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SHIP MANEUVERING AND HANDLING

Agus Hadi Purwantomo

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Politeknik Ilmu Pelayaran Semarang

MENGOLAH GERAK KAPAL

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PREFACE

First of all, I would like to express my gratitude for the abundance of God's grace so that the book of Ship Maneuvering and Handling can be completed. We also thank various parties for supporting this book to be published.

This book is arranged as a reference for learning at Politeknik Ilmu Pelayaran Semarang. The material includes an introduction, internal and external forces, ship preparation, and working procedures. The material is explained practically and described with supporting images.

In the arrangement of this book, of course, there are still many mistakes both in the use of terms and the way of presentation. For this reason, the author hopes for constructive criticism and suggestions to improve this book in the following publication.

We hope this book will be helpful for the readers.

Author

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CHAPTER I.
INTRODUCTION

Ship maneuvering is a technique of how to take a ship from one place to another designated place effectively, efficiently, and safely to carry out an activity by utilizing internal and external resources. It is necessary to make the activity of ship maneuvering as efficient as possible, in terms of time and the use of fuel. It is also important to maneuver safely to protect the ship from danger.

The Captain and Deck Officer must have comprehensive knowledge of ship maneuvering to carry out their watch duty in ship maneuvering properly and correctly. They must be able to utilize the ship maneuvering data on the ship and external force, which can assist the implementation of the ship maneuvering.

There are various types of ship maneuvering to carry out an activity, such as ship maneuvering for berthing and unberthing, ship maneuvering for anchoring, ship maneuvering in narrow waters, ship maneuvering in bad weather, ship maneuvering for rescuing a man overboard, ship maneuvering in Search and Rescue (SAR) operations at sea, ship maneuvering to board the pilots, etc. All of those activities must be controlled by the bridge watch officer.

The implementation of ship maneuvering highly depends on various factors, namely the factors which come from internal of the ship itself and the factors which come from outside the ship, all of which must be understood by the captain and officer for implementing the ship maneuvering as well as avoiding the incidents at sea.

Smooth running in ship handling will be realized along with the increasing experience of the Captain and Officer in carrying out ship maneuvering, especially in using/utilizing ship maneuvering data available on the ship.

CHAPTER II. INTERNAL AND EXTERNAL RESOURCES

2.1. The Implementation of Ship Maneuvering

In carrying out ship maneuvering, there are internal and external resources that can be utilized in ship maneuvering, so that it can be carried out quickly, precisely, safely, and under control, such as ship crew, ship maneuvering equipment, navigation publications, ship maneuvering data, and pilot, including forms for pilotage and tugboats.

2.2. Ship Crew in Implementing Ship Maneuvering

The ship crews involved in ship maneuvering include the Captain and his crew. They must have the competence to carry out their duties under their respective duties and responsibilities in the implementation of ship maneuvering. The duties are:

2.3. Overall Command

The overall command holder of the ship maneuvering is the Captain on the ship's bridge with the duty of coordinating the ship's maneuvering and carrying out internal and external communications.

2.4. Team Commanders

The command holders are the officers, who are placed at the bow and stern of the ship with the duty of coordinating the ship maneuvering at the bow and stern of the ship, and carrying out internal communications.

2.5. Supporting Group

The supporting group consists of deck crew members placed at the ship's bow, stern, and bridge, carrying out orders from the team commanders.

2.6. Engineers and Engine Crew

This group is led by Chief Engineer, with the duty of preparing the machinery used for ship maneuvering.

Table 1. Example of the duties of crew members in ship maneuvering.

NO	NAME	POSITION	PLACE	DUTY
1	Capt. Agus H.P	MASTER	Bridge	Leading the ship maneuvering. Carrying out internal/external communication
2		Chief Officer	Bridge	Assisting the master in ship navigation and internal communication
3		Second Officer	Bow	Leading the ship maneuvering at the bow and communication with the bridge
4		Third Officer	Stern	Leading the ship maneuvering at the stern and communication with the bridge
5		Fourth Officer	Bridge	Picking up the pilots, filling out the ship pilotage forms, and recording the activities in the maneuvering book
6		Boatswain	Bow	Operating the mooring winch for the mooring process according to the command of the Second Officer
7		A/B I	Bridge	Circulating the OHN, raising the necessary flags, steering the ship according to the instructions of the Chief Officer
8		A/B II	Bow	Sending a heaving line ashore and any other mooring lines at the bow and placing them on the bollard
9		A/B III	Stern	Sending a heaving line ashore and other mooring lines at the stern and placing them on the bollard.

NO	NAME	POSITION	PLACE	DUTY
10		O/S I	Bow	Assisting in the installation of pilot ladder and equipment
11		O/S II	Stern	Assisting the delivery, installation/placement of the mooring lines on the bollard
12		O/S III	Bow	Assisting the delivery, installation/placement of the mooring lines on the bollard
13		Engine Officer of the Watch	Engine Room	Operating the machines used in the ship maneuvering
14		Oiler of the Watch	Engine Room	Assisting the engineer in the engine room
15		Engine Cadet	Engine Room	Assisting the engineer in the engine room
16		Deck Cadet	Bow	Assisting the deck officer at the Bow

2.7. Ship Maneuvering Equipment

In carrying out the ship maneuvering, the equipment must be in good condition and ready to use. The ship maneuvering equipment includes.

2.7.1. The Ship's Main Propulsion Engine

Nowadays, the main engine for ships is a diesel engine because the space is limited, and the preparation is faster than steam engines. The reverse power of a diesel engine is 70% - 80% of the forward power, and the start is immediate. Still, sometimes the results are a bit unreliable because of the limited supply of air generated from the compressor.

2.7.2. Auxiliary Engines

Auxiliary engines for ship maneuvering must be in good condition and ready to use, which include:

1. Generator.
   It is a power generator engine for all equipment that requires electricity, so this engine must be in good condition to face external forces during the voyage.

2. Compressor.
   It is the engine needed to generate the high-pressure wind needed to start the main engine and for other purposes.
3. Evaporator.
   It is the engine needed to convert seawater into freshwater, which is required for cooling the boiler.

2.7.3. Steering Gear

The steering gear is used to steer the ship to the designated place, including the main steering gear and the emergency steering gear which is used when the main steering gear cannot function properly.

The Requirements for Steering Gear.

The arrangement of the steering gear must meet the requirements set out in SOLAS 1974 and its amendments. These requirements are:

1. The arrangement must be in such a way that if one of them is damaged, it does not cause damage to the other.
2. The main steering gear must have the following specification: the rudder can be shifted 350 to the right and 350 to the left in 28 seconds.
3. The auxiliary steering gear must have the following specification: the rudder can be shifted 150 to the right and 150 to the left within 60 seconds when the ship is in a full draft and the ship's speed is 7 (seven) knots.
4. Both steering gears must be able to be used for navigation and can restart automatically when the engine is off.
5. For Every tanker (Chemical Tankers and Gas Carriers) with a GRT of 10,000 tons or more, the main steering gear must have two or more power generating units that can work independently.
6. Emergency Steering gear drills must be carried out at least once every 3 (three) months to ensure that emergency steering procedures are practiced.

7. 12 (twelve) hours before the ship departs, a check must be held to ensure that the main steering gear and auxiliary steering gear can work properly.
8. Operating procedures or instructions for steering gears shall be permanently posted on the bridge and wheelhouse.
9. Dates of checking and testing and details of emergency steering drills shall be recorded in the ship's log book.

2.7.4. The Parts of Rudder Arrangement

The ship's rudder arrangement includes:

1. A hydraulic machine which is used as a lower to drive a series of steering gears.
2. The steering wheel on the ship's bridge which is used to steer the ship.
3. Rudder indicator on the bridge which is used to show the steering angle.
4. Steering the wheel at the stern which is used to turn the ship to the right or left.

There are 3 (three) types of ship rudders, namely unbalanced rudders, balanced rudders, and semi-balanced rudders, with an area of approximately $^{1}/_{70}$ to $^{1}/_{80}$ of the ship's center area below the waterline.

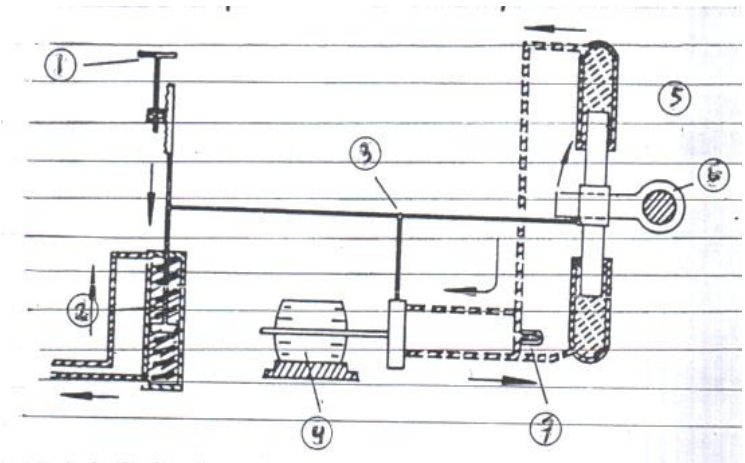


Figure 1. The sketch of Rudder Arrangement.

Description:

1. Steering wheel.
2. Cylinder with spring inside.
3. Intermediate gears; gears; the oil flow direction lever in the hydraulic pump.
4. Electric motors.
5. Hydraulic cylinder.
6. Steering wheel stick; steering wheel stem.
7. Air relief valve for exhausting air in the system

The sketch of ship rudder types:

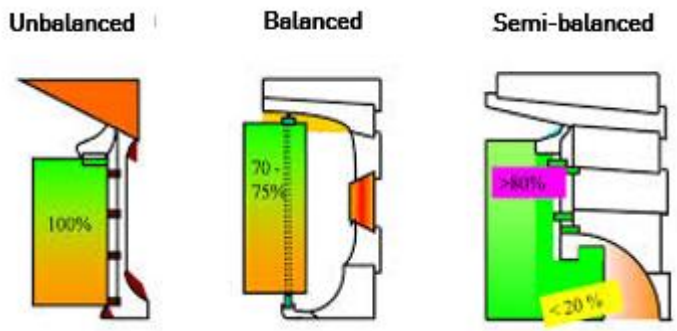


Figure 2. The sketch of rudder types.

WHEEL/HELM ORDERS.

1. Mid Ship.
   The steering wheel is rotated to the right/left to place the needle on the Rudder indicator at zero.
2. Starboard ten.
   The steering wheel is turned to the right to place the needle on the Rudder indicator at 10^0 starboard.
3. Port Twenty.
   The steering wheel is turned to the left to place the needle on the Rudder indicator at 20^0 port.
4. Hard a Starboard.
   The steering wheel is turned to the right to place the needle on the Rudder indicator fully to the starboard (350).

5. Half to Port.
   The steering wheel is turned to the left to place the needle on the Rudder indicator at a number between 0^0 and 35^0.
6. Steady/Steady as she goes.
   Refer to the direction on the Steering Compass when the command is given by the pilot/master and maintain it by turning the steering wheel to the right/left.
7. Meet her/Check her.
   The steering wheel is turned right/left in the opposite direction until there is a Mid Ship signal.

2.8. Propeller

In ship maneuvering, the propeller moves the ship ahead or astern. There are various types of propellers, namely:

1. Based on the construction of the propeller.
   a. Fixed Propeller.
      That is one type of propeller where the angle of the blades cannot be changed.

Figure 3. Fixed Propeller

   b. Controllable Pitch Propeller (CPP).
      That is one type of ship propeller in which the angle of the blades can be changed in position. Thus, when moving the ship ahead or astern, it is not necessary to change the engine speed, but simply by changing the angle of the propeller's blade.

Figure 4. Controllable Pitch Propeller (CPP)

The advantages of a controllable pitch propeller (CPP) are:

1) It is more economical and has better maneuverability.
2) To move the ship ahead, it is not necessary to carry a step-by-step ahead movement. Slow ahead to full ahead can be carried out without going through half ahead.
3) Ship's speed can be selected easily by using combination control.
4) The propeller pitch can be set to a very low speed.
5) At very low speed, the propeller and rudder are still active, and the ship's steering can be maintained for a long time.

The disadvantages of controllable pitch propeller (CPP):

1) When the ship moves at high speed and is no longer in balance with the speed of the propeller, there will be water turbulence behind the rudder that affects its function.
2) Requires extra maintenance.

2. Based on the number of propellers:
   a. Single propeller.

      Most of the ships that use this propeller are right-handed propellers. When the engine is moved forward, this propeller will rotate to the right when viewed from the stern of the ship.

The advantages single propeller:

1) Does not require a large space.
2) Relatively low prices for buildings, equipment, and maintenance.
3) The stern line is not easy to entangle on the propeller.

The disadvantages of a single propeller:

1) If the propeller is damaged, the ship cannot sail/continue its voyage.
2) There is vibration caused by the operation of large machines.
3) It is difficult to maneuver the ship in narrow waters.

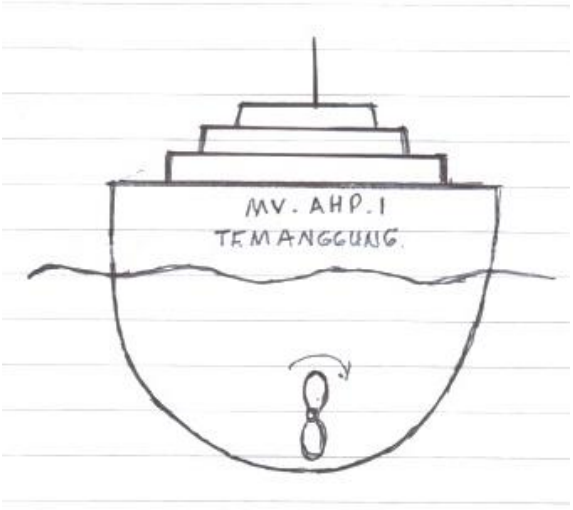


Figure 5.Single Propeller

b. Double propeller.

Most ships that use this propeller are of the out-turning screw type, in which the right propeller rotates to the right, and the left propeller rotates to the left.

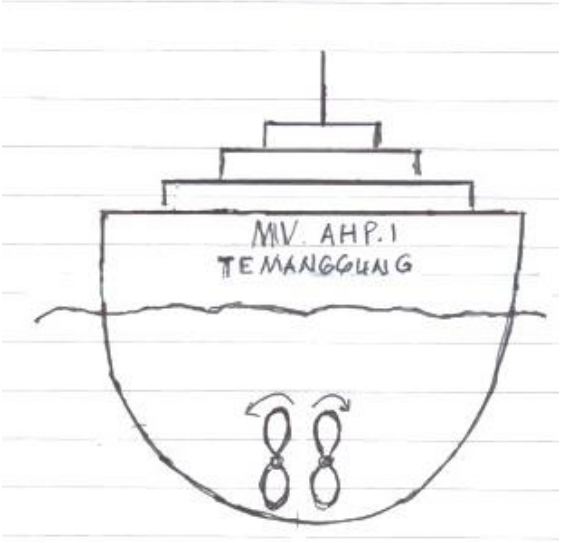


Figure 6. Double Propeller

The advantages of double propeller:

1) If one of the propellers is damaged, the ship still can continue the voyage by using another propeller.
2) If the steering gear is damaged, the ship can still be steered by setting the second rotation of the propeller.
3) Ship maneuvering in narrow waters is easier.

The disadvantages of double propeller:

1) Requires a large engine room to place the engine and propeller shaft.
2) The stern lines are easily entangled with the propeller when transporting the lines ashore.
3) Requires high cost in maintenance and operation.

c. Triple propeller.

This type is widely used on fast coast ships, in which the left propeller rotates to the left, the right propeller rotates to the right, and the center propeller rotates to the right.

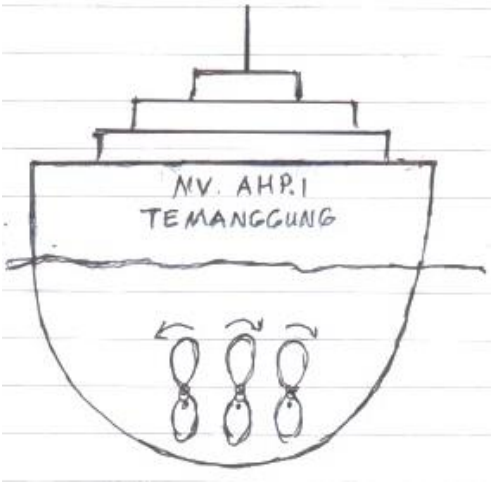


Figure 7. Triple Propeller (Tiga Baling-Baling)

d. Quadruple propeller (empat baling-baling).

The placement of these propellers is 2 (two) pieces on the right rotating to the right and two pieces on the left rotating to the left. Usually, the two in the middle cannot be moved astern. Therefore, the outermost 2 (two) propellers are used during the ship maneuvering.

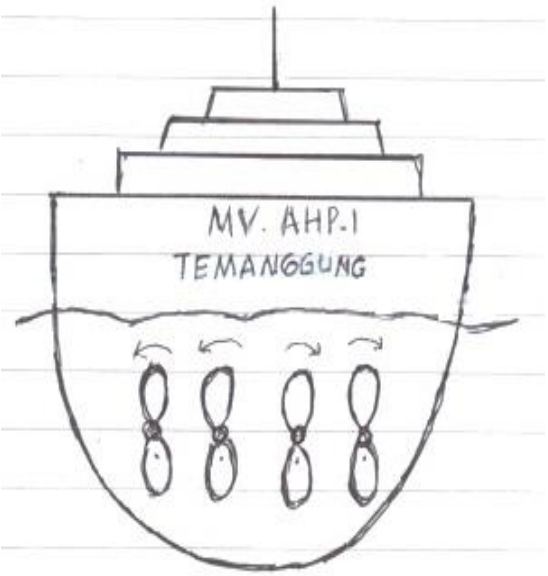


Figure 8. Quadruple Propeller

e. Thruster.

During ship maneuvering, a thruster is used to move the ship to the right/left side by using a propeller. There are some types of thrusters, including Bow Thruster and Stern Thruster.

Figure 9. Stern Thruster

Figure 10. Bow Thruster

2.9. Anchor Arrangement

In ship maneuvering, anchors are used to tie the ship to the bottom of the sea and avoid navigational hazards (collisions and running aground). The type of anchor used in many ships is the patent anchor (plain anchor).

Anchor arrangement includes:

1. Windlass that is used for heaving up and placing the anchor.
2. Anchor chain that is used to connect the anchor to the windlass.
3. Anchor lashings are used to prevent anchors from escaping/losing.
4. Hawse is used to insert anchor rods into the ship's hull.
5. The anchor itself.
6. Anchor lights and anchor objects.

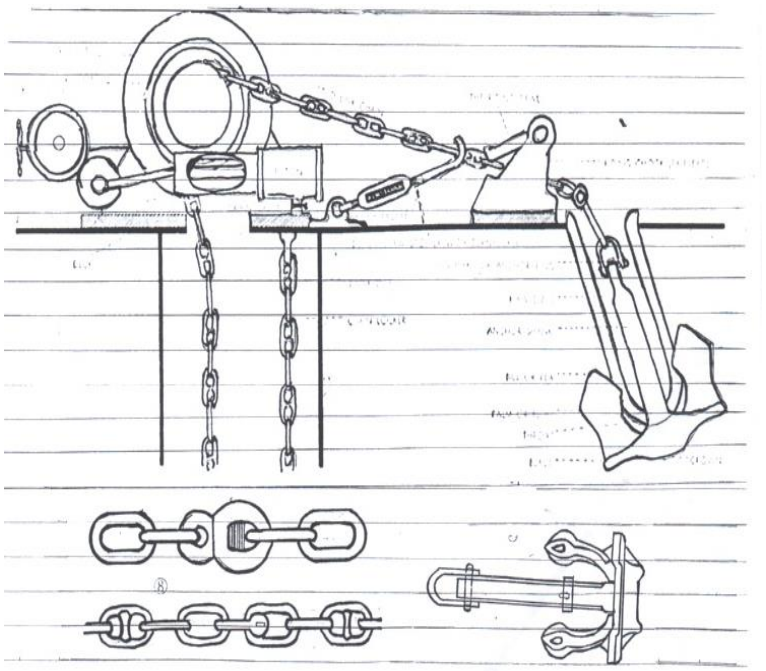


Figure 11. Anchor Arrangement

2.10. Mooring Lines

In ship maneuvering, mooring lines are used to tie a ship to a quay or a ship to another ship. The mooring lines consist of:

1. Head/Stern line, which is used to hold the ship so that the ship does not move forward/aft.
2. Spring line (forward/aft), which is used to prevent forward motion and aft motion of the ship.
3. Breast line, which is used to hold the ship from moving away from the quay.
4. Slip wire is used to tie the ship to the mooring buoy when it is tied to the mooring buoy using an anchor chain which enables the ship to release itself without the help of the mooring buoy crew.
5. Wire tugs are used to tow ships using tug boats.
6. Heave line is used to send lines to the quay or other ships.

