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The Obligations of Single-Propeller Vessels at the Head-On Situation

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ABSTRACT: Manoeuvring characteristics of the vessels at the head-on situation are examined in this study. The meetings between the power-driven vessels are considered based on their propellers. These vessels can either have a single propeller or double propellers. A vessel with a single right-handed propeller alters her course to port side easier than the starboard side. There exists an unnoticed gap, therefore the authors discuss the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs), Rule 14, considering the vessel orientation based on its propeller walk. After presenting all possible cases and their probable consequences, this paper offers authorities to embed the information of propeller characteristics into the Automatic Identification Systems (AIS) in order to prevent misunderstandings during the VHF communications, probable collision risks and discussions on liability issues in case of marine accidents.

1 INTRODUCTION

Safe navigation through the sea and especially within the narrow canals is extremely significant for the various types of vessels with different lengths and tonnages. Passing vessels encounter many different situations and positions with each other. Accordingly, the rules are collected in COLREGs and suggested to navigators. There often exist collisions between the vessels at the head-on situation. The rules of the head-on situation is expressed in the COLREGs, Rule 14. However, COLREGs do not directly or indirectly express the obligations of the vessels at the head-on situation based on their propeller types. In case of a collision, liability apportionment is not conducted considering type of the propellers. COLREGs declare the head-on situation as all vessels should directly alter the course to starboard. This is quoted in the COLGREGs as follows:

Rule 14

Head-on situation

(a) When two power-driven vessels are meeting on reciprocal or nearly reciprocal courses so as to involve risk of collision each shall alter her course to starboard so that each shall pass on the port side of the other.

(b) Such a situation shall be deemed to exist when a vessel sees the other ahead or nearly ahead and by night she would see the mast head lights of the other in a line or nearly in a line and or both sidelights and by day she observes the corresponding aspect of the other vessel.

(c) When a vessel is in any doubt as to whether such a situation exists she shall assume that it does exist and act accordingly.

In case of a collision, after a detailed analysis, collision liability is apportioned cyclical all to the masters of the vessels or their skills of whether or not they apply the COLREGs wholly and correctly. In fact, the above-mentioned rule might construct the infrastructure of unsafe passing for the vessels at the head-on situation if they did not maneuver to starboard too early. Besides all masters are required to know their vessels perfectly, a good seamanship is expected for the vessels to keep clear of each other before five or six miles.

This case is mostly seen at the narrow straits such as Istanbul Strait, shallow waters and the narrow canals include navigational impediments. In practice, the vessels do not maneuver considering the other vessel's propeller characteristics. In this study, two scenarios are simulated based on the previous marine accidents. Finally, as a suggestion, Automatic Information System (AIS) must include the information of type and number of a propellers of the vessels.

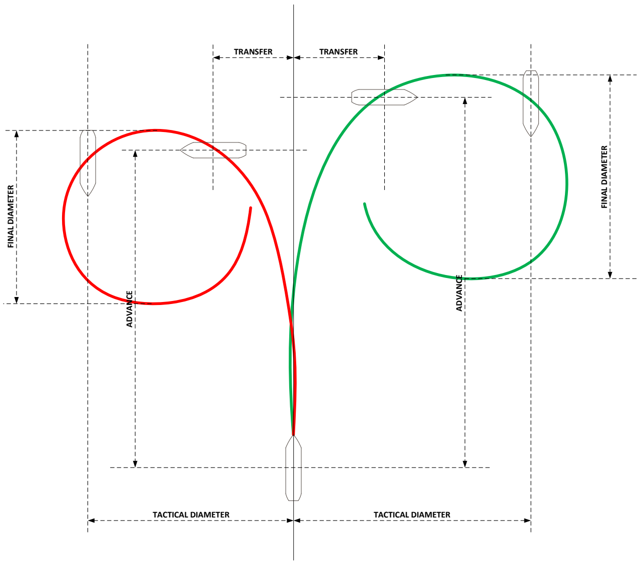
The rest of this paper is organized as follows: Section 2 formally defines the concept of a propeller work and maneuvering characteristics of a vessel. Section 3 provides the previous marine accidents based on the given unnoticed problem. Section 4 presents case study based on all probable scenarios. Conclusion and directions for authorities are expressed in Section 5.

2 THE CONCEPT OF A PROPELLER WORK AND MANEUVERING CHARACTERISTICS OF A VESSEL

The methods applied to define the maneuvering characteristics of the vessels are not new concepts. International Maritime Organization (IMO) Resolution MSC.137 (76) has previously defined it and provided its calculations. In the Figure 1 a diagram of maneuvering characteristics is provided based on the practical experiences of the captains. This diagram is available for all vessels based on their design, tonnage, and type of propeller and so on. According to these diagrams, maneuvering to starboard side and maneuvering to port side are different. Maneuvering diameter is calculated by multiplying the vessel length and coefficient of the maneuvering to starboard or port.

