Analysis of the current navigation environment and Countermeasures in the northern waters of Zhoushan

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Abstract. with the vigorous development of Zhoushan port logistics industry, the rapid expansion of port shipping economy will inevitably lead to the problems such as the complexity of the ship type and the increase of the number of ships in Zhoushan waters. The continuous increase of the number of import and export ships to grasp the impact of the ship dynamics and tide in this area on the ships plays a crucial role in the navigation safety. This paper mainly aims at the existing navigation conditions in the northern waters of Zhoushan, analyzes the navigation environment, studies the representative ship types of the navigation ships in each main channel, the drift caused by the wind and current in the waters of each channel to the ship movement and the field conditions for the safe navigation of the ships, so as to understand and grasp the water environment of each channel and the whole channel in the northern waters of Zhoushan, and to protect the ships in the waters of the northern islands of Zhoushan. It is of great significance for ship navigation and logistics to be smooth and orderly.

1. Introduction
Zhoushan Islands new area is located at the T-shaped intersection of the "golden coastline" in the east of China and the "golden waterway" of the Yangtze River. It is famous at home and abroad for its 1390 islands. It has unique deep-water port resources and remarkable location advantages in connecting the river to the sea. It is the sea gateway and river sea intermodal hub of the Yangtze River Delta and areas along the Yangtze River [1].

Looking at the future development track, the future construction of Zhoushan is bound to be inseparable from the port and waterway. Port logistics and chemical industry will always be an important industry affecting the development of Zhoushan, but with rapid development, a series of risks will inevitably occur. Navigation safety is always the first requirement, which requires us to fully consider various factors affecting navigation environment, grasp the overall situation and recognize the present situation. This paper analyzes the current navigation environment according to the conditions of the navigation field, such as the alternative ship type, the climatic conditions of the channel waters and the characteristics of the ship traffic flow, so as to provide a reference for Chinese ships to deeply understand the navigation environment of the northern waters of Zhoushan, and lay a foundation for the next research on the navigation guarantee in Zhoushan waters.
2. Navigation environment of the island area in the northern waters of Zhoushan

Ningbo Zhoushan port has a total coastline of more than 4000 kilometers. At present, it has 591 productive berths and 53 berths above 10000 tons. It is a transfer and transportation hub for bulk materials such as crude oil and ore in the Yangtze River Delta and the location of two major strategic oil reserves bases in China [2].

2.1. Hydrological and geographical conditions

2.1.1. Hydrological conditions. There are two types of tide in Zhoushan Harbor: regular and irregular. The highest tide level is 5.04m, the lowest tide level is negative 0.05m, and the average tidal range is 2.54M. The current is basically reciprocating [3]. The average rising velocity is generally 1.03-1.54M/s, the maximum is 2.06M/s, and the average falling velocity is generally 0.77-1.08M/s.

2.1.2. Geographical conditions. Zhoushan, backed by large and medium-sized cities such as Shanghai, Hangzhou, Ningbo and vast hinterland such as the Yangtze River Delta, faces the Pacific Ocean and has strong geographical advantages, as shown in Figure 1. The terrain is inclined from southwest to northeast, so compared with the south, the northern island is small, low-lying and sparsely distributed; surrounded by the sea, it has a subtropical monsoon climate, warm in winter and cool in summer, mild and humid, with sufficient light.

2.2. Meteorological conditions

Due to the large number of islands and narrow channel in Zhoushan, the wind force of inter Island routes is seriously affected by the island topography, and the wind force of each route has obvious local characteristics, which makes the actual wind force of some routes deviate from the predicted wind force greatly. From the end of each year to the beginning of the next year, it is easy to be affected by cold wave and strong wind, and the wind force can reach level 9 [4]-[5]. In addition, Zhoushan area is also vulnerable to typhoon, and ship navigation is greatly affected. The annual average fog days in Zhoushan area are 16 days, generally lasting for less than 5 hours, up to 12 hours, and most in spring.

2.3. Traffic conditions

Zhoushan port is located in the intersection of the North-South sea transportation channel and the Yangtze River golden waterway, and faces the Pacific Ocean and close to international routes, which is the junction of international logistics and domestic logistics. There are 87 public air routes for ships entering and leaving the port waters, crisscrossing and crisscrossing.
On September 29, 2019, after three and a half years of construction, the fuchimen bridge, the initial section of the main channel project of Zhoushan port, was officially opened to traffic. As the starting point of the main channel of Zhoushan port, the completion of the fuchimen bridge will be conducive to improving the sea land linkage collection and distribution network of Ningbo Zhoushan port.