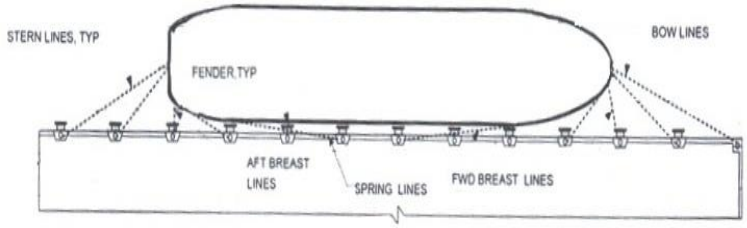


Figure 12. Ship's Mooring

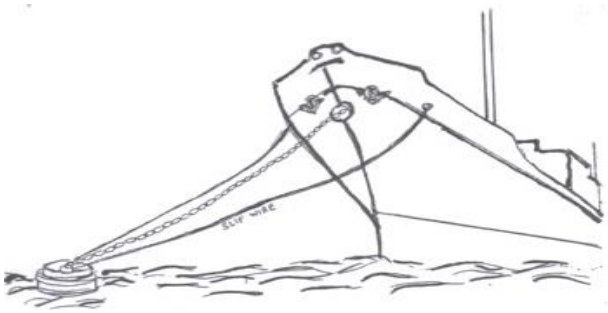


Figure 13. Slip Wire

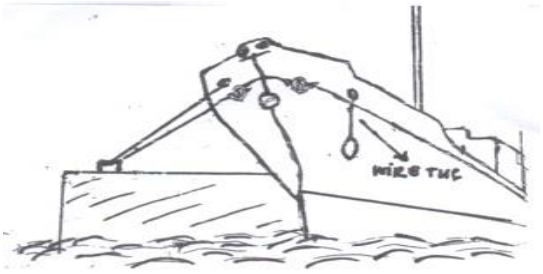


Figure 14. Wire Tug

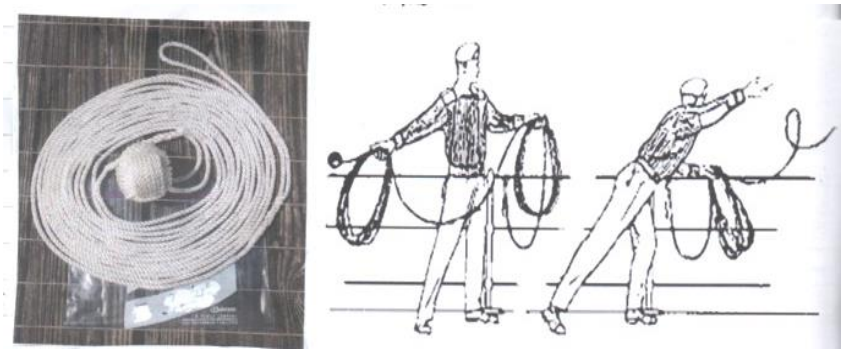


Figure 15. Heaving Line

2.11. Communication Tools

Communication tools during ship maneuvering are used for internal and external communication of the ship. The tool used for communication between the bow/stern and the bridge or vice versa is handy talky, while VHF is used for external communication. These tools also include the signal flags, objects, and navigational lights required to carry out ship maneuvering.

2.12. Navigational Tools

Navigational tools, such as position determination tools, water depth determination tools, and compass speed logs in ship maneuvering, are used for monitoring the ship's position, water depth, ship course, and ship speed.

2.13. Navigational Publications

Navigational publications are used in ship maneuvering to determine safe places for anchoring. These navigational publications include:

1. Up-to-date large-scale nautical charts.
2. Pilot book/shipping guides.
3. Tide tables and tidal current tables.
4. Guide to Port Entry.

2.14. Pilotage Equipment

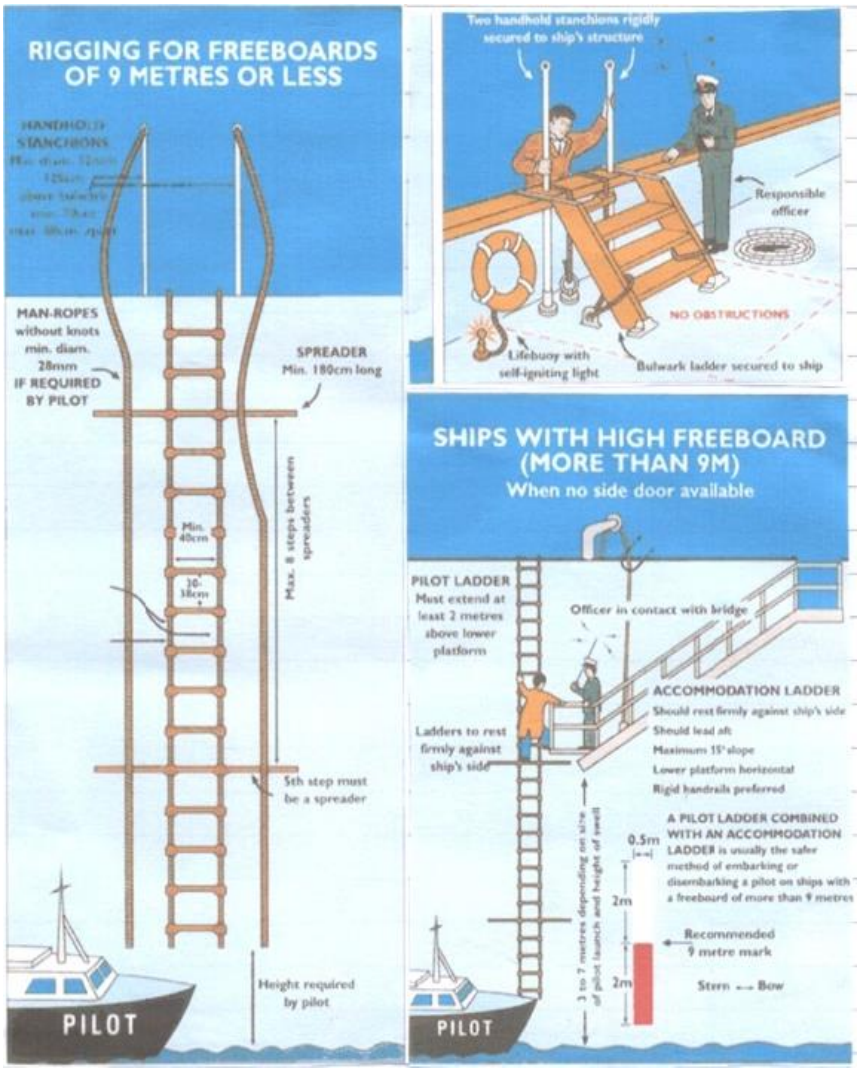


Figure 16. Pilotage Equipment

2.15. Ship Maneuvering Data

Ship maneuvering data are used to carry out ship maneuvering effectively, efficiently, safely, and under control.

Ship maneuvering data are made through experiments/tests carried out when the ship has just been built and made under various conditions (water, cargo, and speed). Therefore, these data are usually available on

new ships. However, the data should also be available when the ships get old.

The ship maneuvering data must be updated if there is a change in ship construction, such as changes in a bow shape and propeller construction due to the incident of the propeller hitting other floating objects.

The captain and deck officer must know how to use and make the maneuvering data of the ship. Some important ship maneuvering data include:

1. Turning Circle Diagram.
2. Z-Manouvering Diagram.
3. Crash Stop Diagram (Emergency Astern & Emergency Ahead).
4. Critical RPM.
5. Man Overboard Instruction.
6. Ship Particulars.
7. Harbour Speed Diagram.
8. Stand Propellers.

2.15.1. Turning Circle Data

The ship's turning circle is the path made by the ship's pivoting point when the ship rotates 360^0 or more. Generally, when the ship turns, the bow is in the turning circle, and the stern is outside the turning circle.

Pivoting point is a point where the ship rotates. This point is located slightly ahead of the center of gravity of the ship G.

The ship's turning circle data are used to determine the amount of advance transfer, tactical diameter, final diameter, kick and drift angle of a ship when the ship makes a turning circle / when turning. These turning circle data are made under various conditions (water, cargo, and ship speed).

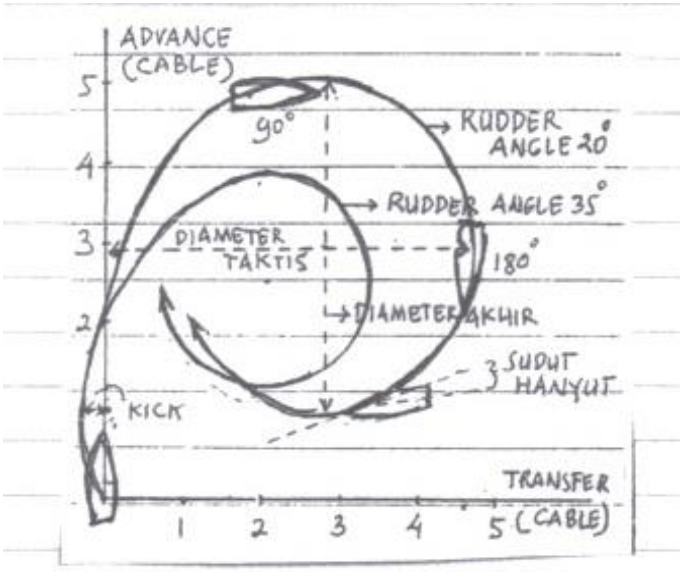


Figure 17. Turning Circle Data

Description:

1. ADVANCE.
   It is the distance measured from point G of the ship when the rudder is shifted to the starboard up to point G of the ship after the course has changed from its original course.
2. TRANSFER.
   It is the distance measured from point G of the ship after the ship's bow has changed to its original course.
3. TACTICAL DIAMETER.
   It is the distance measured from the original course to the line passing through a point 180^0 different from the original course.
4. FINAL DIAMETER.
   It is the diameter of the turning circle after the ship rotates at a constant speed.
5. KICK.
   It is the distance measured from the original course line to point G of the ship after deviating in the opposite direction from the original course.

6. DRIFT ANGLE.

   It is the angle formed between the bow of the ship and the tangent through a point on the path where the ship is located.

HOW TO ESTIMATE THE LOCATION OF THE PIVOT POINT.

The location of the ship's Pivot Point when it moves forward or aft will change. The ways to estimate the location of The Pivot Point are as follows:

1. Ship stopped On Even Keel.

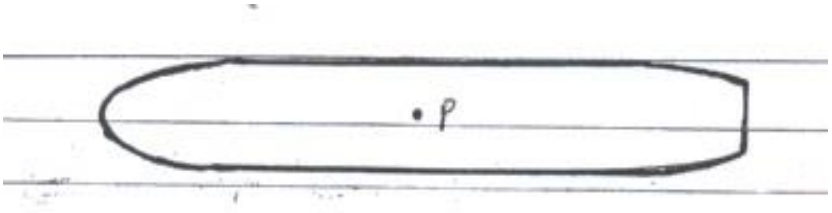


Figure 18. Ship Stopped On Even Keel

Description:

When the ship stops and is in an even keel condition, the position of The Pivot Point (P) is in the middle of the ship's length.

2. Making Headway

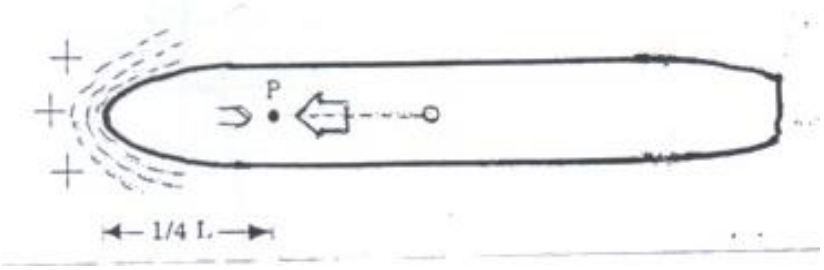


Figure 19. Making Headway

Description:

When the ship moves forward, the point P (The Pivot Point) also moves forward until the maximum will be at a point which location is ¼ LOA measured from the bow post.

3. Making Sternway

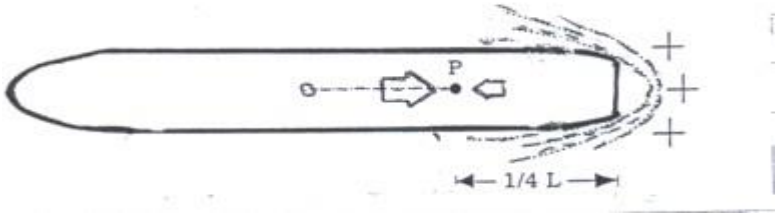


Figure 20. Making Sternway

Description:

When the ship is moving aft, then the point P (The Pivot Point) also moves backward until the maximum will be at a point which location is ¼ LOA measured from sternpost.

2.15.2. Z-Manouvering Diagram

Z-Maneuvering diagram is a diagram used to determine the time required to alter course and determine the OVERSHOOT angle (the excess angle of heading reached by ship when the rudder is applied in the opposite direction from the original curse).

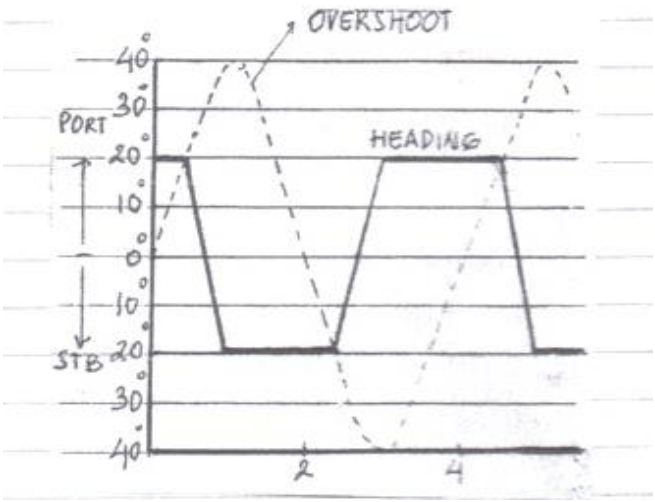


Figure 21. Z-Manouvering Diagram

The use of turning circle diagram and z-maneuvering diagram in ship handling.

We can use the Turning Circle and Z-Manouvering diagrams to determine W.O.P (Wheel Over Point) and the Counter Rudder when the ship alters course. Therefore, after the ship alters course, the ship's position will be on the new track (not falling right/left).

Example:

A ship will alter course from 000^0 to 060^0. Determine the W.O.P and C.R (Counter Rudder) so that after the ship alters course, the ship's position will lie on the new track (not falling right or left) using the Turning Circle diagram and Z-Maneuvering diagram $20^0/20^0$.

Answer:

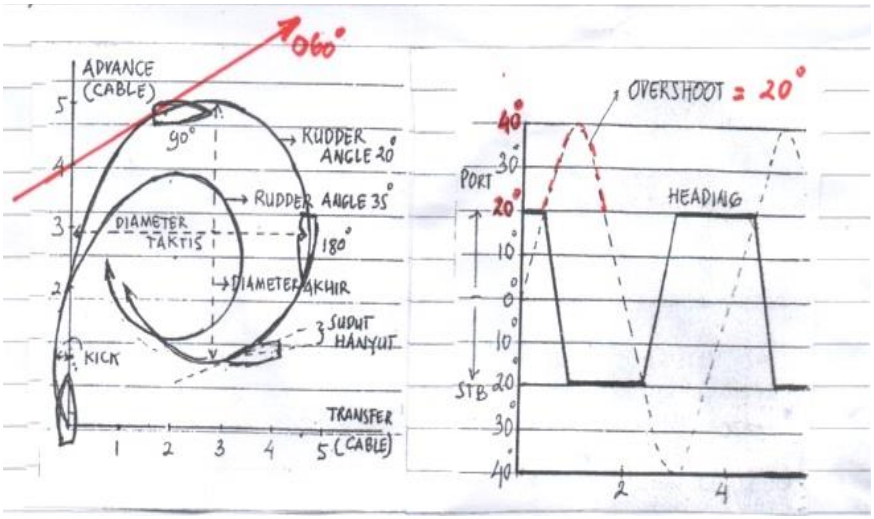


Figure 22. W.O.P dan C.R (Countre Rudder)

Answer:

To find the W.O.P, make a line of 60^0 which intersects with the turning circle for Rudder Angle 20^0 to cut the vertical scale (advance scale), so it is obtained the value of W.O.P = 4 cables before the point of turnaround.

To find C.R (Counter Rudder), use the Z-Maneuvering diagram, in which the overshoot is 20^0 (from $20^0 \rightarrow 40^0 = 20^0$). So, C.R (Counter Rudder) is carried out when the ship course shows the number 40^0 ($60^0 - 20^0 = 40^0$) to the left of 20^0 and continues midship.

2.15.3. Crash Stop Diagram

1. Emergency Astern.
   It is a diagram that aims to determine the time/distance traveled by the ship from when the engine is full astern until it is full stop and moves aft.

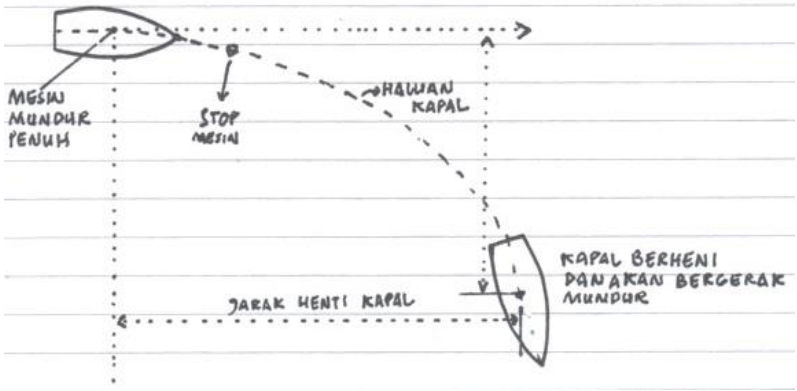


Figure 23. Emergency Astern

2. Emergency Ahead.
   It is a diagram that aims to find out the time/distance traveled by the ship from the time the engine is full ahead until it is full stop and moves ahead.

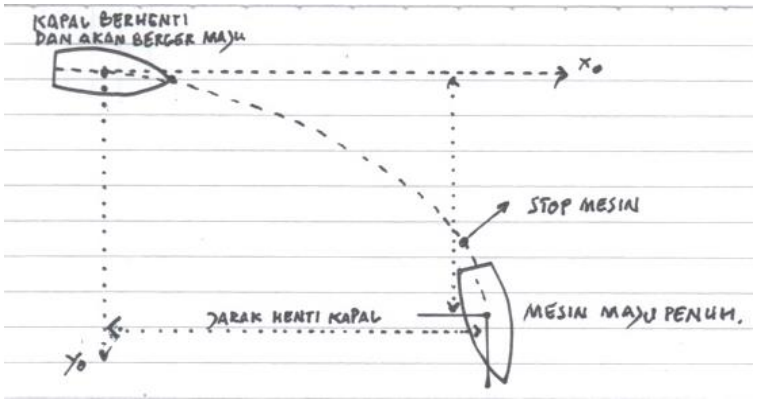


Figure 24. Emergency Ahead

3. Critical Diagram.
   Critical RPM (critical rotation of the main engine) is a critical rotation of the ship's main engine. In that rotation, unbalanced forces cause wild vibrations on the ship that can damage navigation equipment

and the engine itself (lost of power during maneuvering). Therefore, Critical RPM should be avoided. The data/Critical Diagram is illustrated as follows:

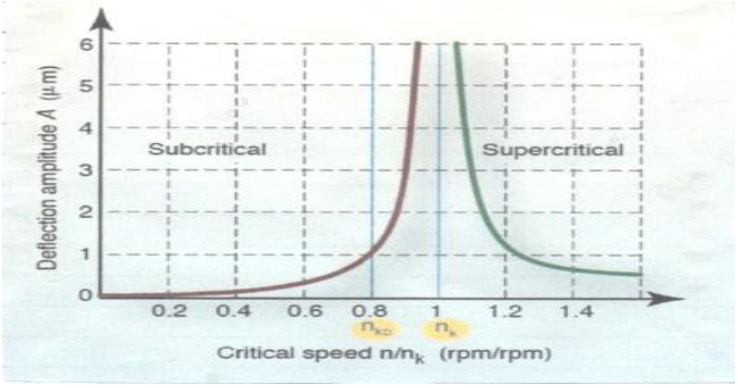


Figure 25. Critical Diagram

4. Man Overboard Instruction.
   Man overboard instruction is an instruction in handling people who fall into the sea—for example, the technique of helping man overboard using the Williamson Turn method.

