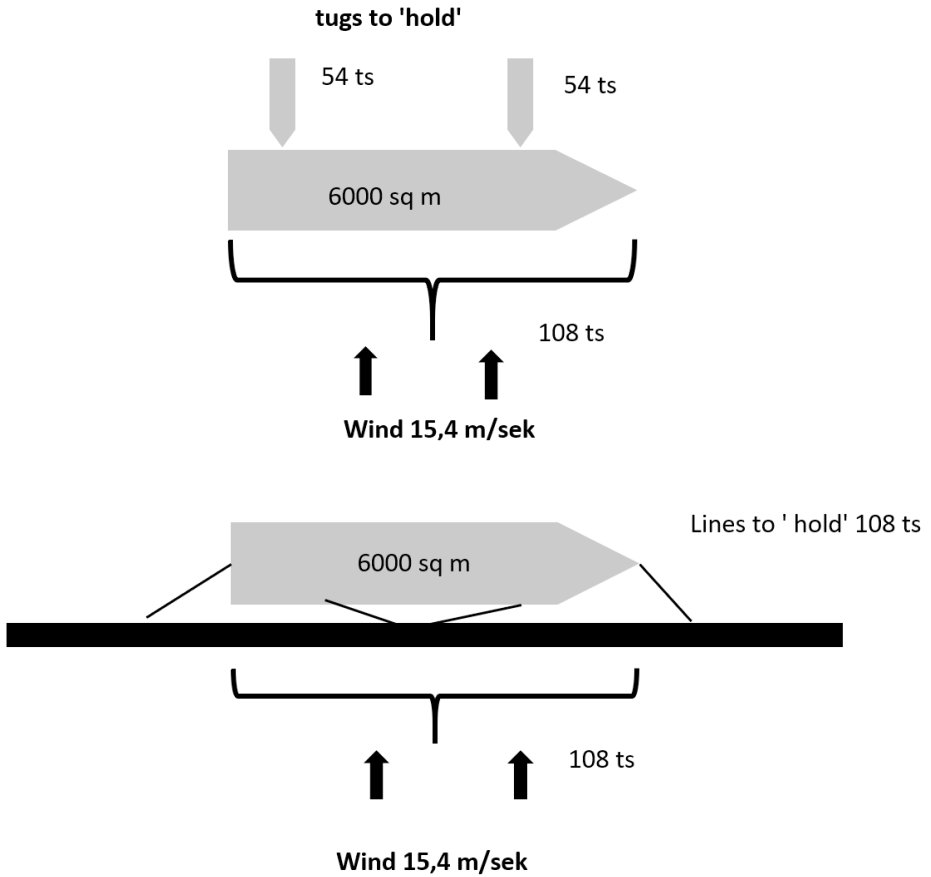


Figure 10 – Example of calculation of wind impact

5.5.2 Example showing the link between underkeel clearance and forces impacting the ship

The below illustration clearly shows the increased forces affecting the ship when the underkeel clearance (UKC) decreases:

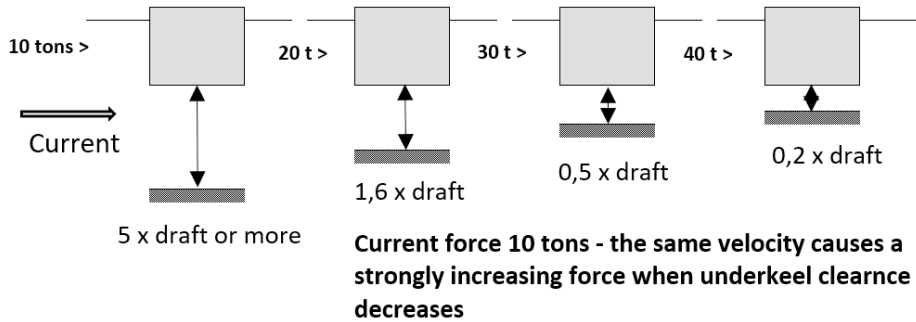


Figure 11 – Example of UKC's affect on the forces impacting the ship

5.5.3 General terms in connection with mooring

Some general terms on a ship that are important in connection with mooring

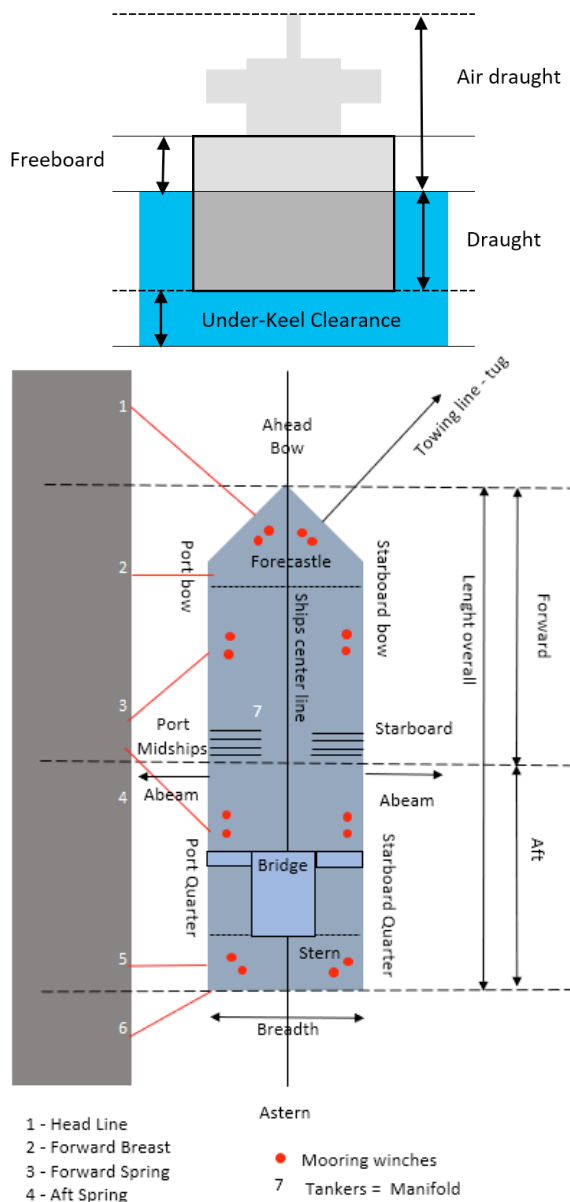


Figure 12 – Illustrative explanation of general terms

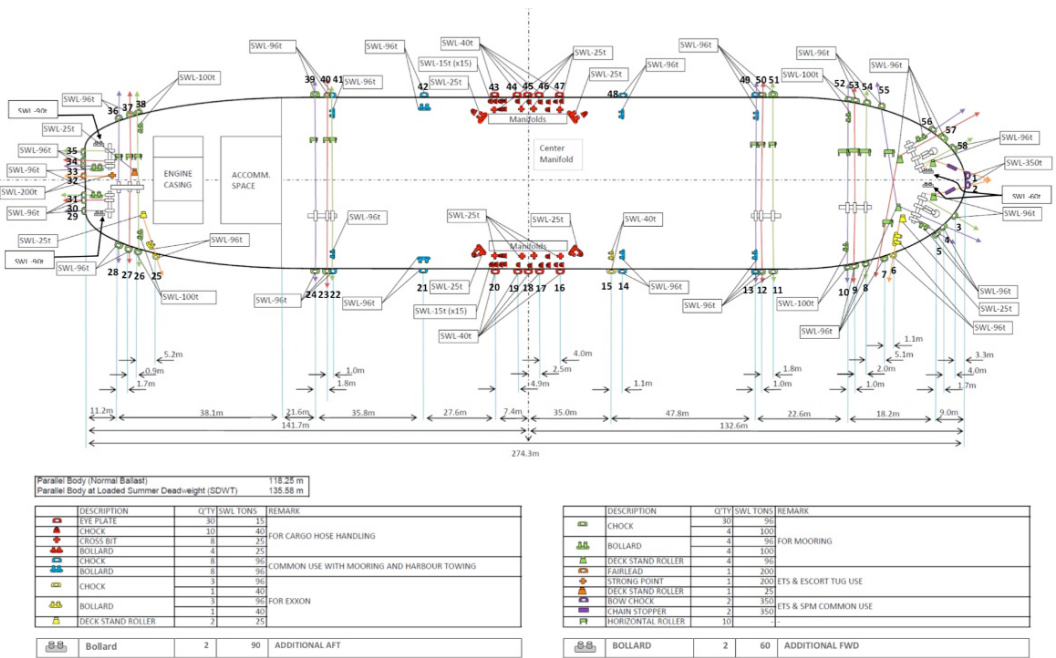


Figure 12a – Illustrative explanation of general term for a tanker mooring set-up

Mooring Equipment Guidelines (see video)^{IV}



5.6 Lines and wire / forces and elasticity

5.6.1 Different mooring materials

Figure 13 shows the minimum breaking load for different mooring types and other characteristics of the individual type of mooring material.