3. Analysis of problems in current navigation environment

3.1. Complex ship traffic flow
Due to the crisscross sea routes in Zhoushan island area, the types of navigable ships are complex. Ships sailing in and out of Shanghai, Ningbo, Zhoushan, Zhepu and other ports in the island area, domestic coastal ships sailing on North-South routes, as well as fishing boats and warships constitute a complex and high-density ship traffic flow in the island area, especially in the northern island area where there is no relatively perfect divided navigation area, leading to disordered passage of all kinds of ships, resulting in a high probability of water traffic accidents. Great promotion.

3.2. Great climate change throughout the year
As the East China Sea is located on the east coast of the Asian continent, which is a typical subtropical monsoon climate, the wind direction changes significantly with the seasons. In winter, it is controlled by the Mongolian high, and the dry and cold northerly wind prevails; in summer, it is affected by the Pacific high, and the humid and hot southerly wind prevails. In recent years, due to the influence of global climate change, it is obvious that the formation and movement of typhoons are irregular, posing a great threat to the navigation of ships. The cold wave and fog season are the high incidence periods of accidents.

3.3. Complex navigation environment
It not only has all the characteristics of the island reef area, but also has many navigable waterways, narrow and complex waterways, and the waterways are interconnected [6]. There are more than one hundred main navigable waterways in Zhoushan island area. The islands near the navigable gate are mountainous and the entrance is not easy to find. There are many dangerous things such as shoals and reefs near the channel, some of which are close to the route, and the navigation mark facilities are not perfect, which seriously threatens the safe navigation of the ship.

3.4. Large current velocity, complex flow direction and large tidal range
The current velocity in most waters is 2-4 knots, and the maximum velocity of Xihoumen and guishanhangmen can reach 7 knots. Because of the influence of topography, there are side current and eddy current at the entrance of navigation gate, which affect the navigation and operation of ships.

3.5. Unadaptable to navigation conditions
According to the people's daily. Com, a new 178 passenger high-speed ship will be built with a cost of 25 million yuan to operate the Baifeng Putuoshan route, a 50 million yuan luxury passenger roll boat named "Penglai Xiandao" will be built, and a 250 passenger high-speed single ship will be built with a cost of 28 million yuan to operate the northern waters of Zhoushan.

The navigable environment in the northern waters of Zhoushan is intricate [6]. In the future, ships will develop towards large-scale, and the navigable environment will be further complicated with the increase of ship flow and cargo throughput, as well as the development of major fishing ports. This development trend also puts forward higher requirements for the navigable situation of Zhoushan Island waterway.
4. Countermeasures

4.1. Strengthen the management of crew
The man-made factor of maritime navigation is the crew. The key to ensure the safety of shipping is to improve the comprehensive quality of the crew and attach importance to the management of the crew [7]-[8]. In recent years, many fishermen in Zhoushan island area have been transformed into merchant ship crew members. This group shows a great lack of professional knowledge and literacy. The basic factor of frequent accidents is that they rely on personal experience for maritime navigation, resulting in low comprehensive quality. Therefore, to strengthen the management of the crew and improve the navigation order is to strengthen the crew's safety awareness, and to improve the crew's sense of responsibility and competence.

4.2. Improve channel infrastructure
The water area in the north of Zhoushan is a complex one, which is characterized by many islands, reefs and fast current. In order to ensure the safe navigation of ships in the area, it is necessary to improve the navigation aids and other facilities [9]. For example, the navigation aids management department needs to reasonably design and set up the lights on the channel, and further improve the navigation conditions and reduce and avoid accidents in the water area by improving the basic facilities of the channel.

4.3. Regulate ship behavior
The regulation of ship behavior is mainly reflected in the maritime department's strengthening the strictness of the implementation of ship navigation management regulations and making more reasonable regulations. For example, in 2016, Zhoushan MSA revised and improved the regulations on the management of ship routing system in deep water route of Ningbo Zhoushan port core port area and the regulations on the safety supervision and management of ship traffic management system in Ningbo Zhoushan port core port area. The new version of the regulations reasonably adjusted the ship reporting line in the waters of the routing system and improved the navigation efficiency. According to the traffic flow and navigation habits of ships, the rules also reasonably adjust the original navigation separation system and the setting of warning area. In the next step, we should continue to do a good job in publicity, popularization and law enforcement inspection, maintain the navigation order of ships, provide navigation safety services, and strive to explore and establish a long-term management mechanism for water traffic safety.

5. Conclusion
Navigation environment and navigation safety are inseparable. Zhoushan is a place with dense crew distribution in China. But in recent years, with the vigorous development of shipping industry, Zhoushan water area is also a place with frequent accidents. In the analysis and understanding of accidents, the hydrological and meteorological conditions in the navigation environment have a greater impact on the safe navigation of ships, based on the clear awareness of the navigation environment in the northern waters of Zhoushan. Reasonable measures should be taken to further improve the navigation environment, so as to reduce the probability of accidents and improve the safety of water traffic [10]-[11].

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