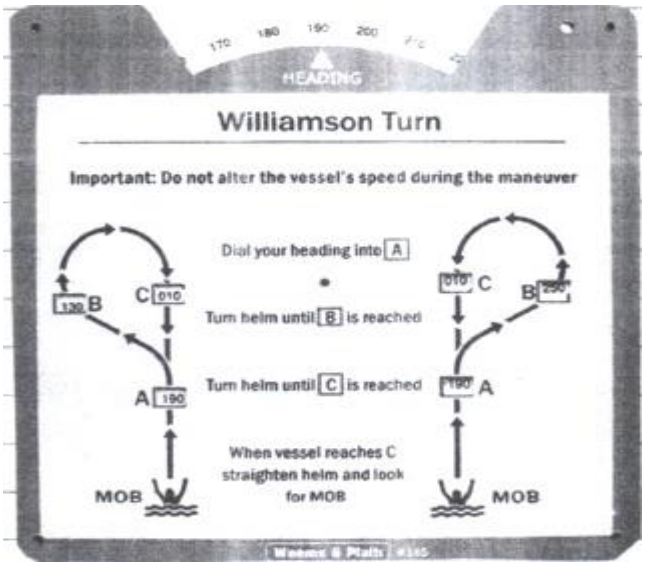


Figure 26. Man Overboard Instruction

2.15.4. Pilot

A pilot acts as an advisor in ship maneuvering. The presence of a pilot on board the ship will not reduce the duties and responsibilities of the captain of the ship.

2.15.5. Tug Boat

In ship maneuvering, the tugboats function to pull/push the ship to the designated place so that the ship's maneuvering can be carried out effectively, efficiently, safely, and under control.

CHAPTER III. INTERNAL AND EXTERNAL FORCE IN CONDUCTING SHIP MANEUVERING

In conducting ship maneuvering, there are internal and external forces that can be used to be able to maneuver quickly, precisely, safely, and efficiently. The internal and external forces include direct rudder force, indirect rudder force, rudder pressure force, the frictional force of the water against the forward hull, the kick/lift force and the drag force, the wind force, the current strength, and the following current.

3.1. Direct and Indirect Rudder Forces on Right-Handed Single Propeller Ships

The direct and indirect rudder force occurs when the ship maneuvers. It occurs when the ship is stopped and the engine makes forward motion, or when the ship is stopped and the engine makes aft motion.

3.1.1. When the Ship is Stopped, and the Engine Makes Ahead Movement

When the ship stops and the engine makes ahead movement, there will be a "DIRECT RUDDER FORCE" due to the action of the N force (normal pressure) on the blades of the propellers when the blades of the propellers rotate/hit the water around them. The value of the N force depends on the distance to the water surface (the N force on the lower blades is greater than the top blade), and makes the STERN OF THE SHIP moves to the right and the SHIP BOW move to the left.

Besides that, when the ship stops and the engine makes ahead movement, it will cause an "INDIRECT RUDDER FORCE" as a result of the rotation of blades against the surrounding water, where the water from the top blades will hit the bottom of the right rudder and water from the lower blade will hit the upper left rudder and the other will hit the left side of the stern (the water from the blades hitting bottom right rudder is greater than the water from the blades hitting the upper left rudder so that the indirect rudder force cause the STERN of THE SHIP move to left and the SHIP BOW moves to the right.

THE DIRECT RUDDER FORCE is greater than the INDIRECT RUDDER FORCE so that when the ship stops and the engine makes forward motion, it will cause THE STERN OF THE SHIP TO THE LEFT and the BOW OF THE SHIP TO THE RIGHT. (See the following picture)

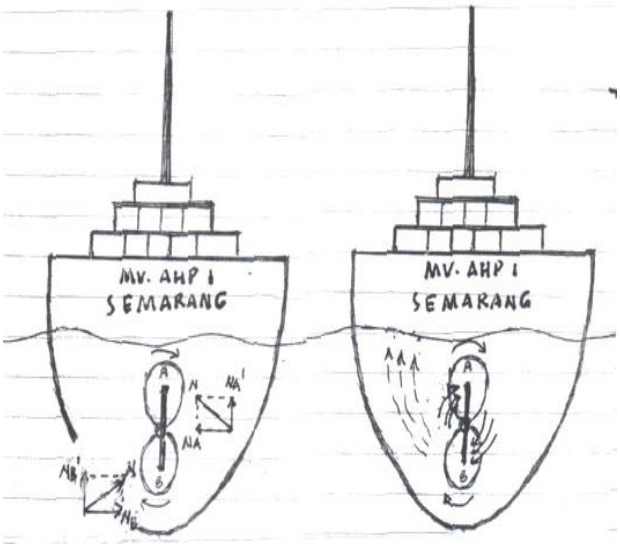


Figure 27. Direct Rudder Force and Indirect rudder Force when the Ship moves ahead

DIRECT RUDDER FORCE (The stern to the right, the bow to the left). INDIRECT RUDDER FORCE (The stern to the left, the bow to the right).

Direct rudder force → indirect rudder force causes the stern to the right, the bow to the left.

3.1.2. When the Ship is Stopped, the Engine Makes Astern Movement

When the ship stops and the engine makes astern movement, it will cause a "DIRECT RUDDER FORCE" as a result of the action of the N force (normal pressure on the blades of the propeller when the blades rotate the water around it), where the value of the N force depends on the distance to the water surface (the N force on the lower blade of the propeller is greater than that on the top blade of the propeller, so this direct rudder force causes the stern of the ship moves to LEFT and the bow of the ship moves to RIGHT). Besides that, when the ship stops and the engine makes an astern movement, it will cause an "INDIRECT RUDDER FORCE" as a result of the rotation of the propeller blades into the surrounding water, where the water from the upper blades will hit the bottom left rudder. The water from the lower blades will hit the upper left rudder, and some will hit the stern (The water hitting the bottom left is greater than the water hitting the upper right rudder, so this indirect rudder force causes the stern to the right and the bow to the left.) Because the astern movement power is always smaller than the ahead movement power, later, the ship's movement will follow the movement caused by the direct rudder movement, that is, the stern to the left and the bow to the right, so that on a ship that is stopped and the engine makes astern movement, the stern of the ship turn to the left and the bow of the ship turn to the right. (See the following picture).

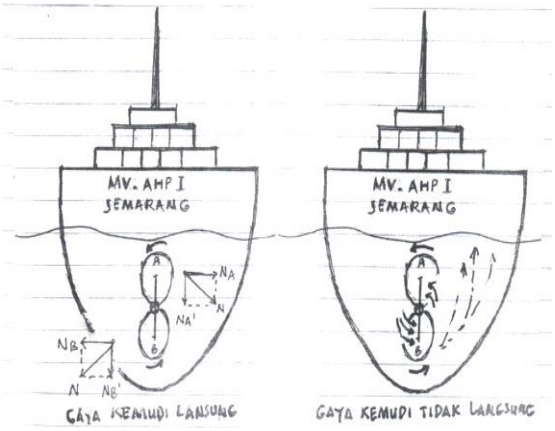


Figure 28. Rudder Force and Indirect Rudder Force when Ship Moves astern

The direct and indirect rudder forces when the ship is stopped and the engine makes ahead or astern movement can be used in maneuvering the ship.

Example 1:

When the ship berth at the starboard or portside of the quay

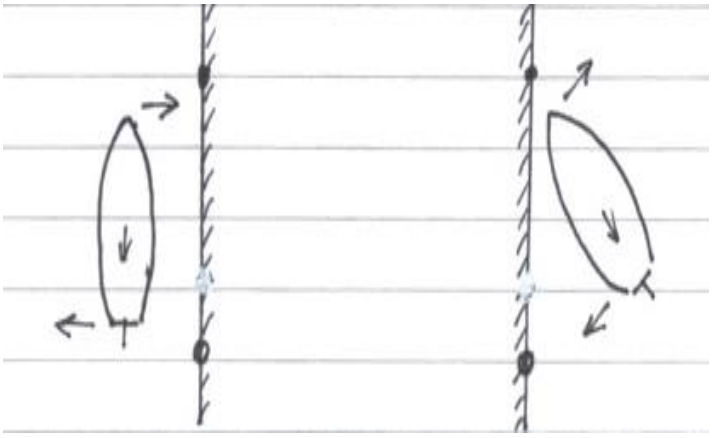


Figure 29. When the Ship will berth

Description:

1. When the ship will berth at the starboard side, approach the quay at a large angle/almost parallel to the quay. After the ship is close to the quay, stop the engine for a moment; then, the engine is moved astern so that the stern moves to the left, and the bow of the ship moves to the right approaching the quay for mooring, after that, the engine is stopped.
2. When the ship will berth to the portside, approach the quay with a small angle / sharp angle with the quay. After the ship's bow is close to the quay, to avoid collision with the quay, stop the engine. Then, move the engine astern so that the stern of the ship moves to the left and the bow moves to the right away from the quay.

Example 2:

When the ship moored at the mooring buoy.

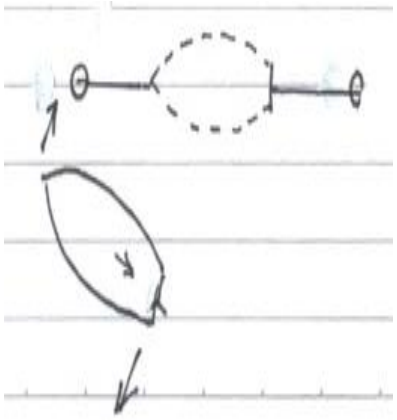


Figure 30. When the ship moored at the mooring buoy

Description:

The fore of the mooring buoy is approached from the portside, and to bring the ship's bow closer to the mooring buoy, the engine is stopped, then moves astern, so that the stern moves to the left of the bow moves to the right, approaches the mooring buoy for mooring.

3.2. Forces on the Double Propeller Ships

The ships that use double propellers for maneuvering ship mostly use right-handed propellers because they work more effectively compared to left-handed propellers. In the left-handed propellers, when the engine moves ahead, the water on the blades meets each other, so there will be a loss of power.

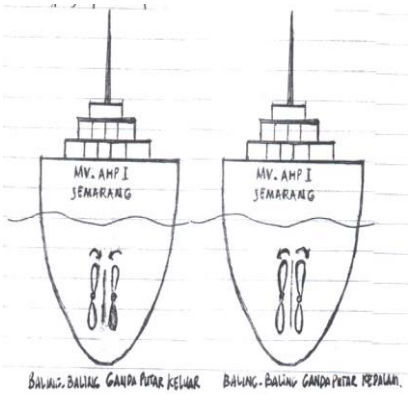


Figure 31. Forces on ships with Double Propeller

FORCES WORKING ON A DOUBLE PROPELLER SHIP WHEN THE LEFT ENGINE MOVES AHEAD AND THE RIGHT ENGINE STOPS.

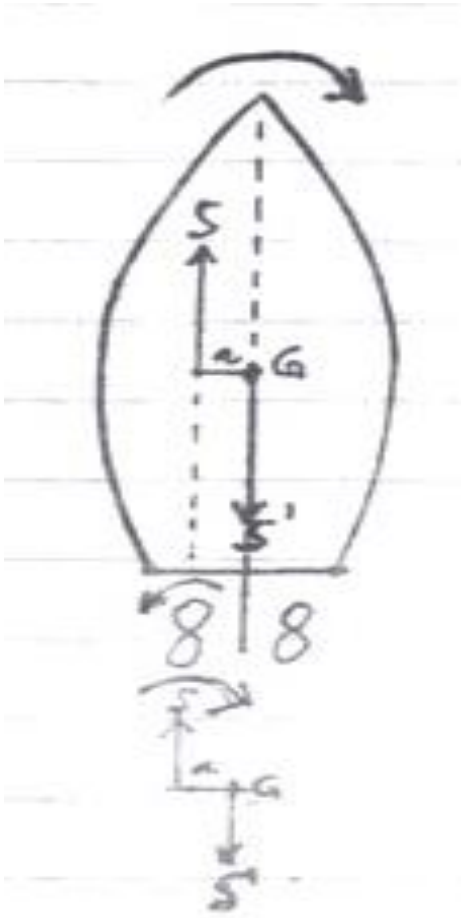


Figure 32. Forces working on Double Propeller Ship when the Left Engine is Moved Ahead and The right engine Stop

Description:

When the left engine is moved ahead (the left propeller rotates outward/to the left), then a force S (forward thrust) arises, which works on the extension of the left propeller shaft, where the S force also works at the G point (Centre of Gravity) but in the opposite direction. While in the extension of the right propeller shaft there is no S force, resulting in the emergence of a COUPLE MOMENT whose moment will turn the ship to the right.

FORCES WORKING ON A DOUBLE PROPELLER SHIP WHEN THE LEFT ENGINE STOPS AND THE RIGHT ENGINE MOVES AHEAD.

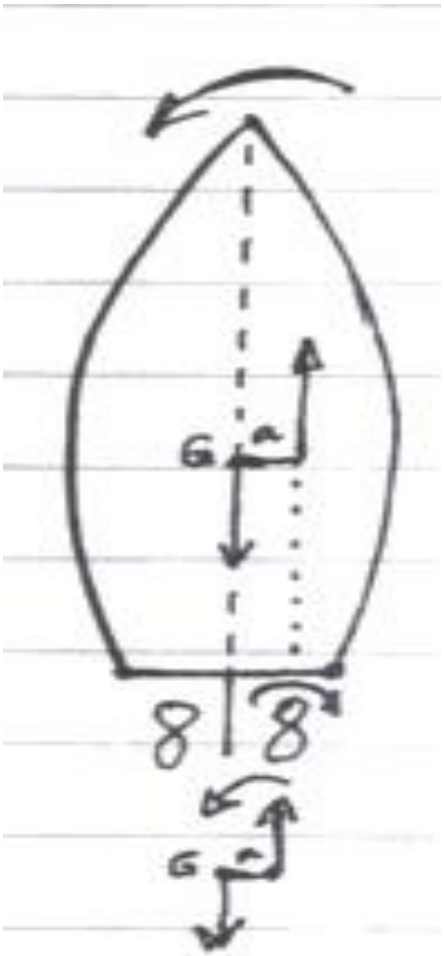


Figure 33. Forces working on Double Propeller Ship when the Left Engine Stops and The right engine moves ahead

Description:

When the right engine moves ahead (the right propeller rotates out/to the right), then a force S (forward thrust) arises, which works on the extension of the right propeller shaft, where the S force also works at the G point (the weight point), but in the opposite direction. At the same time, in the extension of the left propeller shaft, there is no S force, causing a COUPLE MOMENT whose moment will turn the ship to the left.

FORCES WORKING ON DOUBLE PROPELLERS SHIP WHEN THE LEFT ENGINE MOVES AHEAD, AND THE RIGHT ENGINE MOVES ASTERN.

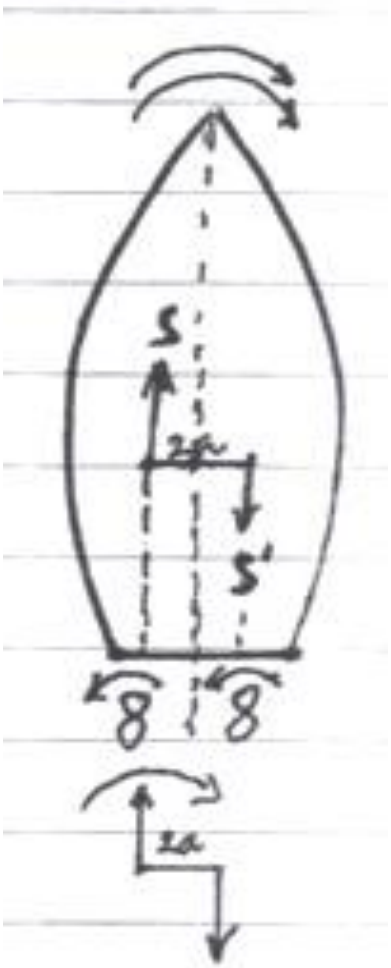


Figure 34. Forces Working On Double Propellers Ship When The Left Engine Moves Ahead, And The Right Engine Moves Astern

Description:

When the left engine moves ahead (the left propeller rotates outward/to the left) and when the right engine moves astern (the propeller rotates inward/to the left), an S force (forward thrust) works on the extension of the left propeller shaft. The extension of the right propeller shaft, a force S' (forward thrust force) arises, causing a COUPLE MOMENT whose moment will rotate/turn the ship to the right more quickly.

FORCES WORKING ON DOUBLE PROPELLERS SHIP WHEN THE LEFT ENGINE MOVES ASTERN AND THE RIGHT ENGINE MOVES AHEAD

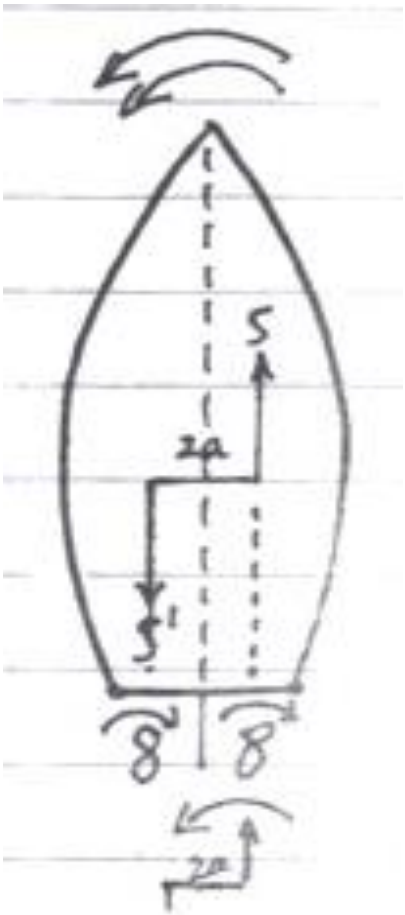


Figure 35. Forces Working on Double propellers ship when the left Engine moves astern and the Right engine moves ahead

Description:

When the left engine moves astern (left propeller rotates inward/to the right) and when the right engine moves ahead (right propeller rotates outward/to the right), then the S' force (forward thrust) works on the extension of the left propeller shaft. On the extension of the right propeller shaft, a force S (forward thrust) arises, causing a COUPLE MOMENT whose moment will rotate/turn the ship to the left more quickly.

3.3. Forces Working on Ship when it Moves Forward then The Rudder is turned to Right or Left

Forces working on the ship when it moves forward the rudder is turned to the right or left are:

1. The rudder pressure force (P force), as a reaction force to the turning rudder which works perpendicularly to the rudder, where this P force also works at G point (Centre of Gravity), thus causing a COUPLE MOMENT whose moment will turn the ship to the left-right.
2. P sin α (drag) force, as a result of the vertical force P works on the ship's centre of gravity (G point) which causes a decrease in the speed of the ship automatically (not changing the engine speed).
3. P cos α (kick/lift) force, as a result of the horizontal P force, works on the ship's center of gravity (G point) which causes the ship's movement widens to the opposite turning of the rudder.
4. The W force (the frictional force of the water with the forepart of the ship's hull as opposed to turning of the rudder), this force also works at G point (the center of gravity of the ship), causes an additional COUPLE MOMENT whose moment will turn the ship to the left/right.
5. The Push Force (S) works to push the ship forward.

We can use the forces mentioned above in the ship's maneuvering; for example, to avoid the danger that suddenly appears at the starboard bow of the ship, we steer hard-to-starboard because when turning, the ship's speed will decrease automatically (without changing the ship's speed).

The sketch of the forces is as follows:

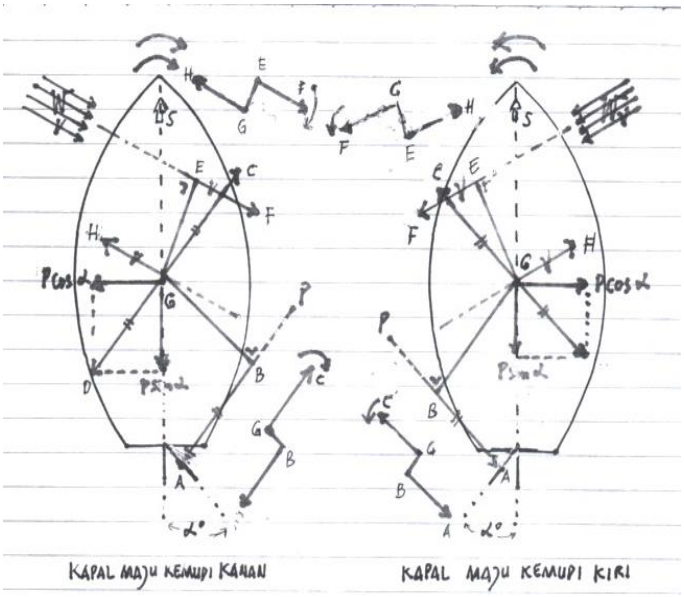


Figure 36. Forces Working when A ship Moves Forward, the Rudder is Turned to Left/Right

To Draw:

1. Sketch the longitudinal cross-section of the ship (seen from above) along with the angle of the rudder.
2. The rudder is divided into two equal lengths, and through that point, a perpendicular line is drawn, namely the P line (rudder push force), then transferred the P force line until it intersects the G point.
3. Make a perpendicular line through point G until it intersects the line of force P, then measure AB=GC=GD so that COUPLE GC=GB=BA arises.
4. Draw a force W line on the front hull opposite the rudder's turning, extend the line, and then transfer the force W until it intersects point G.
5. Make a perpendicular line through point G until it intersects the force W line, then measure W=EF=GH so that the COUPLE GE-GH-GF arises.
6. Make a copy of COUPLE as s result of forces P and W.