Characteristics of each kind of synthetic line, compared to steel wire with the same diameter

HMPE

High Modulus Polyethylene, Dynema, Spectra
Similar to steel for strength and stretch
Light, floats on water
Melting point 150°C

Aramid

Kevlar
75% as strong as steel wire
Heavier than HMPE and does not float
Melting point 425°C

Polyester

Dacron, Terylene
30% as strong as steel wire
Heavier than HMPE and does not float but is flexible and durable
Melting point 250°C

Polyolefin

30% as strong as steel wire
Light, floats on water
Melting point 170°C

Polyamide

Nylon
30% as strong as steel wire
Does not float, stretches more readily than other fibres
Melting point 215-250°C

Polypropylene

60% as strong as polyester
Floats, reasonably durable and cheap
Melting point 165°C

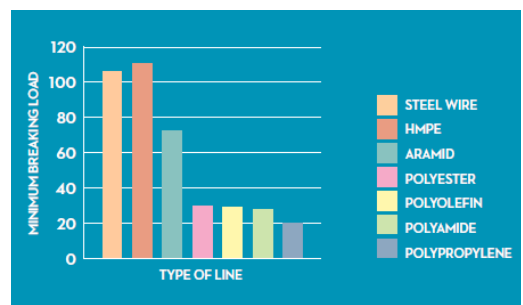


Figure 13 – Different mooring materials compared to steelwires – Source: Seahealth, Denmark

Wire and rope tail
(mooring tail)



5.6.2 The elasticity of mooring materials

Fig. 14 shows the elasticity (elongation) of the same mooring types as a function of minimum breaking load.

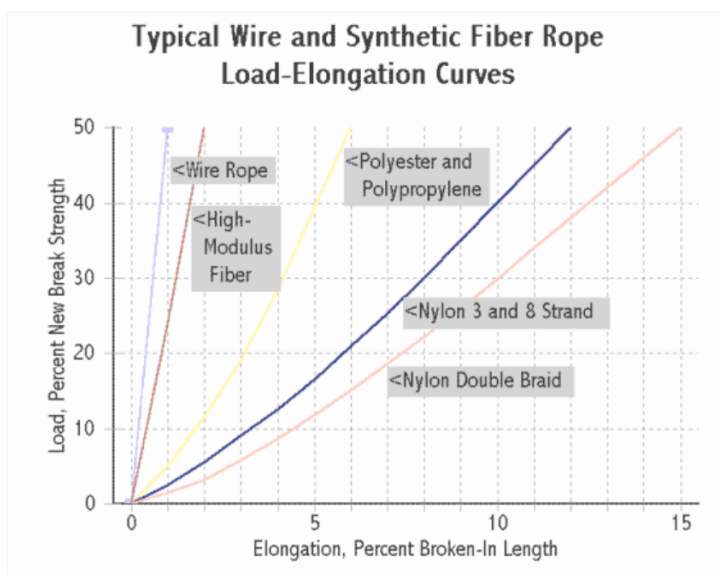


Figure 14 – Elasticity of mooring materials, Source: Seahealth, Denmark

Above examples is “new” lines and wire

Brand new 100%



Retaining Strength
approx 60%



Retaining strength
approx 85%



Retaining Strength
approx 50%



Retaining Strength
approx 70%



Retaining Strength
approx 45%



5.6.3 A detailed description of the characteristics of the mooring types

Synthetic fibres can have different properties:

- The density of the rope will determine if it sinks or stays afloat.
- The elasticity of the rope cannot be too large, but has to be large enough to be able to compensate for any dynamic forces on the ship.

The different synthetic mooring lines can be narrowed down to the following:

High Module Polyethylene

On a weight basis, the high-grade cables are five times stronger than steel cables and are also very stiff. They hardly creep and they are fire resistant. Other advantages are their light weight, easy handling and small backlash. However, these cables have low heat resistance and the price of HMPE is much higher than steel cables.

Polyamide

Also known as nylon will sink in water and will also absorb water-adding weight to the rope. This sinking might pose a problem as the rope could get entangled with a propeller. The absorbed water will reduce the MBF (Minimum Breaking Force, which is the force required for equipment failure) by 20%. Polyamide mooring lines also have large elasticity, which may result in a large backlash, which can be dangerous. The material does have high heat resistance, a low elongation and excellent strength-to-weight ratio.

Polyester

The mechanical characteristics resemble that of nylon rope, but it is more resistant to water. The density of polyester is relatively high, but the absorbing capacity is higher than that of polyamide lines. This will make it more suitable for absorbing large force variation. Also, it is very durable in both wet and dry conditions, which makes it quite expensive.

Steel cables

Steel cables are used where the circumstances allow or demand it, such as mooring wires for tankers and bulk carriers, towing wires for fishing and tugboats. The cable is strong, cheap, has little elongation under tension and has a high wear resistance. The disadvantages of steel cable are that they are heavy and will suffer from corrosion.

5.6.4 Abilities of the mooring materials

This table lists the ability of the mooring material to float or sink in the water.

MATERIAL SPECIFIC GRAVITY	Density	Floating
Polypropylene	0.91	yes
HMPE (Dyneema)	0.98	yes
Fresh Water	1	
Salt Water	1.03	
Nylon	1.14	no
Polyester	1.38	no
Vectran	1.41	no
Aramids (Technora, Twaron, Kevlar, Nomex)	1.44	no
Zylon	1.54	no
Steel	7.85	no

Figure 15 – Density and floating abilities of mooring materials

As is evident from the drawing below (Figure 16), it is very important to ensure that the correct number of mooring lines have been used to moor the ship and to be aware that both the vertical and the horizontal angles of the mooring lines affect the restraint capacity, i.e. what they are able to withstand.

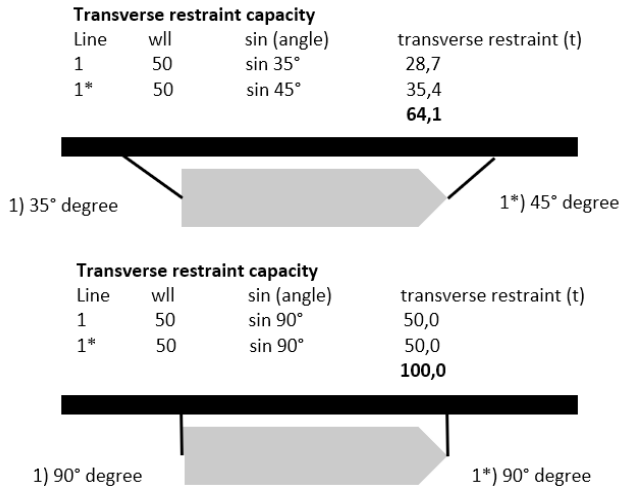


Figure 16 – Example of the importance of mooring angles

As in figure 16 - vertical and the horizontal angles of the mooring lines affect the restraint capacity, i.e. what they are able to withstand.

