

## Study on Safety Countermeasures of Ship Navigation in Narrow Waterway Under Wind and Wave Conditions

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**Abstract.** This paper expounds the navigation conditions of ships in the narrow waterway under the condition of wind and wave, explains the influence of wind waves on the navigation of ships and puts forward the countermeasures of sailing under the conditions of wind and wave, and then guarantees the safe navigation of ships under the conditions of wind and waves.

### Introduction

Most countries in the world today import and export goods are carried out by sea transport way. According to statistics, international maritime transport accounted for more than 90% of the total volume of international trade. The narrow waterway is a special sailing area which often passes through in the course of the ship, and it often encounters stormy weather during the voyage, so it is very important to study the safe navigation of the narrow waterway ships under the condition of wind and wave.

### The Impact of Wind and Waves on the Safe Navigation of Ships

When the ship enters the wind and waves' area, the ship may appear more vigorous movement, slow down, course instability, and other difficulties caused by the manipulation, even the risk of unpredictable.

### There Are Several Main Aspects

Impact, submerged aft, the propeller and the tail shaft will be damaged; if the ship is (1) The swell caused by the gale will increase the ship's navigational resistance, reduce the speed and make the ship swing violently. When the top wave is sailing, it shortens the impact period of the surge and the ship, and increases the number of collisions of the surge, increasing the impact degree and increasing the damage to the hull. When the captain is smaller than the wave wavelength, the sharp longitudinal shake will make the propeller exposed to the surface of the water, so that the tail of the ship is strongly shaken, sometimes causing the pulp leaf to fall off, the tail shaft break, even the tail shell burst into the water; when the captain and the wave wavelength are similar, the ship may be affected by one or two peaks The hull structure is deformed, severely damaged and even the hull is fractured. When sailing, if the ship speed is lower than the wave velocity and the ship is located in the trough, then the swell will similar to the wave velocity and the ship is located in the slope or trough of the front of the swell, the ship is prone to deflection, causing the hull to tilt, which is extremely detrimental to the safety of navigation.

(2) Perpendicular to the propagation direction of the surge, the roll in the ship has not returned to normal state, the next wave will aggravate the tilt of the hull, will make lifeboat, life raft, life buoy, anchor and other deck easy animals, the lashing loose, take off, serious will fall into the sea, cargo movement in the cargo compartment, aggravating the ship tilt; if the influence of free

liquid surface is increased, the stability (GM) value will be decreased, and the risk of ship overturning can be caused seriously.

(3)Due to the resistance of the waves of the ship's mainframe work overload and slow down, mechanical and electrical equipment load, navigation equipment, communications devices and other equipment may be damaged and abnormal conditions. Ships in the big waves sailing, left and right shaking often up to 20 degrees or even 30 degrees, before and after severe turbulence, mechanical and electrical equipment load, especially in ballast sailing, ship draft small, easy speed, prone to malfunction.

(4)It not only brings difficulties to the ship's operation, but also causes the ship to run out of control, causing the ships to collide, run aground and hit the rocks. 4, the deck of serious waves, coupled with a long-term wave of severe shocks, deck machinery, such as anchor machine, stranding machine, cargo aircraft, etc. by the impact of the deck waves easily damaged; the equipment on the deck is washed away by the waves, some watertight door caps are smashed, and the ship is flooded.In the cold sea area, the bare oil pipes on the deck are prone to frost crack, the ballast water pipes and ballast tanks are easy to freeze, and the discharge of water is difficult; the deck waves freeze the snow and increase the ship's load, which adversely affects the stability of the heavy-duty ship.

Table 1. Risk Division and Implications of Wind and Wave Navigation.

Risk grade	meaning
Grade 7	The ship is at great risk of navigation, which may lead to disastrous consequences, be unable to sail, or should enter the harbour to avoid the wind.
Grade 6	The ship is at great risk of navigation, and its safety is seriously threatened. It is not appropriate to sail or to seek refuge from the harbour.
Grade 5	When the ship's safety is threatened, the crew should take effective measures to prevent accidents.
Grade 4	When ship safety is affected, the crew should take precautions and take measures to reduce the risk.
Grade 3	Pay attention to the influence of wind and wave on ship safety
Grade 2	There is no obvious effect on ship safety.
Grade 1	The influence of wind and waves on navigation safety can be ignored.

### Special Conditions for the Navigation of Ships under Narrow Watercourses

In the narrow waterway, the channel is curved, the water shoal is many, there are some obstacles such as reef, sunken ship or fishing gate, the hydrological and meteorological conditions are changeable, the ship traffic is dense.and ships in the narrow waterway navigation, the ship will often change to the motor vehicle, load changes, power plant conditions will change.Therefore, in order to ensure the safety of navigation within a narrow waterway, it is necessary to constantly study and master the geographical characteristics of the waterway and the hydrological and meteorological conditions, strengthen the lookout and careful driving to avoid collisions and shallow accidents.