THE EFFECT OF FORCES WORKING ON A SINGLE RIGHT-HANDED PROPELLER SHIP WHEN MOVING FORWARD AND THE RUDDER TURNED TO THE RIGHT/LEFT ARE:

The force working on a single right-handed propeller affects the ship's handling, namely:

3.3.1. The Ship Turns to the Starboard Side

This is because when the rudder is turned to the right, there will be a rudder push force (P) which works perpendicularly to the rudder, where this P force also works on the Center of Gravity (point G), causing COUPLE whose moment will turn the ship to the right. (View image).

Note: A COUPLE is a pair of forces that are equal in value and works opposite way, and do not lie in a straight line working on a homogeneous object, causing this object to rotate.

3.3.2. The Ship's Speed Reduces Automatically When the Ship Turns (Without Changing Engine Speed)

This is because when the rudder is turned to the right, there is a P sin α (drag) force as a result of vertical the P force working on the center of gravity (point G), which causes the ship's speed to decrease automatically (without changing engine speed).

3.3.3. The Ship Turns Slightly to the Left before Right Turning

This is because when the rudder turns the right, a P cos α (kick/lift) force occurs as a result of the horizontal P force working on the center of gravity (point G), which causes the widening movement to the left (opposite to the direction of the turning rudder leaf).

3.3.4. The ship Turns Faster without Increasing the Rudder Angle

This is because when the ship has turned, the W force works (the frictional force of the water with the hull of the bow opposite to the turning of the rudder), where the W force is also on the center of gravity

(point G), causing an additional COUPLE whose moment turn the ship to the right more quickly.

3.3.5. The Ship Listing When Turning.

1. At first, the ship is listing to the starboard side (inward/toward the turn of the rudder) caused by the action of the rudder push force working under G point where this P force also works on the Center of Gravity (point G), causing a COUPLE whose moment will list to the starboard side (toward the turn of the rudder).
2. After a moment (after the ship turns at a constant speed), the ship will return upright because when the ship is listing to the starboard side (inward/toward the turn of the rudder), a entrifugal force arises that leads to the Center of Gravity (point G) and centripetal forces that lead to the Center of Buoyancy (point B), causing COUPLE whose moment will raise the ship.

CHAPTER IV. SHIP PREPARATION FOR MANEUVERING

To make ship maneuvering effective, efficient, safe, and under control, it is necessary to prepare everything related to maneuvering for each destination, such as maneuvering during the departure/arrival at the port, anchoring operation, maneuvering in narrow waters, in restricted visibility/bad weather, and etc.

4.1. The Preparation for Ship Maneuvering

4.1.1. Assigning One Hour Notice (OHN)

One Hour Notice (OHN) is an order from the captain addressed to those involved in the implementation of the ship's maneuvering (the chief engineer and the engineer on watch, the officers, and other crew members) to prepare the equipment one hour before the ship departs. The One Hour Notice is signed by the captain and those involved in the implementation of the ship's maneuvering.

4.1.2. Preparing the Necessary Equipment

In preparing the equipment used in a ship maneuvering, there are 2 (two) important things that must be considered; including the equipment that must be checked/tested and which equipment does not need to be tested (just make sure that the equipment is in good condition and ready for use).

1. Equipment that must be checked/ tested before use, include:
    a. Main Engine (Propeller).
    b. Telegraph.
    c. Steering Gear (manual, autopilot, emergency steering gear, and Rudder indicator)
    d. Thruster control and indicator.
    e. CPP (Controllable Pitch Propeller) and its indicator.
    f. Radio Communication.
    g. Navigation Light.
    h. Ship's whistle.
    i. Window Whistle.
2. Equipment that does not need to be checked/tested (just make sure that the equipment is in good condition and ready for use during ship maneuvering), include:
    a. Anchor Arrangement.
    b. Echosounder.
    c. Compas and Repeaters.
    d. Ship Positioning Devices (Radar and GPS).
    e. Ship's Watch.
3. Prepare for the Pilot Poarding
    When the ship is guided by a Pilot when entering/ leaving the port, to ensure safety, some equipment is needed, including:
    a. Pilot Ladder.
    b. Gangway equipped with nets.
    c. The combination of the gangway and pilot ladder when the height is more than 9 m.
    d. Pilot hoist if the Pilot uses a helicopter.
    e. Man Ropes.
    f. Hull Light.

g. Lifebuoy that has been equipped with a light and a lifeline of 27.5 m in length.

h. Torch.

i. Radio Communication.

j. Life jacket.

k. P and G Flag.

4. Preparing the mooring lines.
   The mooring lines that will be used to moor the ship at the pier/buoy, such as headlines, spring lines, breast line, wire ropes, and wire tug, must be well prepared and ready to use (including heavy line).

5. Preparing equipment for ship maneuvering
   Besides the equipment that has been mentioned previously, it is necessary to prepare other equipment for ship maneuvering, such as:

   a. Ship Maneuvering Log Book.

      This book is used to record the activities carried out during the ship maneuvering (when the engine is fully ahead, half ahead, dead slow ahead, stop, full astern, half astern, dead slow astern, during FWE, when the first mooring ashore, etc.)

   b. Passage Planning.

      It is used to guide the ship's movement to avoid navigational dangers while maneuvering.

   c. Navigational Publications.

      It is used to obtain information about navigational hazards.

   d. Flag Signs and Object Signs.

      It is used for visual cues during the ship's maneuvering.

   e. Binocular.

      It is used to monitor the area around the ship.

CHAPTER V. WORKING PROCEDURES OF SHIP MANEUVERING DURING PILOTAGE

To conduct ship maneuvering (especially in areas with many navigational hazards) effectively, efficiently, safely, and under control, when the ship enters/leaves the port, a pilot service is needed to guide the maneuver of the ship.

Pilots are employees of the local port authority who have a special duty to guide ships during maneuvering when entering and or leaving ports/other areas that require pilotage.

The pilot's responsibility on the ship is as an adviser to the implementation of the ship maneuvering because the pilot is very familiar with the conditions of the areas where the ship will be guided.

If the pilot's orders can endanger the ship's safety, the captain can refuse the pilot's orders under the existing procedures.

In the ship pilotage, the terms Compulsory Pilotage and Not Compulsory Pilotage are known.

5.1. Compulsory Pilotage

Compulsory Pilotage refers to the areas that require pilotage services. Every ship which enters/leaves these areas is required to use pilot services due to the risks of navigational hazards that can endanger the safety of the voyage.

5.2. Advantages of Not Using Pilotage Services in Non-Compulsory Pilotage Areas

The advantages of not using pilot services in non-compulsory pilotage areas are:

1. Cut the ship's operating costs.
2. Save the voyage time.
3. Ensure the Ship's safety.

5.3. Non-Compulsory Pilotage

Non-Compulsory Pilotage refers to the areas that do not require pilotage services. Every ship which enters/leaves these areas does not require a pilot service. Still, to improve the safety of ships from navigational hazards, pilot services may be used.

5.4. Disadvantages of Not Using Pilotage Services in Non-Compulsory Pilotage Areas

The disadvantages of not using a pilotage service in non-compulsory pilotage areas are:

The safety of the ship during navigation cannot be guaranteed because the ship maneuvering when entering/leaving the area is only carried out by the captain without consideration of a pilot, who is more familiar with the condition of the area.

5.5. The Cooperation between the Captain and the Pilot in Navigating the ship

The cooperation between the captain and the pilot in navigating the ship includes:

1. The captain and the pilot must build good cooperation in checking the ship's position and movement accurately.
2. The captain and pilot must exchange information related to navigation procedures, ship characteristics, and local conditions.

3. Although the pilot's duty in navigating the ship is to carry out direct navigation, the presence of the pilot on the ship does not reduce the functions and responsibilities of the captain.

5.6. Exchange Information

The exchange of information between the captain and the pilot related to the pilotage of the ship must be understood and agreed upon by both parties, so that the pilotage of the ship can be carried out effectively, efficiently, safely, and under control.

This information exchange is carried out through filling out forms for ship pilotage, namely: "shore to ship pilot/master exchange" and "ship to shore master/pilot exchange," as well as "pilot boarding chart."

5.7. Shore to Ship/Master Exchange

It refers to a form of exchange of information from shore to ship regarding pilotage which contains the following data:

1. Ship Requesting Pillotage Details, consisting of ship's name and ship's call sign.
2. Originating Authority, such as the name of the contacted officials, VHF channel, and other necessary equipment.
3. Pilot Boarding Instructions, such as the date and time of arrival of the ship at the Pilot Station, the position where the pilot will be boarded, which side of the hull the pilot will be boarded (starboard or portside), the course and speed in approaching the pilot station, and the equipment needed to board the pilot.
4. Berth dan Tug Details, such as the purpose of berthing, the side of the hull where the ship will berth (starboard or portside), the duration of berthing, the position and the number of the tugboats, and the ship equipment needed.
5. Local Weather and Sea Conditions at the Pilot Boarding station on arrival, including tidal conditions (water level and time), current conditions, and weather forecast.

6. Details of the Passage Plan, including abort points/Emergency Plans.
7. Regulations Including VTS Reporting, anchor/lookout attendance, and maximum allowable draught.
8. Other important details include navigation hazards and ships movement.

5.8. Ship to Shore Pilot/Master Exchange

It refers to a form of information exchange from ship to shore regarding pilotage which include the following data:

1. Ship Identity includes ship's name, call sign, flag, agent, year of build, SMO number, type of cargo, and last port visited.
2. Additional Communication Information such as fax number, telex number, etc.
3. Pilot Boarding, including date and ETA of the ship, Free Board, and Boarding Position (starboard/portside).
4. Ship Particulars include fore draft, aft draft, main draft on the water/air tower, air draught, LOA, beam, Displacement, DWT, Gross Tonnage, and Nett Tonnage.
5. Anchors, including the length of right and left chain
6. Manouvering Details at Current Condition, including Full speed, Half Speed, Slow Speed, Minimum Steering Speed, the direction of the propeller, presence of Controllable Pitch, and the number of forward thrusters and aft thrusters.

5.9. Pilot Boarding Chart

It is a form that must be filled out by the ship crew regarding pilotage which includes the following information:

1. Ship's Particulars, including ship's name; ship's call sign; Displacement; DWT; LOA and Beam; fore draft, aft draft, and main draft; bulbous bow; thruster; air draft; the length of right/left chain; etc.

2. Main Engine data such as type of the main engine; maximum power (KW/HP); Engine critical RPM; Time full ahead to full astern (second); time limit astern (minute).
3. Steering, such as the number and type of rudder; maximum angle of the turning rudder; time duration from hard-to-starboard to hard-to-port (second).
4. Propeller such as number and type of propeller rotation; Controllable Pitch Propeller (CPP) if any; thruster (front/aft) if any.
5. The results of maneuvering equipment checking, include anchor arrangement, steering arrangement, telegraph, compass, mooring winch, echosounder, Speed log, mooring winch, etc.
6. Equipment malfunctions/errors of the devices.

5.10. Bridge Check List for Ship Pilotage When the Ship Will Enter A Port/Depart From A Port

To avoid mistakes in the activities related to pilotage, it is necessary to make a checklist that contains the following information:

1. The readiness of OHN (One Hour Notice).
2. The readiness of the propulsion of the ship for maneuvering.
3. The readiness of ships' documents for clearance to enter the port.
4. The readiness of ship maneuvering equipment, by testing the telegraph, steering gear, ship's whistle, VHF and portable radio communications, thruster control, CPP control, communications devices, and navigation lights.
5. The readiness of passage planning.
6. The readiness of equipment in pilot boarding.
7. The readiness of anchor, light of anchoring, anchoring objects.

5.11. The Procedures in Providing Services to Pilot

As an advisor during ship maneuvering, a pilot is very familiar with the conditions of the areas in their territory. Considering the important role of a pilot, the safety of the pilot starting from the moment of stepping on the first ladder when boarding the ship to stepping on the last ladder

when leaving the ship becomes the responsibility of the captain. While staying on board the vessel, a pilot must receive good services.

The procedures for providing services to pilots while on board are:

5.11.1. Install the Pilot Ladder According to the Request

Install the pilot ladder according to the pilot's request properly and correctly, such as the steps must not be tilted, the ladder must not be slack, the end of the ladder on the ship must be permanently tied, and the steps on the water must be above the water level according to the pilot request.

5.11.2. Picking up the Pilot

An officer must be appointed for picking up the pilot with the following tasks:

1. Supervise the pilot while he is climbing the pilot ladder.
2. Carry out communication with the bridge using a VHF portable radio.
3. Bring a torch for lighting at night.
4. When the pilot falls into the sea, shout loudly, "Man Over Board."

5.11.3. Officer on Watch (Oow) with the Duties

1. The task of oow (officer on watch) when the pilot has boarded the ship, but the ship has not sailed:
    a. Completing ship pilotage forms, such as Ship to Shore Master/Pilot Exchange; Shore to Ship Pilot/Master Exchange, and Pilot Boarding Chart.
    b. Filling out the ship's maneuvering book.
    c. Raising the G flag (during the day) and turning on the white and red lighting vertically on the bridge.
    d. Providing important data from the ship, such as:
        1) Ship's Draft (water draft dan air draft).
        2) Engine speed and ship speed on standard telegraph setting.
        3) Number of propellers and ship engine type.

4) The shape and number of rudders.
5) Thruster availability.
6) Squats.
7) Turning circle diagram.
8) Stopping distance diagram.
9) Z-maneuver diagram.
10) Skip condition.

2. The duties of oow (officer on watch) when sailing with pilot.
   a. Assist the pilot in communication.
   b. Handle the telegraphs.
   c. Monitor the execution of helm orders.
   d. Monitor the engine speed.
   e. Monitor the operation of navigation equipment.
   f. Monitor the movement of the ship and other ships.
   g. Monitor the water depth.
   h. Turn on/off navigation lights.
   i. Show important objects.
   j. Record important maneuvering activities in the ship's maneuver book.
3. The duties of OOW (officer on watch) when conducting telegraph works.
   a. Always stand as close to the telegraph as possible until the important maneuver is completed.
   b. Pay attention to every command of the captain/pilot and repeat the order to ensure it is correct.
   c. Record the time of execution of the captain's orders/pilot into the ship's maneuvering log book.
   d. When uncertain about the order given by the pilot, immediately clarify it to the pilot. If there is still doubt, immediately report it to the captain and take the necessary action.

5.11.4. Pilot's responsibility

1. The pilot's duty on board is to carry out direct ship navigation and advise the captain on using anchors, mooring, and towing lines.
2. Although the pilot's duty on board is to carry out direct navigation, his presence on the ship does not reduce the duties and responsibilities of the captain.
3. The captain and pilot must exchange information related to navigation procedures, local conditions, and ship characteristics.
4. The captain and pilot must cooperate as well as possible to check the ship's position and movement accurately.
5. Carry out the ship maneuvering in embarking and disembarking of the pilot.

Approaching pilot station.

When approaching the pilot station to disembark the pilot, the actions taken by the parties are:

1. The captain informs the tug boat where the pilot ladder is installed and other important information.
2. After the pilot disembarks/leaves the bridge to the embarkation pilot leaving, the captain maneuvers the ship until the tug boat is alongside the ship.

5.12. Boarding the Pilot

1. The captain must create safe conditions for the tug boat approaching the hull side by turning the ship, creating a calm sea level on the leeward side.
2. The captain must communicate with the pilot using the radio. Usually, the pilot will instruct the ship to install the pilot ladder and the height of the bottom step to the water level.
3. When boarding the pilot, make sure that the engine is stopped.

5.13. Disembarking the Pilot

When disembarking the pilot from the ship, the following actions must be taken:

1. Disembark the pilot through the prepared pilot ladder on the lee side and keep an eye on him until he boards the pilot boat.
2. The captain stops the engine until the pilot boards the pilot boat.

5.14. Clearing the Pilot Station

When the pilot has disembarked from the ship to leave the Pilot Station, the actions that must be taken by the crew ship include:

1. The ship is steered safely from the pilot station to WP I.
2. OOW must fully understand the orders of the captain.
3. If the course is on TRACK and free from the Port boundary, the captain will determine Full Away and hand over the watchkeeping to OOW.

If the OOW is uncertain about the actions taken by the pilot while navigating, he must clarify it to the pilot. If doubt still exists, he must notify the captain as soon as possible and take necessary action to save the ship before the captain arrives at the bridge.

5.14.1. Communication in Ship Pilotage

The ship's communication with the pilot must be clearly stated using radio communication tools. Every order from the pilot must be clarified to ensure the accuracy of the order. The following are examples of radio communication from pilot to the ship.

1. Captain, we are coming up to the pilot station, please rig pilot ladder on starboard side one meter above the water.
   Actions to be taken:
   a. Clarifies the command to the pilot.
   b. Prepare ship pilotage forms, such as pilot boarding charts, and exchange information between the captain and pilot.

c. Prepare Clearance documents.

d. Order the officer of the watch to prepare a pilot ladder installed on the right side, rigging 1 (one) meter above the water along with its equipment, such as Man rope, life jacket, spotlights, etc. If the height is more than 9 m, the pilot ladder is combined with the gangway; The ladder must not be tilted, and the ladder must not be slack.

e. Appoint one of the officers to pick up the pilot.

f. Immediately create a safe situation for the pilot boat to approach the ship when the pilot is close.

2. Stop engine and steady, let me know when she does not answer the wheel.

   Actions to be taken:

   a. Clarify the command to the pilot.

   b. Order the officer on watch to stop the ship/stop the engine and steady as she goes

   c. Report to the captain if the engine stops when the ship does not answer the wheel.

   d. Wait for the following command from the pilot and immediately carry out the order after the pilot gives the order.

3. Captain, when i have left keep steering zero zero three, this will take you to the fairway buoy, pass the buoy then you can set course to the east.

   Actions to be taken:

   a. Clarifies the command to the pilot.

   b. Carry out the pilot's order. After the pilot disembarks, maintain the ship's course 003^0 until the outer buoy passes a little over the buoy and then changes the course to the east.

   c. Perform an accurate check of the position and movement of the ship.

d. Monitor the operation of ship navigation tools.
e. Record actions in the ship's log book.
f. Carry out proper observations of the surrounding using existing equipment.

CHAPTER VI.
WORKING PROCEDURES IN SHIP MANEUVERING CONTROLLING TECHNIQUES WHEN SAILING IN NARROW AND SHALLOW WATERS

When maneuvering in narrow waters where the ship cannot freely navigate, there are some things/actions that the captain and Officer on Watch (OOW) must consider, include:

6.1. The Correlation to Bernoulli's Law

Bernoulli's law states that the pressure of a moving fluid such as air decreases when the fluid is moving faster. It proves that the greater the velocity of the fluid, the lower the pressure, and vice versa; the lower the velocity of the fluid, the greater the pressure.

In correlation with that, when the ship sails in narrow water (river), the speed of the current increases, then the pressure weakens (the pressure decreases) so that if the ship moves at high speed, it will cause bow waves, the water surface on both sides of the hull declines, weak currents, tidal currents, and stern waves. (view image).

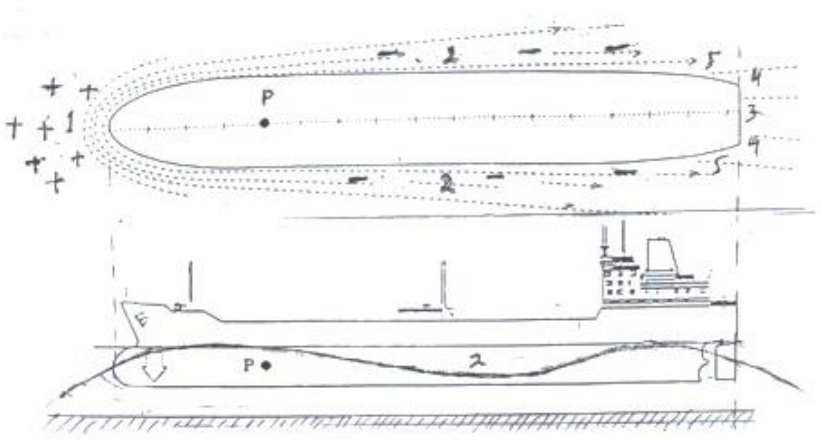


Figure 37. Bow Wave

Description:

1. Bow wave.
2. The water level on both sides of the hull declines.
3. A weak current at the extension of the ship's axis.
4. The following current.
5. The stern wave.

The five events mentioned above are known as "general phenomena" when the ship sails in narrow and shallow waters.

6.2. Dangers That Can Occur When Sailing in Narrow and Shallow Waters

When a ship sails in narrow and shallow waters at high speed, there might be dangers to the safety of the ship, including:

1. Cushion dan suction effect.
   The cushion and suction effects occur when the ship sails too far from the track and moves at high or change speed.