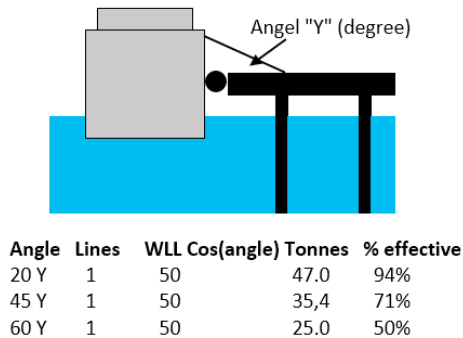


Figure 17 – Example of the link between mooring angle and efficiency

5.7 Ideal mooring

- 1 - Head line
- 2 - Stern line
- 3 - Brest lines(forward/aft)
- 4 - Spring line (forward/aft)



Brest lines provide the maximum transverse restraint and spring lines the maximum longitudinal restraint against vessel movement in athwart and in fore-aft direction, respectively. Head and stern lines are much less effective for these purposes. The applied mooring layout should follow these principles as far as possible with respect to the port facilities and as far as reasonable with respect to the vertical line angles.



Figure 18 – Efficiency of different lines

This mooring is based on a typical tanker terminal but the maximum angles that are recommended here may of course also be used for non-tanker terminal (not tankers). For ordinary quays, it will probably be very difficult to observe the following requirements. However, it is recommended that this is used as a good guideline for non-tanker terminals.

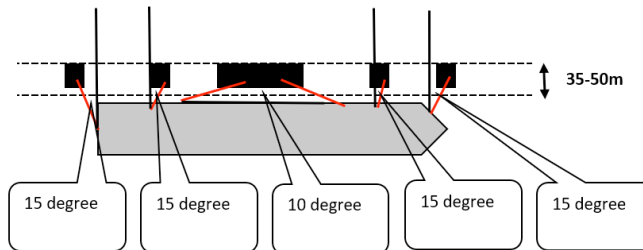
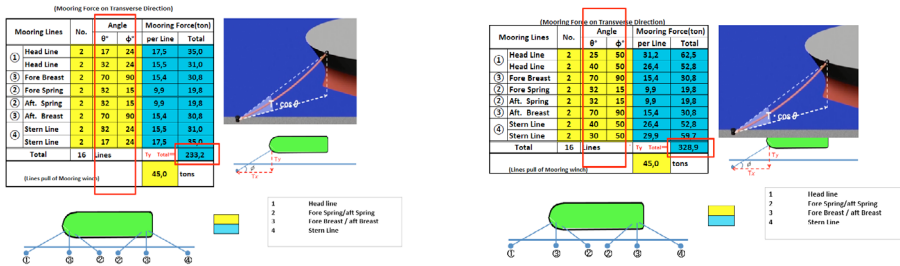


Figure 19 – Ideal angles for different lines

An example of the strength of mooring winch in tons on the different lines at different vertical and horizontal angles.



5.7.1 Agreement of mooring plan arrangement

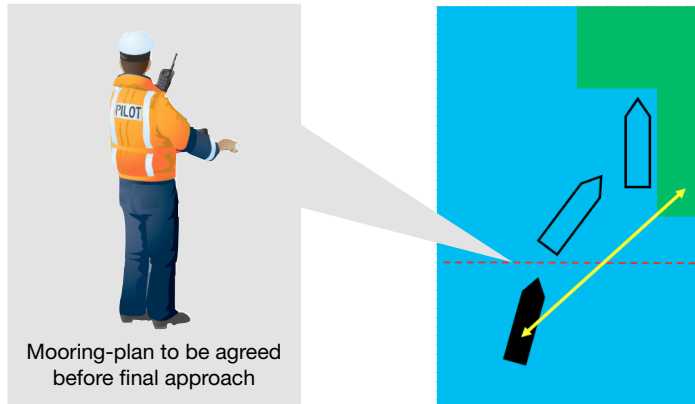


Figure 20 – An illustration of a mooring-plan

5.8 Modern mooring methods

Hydraulic berthing
Magnetic mooring
Pneumatic mooring

We are gradually seeing more types of equipment that have replaced mooring lines. Under references, we have included a random selection of these possibilities. In Danish ports, we have not yet seen any significant progress in this area but only a few ferry terminals that use such systems.

In Figure 21 below, the ship itself (the barge) has been provided with mooring equipment to replace the traditional lines/wire).

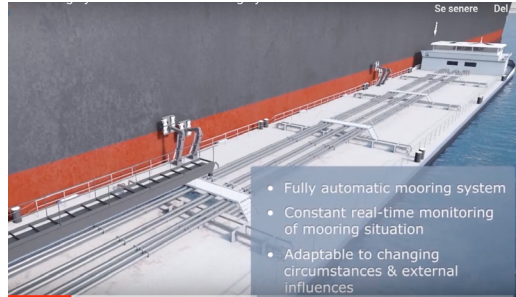


Figure 21 – Example of modern mooring



Figure 21a – Example of modern mooring. Ferry harbor Spodsbjerg, Denmark

Look under references regarding additional about new approaches technological approaches to mooring equipment.

5.9 Determination of the number of mooring lines

Equipment number

This "number" has been used for years for the class as a calculation basis for winches, anchors etc., but as it may be seen, IMO will now use this "number" as a basis for calculation of lines/wire in connection with mooring.

Number for anchors and chain cables

The equipment number is given by the formula:

$$EN = \Delta 2/3 + 2 BH + 0.1 A$$

Number of mooring lines

The total number of head, stern and breast lines should be taken as:

$$n = 8.3 \cdot 10^{-4} \cdot A1 + 6$$

For oil tankers, chemical tankers, bulk carriers and ore carriers the total number of head, stern and breast lines should be taken as:

$$n = 8.3 \cdot 10^{-4} \cdot A1 + 4$$

The total number of head, stern and breast lines should be rounded to the nearest whole number.

The total number of spring lines should be no less than:

two lines where $EN < 5,000$

four lines where $EN \geq 5,000$

As can be seen, the working group does not quite agree with OCIMF's new book MEG4 on designations, and the final outcome has been postponed to the next meeting of the IMO on the subject.

There is also news on "tow" vs. swl – see below. This is a subject that has been discussed countless times, but the ships continue to moor as they have always done – although it is incorrect and results in a much smaller indication of swl (now tow).

The below determination of the number of mooring lines is a minimum, and it is also evident from the below calculation of the number of mooring lines that the number of lines for example on a panmax is somewhat lower than the number of lines you would normally use to moor a ship of that size.

5.9.1 SOLAS determination of terms

The following is based on the "Revised SOLAS regulation II-1/3-8 and associated guidelines (MSC.1/CIRC.1175) and new guidelines for Safe mooring operations for all ships.

SDC 6/3 25 October 2018

Determination of terms:

Line Design Break Force (LDBF) means the minimum force at which a new, dry, spliced mooring line will break. This is for all synthetic cordage materials.

Ship Design Minimum Breaking Load (MBLSD) means the minimum breaking load of new, dry, mooring lines for which shipboard fittings and supporting hull structures are designed in order to meet mooring restraint requirements.

Working Load Limit (WLL) means the maximum load that a mooring line should be subjected to in operational service, calculated from the relevant environmental mooring restraint requirement.]

Towing and mooring arrangements plan means the plan as described in section 5 of the annex to the Revised guidance on shipboard towing and mooring equipment

Safe towing load (TOW)

TOW used for normal towing operations should not exceed 80% of the design load as given in 3.3.1 (1), and TOW used for other towing operations should not exceed [80% of] the design load as given in 3.3.1 (2). For fittings used for both normal and other towing operations, the greater of the safe towing loads should be used.