The vessels moving ahead or astern are always under sidewise latent effects which cause deviations from the motion directions because of propeller design and its characteristics. These forces are propeller discharge current effect and transverse thrust (propeller walk). However, propeller discharge current is negligible for the vessels moving ahead. When the vessels moving ahead there exists a strong inertia. The transverse thrust strongly comes out when the ship is in the shallow water with a low speed.

In this study, following figures depict the analysis of interaction of all vectors with the different rudder angles and all effects to the vessel are determined as integrated vectors. Then, horizontal and vertical components of resultant force are shown. The Figures 2a, 3a and 4a show the effects of forces (vectors) to the ship in which "*T*" represents the motion from aft to forward, "*f*" symbolizes rudder force and "P_s" is for sidewise effect. Vectors are assigned relatively considering the ahead motion of the vessels.



Turning Circle Diagram / Angle = 35 deg.
Ship Speed Port. = 6 knots
Ship Speed Starboard = 6 knots
Mean Draught = 10 m.
Displacement = 30000 t.
Figure 1. Manoeuvring characteristics of the vessel

It is found that sidewise component of final *f* force is increased by the parallel effect of P_s to *N*. Thus, the force that alters the bow of the ship to port side is increased (Figure 2a).

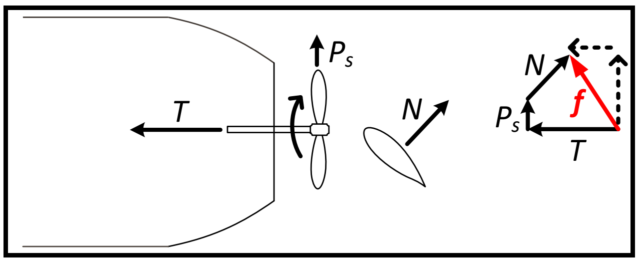


Figure 2a. Vector analysis in case of rudder hard to port.

If rudder command is given as hard to port, stern of the vessel moves more to starboard and similarly ahead of the vessel moves more to port (Figure 2b).

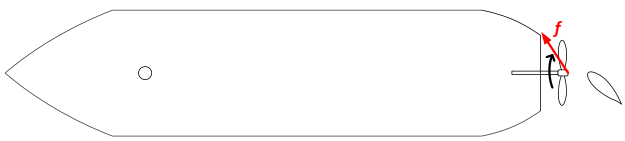


Figure 2b. Resultant force for the vessel altering its course to port

Secondly as shown in the Figure 3a, final *f* vector tends to alter ship's aft to starboard thus, ship's bow tends to move to port side even the rudder is midship. Here, transverse thrust causes P_s as a force to pull aft to starboard.

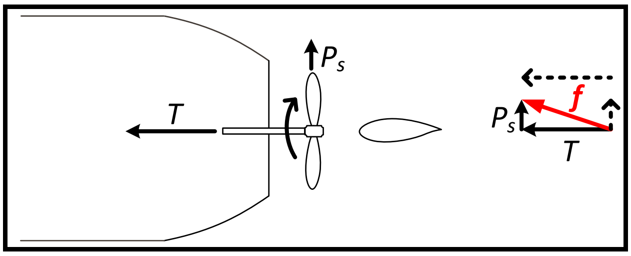


Figure 3a. Vector analysis in case of rudder midship

During the small ahead motion of the vessel with its rudder midship, because of the transverse thrust, the stern of the vessel is pulled to starboard and thereby astern of the vessel are dragged to the port (Figure 3b).

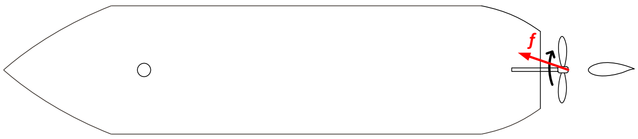


Figure 3b. Resultant force for the vessel moving ahead

Thirdly, as seen in the Figure 4a, when the rudder command is given as hard to starboard, *Ps* affects *N* in negative direction. For manoeuvring to the starboard, the sidewise component of final *f* vector is less than the case of rudder is midship.

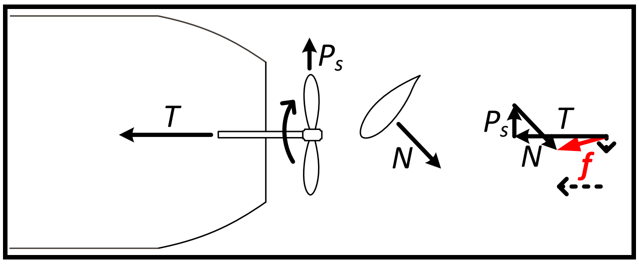


Figure 4a. Vector analysis in case of rudder hard to starboard.

If rudder command is given as hard to starboard, because of the negative directed transverse effect, stern of the vessel moves less to the port and similarly ahead of the vessel moves less to starboard (Figure 4b).

Figure 4b. Resultant force for the vessel altering its course to starboard.