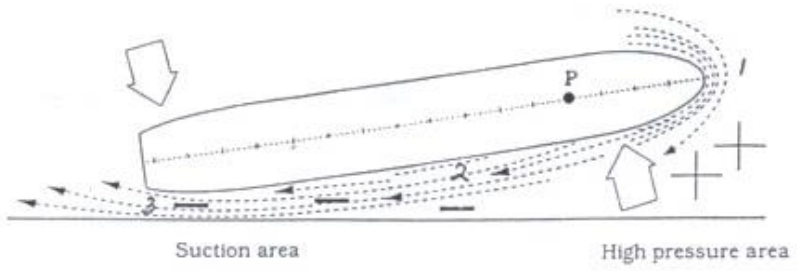


Figure 38. Cushion and Suction Effect

Description:

If the ship sails too far from the track axis (too close to the right), then the following situation occurs:

The area between the ship and the bank will appear:

a. Between the ship's bow and bank, there is high pressure (++).
b. Between the mid-length of the ship to the stern

Maneuvering techniques to avoid cushion and suction effects.

a. The correct ship maneuvering in narrow waters.

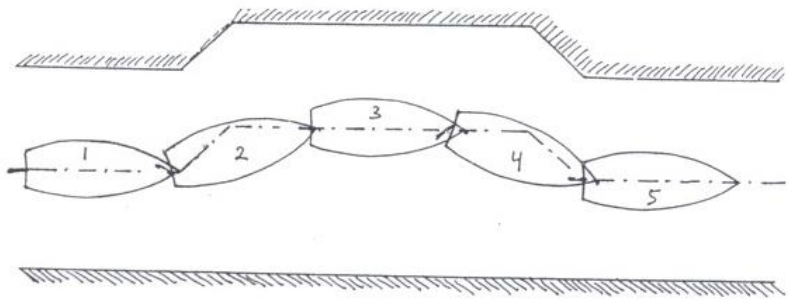


Figure 39. The Correct Ship Maneuvering in Narrow Waters

Description:

Position 1 – The ship is on the track axis, the wheel is in midship position.

Position 2 – The wheel is turned to the port side to place the ship on the widened water area.

Position 3 – Now, the ship is in the widened area, the wheel is in midship position.

Position 4 – The wheel is turned to the starboard side to turn the ship on the next track.

Position 5 – The ship is on the track and the wheel is in midship position.

b. The incorrect ship maneuvering in narrow waters.

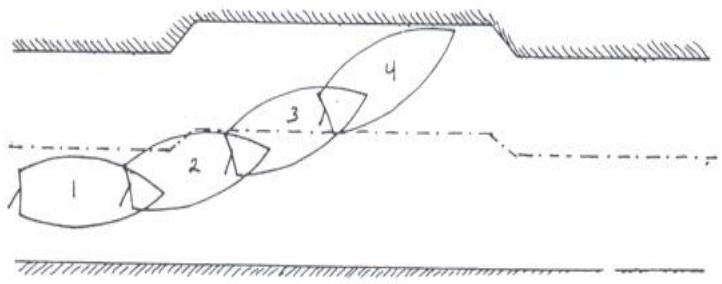


Figure 40. The incorrect ship maneuvering in narrow waters

Description:

Position 1 – The ship is too close to the bank, and the wheel is turned to the starboard side.

Position 2 – Due to the Suction Effect, the stern of the ship will be absorbed by the bank, and because of the Cushion Effect, the ship's bow will sheer away from the bank.

Position 3 – Even though the wheel is turned to the starboard side, the bow will still sheer away from the bank.

Position 4 – Even though the wheel remains on the starboard side, the ship's bow will enter the widened area.

c. Ship maneuvering in narrow zig-zag waters if current comes from the front side to avoid suction and cushion effect.

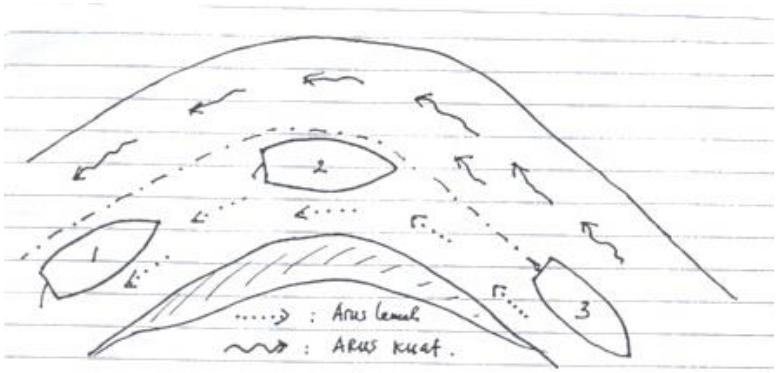


Figure 41. Ship Maneuvering In Narrow Zig-Zag Waters If Current Comes From The Front side To Avoid Suction And Cushion Effect

Description:

Position 1 – The ship is placed in such a way on the inner side of the fairway (to the right side of the fairway) where there is a weak current flowing so that the ship's bow does not enter the area of a strong current (not open to currents). With the support of the wheel to the starboard side slightly and the engine is full ahead, the ship will be in Position 2.

Position 2 – To protect the ship's bow from the current, the speed of the engine is increased, the wheel is hard a-starboard, and the ship will be in point 3.

Position 3 – Next, the ship sails to its destination on the track axis.

The outer side of the waters is located to the left of the track axis when the waters turn right.

The inner side of the water is located to the right of the track axis when the waters turn right.

d. Ship maneuvering in narrow zig-zag waters if the current comes from the back side to avoid suction and cushion effect.

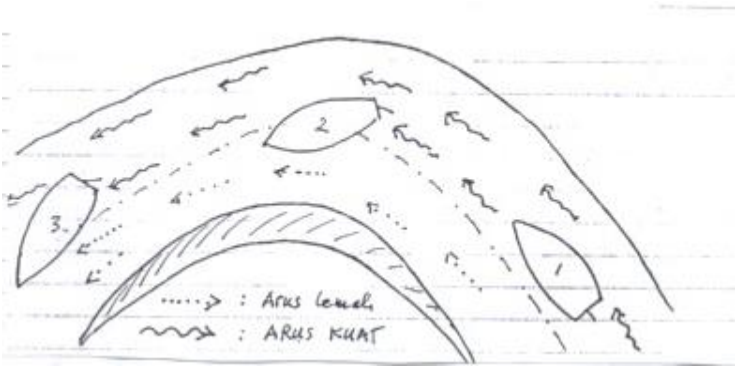


Figure 42. Ship Maneuvering In Narrow Zig-Zag Waters If The Current Comes From The Back Side To Avoid Suction And Cushion Effect

Description:

Position 1 – The ship is positioned on the outer side of the track (to the right side of the track axis), where there is a strong current so that the current will push the ship's stern. With the support of the wheel turning to the port side slightly and the engine is full ahead, the ship will move to Position 2.

Position 2 – To avoid the ship's stern being thrown to the bank, the engine is full ahead and the wheel is hard a starboard; the ship will be in Position 3.

Position 3 – The ship sails to its destination on the track axis.

The outer side of the water is located to the right of the track when the water turn left.

The inner side of the water is located to the left of the track if the water turn left.

e. Ship's maneuvering in narrow waters that have a steep bank.

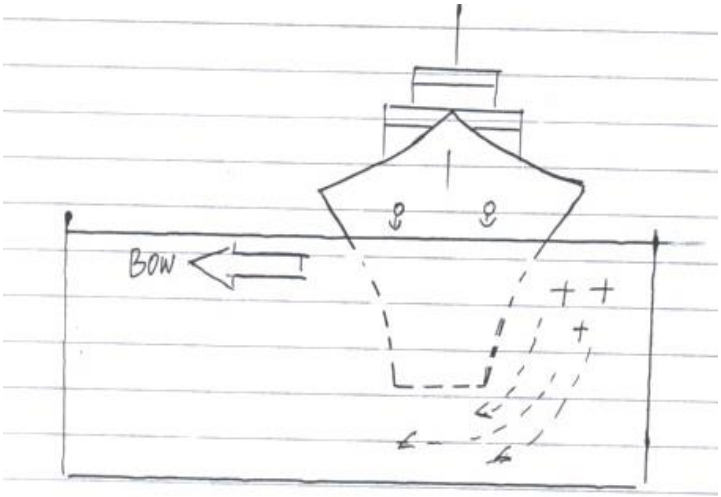


Figure 43. Ship's Maneuvering In Narrow Waters That Have A Steep Bank.

Description:

1) In narrow waters with a steep bank, the ship's bow will be pushed away from the bank because the area between the bow has high pressure.
2) Because of the bow waves, the ship's bow will be pushed from the bank to the right.

f. Ship maneuvering in narrow waters that have a slope bank.

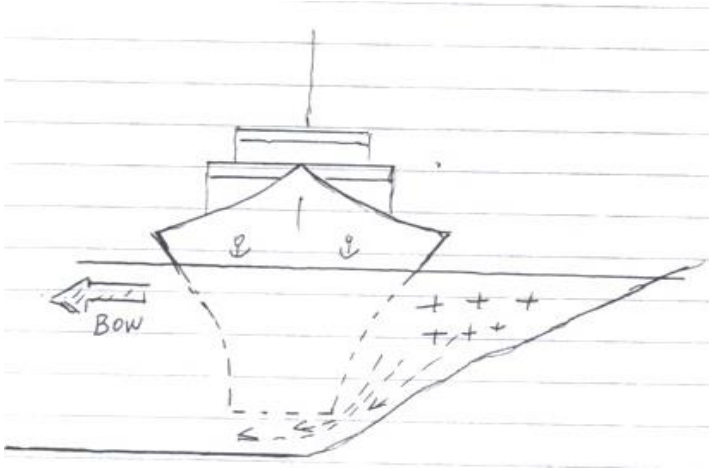


Figure 44. Ship Maneuvering In Narrow Waters That Have A Slope Bank.

Description:

In narrow waters with a sloping bank, the ship's bow will be pushed from the bank because the area between the bow has high pressure.

g. The effect of shallow water in turning circle.

1) The List of the Ship

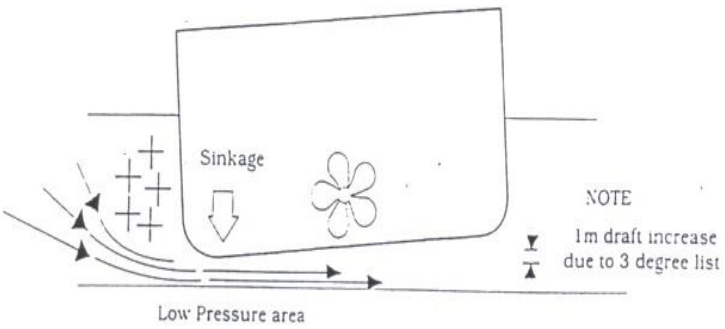


Figure 45. The List of the Ship

2) Lateral Resistance

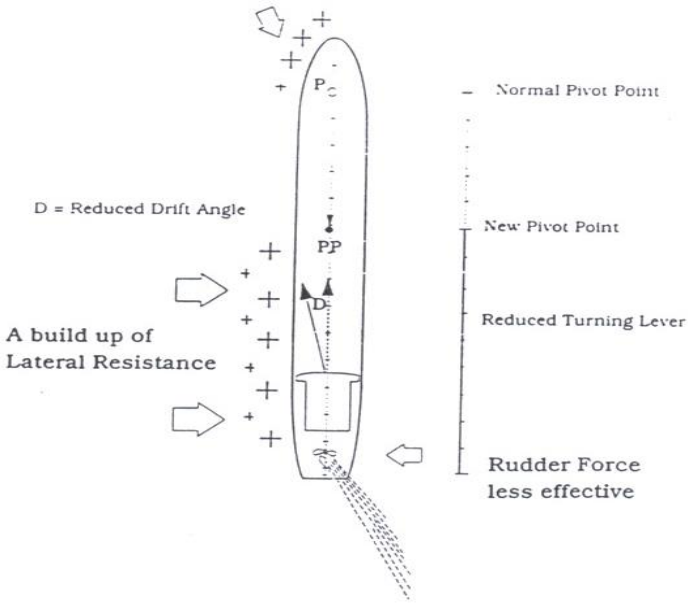


Figure 46. Lateral Resistance

2. Interaction between ships when two ships are passing and overtaking.

   Interaction between ships occurs if two ships are too close to each other while sailing in narrow waters and moving at high speed. The interaction between these vessels may result in a collision.

   In order to maneuver the ship in narrow and shallow waters effectively, efficiently, safely, and under control, there are several things that need to be understood and implemented by the captain, officers, and pilot, including:

   a. Stages when passing.

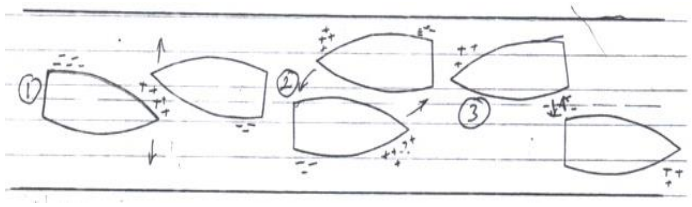


Figure 47. Stages when Passing

Description:

1) Stage 1 is when the bows are close to each other (will pass).
2) Stage 2 is when the two ships exactly/nearly pass each other.
3) Stage 3 is when the stern of the ship is close to each other (after passing).

   b. Stages on overtaking.

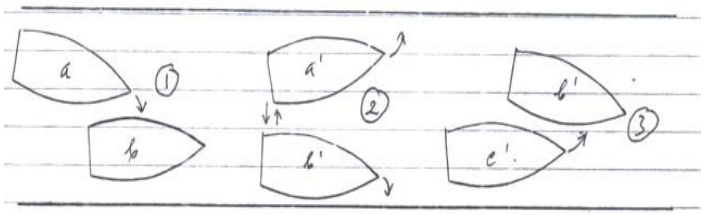


Figure 48.Stages on overtaking

Description:

Ship a will overtake ship b.

c. Interaction between ships when passing

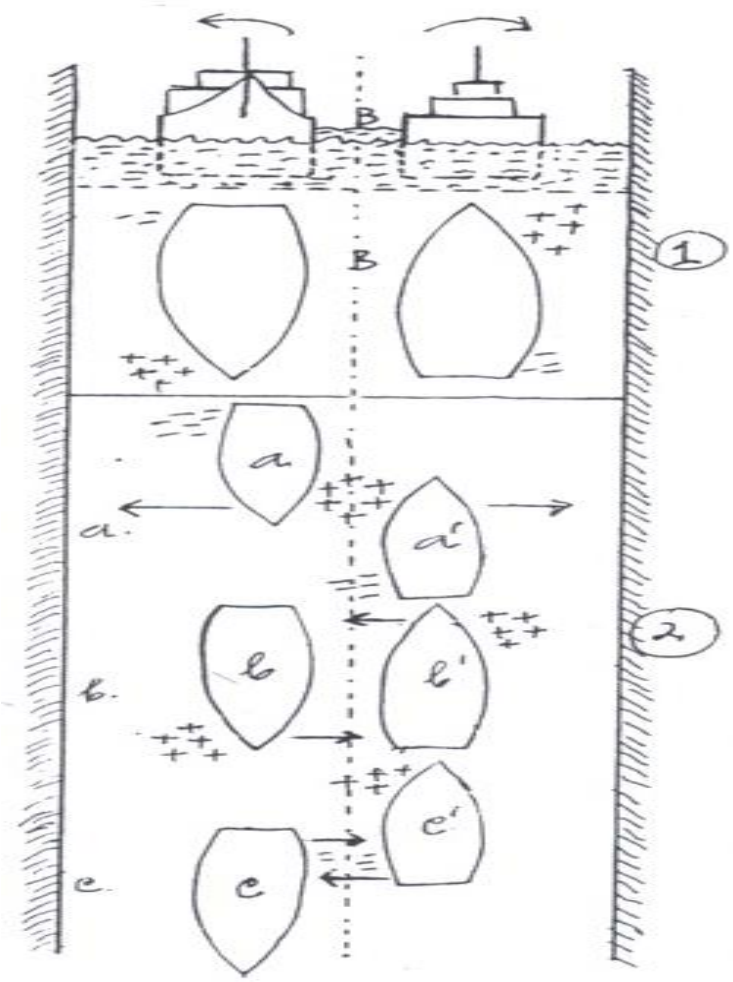


Figure 49. Interaction between two ships when passing

Description:

The interaction occurs because the upper side of the two vessels moves away from each other, and the lower side approach/absorbs each other.

This situation is caused by general phenomenon no. 2 (water level on both sides of the ship's hull drops), which causes the water surface on the right, left, and in the middle of the two ships to drop, where the lower water level will be filled by water from the surroundings, due to water dropping in area B is not too deep (because the process of passing is fast), the water fills the area B too much so that it accumulates there. As a result, the top of the ship will move away from each other, and the bottom of the ship will get closer/absorb each other.

1) Position a: each bow of the ship away from each other.
2) Position b: each bow of the ship will lead to the other ship's stern.
3) Position c: each stern will approach each other.

The techniques of ship's maneuvering to avoid the condition are as follows:

1) Position 1:
   - Each ship alters course to the port side.
   - reduce the speed and don't get too close.
2) Position 2:
   - Each ship alters course to the starboard side.
   - reduce the speed and don't get too close.
3) Position 3:
   - Each ship alters course.
   - reduce the speed and don't get too close.

d. The techniques of ship's maneuvering when passing to avoid interaction between ship.

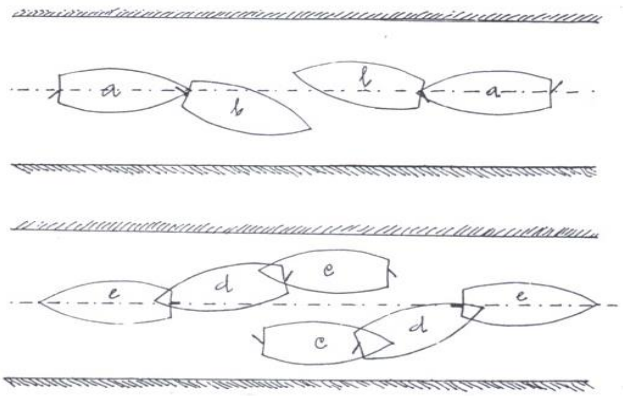


Figure 50. The method of Ship maneuvering in Passing to avoid Ship's Interaction

Description:

1) Position a: each ship steers to the starboard side to be able to pass each other on the left.
2) Position b: each ship steers to the port side so that each ship's bow does not move away.
3) Position c: each ship steers to the port side.
4) Position d: each ship steers to the starboard side so that the stern is not pushed to the bank.

e. Interaction between ship when overtaking (ship a overtake ship b)

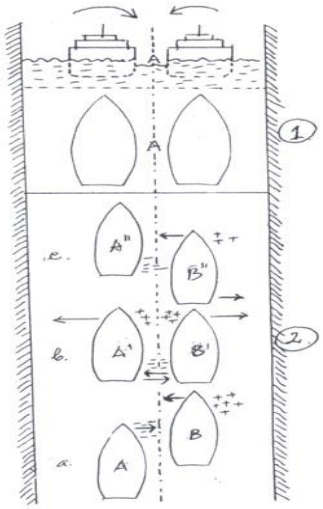


Figure 51. Ship's Interaction when overtaking (Ship A Overtakes ship B)

Description:

The interaction occurs because the upper parts of the two ships approach each other, and the lower parts move away from each other.

This situation is caused by general phenomenon no. 2 (the surface of the two sides of the ship's hull drops), which causes the water level on the right, left, and middle of the two ships to drop, where the drop of water level will be filled by water from the surroundings. However, because the water drop in area A is too deep (because the overtaking process takes a long time) then, the water that fills area A is very less; as a result, the top of the ship is getting closer/absorbed, and the bottom of the ship is moving away from each other.

1) In Position a: the bow of ship A will hit ship B, and the bow of ship B will intercept ship A.
2) In Position b: the two bows of the ship moved away, and the stern of the ship approached each other.
3) In Position c: the bow of ship B will hit ship A.

The actions that need to be taken are as follows:

1) Don't get too close in a passing or overtaking situation.
2) Reduce the speed of the ship.
3) The ship that will overtake asks permission from the ship to be overtaken according to existing procedures. If the ship that will be overtaken disagrees, then do not overtake.

f. The techniques of ship's maneuvering in overtaking situation to avoid interaction between ship.