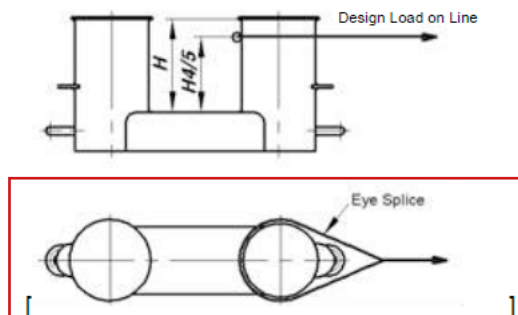


Figure 22 How to determine the acting point

5.9.2 DNV's guideline on the subject

DNV – on the subject^V

5.9.3 Calculating the EN number ^{VI}

Calculation of EN (video)^{VII}

The Group could not reach an agreement on the requirement for training of shore-based mooring personnel, i.e. paragraph 3.1.3, and put the text which makes reference to the FAL ^{VIII} circular in square brackets^{IX}.

Appendix B

Equipment number

The equipment number (EN) should be calculated as follows:

$$EN = \Delta/3 + 2.0hB + A/10$$

where:

Δ = Moulded displacement, in t, to the Summer Load Waterline.

B = Moulded breadth, in m.

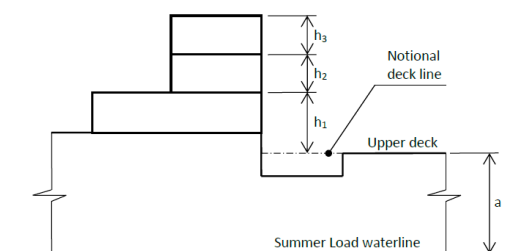
h = Effective height, in m, from the Summer Load Waterline to the top of the uppermost house; for the lowest tier 'h' should be measured at centreline from the upper deck or from a notional deck line where there is local discontinuity in the upper deck, see figure below for an example.

a = Distance, in m, from the Summer Load Waterline amidships to the upper deck.

h_i = Height, in m, on the centreline of each tier of houses having a breadth greater than $B/4$.

A = Side-projected area, in m^2 , of the hull, superstructures and houses above the Summer

Load Waterline which are within the equipment length of the ship and also have a breadth greater than $B/4$.



NOTES:

1. When calculating h , sheer and trim should be ignored, i.e. h is the sum of free-board amidships plus the height (at centreline) of each tier of houses having a breadth greater than $B/4$.
2. If a house having a breadth greater than $B/4$ is above a house with a breadth of $B/4$ or less, then the wide house should be included but the narrow house ignored.
3. Screens or bulwarks 1.5 m or more in height should be regarded as parts of houses when determining h and A . The height of the hatch coamings and that of any deck cargo, such as containers, may be disregarded when determining h and A . With regard to determining A , when a bulwark is more than 1.5 m high, the area shown below as A_2 should be included in A .

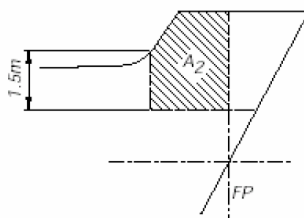


Figure 23 – explanation of different variables

4. The equipment length of the ships is the length between perpendiculars but should not be less than 96% nor greater than 97% of the extreme length on the Summer Waterline (measured from the forward end of the waterline).

5.9.4 Example of calculation for a panmax

1. Principal Particulars

Rule length (L) = 216.362*) m : is defined as: Rules Breadth moulded (B) = 32.2 m
 Depth moulded (D) = 20.9 m Summer draft moulded (Ts) = 13.8 m Moulded displacement at 13.8 m draft (Δ) = 83,957 T (= 81,909 x 1.025)

*) lpp

2. Calculation of "H"

$a = D - Ts = 20.9 - 13.8 = 7.1$ m $\Sigma hi = 2.9 + 2.8 \times 4 = 14.4$ m (heights of accommodation decks) $H = a + \Sigma hi = 7.1 + 14.1$

$H = 21.2$ m

3. Calculation of "A"

Main Hull = $216.362 \times 7.1 = 1,536.17$ sq.m On Upper Deck = $15.2 \times 2.9 = 44.08$ sq.m On A-Deck = $24.8 \times 2.8 = 69.44$ sq.m On B-Deck = $15.2 \times 2.8 = 42.56$ sq.m On C-Deck = $15.2 \times 2.8 = 42.56$ sq.m Nav.Deck = $14.8 \times 2.8 = 41.44$ sq.m Engine casing (upper) = $8.4 \times 2.9 = 24.36$ sq.m Engine casing (B) = $7.2 \times 3.9 = 28.08$ sq.m
 Total of "A" = 1,828.69 sq.m

4. Calculation of Equipment Number

$\Delta^{(2/3)} = (83,957)^{(2/3)} = 1,917.4$ 2 B H = $2 \times 32.2 \times 21.2 = 1,365.3$ 0.1 A = $0.1 \times 1,828.69 = 182.9$

Equipment Number EN = $\Delta^{(2/3)} + 2 B H + 0.1 A = 1,917.4 + 1,365.3 + 182.9$
 $EN = 3.465,6$

1. Principal Particulars

Breadth moulded (B) = 32,

Breadth moulded (B) = 32,2m

Summer draft moulded (Ts)

Summer draft moulded (Ts) = 13,8

*Moulded displacement at 13,8m draft (Δ) = 83,957T (= 81,909 * 1,025)*

2. Calculation of "H"

$$\begin{aligned} a &= D - Ts \\ &= 20,9 - 13,8 \\ &= 7,1m \end{aligned}$$

$$\sum h_i = 2,9 + (2,8 * 4) = 14,4 (\text{heights of accommodation decks})$$

$$\begin{aligned} H &= a + \sum h_i \\ &= 20,9 - 13,8 \\ &= 21,5m \end{aligned}$$

3. Calculation of "A"

$$\text{Upper deck} = 15,2 * 2,9 = 44,08m^2$$

$$\text{Upper deck} = 15,2 * 2,9 = 44,08m^2$$

$$\text{On B - deck} = 15,2 * 2,8 = 42,56m^2$$

$$\text{On B - deck} = 15,2 * 2,8 = 42,56m^2$$

$$\text{Nav. deck} = 14,8 * 2,8 = 41,44m^2$$

$$\text{Nav. deck} = 14,8 * 2,8 = 41,44m^2$$

$$\text{Engine casing (B)} = 7,2 * 3,9 = 28,08m^2$$

$$\text{Engine casing (B)} = 7,2 * 3,9 = 28,08m^2$$

$$\sum m^2 = 1.828,69m^2$$

4. Calculation of Equipment Number

$$\begin{aligned} EN &= \Delta^{\frac{2}{3}} + 2hB + \frac{A}{10} \\ &= 83,957^{\frac{2}{3}} + (2 * 32.3 * 21.2) + \frac{1.828,69}{10} \end{aligned}$$