However, if the submergence of the rudder is adequate enough and the inertia of the vessel is too high, transverse effect less considerably affect the vessel.

3 PREVIOUS MARINE ACCIDENTS

In case of Catherine Desgagnés, the significance of transvers thrust is reported as "The transverse thrust created by a right-handed propeller tends to swing a vessel's head to starboard when the propeller is turning astern and to port when the propeller is turning ahead. The effect of the transverse thrust is at its maximum when the vessel has little way on and decreases as the vessel's speed increases". Besides, case of Amarantos identifies negligence of this effect as a contributing factor to the incident and points out that transverse thrust unpredictably affects the vessel largely in shallow water. Kapitan Serykh shows effect of transverse thrust that might cause grounding of vessel. In addition, in case of Enterprise, although master and pilot are aware of transverse thrust, while manoeuvring off the berth, unexpected large transverse thrust created by propeller caused grounding on rocks. Case of Marjorie Jackson accident, she has double propeller but not counter rotating, due to this fact she has large transverse thrust that requires constant steering adjustments for straight line navigation and she has trouble to fix this gap, and accordingly collision occurs. In case of Pride of Cherbourg and Briarthorn, lessons are circulated which contain being aware of the effects of transverse thrust to be learnt from this incident to its master and deck officers. In case of Sichem Melbourne, due to transverse thrust of right handed propeller, she crashes shore and mooring dolphin. In grounding of Coaster Whilst, it is reported that "the Master should have been aware that under the prevailing conditions and with the effect of transverse thrust that it would tend to swing her stern and bow." On the other hand, in investigation report of Mv Katika, it is noted that effect of transverse thrust could beneficially be utilized, if its effect is well-known. However, in many accidents, it can be observed that transverse thrust involves marine accidents directly or indirectly.

4 CASE STUDY

In case of head on situation, two right-handed propeller vessels maneuvering to the port side are simulated in the Figure 5. As it is seen in the Figure 5, by the help of the positive transverse thrust, both vessels keep clear while passing safely starboard to starboard. This is the most proper maneuver for the right-handed single propeller vessels in case of head-on situation to avoid collision. At this point, COLREGs, declare *"…involve risk of collision each shall alter her course to starboard so that each shall pass on the port side of the other."* Instead, as a suggestion:

*When two power-driven vessels are meeting on reciprocal or nearly reciprocal courses so as to involve risk of collision each shall alter her course considering their **maneuvering and propeller characteristics** so that each shall pass **safely** each other.*

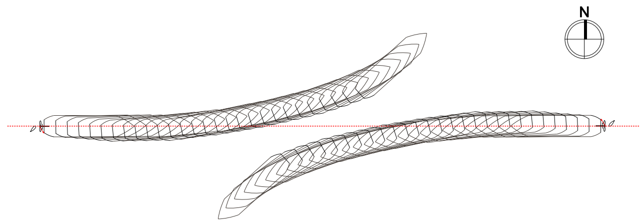


Figure 5. Both vessels are altering their courses to port in case of head-on situation.

However, if both vessels turn rudder hard to starboard side in the same situation, they might not maneuver properly because of the negative transverse thrust. As simulated in the Figure 6, it is found that both vessels cannot maneuver properly to keep clear each other. Accordingly, risk of collision or dangerous contact may occur in this situation. Similar marine accidents related to transverse thrust are given in the previous section.

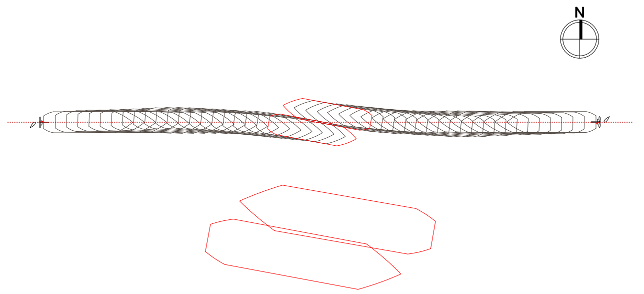


Figure 6. Collision between the vessels which they are altering their courses to starboard in case of head-on situation.

5 CONCLUSIONS

This study provides a comprehensive overview about orientations and obligations of right-handed single propeller vessels at the head-on situation. The difference between the maneuvering characteristics of starboard and port should be considered as a disadvantage for altering the course. It is expected to tolerate and to fill this gap by an experienced seamanship with a perfect marine and navigation knowledge. Moreover, COLREGs do not provide any active, positive and rational precaution that brings a certain solution for the collision risk caused from this well-known difference. In this study, maritime authorities are offered adding a feature to AIS that shows the maneuvering characteristics of the vessels in order to inform the users for all cases. Thus, after getting the information of the propeller and maneuvering characteristics of each other, the vessels will have the opportunity to discuss the probable future positions of the vessels during the VHF communications. Finally, all vessels will always be ready to take an action for all scenarios including emergency cases.

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