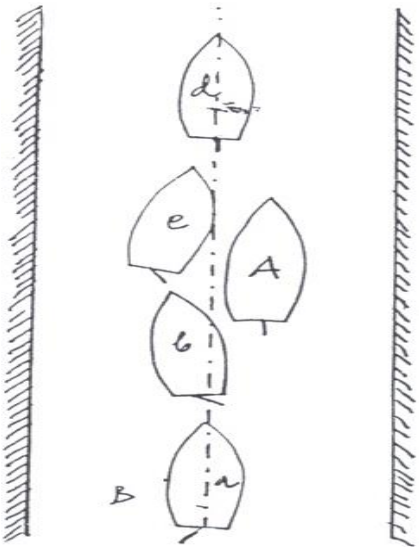


Figure 52. Techniques of Ship maneuvering in Overtaking Situation to Avoid Interaction Between Ships

Description:

1) Ship B will overtake Ship A, So Ship A will reduce the speed and place the wheel midships.
2) Ship B also reduces the speed, and when in:
   a) Position a: steer to the port side, away from Ship A.
   b) Position b: steer to the starboard side to prevent the bow from being pushed to the bank.

c) Position c: steer to the starboard side, in order to make the stern away from ship A.

d) Position d: steer to the port side to place the ship at the track.

3. Squats.

Absorption with the bottom of the water (squats) is a condition in which the aft draft of the ship increases when the ship sails in narrow and shallow water and moves at high speed. Squats must be avoided because if there are wrecks or corals, the ship's keel can be damaged.

To maintain the safety of ships from the danger of squats when sailing, many countries set a minimum Under Keel Clearance (UKC) that must be fulfilled; for example, the North Sea stipulates the minimum UKC of ships navigating in that area is 20% of ship draft because the North Sea is narrow, shallow, crowded, and has many navigational hazards.

The effect on the ship's maneuvering if the UKC is less than 20% of the ship's draft are:

a. The ship might experience squat when it is moving at high speed.
b. The ship might experience the danger of suction and cushion effects when the ship sails too far from the track axis.
c. The ship might experience the danger of interaction between ships if the ships sail too close to each other.

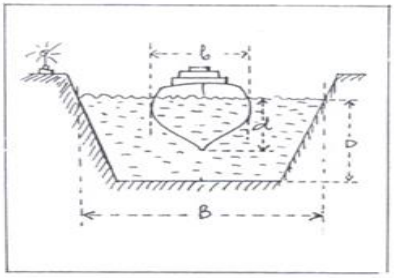
The minimum UKC that must be maintained by a ship to avoid the danger of squats is stated by the formula:

Max squats in narrow waters $= 2 \times CB \times \frac{V^2}{100}$ meter

Max Squats in wide waters $= CB \times \frac{V^2}{100}$ meter

(CB=Block Coefisien, V=ship's speed in knots)

To find CB is:



$$\text{BLOCKAGE FACTOR (CB)} = \frac{b}{B} \times \frac{d}{D}$$

Figure 53. Blockage Factor (CB)

Example:

It is known b=12 m; B=25 m; d=7 m; D=21 m.

Determine the value of the Blockage Factor of the ship when the ship is sailing in shallow and narrow waters.

Answer:

$$\text{BLOCKAGE FAKTOR (CB)} = \frac{12}{25} \times \frac{7}{21} = \frac{84}{525} = 0{,}16$$

Squats occur because of general phenomenon no. 2 (water level on both sides of the hull drops), causing velocity near the hull when moving forward and creating pressure around the ship (the ship's draft will increase).

Squats also occur because of the difference between the ship's speed and the waves, causing the ship's bow is higher than the stern (a → b). Usually, the ship's stern is not supported by sufficient buoyancy so the ship will experience squats. (view image).

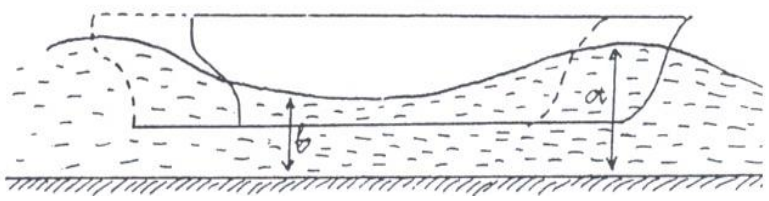


Figure 54. The ship is experiencing Squats

The risks of navigating in the canal relate to the deepest draft, relates to UKC, which is required at least 10% of the ship's draft, are:

a. When moving at high/changing speed, the ship will experience SQUAT, which can cause the ship's keel to touch the seabed, and if there is a wreck at the bottom of the water, the ship can leak and sink.
b. When maneuvering and the ship deviates from the track axis, the ship will experience suction and cushion effects; that is, the bank will pull the stern, and the bow will be pushed from the bank.
c. when passing or overtaking, if the two vessels are too close to each other, then the two vessels interact with each other, which can cause the two vessels to collide.

Factors that can affect the Squats of a ship are:

a. Ship's speed.
b. Type of ship's bow.
c. The location of the L.C.B (Longitudinal Center of Buoyancy), if the L.C.B is located behind the Center of Flotation, then the Squats occur at the stern of the ship. If the L.C.B is located in front of the Center of Flotation, the Squats occur at the ship's bow.
d. The amount of CB.

6.3. Things Need to be Considered When Sailing in Narrow And Shallow Waters

1. The duties of officer on watch (OOW).
   a. Keep the situation under control.

b. Assess the possibility of collision, ship-to-ship interactions, suction and cushion effects, and squats and take necessary action.
c. Manage the time of watchkeeping properly.
d. Call the Master before a potentially dangerous situation becomes critical.
e. Observe weather changes and place a lookout in bad weather.
f. Use manual steering during heavy traffic.
g. Carry out navigation accurately.
h. Monitor the operation of navigation tools.

2. Actions that must be taken when sailing in narrow and shallow waters:
   a. Sailing on the track axis if the waters are wide, sailing on the outer side of the track if the waters are zigzag and the current comes from behind and sailing on the inner side if the waters are zigzag and the current comes from the front to avoid suction and cushion effects.
   b. The speed is not too fast/changed to avoid the occurrence of squats.
   c. When passing/overtaking with other ships, the distance is not too close to avoid interactions between ships.
   d. Note some good seafarer skills, such as standby engines and standby anchors while sailing in narrow waters and paying attention to the underwater pipes and people's houses.

6.4. The Effect of Trim and Squats.

1. Normal steering lever.

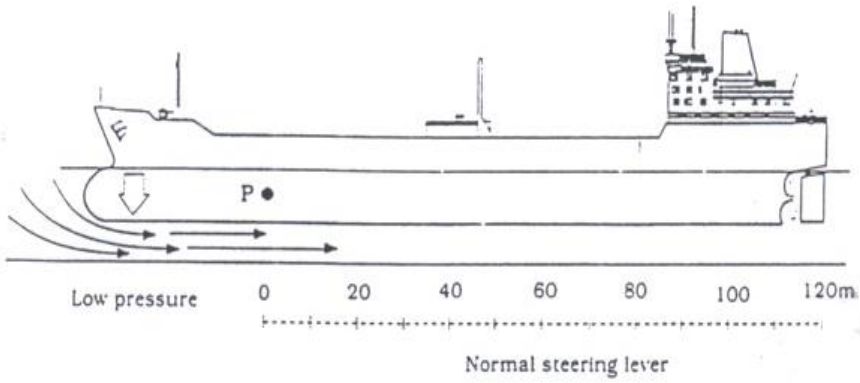


Figure 55. Normal Steering Lever

2. Reduce steering lever.

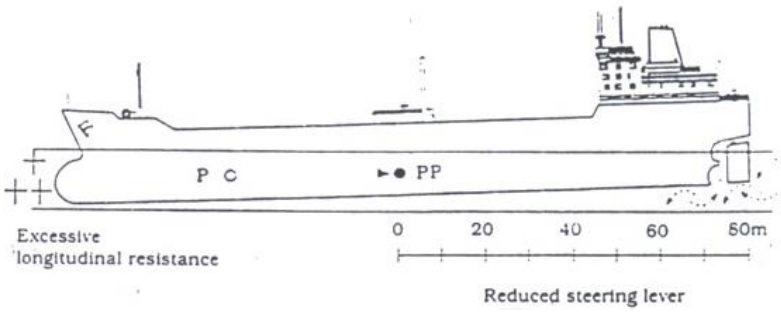


Figure 56. Reduce Steering Lever

3. Poor response to helm likely.

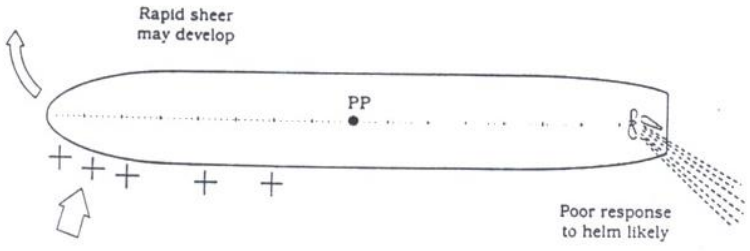


Figure 57. Poor Response to Helm Likely

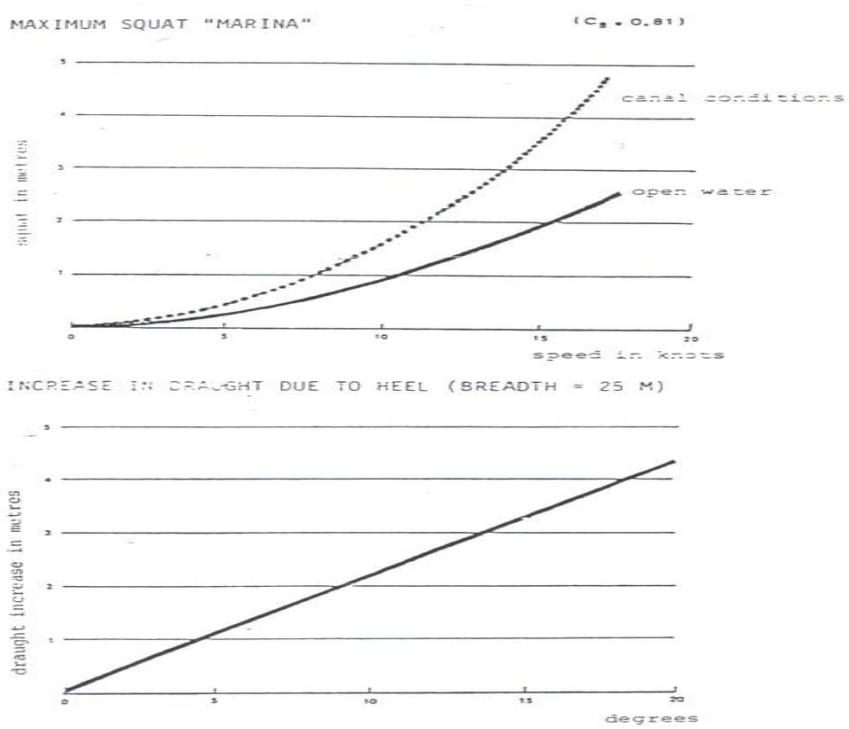


Figure 58. Maximum Squat "MARINA" dan Increase in Draught Due to Heel (Breadth=25 M)

4. Poor response to helm likely.

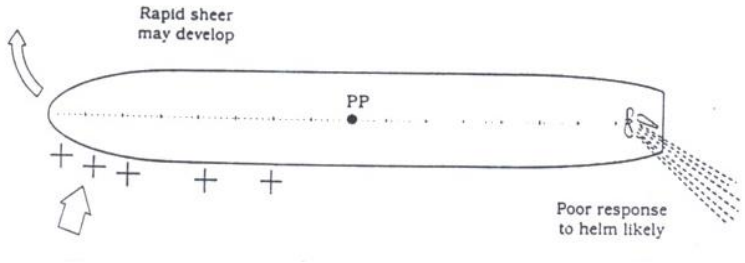


Figure 59. Poor Response to Helm Likely

Ship's turning maneuver on narrow waters.

1. For a single right-handed propeller ship.

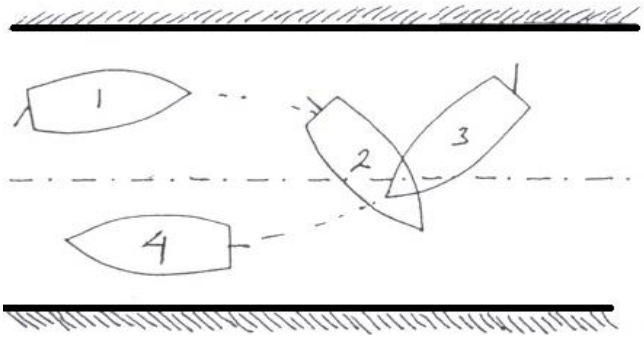


Figure 60. For Single Right-Handed Ship.

Description:

a. Position 1: The ship starts turning from the left of the track, the engine moves ahead as needed, and steers to the starboard side; then, the ship will be at Position 2.
b. Position 2: Stop the engine, the wheel is midships, then the engine is full astern. The stern will move to the left, and the bow will move to the right so that the ship will be at Position 3.
c. Position 3: The engine moves ahead as needed, steers to the starboard side, then the ship will be in Position 4.
d. Position 4: The engine moves ahead as needed and steers to the starboard side slightly to place the ship on the track to continue its voyage.

2. For pitch right-handed propeller ship.

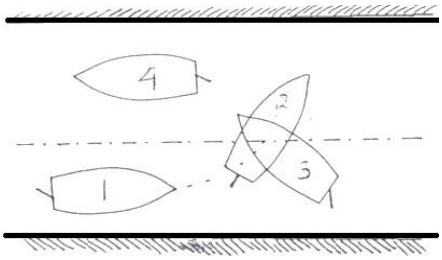


Figure 61. For Pitch Right-Handed Propeller

Description:

a. Position 1: The ship starts turning at the right of the track, the engine moves ahead as needed and the wheel is to the port side, then the ship will be at Position 2.
b. Position 2: The engine stopped, the wheel is midships; then, the ship is full astern, then the stern moves to the right, the bow moves to the left (because even though the ship moves astern, the engine still moves ahead), so the ship will be at Position 3.
c. Position 3: The engine moves ahead as needed and the wheel is to the port side; then, the ship will be at Position 4.
d. Position 4: The engine moves ahead as needed and the wheel is to the port side slightly to place the ship on the track axis to continue its voyage.

3. Turning in narrow water using anchor.

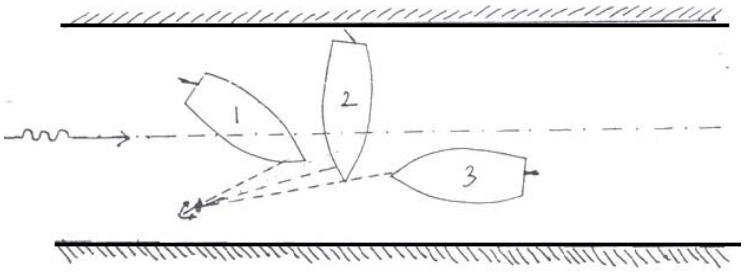


Figure 62. Turning in Narrow water Using Anchor

Description:

The ship sails with the current coming from behind, then on:

a. Position 1: The ship is placed slightly across the current, then one of the anchors (anchor above the current/right anchor) is dropped approximately half shackle plus the depth of the water, and the engine stops. Because of the current, the ship will be at Position 2.
b. Position 2: The wheel is to the starboard side, and the engine stops because the current pushes the stern of the ship, then the ship will be at Position 3.

c. Position 3: The wheel is midships, and the engine moves ahead as needed while heaving up the anchor to continue its voyage.

4. Turning in narrow waters by utilizing the bank.

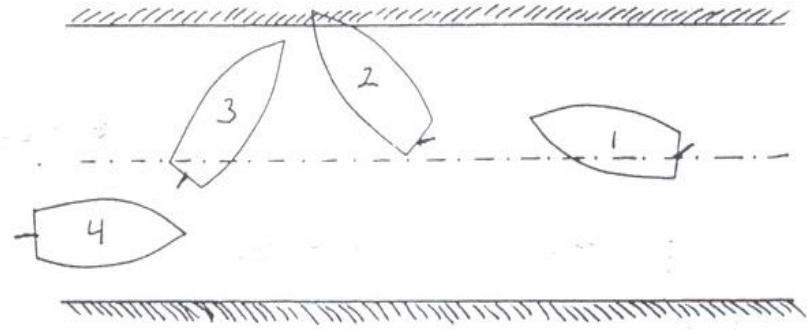


Figure 63. Turning in Narrow Water By Utilizing the Bank

Description:

a. Position 1: The ship is placed slightly out of the track axis, the wheel is to the starboard side, and the engine is full ahead until the ship is at Position 2.

b. Position 2: The ship's bow is pushed to the bank, the engine stopped, the wheel is midships, then the engine is full astern. Then, the stern of the ship moves to the left, and the bow moves to the right. The ship would be at Position 3.

c. Position 3: The engine moves astern as needed, the wheel is turned slightly to the port side. The ship will be in Position 4.

d. Position 4: The engine moves ahead as needed, the wheel is slightly turned to the port side to place the ship on the axis of the track to continue its voyage.

5. Turning at narrow waters for double propellers ships.

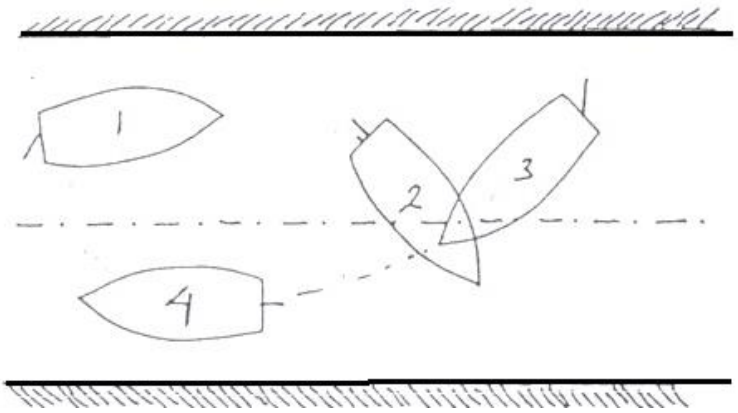


Figure 64. Turning at narrow waters for double propellers ships.

Description:

a. Position 1: The ship starts turning from the left side of the track axis, the wheel is turned to the starboard side, the left engine is slow ahead, and the right engine is slow astern. The ship will be at Position 2.
b. Position 2: The wheel is turned to the starboard side, the left engine is slow ahead. The ship will be at position 3.
c. Position 3: The wheel is steered to the starboard side, the right engine is slow ahead, and the left engine stops. Then, the ship will be at Position 4.
d. Position 4: Steer to the starboard side slightly; both right and left engines move ahead as necessary to place the ship on the track axis to continue its voyage.

CHAPTER VII. PROCEDURES IN SHIP'S MANEUVERING CONTROLLING TECHNIQUES IN ANCHORING OPERATION

Anchoring is mooring the ship to the bottom of the water so that the ship does not drift due to the current/wind to carry out an activity, such as: waiting for clearance to enter the port, conducting loading and unloading activities, waiting for pilots, etc.

The anchoring operation must be carried out effectively, efficiently, safely, and under control; therefore, there are 4 (four) main things that must be considered, namely:

7.1. Preparation for Anchoring Operation

To do anchoring activity effectively, efficiently, safely, and under control, the following preparations must be taken:

1. One (1) hour before the anchoring, the captain makes an OHN (One Hour Notice) and informs the crew relating the ship's maneuvering, consisting of the Chief Engineer, the deck officers, and the crew to prepare everything needed for anchoring operation, such as:
    a. Test the main engine (propeller), telegraph, steering gear, thruster, CPP, radio communication equipment, and ship whistle.

b. Ensure the following equipment can work properly including anchors arrangement, echosounder, compass, ship positioning tools, and ship watch.

2. If a pilot will be involved, prepare the boarding pilot equipment, such as pilot ladders, man ropes, a life buoy equipped with a lifeline and floating lights, torches, radio communication equipment, life jackets, and flag symbols. Install the necessary equipment properly and pick-up the pilot onboard.
3. Prepare clearance documents, such as immigration, customs, and ship documents.
4. Raise the national flag of the ship, the flag of the ship's name, and the flag of the country visited.
5. Choose an anchorage position.
6. Prepare the anchor ready to let go.

7.2. Choosing Anchorage Position

In choosing an anchorage position, some factors must be considered, including:

1. The depth of the water where the anchoring will be carried out; that is, choose an area with moderate depth.
2. The possibility for the ship's movement so that when it is anchored, the ship will not hit other ships in the surrounding.
3. The condition of the area where the anchoring will be carried out (do not anchor in the middle of the fairway and avoid strong currents).
4. Communication with the shore where the anchoring will be carried out (it is not too far from the land).

7.3. Approaching the Anchorage Position

When approaching the anchorage position that has been selected/determined, there are some things that must be considered; including:

1. Adjust the ship's speed with the distance of the anchorage that has been chosen/determined. If it is still far away, the ship's speed should not be too slow and vice versa if it is close, do not be too fast.
2. Determine objects that can be used as a landmark in navigation, such as islands, headlands, lighthouses, etc.
3. Follow a guideline drawn through two lighthouses (if any) and one other bearing object.
4. Try to approach the anchorage position by moving against the currents. If the main engine does not work when dropping the anchor, the ship will not turn and will move astern slightly. It is done so that the time for dropping the anchor is not too long and the situation is under control.