Equipment Number lies between 3.400 and 3.599

Equipment letter: P

Equipment number	Equipment letter	Stockless bower anchors		Stud-link chain cables				Towline (guidance)		Mooring lines ¹⁾ (guidance)		
		Number	Mass per anchor kg	Total length	Diameter and steel grade			Steel or fibre ropes		Steel or fibre ropes		
				m	VL K1 mm	VL K2 mm	VL K3 mm	Minimum length m	Minimum breaking strength kN	Number	Length of each m	Minimum breaking strength kN
1390 to 1479	B	2	4320	550	66	58	50	200	836	4	180	324
1480 to 1569	C	2	4590	550	68	60	52	220	888	5	190	324
1570 to 1669	D	2	4890	550	70	62	54	220	941	5	190	333
1670 to 1789	E	2	5250	577.5	73	64	56	220	1024	5	190	353
1790 to 1929	F	2	5610	577.5	76	66	58	220	1109	5	190	378
1930 to 2079	G	2	6000	577.5	78	68	60	220	1168	5	190	402
2080 to 2229	H	2	6450	605	81	70	62	240	1259	5	200	422
2230 to 2379	I	2	6900	605	84	73	64	240	1356	5	200	451
2380 to 2529	J	2	7350	605	87	76	66	240	1453	5	200	480
2530 to 2699	K	2	7800	632.5	90	78	68	260	1471	6	200	480
2700 to 2869	L	2	8300	632.5	92	81	70	260	1471	6	200	490
2870 to 3039	M	2	8700	632.5	95	84	73	260	1471	6	200	500
3040 to 3209	N	2	9300	660	97	84	76	280	1471	6	200	520
3210 to 3399	O	2	9900	660	100	87	78	280	1471	6	200	554
3400 to 3599	P	2	10500	660	102	90	78	280	1471	6	200	588
3600 to 3799	Q	2	11100	687.5	105	92	81	300	1471	6	200	618
3800 to 3999	R	2	11700	687.5	107	95	84	300	1471	6	200	647
4000 to 4199	S	2	12300	687.5	111	97	87	300	1471	7	200	647
4200 to 4399	T	2	12900	715	114	100	87	300	1471	7	200	657
4400 to 4599	U	2	13500	715	117	102	90	300	1471	7	200	667
4600 to 4799	V	2	14100	715	120	105	92	300	1471	7	200	677
4800 to 4999	W	2	14700	742.5	122	107	95	300	1471	7	200	686
5000 to 5199	X	2	15400	742.5	124	111	97	300	1471	8	200	686
5200 to 5499	Y	2	16100	742.5	127	111	97	300	1471	8	200	696
5500 to 5799	Z	2	16900	742.5	130	114	100	300	1471	8	200	706
5800 to 6099	A*	2	17800	742.5	132	117	102	300	1471	8	200	706
6100 to 6499	B*	2	18800	742.5	137	120	107	300	1471	9	200	716
6500 to 6899	C*	2	20000	770		124	111	300	1471	9	200	726
6900 to 7399	D*	2	21500	770		127	114	300	1471	10	200	726
7400 to 7899	E*	2	23000	770		132	117	300	1471	11	200	726



6. Communication

Closed loop

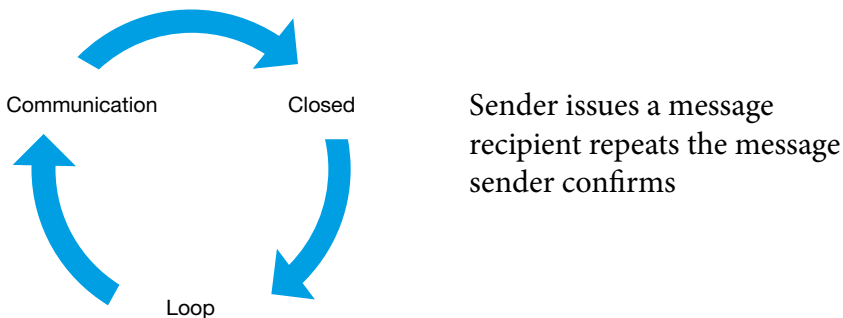
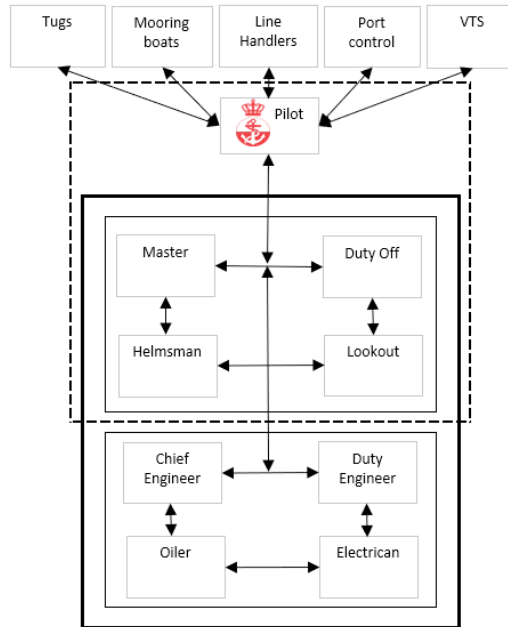


Figure 24 – Illustration showing closed loop communication

Why would we like the communication between the ship and persons ashore to take place according to the above model?

When orders are given on the bridge of a ship between the bridge team and the pilot, it always takes place by means of this method - this minimises misunderstanding of orders. During manoeuvring, many persons have to be kept informed and it is therefore important to keep the communication as short and clear as possible and to clearly indicate if something has not been understood properly.

Here is a list of the persons with whom the pilot communicates during operations.



Use Imo Standard Marine Communication phrases^X. Source: Navigator

Examples:

- .9 Heave on the ... line(s) / ... spring(s)..
- .10 Pick up the slack on the ... line(s) / ... spring(s)..
- .11 Heave away.
- .11.1 Stop heaving.
- .12 Slack away / check the ... line(s) / ... spring(s)..
- .13 Hold on the ... line(s) / ... spring(s).
- .14 Heave in easy.
- .14.1 Heave alongside.
- .15 Keep the ... line(s) / ... spring(s) tight.
- .16 Report the forward / aft distance to
- .16.1 The forward / aft distance to is metres.
- .17 We have to move ... metres ahead / astern.
- .18 We are in position.
- .19 Make fast fore and aft.
- .20 Finished with manoeuvring stations.
- .3 **Unberthing**
 - .1 Stand by engine(s).
 - .2 Are you ready to get underway?



7. Safety and safety recommendations

We often focus on the things that go wrong and analyse them. We also have a chapter on subjects that often cause accidents so we are in no way an exception. We would, however, like to promote the more recent approach to the subject of safety - looking at the many times when things go well and why, and to learn from it. Fortunately, at most ports, the persons involved in mooring operations know what they are doing and things therefore usually go well. However, we cannot omit to mention that sometimes episodes occur that are regarded as near misses, for example linesmen standing too close to weight-bearing lines/wire. We therefore recommend that snap-back zones are taken seriously and that the persons in question keep an appropriate distance from weight-bearing lines/wire, wait and agree when it is “safe” to start an operation at a mooring site. IMO International ship and port facility security code and SOLAS Amendments of 12 december 2002

As described in chapter 6, good communication contributes to creating a good and safe mooring operation. An example of a good and safe arrival/departure from the quay.

Arrival

The pilot notifies the mooring personnel as early as possible of the plan for the coming arrival at a given quay. The number of mooring lines that are expected to be used and the order and types of lines/wire on the ship. It is also agreed/notified

whether a heaving line or messenger will be used, and it is agreed whether a line boat will be used. Depending on the line types, it is agreed whether one or two lines can be fed at a time. Everything is repeated and confirmed, see Chapter 6. The linesmen notify the pilot/ship if they observe anything in the quay area that may interfere with the mooring. The mooring operation should proceed at a calm pace both on board and ashore, especially during the winter half of the year where it may be slippery on the ship and ashore. The ship's final position at the quay must often be relatively exact (especially tankers loading/unloading via hard arm - Chiksan), and the linesmen (on terminals, it is often the terminal staff who assign the position and, in some ports, the port's port assistants) inform the pilot/ship of the distance in metres from the position until the ship is correctly positioned in relation to the designated berth.

Departure

In the same way as arrival, the pilot/ship/linesmen agree on the order in which the mooring lines will be cast off. The 'single up principle' is often used, but in this connection it should be mentioned that if you single up to 1/1 ahead and astern, and the ship is exposed to forces of wind/current, the remaining lines suddenly have to withstand great forces involving a risk of breaking unless you have tugs or the ship's own manoeuvre components to compensate for the brief but significant impact on the mooring lines.