## Navigation of the Narrow Waterway under the Condition of Wind and Wave

### Water Depth is Limited, Channel Narrow and the Channel Width Changes Frequently

In general, the width of the narrow waterway is relatively small, and even some narrow waterways can only allow one-way navigation, which makes some large draft more difficult to ship, so the ship should strictly abide by the relevant provisions, such as: The Sea Collision avoidance rules, the port of specific waters air traffic regulations. Especially in the stormy weather conditions, more prone to accidents, we must pay extra attention to safety. The hydrodynamic effect of ship is obvious Under the condition of wind and wave, the characteristics of the flow field around the ship will change, and the velocity of the flow field around the ship will accelerate and decelerate, thereby increasing the ship's hydrodynamic torque and leading to the ship's turning head phenomenon. When the ship is near the side of the bank wall, as the flow velocity increases on one side of the bank wall, according to the Bernoulli equation, the water pressure of the position will be reduced, so the ship will be subjected to the shore suction towards the nearshore, and the aft part is more large by the flow velocity, so the stern shore suction is greater than the bow. As a whole, the bow will be subject to the shore thrust from the bank wall.

This greatly increases the difficulty of navigating the narrow waterway under stormy conditions.

Complex sailing conditions Under the condition of wind and wave, the navigation conditions of the narrow waterway are more complicated, one of the most important factors is that the ship is prone to the movement of rolling, rolling and swinging, which is disadvantageous to the safety, and the narrow channel bends more frequently, which leads to the frequent change of the ship's course, and some cases even require a large turn. All of these will cause problems for the safety of the ship.

### The Bernoulli Equation

$$p + \frac{1}{2}\rho v^2 + \rho gh = C, \quad (1)$$

is a constant, where  $p$  is a point in the fluid,  $v$  is the flow velocity at this point,  $\rho$  is the density of the fluid,  $g$  is the acceleration of gravity,  $h$  is the height at which the point is located,  $C$  is a constant. It can also be expressed as

$$p_1 + \frac{1}{2}\rho v_1^2 + \rho gh_1 = p_2 + \frac{1}{2}\rho v_2^2 + \rho gh_2. \quad (2)$$

### Research Countermeasures

Due to the fact that the conditions of navigation in the narrow waterway are different from those of other water vessels, there are many risk factors in the course of sailing, so it is necessary to prepare fully before entering the narrow waterway under the conditions of wind and wave.

(1) Pre-analysis of meteorological conditions Ship pilots should collect meteorological data as much as possible before they will face the storm. Except for the routine meteorological forecasts that ships receive daily. Also through the meteorological fax machine to receive the ground weather facsimile map, ground weather forecasts, high-altitude weather map, but also to pay special attention to the Navtex issued by the meteorological warning information at the end of the collection of all the meteorological information summarized and analyzed, so as to make a reasonable ship sailing plan

(2) Feasibility of pre-award voyage Prior to entering the narrow waterway, the ship driver was

to view the minimum chart depth of the narrow waterway and to relate to the maximum draft of the vessel and the minimum depth of the chart. If it is found that the maximum draught of this ship is greater than the depth of water in a narrow waterway, it is important to consult the data, use tidal navigation, accurately calculate tidal and tidal heights, and avoid ship stranding.

(3) Prepare and update library materials. First, the necessary navigational information such as nautical charts, route guides and tidal tables must be prepared. Secondly, in order to study and verify the navigational data in time, the ship driver should ensure the completeness and renewal of navigational information, timely receive and read navigational notices, navigational warnings, meteorological faxes and so on, and change the chart data to the latest, and pay special attention to the change of water depth.

(4) Use of reasonable navigational methods. When sailing in the narrow waterway under the condition of wind and wave, the conditions will be much worse and the difficulty of operation increased, so the navigation safety can only be improved by using proper method of ship handling.

## Conclusion

The ship's navigation in the narrow waterway is different from the ordinary water, especially under the condition of wind and wave, the particularity of the narrow waterway waters under the wind wave condition has put forward the higher request to the pilot, in order to improve the safety of the narrow waterway navigation under the wave condition, the ship driver should use as many methods as possible to confirm the ship track and position.

Paying special attention to the various ship effects caused by hydrodynamic forces, minimizing the chase with his ship, making reasonable use of navigational aids and communication tools, so as to improve the safety of navigation as much as possible.

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