7.4. The Anchoring Operation

To conduct anchoring operations effectively, efficiently, safely, and under control, there are some things that need to be understood and implemented by the captain and Officer on Watch (OOW), which include:

7.4.1. Types of Anchoring Operation

1. According to the number of the anchor which is let go
    a. Single anchor operation (usually using 1 (one) bow anchor).
    b. Double anchor operation (usually using 2 (two) bow anchors or using 1 (one) bow anchor and 1 (one) stern anchor).
    c. Anchor operation (usually using 1 (one) bow anchor and a steel wire rope from the stern).
    d. Mediterranean Mooring Anchor Operation (usually using 2 (two) bow anchors and 2 (two) stern mooring lines).
    e. Baltic Mooring Anchor Operation (usually using 1 (one) bow anchor, a steel wire rope, bow/stern mooring lines, and bow/stern springs).
2. According to the depth of the waters:
    a. Anchor in shallow water (⇱40 fathoms)

b. Anchor in deep water (↗40 fathoms).

c. Anchor in steep waters.

7.4.2. Consideration in Double Anchor Operation

1. Virtuin anchoring.

Figure 65. Virtuin Anchoring

VIRTUIN anchoring is an operation using two bow anchors, where 1 (one) anchor points forward, and the other anchor points backward, with the chains being the same length and forming a line parallel to the current.

The considerations for choosing VIRTUIN anchor are:

a. When the waters are narrow, the ship is not free to maneuver.

b. When the current changes direction regularly.

THE ADVANTAGES AND DISADVANTAGES OF VIRTUIN.

a. The advantages are:
   1) The turning the circle is small.
   2) It is stronger because it uses two anchors.

b. The disadvantages are:
   1) There is a possibility of entanglement of the anchor chain.
   2) Anchor chains pointing backward can damage the lower hull plating.

DOUBLE ANCHOR (VIRTUIN) METHODS.

a. Running moor/flying moor anchor operation.

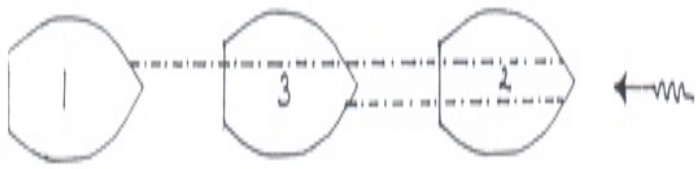


Figure 66. Running Moor/Flying Moor Anchor operation

1) Position 1: The ship moves against the current and approaches the anchorage position that has been planned. We drop one of the anchors (i.e. the port side anchor). When the ship continues to move ahead, let out the chain ± 2 times the length of the chain that will be dropped → so that the ship will be in position 2.
2) Position 2: When the ship arrives at position 2, we will drop the second anchor (i.e. the starboard anchor). Meanwhile, we will heave up the first anchor chain (port side anchor chain) until both chains are the same length → so the ship will be in position 3.
3) Position 3: The ship is held by two anchors whose chains are the same length and parallel to the current.

b. The ordinary moor anchoring operation.

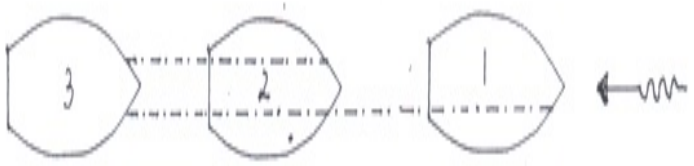


Figure 67. The Method of Ordinary Moor Anchoring Operation

1) Position 1: The ship moves against the current and passes the anchorage position that has been planned; then, we drop one of the anchors (i.e. the starboard side anchor). Meanwhile, the engine runs astern as needed and lets out

the chain ± 2 times the length of the chain that we will drop → so that the ship will be in position 2.

2) Position 2: After the ship is in position 2, then drop the second anchor (i.e. the port side anchor). Meanwhile, the first anchor chain is heaved up (the starboard side anchor chain) until both chains are of the same length → so that the ship is in position 3.

3) Position 3: The ship is held by two anchors whose chains are the same length and parallel to the current.

2. Open moor anchor operation.

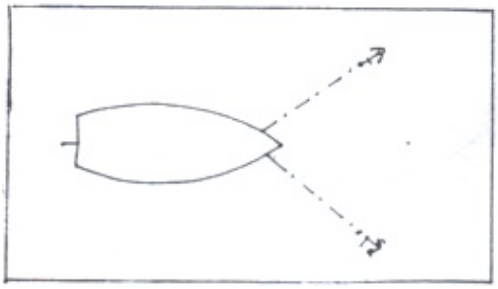


Figure 68. Open Moor Anchor Operation

Open Moor anchor operation is anchoring using two bow anchors, where both anchors point forward with the chains of the same length, and both chains form an angle between 60^0-120^0 to the direction of the current (which is best at an angle of 90^0 to the direction of the current).

CONSIDERATIONS IN CHOOSING AN OPEN MOOR ANCHOR OPERATION ARE:

a. When in narrow waters where the ship cannot freely maneuver.
b. When there are strong winds and currents from one direction only (during shelter).

CONSIDERATIONS OF CHOOSING OPEN MOOR ARE:

a. The advantages are:
   1) The turning circle is smaller.
   2) The tension in both chains is equal.

3) The movement of the ship is limited.

b. The disadvantages are:

1) There is a possibility of entanglement of the two anchor chains.

2) The tension in the two windlasses is equal.

THE TECHNIQUES OF OPEN MOOR ANCHOR OPERATION

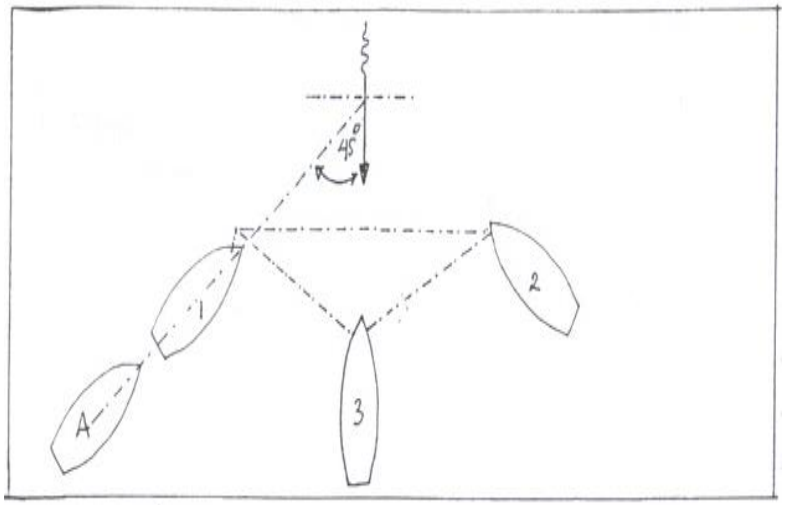


Figure 69. The method of Open Moor Anchor Operation

Description:

a. Position A: The ship forms an angle between 4-5 quadrant directions of the current.

b. Position 1: We have to drop the anchor and let out the chain ± 2 times the length of the chain that will be dropped so that the ship will arrive at position 2.

c. Position 2: When the ship is in position 2. The other anchor, under the current, is dropped, the first anchor chain is heaved up, then let out the second chain → so that the ship will be in Position 3.

d. Position 3: The ship will be held by two anchors whose chains are the same length and form an angle of 60^0-120^0 with the direction of the current.

7.4.3. Consideration of Using Single Anchor

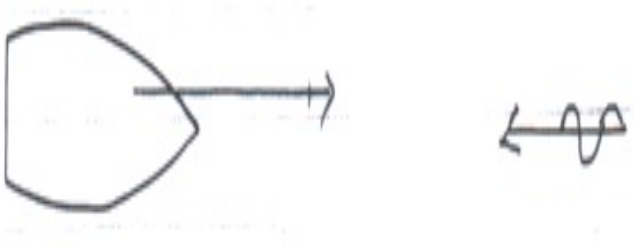


Figure 70. Consideration of Using Single Anchor

Single anchor operation is anchor operation using one (1) bow anchor, where the anchor points forward, and the chain is parallel to the current

The considerations for choosing single anchor operation are:

1. When the area is wide enough and the ship can maneuver freely.
2. When the current does not change direction.

ADVANTAGES AND DISADVANTAGES OF SINGLE ANCHOR OPERATION:

1. Advantages:
    a. The anchorage operation is faster.
    b. There is no possibility of entanglement of the anchor chain.
2. Disadvantages:
    a. The turning circle is big.
    b. It is less strong because it only uses one (1) anchor.

THE TECHNIQUES FOR SINGLE ANCHOR OPERATION

1. In shallow water (depth ↖ 40 fathom).
    a. The anchor is taken out from the hawsepipe and then hung ± 1 meter above the water surface, then the anchor is ready to let go.
    b. Pass the anchorage position slightly, then the engines run astern. When the water propeller is in the middle of the axis, then the anchor is dropped.

2. In deep water (↗ 40 fathoms).
    a. The anchor is taken out from the hawsepipe and then hung ± 1 meter above the water, then the anchor is ready to let go.
    b. Pass the anchorage slightly, and the engines run ahead. If the water propeller is already in the middle of the axis, then the anchor can be dropped.
    c. Make sure the ship's direction after the anchor dropped is the same.
3. In steep water.
    a. The anchor is taken from the hawsepipe and then placed as deep as the place to arrive from a considerable distance.
    b. After the anchor touches the seabed, drag the anchor slightly ahead to see if the anchor has reached the bottom.
    c. The anchor is dropped after passing the planned position, then the engine runs astern.

7.4.4. Similarities and Differences between Virtuin and Open Moor

THE SIMILARITY:

1. Both virtual and open moor use 2 (two) bow anchors.
2. The two chains used are the same length.
3. Both are used in narrow waters which have limited ship movement.

DIFFERENCES

VIRTUIN	OPEN MOOR
Against the Current	Form 4-5 quadrant direction to the current
One of the chains is in the front direction and the other in the backward direction.	Both chains are in the front direction.

Figure 71. The Difference of Virtuin and Open Moor

BALTIC MOOR ANCHORING, MEDITERRANEAN MOOR ANCHORING, AND ANCHOR TO CREATE A CALM SIDE

1. Baltic moor.

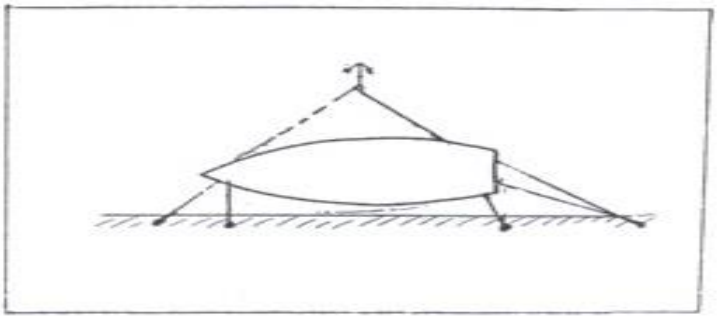


Figure 72. Baltic Moor

Description:

Baltic moor is an anchor operation to hold the ship that is not strong enough to support the weight of the ship.

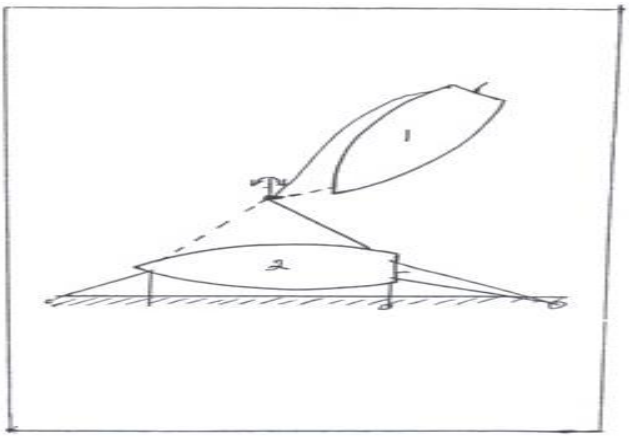


Figure 73. The maneuvering technique of the Baltic Moor

Description:

a. Position 1: Release the wire rope from the stern of the ship, then carry it forward through the outside of the hull, and connect it to one side of the left anchor chain. After that, the engines run dead slow ahead, place the wheel midships, drop the right anchor and the chain, and let out the wire rope. Once the ship is parallel to the pier, send mooring lines ashore, then heave up, so the ship will be in position. 2.
b. Position 2: The ship is in its Position.

2. Mediterranean moor.

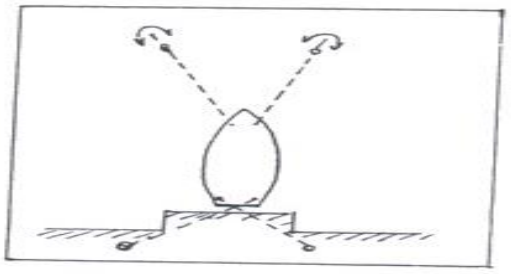


Figure 74. Mediterranean Moor

It is an anchor operation to hold a ship on a narrow pier in bad weather conditions

Both anchor chains are tight and pointing forward. The stern is moored with a cross-mounted mooring.

MEDITERRANEAN MOOR WAY

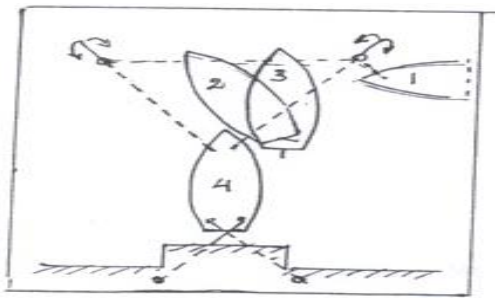


Figure 75. Mediterranean Moor

Description:

a. Position 1: The ship arrives // pier, the engines run slow ahead, the wheel is midships, let go the right anchor → then the ship will be at Position 2.
b. Position 2: The engines run dead slow ahead, the wheel is to the starboard side, drop the left anchor, and stop the engine. After that, the right anchor is heaved up → then the ship will be in the Position 3.
c. Position 3: Place the wheel midships, the engines run slow astern, and the stern mooring line is sent ashore. After being

connected to the land bolder, the mooring line is heaved up, then adjust the two chains until they are the same length → then the ship will be at Position 4.

3. Anchoring to create a calm side.

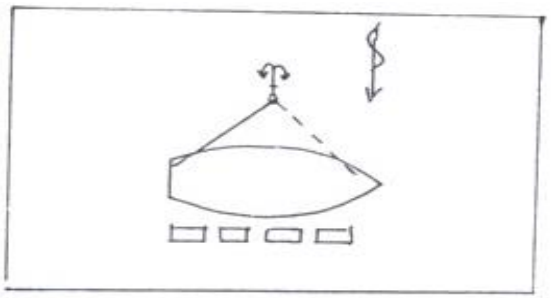


Figure 76. Anchoring to create a Calm Side

It is an anchorage technique to create a calm side to carry out loading/unloading in conditions of strong waves.

TO DO THE MANEUVERING:

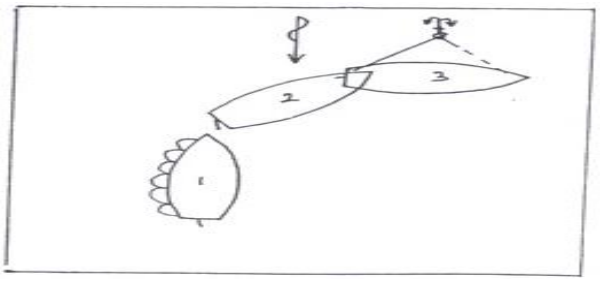


Figure 77. To Do the Maneuvering

Description:

a. Position 1: The ship moves against the current, takes out the stern lines, and then carries them forward through the left outer hull, then these lines are connected to one of the anchor chains that are ready in the area.
b. Position 2: The wheel is to the starboard side, the engines run dead slow ahead, let out the chain anchor and stern lines. By letting out the chain and lines, the ship will automatically rotate in a transverse direction against the wind and waves.

c. Position 3: Stop the engine, place the wheel midships and adjust it until the chain and lines are the same lengths. Then, loading and unloading activity can be carried out safely on the leeward side.

7.4.5. The Let-Out Chain Length When Anchoring.

In principle, the length of the chain that must be let out is optional so that the ship will not drift during anchoring depending on the ship's displacement, depth and type of water, wind and current strength, duration of anchoring, and the distance with other ships.

According to existing research, the length of the chain that must be let go when anchoring is:

1. Two (2) to three (3) shackles plus the depth of the water, because with this length it is expected that the anchor position rest completely on the bottom of the water and part of the chain is embedded in the mud, so the ship will not drift.
2. If the chain is not long enough, it will make the anchor cannot rest completely on the seabed. Still, it will form an angle to the bottom of the water (if the anchor position forms an angle of 5^0 to the bottom of the water, the strength is reduced by 15%, and if it forms an angle of 15^0 the strength will be reduced up to 50%).
3. The minimum length of the chain that must be dropped can also be found using the admiralty formula, namely:
   a. Chain length : 25 x √D (fathoms)
   b. Chain length : 28 x √D (fathoms)
   c. Chain length : 29 x √D (fathoms)

   D = Depth in meter

7.5. Action that Must be Taken after Anchoring

The actions that must be taken after anchoring are:

1. Install the windlass brake and the chain holders properly.
2. Close the anchor hawsepipe.

3. Check the ship's position continuously and periodically to ensure that the ship is not drifting.
4. Pay attention to the twitches in the anchor chain, but this is not accurate because sometimes the chain twitches, but the ship doesn't drift, and vice versa. Sometimes the chain doesn't twitch, instead, the ship drifts.
5. If the ship is drifting, the first action must be taken is to add the length of the chain. If it does not work, then use the main engine.

7.6. Terms in Anchoring

Some terms that must be understood by those are involved in the anchoring operation are:

1. Anchor position is the position when the anchor is dropped into the water.
2. The ship's position is the position after the anchor is held against the water.
3. Heave up is lifting anchor.
4. Anchore up is the anchor is already above the water surface when the anchor is lifted.
5. Anchore up and down is an anchor that is free from the seabed when the anchor is lifted.
6. Three shackles on the deck is a condition where at the time the anchor is heaved up/ dropped, the third shackles mark is on the deck.
7. Three shackles in the water is a condition where when the anchor is heaved up /dropped, the third shackle mark is on the water's surface
8. Anchor watch is the direction in which the anchor is pointing at the time of letting go of the anchor, for example, 12 o'clock, meaning the anchor is pointing straight ahead, and 3 o'clock indicates the anchor chain is pointing to the right.

7.7. The Duties of OOW when Anchoring

1. Check the possibility of a drift, another ship approaching, any changes in currents, and the movement of ships related to the movement of other ships.
2. Report to the captain immediately if the ship is drifting.
3. Check the ship's position at least once an hour if there are strong currents, winds, and waves.
4. Carry out communication with other ships approaching when there is a danger and take immediate action.
5. Use engines to avoid danger.
6. Turn on/off the deck lights and anchor lights, or show the shapes of anchored objects.
7. Monitor navigational hazards.
8. Patrol around the ship.

7.8. Fixing the entangled Anchor Chains when Anchoring using Two Bow Anchors.

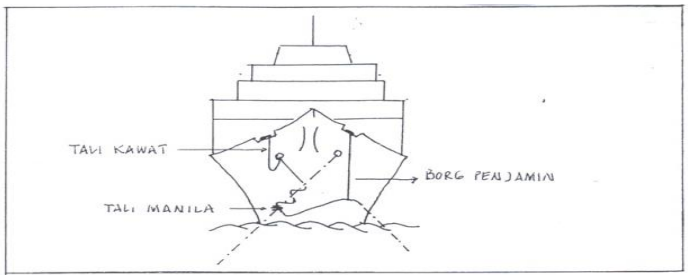


Figure 78. Fixing the entangled Anchor Chains when Anchoring using Two Bow anchors

Description:

1. Look for tight chains and loose chains. The tight chain holds the ship, and the loose chain is the entangled one.
2. Both chains are heaved up so that the entangled chain is seen above the water. Then, the entangled chain is tied with a rope so that it does not fall.
3. Hold the entangled chain with a wire rope borg.
4. Find whether the entanglement starts from the top or the bottom.

5. The entangled chain is lifted until the connecting shackle is on the deck, then the shackle is opened.
6. Insert the wire rope through the outer hawsepipe to be connected to the end of the chain whose shackle was opened earlier, while the other end of the wire rope is held in the Gipsy head of the anchor joint, then it is heaved up so that all chains are outside.
7. The connection between the entangled chain around the wire rope is connected to another wire rope that goes through the top/bottom (depending on the entanglement). By alternating up/down, all entanglement can be removed.

CHAPTER VIII. THE TECHNIQUES OF SHIP MANEUVERING IN ADVERSE WEATHER

When sailing on the open seas, sometimes we face bad weather, which results in strong waves/winds and limited visibility. Such a situation can endanger the safety of the ship and everything inside.