As the mooring lines become slack and an order has been given to let them go ashore the linesmen will advise both ahead and astern when the lines are "free" of the water and especially astern when the propeller is ready, i.e. no mooring lines in the water or near the propeller/thrusters.

7.1 – Lines breaking

Snap back zone – simply means the distance that a line/wire that breaks may travel and hit, for example, people.

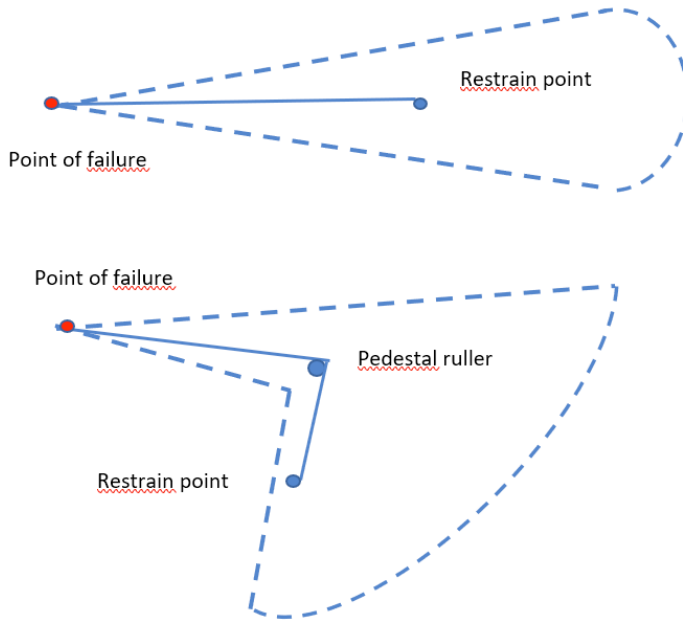


Figure 25 – Snap-back zone

7.2 Heavy lifts

It can be a heavy task to pull lines and wire ashore from a ship. Casting off mooring lines can also be quite a heavy job. We therefore recommend that companies involved in mooring operations take a sensible approach to this and examine whether the individual mooring locations require other material for mooring such as winch or cart with winch etc.

In the last part of this guide, there are references to good advice on heavy lifts.

7.3 Heaving lines and things that may “fall down”

During mooring operations ashore, the risk of objects falling from the ship should always be taken into account, and even small, relatively light objects may, under very unfortunate circumstances, have catastrophic consequences. Heaving lines are often designed in many different ways, and sometimes heavy things are inserted in the monkey's fist itself. This may have catastrophic consequences when thrown if a person is hit. Reference to this subject can be found in the last section.

The below chart shows the height of an object and a given dropped height as a function of the weight of the object. When focusing on these two parameters, it may be seen that even relatively light objects may cause great personal injury.

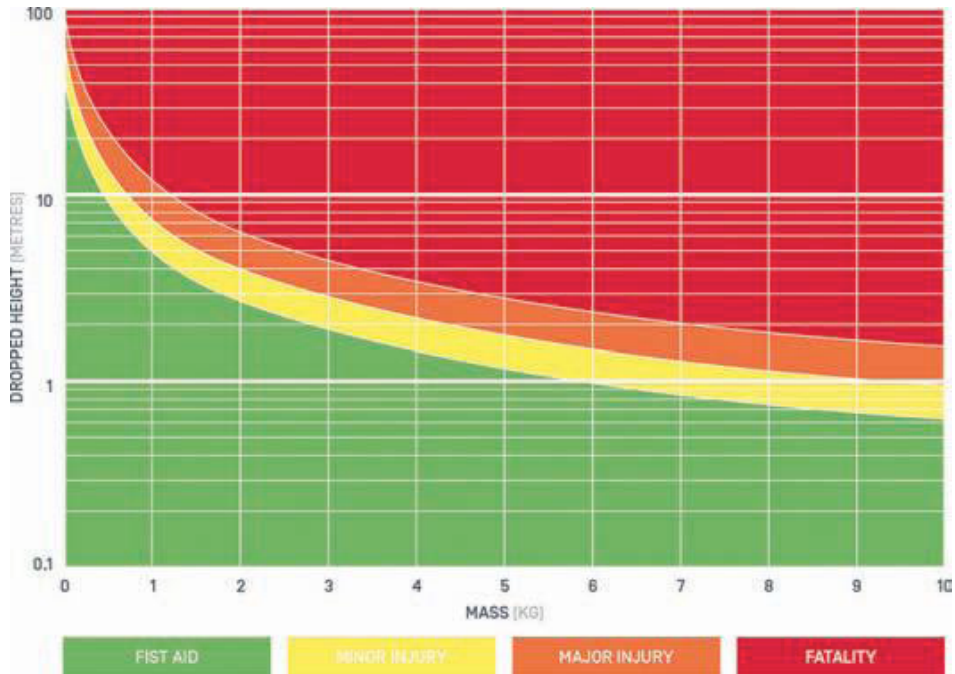


Figure 26 – Chart showing how light objects can cause injuries when dropped from a great height. Source British Tugowners association.

7.4 Examples of objects that may cause accidents

7.4.1 Examples of mooring objects that often cause accidents - seen from ashore

Manual handling risks due to sending ashore two or more heavy lines together.
Use of weighted monkey's fists.

Inadequate assessment of tidal situation and effect of bow thruster, tug and propeller wash when sending lines away.

Failure to have anchors home and housed

Failure to recognise risk of line boat getting trapped between ship and quay, particularly with onshore wind or tide.

Ropes being paid out from winch drums getting trapped and heaved back in, instead of paying out.

Lowering too much line too quickly into the water.

Sending heavy lines or wires as first lines ashore, often with vessel still moving alongside the berth.

Not watching what's happening on the jetty, due to having an inadequate number of personnel on bow/stern, making assumptions and failing to warn.

Failure to appreciate the risk to shore personnel working within the snap-back zones on the jetty.

Tensioning or heaving-in ropes on quick-release hooks, and on small dolphins, without waiting for instructions that shore crew are clear.

Heaving in lines at high speed without warning the shore crew, or while they are still in an unsafe position.

Not allowing shore crew enough time to get a jammed rope off the bollard before starting to heave it in.

Failure to give due regard to difficulties in both taking and letting go wire ropes with fibre tails and Mandel shackles.

Failure to consider safety of both ship and shore mooring crew when:

- a. Unberthing as the number of lines is reduced and risk of failure increases on remaining lines;
- b. Springing a ship off the berth.

Linesmen berthing/unberthing

Poor overview, crossing line, lines in mess on mooring boat, line thrown without telling linesmen, strong current, mess on the quay, line caught in fender, bad lighting, poor communication between pilot & captain & tug, line comes off bollard – steep angle, line round propeller, several lines on same bollard.

7.4.2 Examples of mooring objects that often cause accidents - seen from the ship

Equipment:

Use of old, damaged wire
Poor equipment
Poorly designed mooring system
No overview of mooring area
Hazard/tripping risk sites not highlighted

Work processes:

Lack of communication and planning
Poor wire/line handling

Crew qualifications:

Lack of knowledge about the hazards of the job
Unclear instructions
Lack of information
Lack of supervision (supervisor involved elsewhere)
Small, untrained deck crew
Ineffective on-board mooring training, without identifying and understanding the dangers associated with snap-back zones

concentration:

Stress and fatigue

Ship's safety culture:

Procedures not followed

Shortcuts taken

Standing in the wrong places (in the snap-back zone)

Standing/walking on a bight

Walking over a wire

Quick mooring versus safe mooring

No risk assessment process prior to mooring operations

Cluttered mooring area

Cluttered deck

Weather:

Icy, slippery deck

7.5 10 Rules of thumb for the crew on board the vessel (Seahealth)

Always wear the correct personal protective equipment (PPE), which is an important part of proper preparation considering that PPE is the last line of defence.

Always consider whether you are in a snap-back zone and never stand on either an open line or a closed bight of line.

Keep an eye out for all members of the team. If you think they are in an unsafe position, alert them.

All operations need to be carried out calmly without rushing about. Rushing leads to slips, trips and falls.

Never lose sight of what is going on around you and have an escape route from any likely danger (that is, avoid being trapped against the bulwark or other obstacle when a line parts).

Always put an eye onto a bollard or bitts by holding the eye either on its side or by a messenger line to avoid getting fingers trapped against the bollard if the line suddenly snaps tight.

Never heave blindly on a line when no one is watching what is happening at the other end.

Never try to be heroic by jumping onto a line that is clearly running over the side and out of control as you are likely to go overboard with it.

Never run more than one line around a fairlead sheave as the lines chafe through more quickly and the sheave is really only strong enough to take the load of a single line under tension.

Never use any equipment that is obviously faulty. If you notice damage, then it should be reported and an alternative arrangement for the mooring line used.

Never let go of a mooring line under heavy load without determining first why the load is so heavy and then taking the proper precautions if it must be let go.



8. ISPS (International Ship and Port Facility Security) – Danish ports

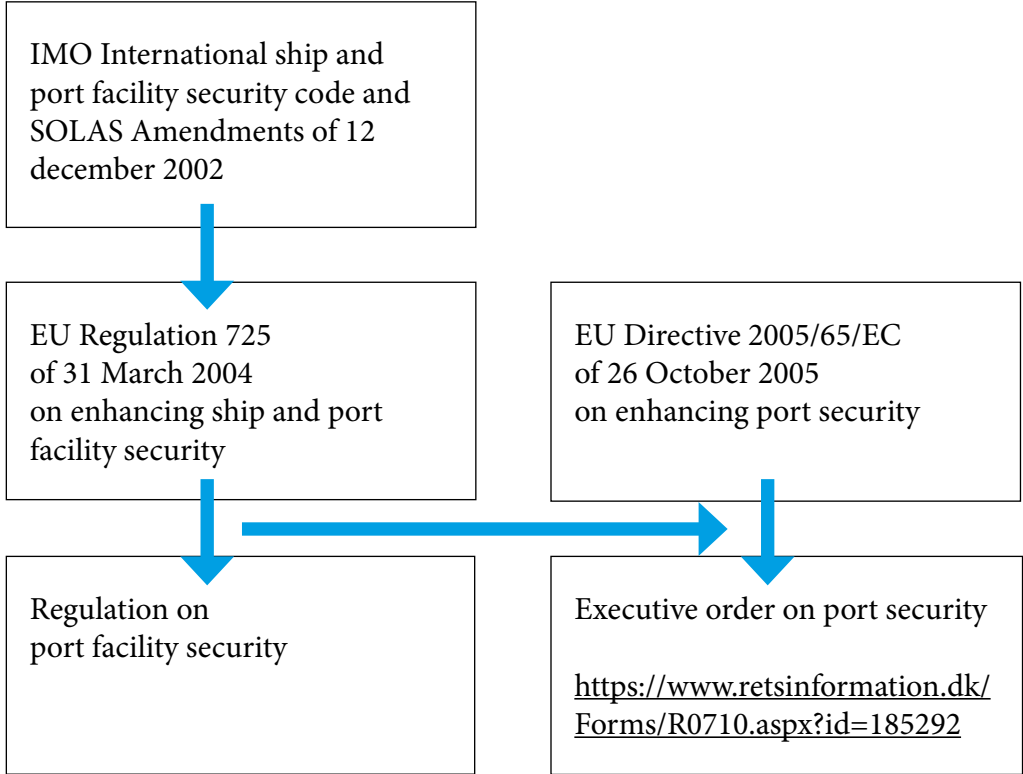


Danish Coastal Authority

The overall responsibility for coordination of the work with securing ports and implementation of rules rests with the Danish Coastal Authority, which also carries out supervision and control with respect to compliance with the rules^{XI}.

The Danish Coastal Authority (Kystdirektoratet) is the official coastal government agency - a division of the Danish Ministry of the Environment and part of the Danish Nature Agency. It is as such also adviser for the Danish Minister of the Environment.

Legal basis for maritime security



Approved port facilities in Denmark^{XII}

IMPORTANT: The information provided in the GISIS Maritime Security module is continuously updated and you should refer to the latest information provided by IMO Member States which can be found on: <https://gisis.imo.org/Public/ISPS/PortFacilities.aspx>

Port Name 1	Port Name 2	Facility Name	Facility Number	Description	Longitude	Latitude
Akzo Nobel Salt		Akzo Nobel Salt - Akzo Nobel Salt A/S Kaj	DK109-0005	bulk carier	0100217E	564058N
Allinge	Allinge	Allinge - Kaj nr. 1	DKAGE-0001	Passenger ship	0144830E	551670N
Asnæsværkets Havn	Asnæsværkets Havn	Asnæsværkets Havn - Asnæsværkets Havn	DKASV-0001	Oil tanker, bulk carrier	0110500E	554000N



9. References, best practices, incidents – cases etc.

1. International guidelines and best practice
2. Legislation – Danish
3. Security and mooring
4. Reports on accidents and incidents
5. Guidelines
6. Practical guidelines
7. Mooring systems

1 International guidelines and best practice

Ship/port interface guidelines on minimum training and educations for mooring personnel (revised 2016)

- <http://www.imo.org/en/OurWork/Facilitation/docs/FAL%20related%20non-mandatory%20instruments/FAL.6-CIRC.11-REV.1.pdf>

Revised solas regulation II-1/3-8 and associated guidelines (MSC.1/CIRC.1175) and new guidelines for safe mooring operations for all ships.SDC 6/3 25 October 2018

- https://www.ukchamberofshipping.com/documents/1448/SDC_6-3_-_Safe_Mooring.pdf

ILO port Safety and Health (revised 2016)

- https://www.ilo.org/sector/activities/sectoral-meetings/WCMS_546257/lang--en/index.htm

The European members of the IBLA are also members of the European Boatmen Association, called EBA.

- <http://ibla.info/certifications/>

ISGOTT International Safety Guide for Oil Tankers and Terminals

- http://www.axelzone.ro/storage/ttm/_lessons/tankers/iscott2006.pdf

Mooring – do it safely

- <http://www.marinedocs.co.uk/wp-content/uploads/2017/03/Mooring-Do-It-Safely.pdf>

Explanation of Ocimf mooring guidelines - Intertanko

- <https://www.intertanko.com/News-Desk/Weekly-News/Year-2000/No-292000/EXPLANATION-OF-OCIMF-MOORING-GUIDELINES/>

IMO Standard marine communication phrases

- <http://www.segeln.co.at/media/pdf/smcp.pdf>

2 *Legislation – Danish*

Heavy lifts

- <https://amid.dk/media/1756/d-3-1-loeft-traek-skub20pdf.pdf>

Executive order on standard Regulations for the Observance of Good Order in Danish Commercial Ports

- <https://www.retsinformation.dk/forms/r0710.aspx?id=22340>

Workplace assessment

- <https://arbejdstilsynet.dk/da/arbejdspladsvurdering>

Consolidated Act on Ports

- <https://www.retsinformation.dk/Forms/R0710.aspx?id=141663>

Executive Order on the Performance of Work

- <https://www.retsinformation.dk/Forms/R0710.aspx?id=203578>

Reporting of industrial accidents

- <https://indberet.virk.dk/arbejdsmarkedets-erhvervssikring/arbejdsulykke-easy>

3 *Safety and mooring*

ANGOPI_ Mooring Men

- <https://vimeo.com/219581722>

Maritime Training: Line Handling Accident Prevention

- <https://www.youtube.com/watch?v=3GsSMfLYIQg>

Port & Harbour Risk Assessment and Safety Management Systems

- <https://www.maritimenz.govt.nz/commercial/ports-and-harbours/documents/Port-harbour-risk-assessment.pdf>