The captain and his crew must understand the signs of bad weather and be able to take action to save the ship from the danger of sinking. For that reason, several important things must be considered by the ship crew (especially the Master and OOW), including:

8.1. Signs of upcoming Bad Weather (Hurricane/Typhoon/Tropical Storm)

An OOW (Officer on Watch) must be able to know the signs of upcoming bad weather so that they can prepare and can take safety precautions when bad weather occurs. Signs of upcoming bad weather are:

1. There is a deviation of air pressure from normal to drop, which is indicated by the barometer reading which continues to decrease slowly, and then the weather turns bad.
2. The wind becomes stronger and does not change direction.
3. The waves get higher and the swell gets bigger.
4. High clouds appear (Ci, CiCu, CiStr) followed by medium clouds (AltCu, AltStr) then the sky will be covered by clouds.

5. Low clouds and black clouds appear to be expanding and getting higher.
6. Rain falls.

8.2. How to Monitor Tropical Storm Movements that are likely to change into Typhoons

1. Observing the natural symptoms of:
   a. Barometer reading (the indicator continues to decrease slowly).
   b. The sky/clouds, i.e. high clouds appear, followed by low clouds that expand, get higher, and are accompanied by rain.
   c. The height of the waves and the size of the swell, that is, when the waves get higher and the swell gets bigger.
   d. Visibility (the visibility is very good at the beginning, but becomes bad quickly).
   e. The strength and direction of the wind, i.e., the wind is getting stronger, and its direction does not change much.
2. Using 3 cm RADAR or 10 cm RADAR, in good visibility, the Center Radar will be able to detect the Storm center, which is a Dark Circular Area.
3. Using radio, telex, or navtex broadcast by Meteorological Service.
4. How to determine the bearing direction from the center of Storm
   a. In the Northern Hemisphere.

      If we stand facing the wind, the storm center is located on the right ± 12 letters when the barometer indicator begins to decrease, ± 10 letters when the barometer indicator drops 10 hPa, ± 10 letters when the barometer measurement drops 20 hPa.

   b. In the Southern Hemisphere.

      If we stand facing the wind, the storm center is located on the left ± 12 letters when the barometer reading begins to decrease, ± 10 letters when the barometer indication drops 10 hPa, ± 10 letters when the barometer measurement drops 20 hPa.

5. The direction of the track shifting of tropical storms in the northern and southern hemispheres.
   a. In the Northern Hemisphere.

      A tropical storm, moving first west, then northwest, north, and finally north northeast.

   b. In the Southern Hemisphere.

      A tropical storm, moving first west, then southwest, south, and finally southeast.

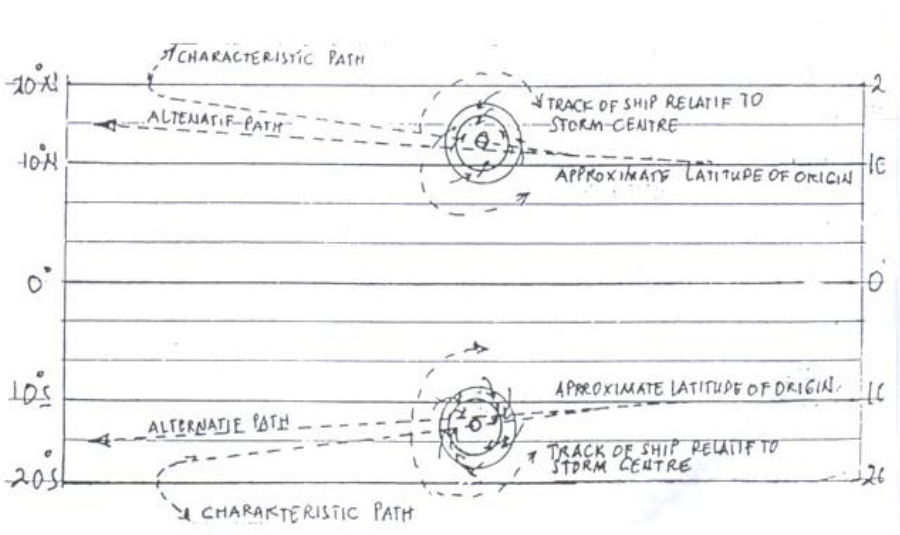


Figure 79. The changing direction of tropical storms in the Northern Hemisphere and in the Southern Hemisphere

8.3. How to Know "Navigable Semi Circle" and "Dangerous Semi Circle" Areas

In bad weather, we know the "NAVIGABLE SEMI CIRCLE" area. It is a dangerous area in which if the ship enters this area, it is still possible to get out of the area. Meanwhile, the "DANGEROUS SEMI CIRCLE" area is a dangerous area in which if the ship enters this area, it is very difficult to get out of it. Therefore, the Bridge Team must be able to determine which area is a "NAVIGABLE SEMI CIRCLE" and which area is a "DANGEROUS SEMI CIRCLE."

HOW TO DETERMINE:

1. In the Northern Hemisphere
   "Navigable Semi Circle" is located to the left of the track/path.

   "Dangerous Semi Circle" is located to the right of the track/path.

2. In the Southern Hemisphere
   "Navigable Semi Circle" is located to the right of the track/path.

   "Dangerous Semi Circle" is located to the left of the track/path.

DIAGRAMS OF "NAVIGABLE SEMI CIRCLE" AND "DANGEROUS SEMI CIRCLE" AREAS

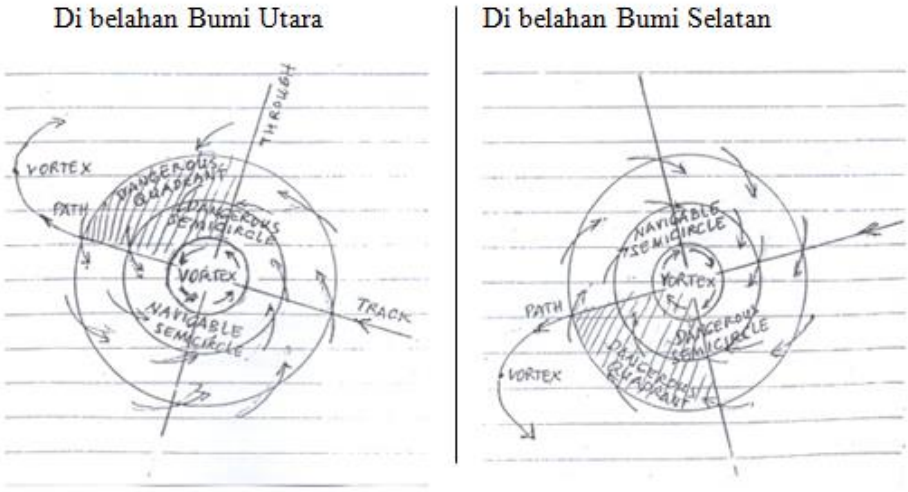


Figure 80. Diagrams of "Navigable Semi Circle" and "Dangerous Semi Circle" Areas

8.4. Preparations for Bad Weather

1. The anchor is tied tightly after the anchor shank is inserted into the hawsepipe, and the two flukes are close to the hull.
2. The hawse hole and air pipes are tightly closed.
3. All sounding pipes, air pipes, and ventilation holes are tightly closed.
4. The hatch is tightly closed and the covers are properly installed.
5. Install the safety ropes on the deck and immediately stop maintenance activities.
6. Loading rods are lowered and then tied tightly.

7. Lifeboats and other movable items are securely fastened.
8. Inform all crew to tie up their belongings in their cabin, engine room, galley, etc.
9. Prepare wave-calming oil on the leeward side.
10. Increase the GM value of the ship.

8.5. Actions to be Taken on a Ship That is still in a Port and There Will be a Tropical Storm

When the ship is in a port (whether it is for berthing or anchoring), during the period of the Tropical Storm vigilance must always be maintained just as when the ship is sailing on the open seas by observing the barometer indicator, wind strength and direction, and clouds.

If a storm is declared, precautions must be taken immediately. If the storm's center passes close to our ship, it is suggested to take the ship out of the port. If you decide to stay in the port and do the anchoring, use the engine and or release the second anchor. Or, if it is available, the ship should be tied to two mooring buoys.

8.6. How to Maneuver the Ship out ofThe "Dangerous Semi Circle" And "Navigable Semi Circle" Areas

1. How to maneuver the ship out of the Dangerous Semi Circle area

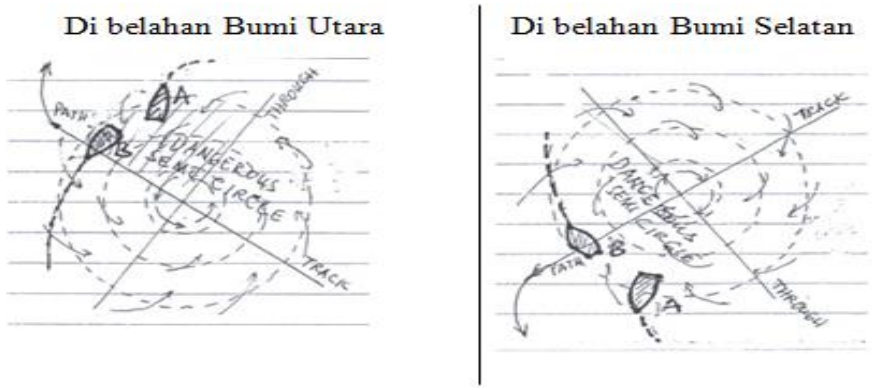


Figure 81. How to maneuver the ship out of the Dangerous Semi Circle area.

Description:

a. In the Northern Hemisphere:

   Ship A

   1) Move at full speed.
   2) Place the wind blowing from the front or the starboard bow.
   3) Alter course to the starboard side if the wind is VEERING.
   4) If the space is insufficient for such maneuver, try to place the wind blowing from the starboard side.

   Ship B

   1) Move at full speed.
   2) Place the wind blowing from the starboard quarter.

b. In the Southern Hemisphere:

   Ship A

   1) Move at full speed.

8.7. How to Choose a Good Shelter to Avoid Typhoons

In choosing a safe shelter, make sure:

1. That the place must be completely protected from the wind.
2. That the water depth is not too deep for anchorage to avoid drifting.
3. That the place is sufficient for turning the ship.

8.8. How to Maneuver the Ship to Avoid Synchronization between the Ship's Rolling Period and the Wave Period

The risk that can occur if there is a synchronization between the ship's rolling period and the wave period is that the ship can capsize. (See the image below):

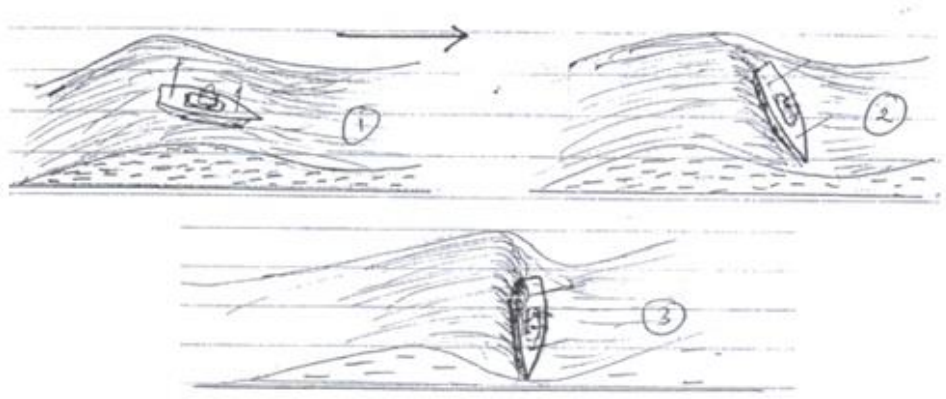


Figure 82. How to Maneuver the Ship to Avoid Synchronization between the Ship's Rolling Period and the Wave Period

Description:

1. The ship's bow entered the waves, the stern of the ship turned, and the ship swung to the left so that it is difficult to control the ship.
2. When the ship is down from the wave, the ship's roll will increase.
3. The ship will heel over and capsize.

The technique of maneuvering to avoid synchronization between the ship's rolling period and the wave period is to do a "Zig-Zag maneuver" by cutting the waves at an angle of 45^0.

8.9. The Duties of OOW (Officer on Watch) When Ships Sailing in Narrow Areas in Bad Weather

1. Monitor weather conditions; if the situation worsens, immediately call the captain to the bridge.
2. Implement relevant rules to prevent collision hazards (rule 19 COLREG 72).
3. Prepare the engine to be ready for maneuvering.
4. If the situation is critical, assign lookouts and a helmsman to steer the ship manually.
5. Turn on/off navigation lights.
6. Operate ARPA.
7. Carry out observations of the surrounding using RADAR mounted on a long-range.

8. Take action as quickly as possible to prevent the situation from getting too close when in doubt about the movement of other vessels.

8.10. How to Sail on The Open Seas in Bad Weather

1. BYLIGGEN. It is sailing in bad weather conditions with the engines running slow ahead and the wind/wave direction forming an angle between 3-4 letters in front of the transverse direction of the ship.
2. LENSEN. It is sailing in bad weather conditions with the engines running slow ahead and the wind/wave direction at an angle of 180^0 from the aft of the ship.

8.11. Dangers That Can Occur When the Ship Sails on The Open Seas in Bad Weather

1. BROACHING TO is a hazard that can occur when the ship sails along the waves in bad weather conditions in which:
   a. The ship's bow enters the waves, and the stern is lifted high so that it does not function effectively and causes the ship to swing violently and the ship can capsize.
   b. When the ship is down into the wave valley, the ship's roll will increase, and the ship can capsize.
   c. Broaching To occurs when the length of the ship/speed of the ship is proportional to the length/speed of the waves.
2. POOPED is a hazard that can occur when the ship sails with the waves in bad weather, in which the stern of the ship is swept away by waves which makes the ship difficult to control and can also cause damage to the stern of the ship. Pooped occurs when the ship's speed is proportional to the speed of the waves; to overcome this, the ship's speed is reduced to 40%.

8.12. How to Turn a Ship in the Waves

The act of turning the ship in the waves must be done at the right time, considering the internal and external factors of the ship.

The action of turning the ship is carried out at the time of the lowest wave height, and when the ship reaches half a turn, then use the engine and rudder according to the existing conditions. After the ship turns, reduce the speed of the ship.

8.13. Principles of Ship Maneuvering in Bad Weather

1. The ship's speed is reduced and do not use the wheel too much, let the ship's rudder choose its course. The speed of the ship is reduced to minimize the occurrence of heavy pitching, which causes the stern of the ship lifted above the water and the propeller rotates in the air, resulting in stress on the propeller axle and the hull vibrating strongly, which can damage the ship and its equipment.
2. If the leeward area is large enough, let the above situation (no. 1) take place but take into account the supply of fuel, water, and food, the distance to the port of destination, and the maneuverability of the ship

8.14. How to Heave Up Anchor after Implementing Shelter in Bad Weather

1. When the wind, waves, and currents are very strong, if the anchor chains are not equally tight, then the slack chain is lifted first so that both chains are equally tight, and only then are both chains slowly lifted.
2. If the two anchor chains are equally tight, then the two anchor chains can immediately be lifted together.
3. When you heave the anchor chain up, make sure the two anchor chains are not entangled with each other.
4. If the wind, waves, and currents are very strong, then as soon as the anchor is up, the engine runs ahead so that the ship will not drift.

CHAPTER IX. WORKING PROCEDURE OF SHIP MANEUVERING TECHNIQUE IN SAR (SEARCH AND RESCUE) OPERATION AT SEA

To make the ship maneuvering in SAR (Search and Rescue) operations take place effectively, efficiently, safely, and under control, some things must be considered by those involved in its implementation.

9.1. Preparations That Must Be Done on the Ship

1. Attach/hang a rope on the hull slightly above the water level from the bow to ± $^3/_4$ of the ship's length.
2. Prepare cranes and cargo slings, cargo nets, platforms, etc., to transport victims who are exhausted and injured.
3. Prepare lines, ladders, and rescue nets on both sides of the ship's hull.
4. Prepare an Inflatable Liferaft (if necessary, inflate it all at once).
5. Prepare medical personnel and equipment to help the victims.
6. Prepare line throwing apparatus and other important lines.

9.2. Man Overboard Situations

1. Immediate action situation.
   It is an emergency, that is, soon after a person falls into the sea, the incident is immediately known by the officer, and the rescue is immediately carried out (without delay).
2. Delayed action situation.
   It is an emergency, that is, when a person falls into the sea, the incident is reported to the bridge by the witness shortly after the incident happens, so that the rescue is not immediately carried out.
3. Person missing situation.
   It is an emergency in which a missing person is reported to the bridge after a period of time, so the search and rescue take a very long time.

9.3. Ship's Maneuvering in Rescuing Man overboard.

1. Immediate action situation.
   a. Single turn: This technique will bring the ship back to the man overboard position faster.
   b. Williamson turn: This technique will take a relatively long time to bring the ship back to the victim's position, and the ship will be a bit far from the victim's initial position.
   c. Scharnow turn: This technique is not appropriate to be implemented.
2. Delayed action situation.
   a. Single turn: This technique will be suitable to be implemented.
   b. Williamson turn: This technique will bring the ship back to its initial position.
   c. Scharnow turn: This technique will bring the ship back to its initial position faster

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AUTHOR'S PROFILE

Agus Hadi Purwantomo

Capt Agus Hadi Purwantomo, SP.1,. M.Mar. was born in Temanggung, August 24, 1956. Graduated from Semarang Large Shipping Officer education with MPB III - Strata -A/Nautika diploma in 1978. Then completed Education with Vocational Expert Training Jakarta with MPB II + Strata-B diploma / Nautika in 1985. In 1985 after attending education in Amsterdam with a specialist study I Seaman Ship. Then he studied at the Center for Shipping Education and Shipping Science Improvement (BP3IP) Jakarta, obtaining MPB I/ANT I Master Marine/Applied Masters in 1990-1991.

His various knowledge has been applied in various work experiences, one of which is as a captain on foreign-flagged tankers (Panama and Singapore).

The last position he held in an official government institution at the Maritime Science Polytechnic (PIP) Semarang was as a functional official for the 2008-2016 period, continued as a functional official of the head lector and as a permanent lecturer, Examiner of the Seafaring Expertise Examination as well as assessors and lecturers at PIP Semarang up until now.

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Istiqomah Khoirul Ilmi is a Translator and an English Instructor. She received her first degree from Universitas Negeri Semarang in 2015, majoring in English education. Istiqomah completed her Master's degree in the same field and university in 2019. She has pursued her career as a translator and English instructor since 2014. Her first translator career was becoming one of the founders of the translator team, namely Translator House Semarang. She was a part of the CDC translator of Unnes, translating some lesson plans and syllabi. She has also translated many international science, law, humaniora, and technology journals. She is also interested in teaching English for specific purposes such as Maritime English, business, and technology.

Latifa Ika Sari

Latifa Ika Sari is an English lecturer at Politeknik Ilmu Pelayaran (PIP) Semarang. Born in Semarang, on July 31, 1985, she has a great passion for the field of English Education and Psychology. In 2006, Latifa completed her Diploma III majoring in English for Office Management at Universitas Dian Nuswantoro Semarang. In 2008, She completed her Bachelor's Degree in Psychology at Universitas Diponegoro (UNDIP) Semarang. In 2014, he obtained a Bachelor's degree in English Education from Universitas Terbuka, Jakarta. Her Master's degree in English Education was achieved in 2017 from Universitas Negeri Semarang (UNNES). Her best achievement was in 2021 when she completed her doctoral degree in English education from the same university.

Latifa joined the Ministry of Transportation in 2008. Starting her career as a counselor for cadets at Balai Pendidikan dan Pelatihan Ilmu Pelayaran Tangerang (now Politeknik Pelayaran Banten), she was then assigned to teach Maritime English in 2009. In 2015, Latifa moved to Politeknik Ilmu Pelayaran (PIP) Semarang and was appointed to become a lecturer in 2019.

Latifa actively participates in various scientific meetings (seminars, conferences) related to English language teaching and learning. She has written several research articles published in various proceedings and journals. Her research interests include English for Specific Purposes (ESP), Maritime English, evaluation, and social semiotics.

Ship Maneuvering and Handling

Ship maneuvering is a technique of how to take a ship from one place to another designated place effectively, efficiently, and safely to carry out an activity by utilizing internal and external resources, It is necessary to make the activity of ship maneuvering as efficient as possible, in terms of time and the use of fuel, It is also important to maneuver safely to protect the ship from danger,

The Captain and Deck Officer must have comprehensive knowledge of ship maneuvering to carry out their watch duty in ship maneuvering properly and correctly, They must be able to utilize the ship maneuvering data on the ship and external force, which can assist the implementation of the ship maneuvering,

The implementation of ship maneuvering highly depends on various factors, namely the factors which come from internal of the ship itself and the factors which come from outside the ship, all of which must be understood by the captain and officer for implementing the ship maneuvering as well as avoiding the incidents at sea,

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