The relationships between seafarers and shore-side personnel: An outline report based on research undertaken in the period 2012-2016

- <https://orca-mwe.cf.ac.uk/92378/1/The%20relationships%20between%20seafarers%20and%20shore-side%20personnel.pdf>

Safety in mooring

- <https://www.iadc-dredging.com/ul/cms/terraetaqua/document/4/8/5/485/485/1/article-safety-in-mooring-143-2.pdf>

SIP005 – Guidance on mooring

- <https://www.portskillsandsafety.co.uk/sites/default/files/2017-05/SIP005%20-%20Guidance%20on%20mooring%20operations%20-%20Issue%201.pdf>

OCIMF – guide-to-purchasing-high-modulus-synthetic-fibre-mooring

- <https://www.ocimf.org/media/53251/guide-to-purchasing-high-modulus-synthetic-fibre-mooring-lines-februar.pdf>

4 *Reports on accidents and incidents*

Safety Alert – Deadly Spring Kills Linesman

- <http://maritimeaccident.org/2009/09/safety-alert-deadly-spring-kills-linesman/>

Injury during mooring operation

- https://maddenmaritime.files.wordpress.com/2016/07/injury_during_mooring_operation_july_-2016.pdf

Marine Accident report july 2014ATAIR (Denmark)

- <http://www.dmaib.com/Ulykkesrapporter/ATAIR%20J%20-%20mooring%20accident%20on%203%20October%202014.pdf>

Mooring boat crushed

- <https://marineinsight.com/case-studies/real-life-incident-mooring-boat-crushed-sinks/>

Two Killed After Mooring Line Snaps at Port of Longview

- <http://gcaptain.com/two-killed-after-mooring-line-snaps-at-port-of-longview-washington/>

Video – Longview

- <https://www.fleetmon.com/maritime-news/2018/22881/snapped-mooring-line-bulk-carrier-killed-1-wounded/>

Morraborg – under fortøjning

- https://www.havkom.se/assets/reports/English/RS2014_03e.pdf

Mooring accident

- <https://www.nautinst.org/en/forums/mars/mars-2012.cfm/mooring%20Accidents>

Nautical Institute – March 2018 – uheld linesmen

- <https://www.nautinst.org/en/forums/mars/mars-2018.cfm/MARS201850>

Devprayag 24 June 2008

- <https://www.maritimenz.govt.nz/commercial/safety/accidents-reporting/accident-reports/documents/Devprayag-96892-mnz-accident-report-2009.pdf>

5 Guidelines

Safety folder for mooring

- <http://operasjonsmanual.norog.no/selskapsesifikke/equinor/English/B/B-09%20Safety%20folder%20for%20mooring%20operations.pdf>

Mooring operations – safe working practice

- <http://training.hmm.lv/wp-content/uploads/2014/03/MOORING-OPERATIONS-v130314-Nr-video.pdf>

Docking and Mooring

- <http://www.trelleborg.com/en/marine-systems/products--solutions--and--services/docking--and--mooring>

Forebyg arbeidsulykker

- https://amid.dk/media/3610/kvikguide_ulykker.pdf

Vejledning af havnesikring

- <https://www.trafikstyrelsen.dk/~media/Dokumenter/11%20Havne/Vejledning%20om%20havnesikring.pdf>

Forebyggelse af arbeidsulykker Identificering af risici

- https://www.google.com/search?q=8-3-Vejledning-i-risikoanalyse%2520pdf.pdf&rlz=1C1GCEA_enDK793DK793&oq=8-3-Vejledning-i-risikoanalyse%2520pdf.pdf&aqs=chrome..69i57.489j0j8&sourceid=chrome&ie=UTF-8

9 gode råd om oplæring, instruktion og tilsyn

- <https://amid.dk/media/2978/oplaering-og-instruktion-af-nyansatte.pdf>

6 *Practical guidelines*

Master's guide – Berthing

- <http://www.standard-club.com/media/24148/AMastersGuidetoBerthing2ndedition-2.pdf>

Mooring lines and maintenance

- <https://www.steamshipmutual.com/Risk-Alerts/RA07MooringLineCareMaintenance.pdf>

Mooring speeds/ships/quay

- <https://static1.squarespace.com/static/55bc3028e4b002b451bfd436/t/55c31853e4b0a0eb283c28e9/1438849107353/Berthing+Velocities+and+Brolsma%27s+Curves.pdf>

Styrker på div. fortøjninger

- <https://www.bairstow.com/v/vspfiles/pdf/safety/N7806.pdf>

DANGEROUSLY WEIGHTED SHIPS HEAVING LINES

- <https://britishtug.com/dangerously-weighted-heaving-lines-a-frequent-and-frequently-unacknowledged-problem-that-needs-to-be-tackled/>

Closed-loop communication

- https://en.wikipedia.org/wiki/Closed-loop_communication

ILO – Safety and health in ports (revised 2016)

- https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/normativeinstrument/wcms_546257.pdf
- <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32017R0352>

REGULATION (EU) 2017/352 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 February 2017 - establishing a framework for the provision of port services and common rules on the financial transparency of ports

- <https://www.trafikstyrelsen.dk/DA/Havne-og-VVM/ordensreglementet.aspx>
- In accordance with section 15 of the Danish Ports Act, all ports must have rules of conduct. This applies to commercial ports as well as marinas.

7 *Mooring equipment (Shore side)*

Fenders

- <https://f.nordiskemedier.dk/2wka8syerne6sdpa.pdf>

The ShoreTension

- <https://shoretension.com/>

Trelleborg Marine Systems

- <http://www.trelleborg.com/en/marine-systems>

Designing of imoor jetty management system

- <http://www.irmome.com/designing-of-imoor-jetty-management-system/>

Wärtsilä Encyclopedia of Marine Technology

- <https://www.wartsila.com/encyclopedia/term/mooring-equipment>

Cavotec – MoorMaster Automated Mooring

- <http://www.cavotec.com/en/your-applications/ports-maritime/automated-mooring>

MacGregor automated mooring system

- <https://www.macgregor.com/Products-solutions/products/port-and-terminal-equipment/automated-onshore-mooring-system-moorex/>

The ShoreTension

- <https://shoretension.com/>

- I http://www.trykteamepub.dk/epub/DanPilot_Transit_Passage_Plan/
- II http://trykteamepub.dk/epub/DanPilot_Habour_Plan/
- III www.seahealth.dk/en
- IV <https://www.ocimf.org/meg4.aspx>
- V <https://rules.dnvgl.com/docs/pdf/dnvgl/ru-ship/2017-01/DNVGL-RU-SHIP-Pt3Ch11.pdf>
- VI Revised solas regulation II-1/3-8 and associated guidelines (MSC.1/CIRC.1175) and new guidelines for safe mooring operations for all ships
SDC 6/3 25 October 2018
https://www.ukchamberofshipping.com/documents/1448/SDC_6-3_-_Safe_Mooring.pdf
- VII <https://www.youtube.com/watch?v=XQixvZxvupM>
- VIII <http://www.imo.org/en/OurWork/Facilitation/docs/FAL%20related%20non-mandatory%20instruments/FAL.6-CIRC.11-REV.1.pdf>
- IX <http://www.imo.org/en/OurWork/Facilitation/docs/FAL%20related%20non-mandatory%20instruments/FAL.6-CIRC.11-REV.1.pdf>
- X https://issuu.com/aktofylakas/docs/imo_standard_marine_communication_phrases
- XI <https://www.trafikstyrelsen.dk/DA/Havne-og-VVM/MaritimSikring/pre-arrival-information.aspx>
- XII <http://eum.nu/files/Denmark,-Port-Facility-Number.pdf>



Mission: - Safeguarding
our customers' vessels
and the environment

Vision: - The most reliable
pilot service in Europe

