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Research on the Impact of Ningbo Meishan Port Terminal Project on the Surrounding Submarine Topography

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ABSTRACT

The changes in the surrounding seabed topography during ocean engineering construction are a key technical issue in the development and construction of coastal engineering, which is beneficial for the protection of the nearshore marine environment and the development and utilization of resources. This study analyzes the changes in the surrounding seabed topography before construction (2011), during construction period (2016, 2017), and after construction (2022) based on the measured seabed topography data of four voyages of the Ningbo Meishan Port Terminal Project from 2011 to 2022. Research has found that the actual survey area of the Meishan Port Terminal Project has a total of approximately 1.638 million cubic meters of sedimentation and 1.963 million cubic meters of erosion. After the erosion and sedimentation offset, the overall net erosion in the actual survey area is about 325000 cubic meters. Overall, when conducting artificial engineering in the surrounding sea area of the Ningbo Meishan Port Terminal Project, efforts should be made to avoid significantly changing the hydrodynamic conditions, which may affect the surrounding seabed topography and thus have adverse effects on the surrounding marine environment.

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Introduction

Ningbo - Zhoushan Port is located in the middle of China's mainland coastline, located in the intersection of China's north-south shipping channel and the golden waterway of the Yangtze River, moderate geographical location, obvious geographical advantages, unique conditions for port construction, is the main coastal port of China, responsible for Zhejiang Province, the Yangtze River delta and the Yangtze River along the area of domestic foreign trade materials transit tasks. According to the Master Plan of Ningbo-Zhoushan Port, Ningbo Meishan Port Area, with its advantages as a bonded port area, will attract container cargo sources related to international transit, international distribution, international procurement, international entrepot trade, bonded processing and bonded logistics, and undertake the tasks of ocean and coastal container transportation [1].

The terminal construction project of Ningbo Meishan Port Area will enhance the attractiveness of Ningbo-Zhoushan Port to large container ships and international transit containers in East Asia, which can meet the needs of the rapid development of container transportation business of Ningbo-Zhoushan Port. The container terminal built by the project is arranged on the east side of Meishan Island, where the water area is mainly Fodu Waterway. The beach of the southeast shore (Meishan Salt Farm) is narrow and the width is generally 200-300m. The width near Pantou Mountain near the north end of Meishan Salt Farm is larger, the widest is about 500m, and the 10m isobath is 200~1000m from the shore. 20m isobath offshore distance between 300~1500m; On the northeast side of Meishan Island, there are two islands, Qinglongshan and Pou Snake Mountain, which are narrow and long waterways, the width of which is generally 200-500m.

A correct understanding of hydrodynamic conditions, sediment transport and sea-bed erosion and deposition changes in the sea area is necessary to carry out coastal engineering development. The key technical issues established are also conducive to the protection of offshore Marine environment and the exploitation and utilization of resources [2-11]. According to the survey data from 2012 to 2013, Gong Shiqi et al. [12] found that the overall changes of the seabed topography in the north of Meizhou Bay were not large, and the large changes in individual areas were caused by factors such as man-made dredging and port dredging. Chu Hongxian et al. [13] studied the shallow sea labor in Caofeidian. The law of sediment erosion and deposition in the sea area around the island project, and the degree of submarine sedimentation and erosion are quantitatively evaluated. Pass no based on the comparison of water depths in the same period, the change of seabed topography of the backsilting of Shidao Xingang Basin was analyzed, the magnitude of siltation was quantitatively evaluated, and the main factors affecting siltation change and the law of siltation change were analyzed [14]. Sun Yonggen et al. [15] studied that the construction of Luearingjiang Coastal Highway and Sandun Highway in Qinzhou Bay led to changes in the overall morphology of the bay, and conducted in-depth research on the specific impacts. Through numerical simulation of Daishan-Yangshan cross-sea Bridge, Li Wendan et al. [16] found that after the implementation of the project, the variation range of high and low tide levels near the axis of the bridge was mostly within 2 cm, while the distance was basically unaffected. In this paper, based on the measured seabed topographic data in the sea area around Meishan Port, Ningbo, the evolution characteristics of seabed topographic erosion and deposition are studied, which can be used as an important basis for the construction of the project. This project is based on the planning and design of the project and the protection of the surrounding environment [17], and it is also of great significance to the research on the characteristics of the changes of the seabed topography in the surrounding sea area.

Study Area and Data Source

Based on the data obtained from the topographic survey conducted in May 2016 and May 2022 in the sea area around the pier project in Meishan Port Area, Ningbo. The survey data in May 2011 are used as pre-construction data, the survey data in May 2016 and May 2017 are used as construction data, and the survey data in May 2022 are used as post-construction data. There are a total of 4 voyage data. The survey project involves the seabed topography and hydrodynamics of the surrounding sea area. The collection, fixation, storage, transportation and analysis of samples are strictly in accordance with the provisions of the Code for Marine Monitoring (GB17378-2007) [8]. In addition, the plane coordinates of topographic survey are Ningbo independent system, the base plane is national 85 elevation, the measurement scale is 1:500, the DGPS is used, the water depth is measured by digital automatic recording sounder, and the measured data are comprehensive, accurate and reliable.

Coastal Geomorphic Features

Meishan Island, the fourth largest island in Ningbo, is located in the northeast of Xiangshan Port Gate. It is elliptic in shape, with a long axis of about 10 km and a short axis of about 4 km, with a total area of 26.9 km2. Meishan Island faces Shangyang Township and Guo Chen Town in Beilun District in the northwest across Meishan Waterway, which is about 0.45km wide. Meishan Island faces Qitou Ocean in the northeast, Fodu Island and Liuheng Island in the southeast across Fodu Waterway, and Xiangshan Port Gate Mizaki in the southwest [18].

Meishan Port area is backed by the mainland Chuanshan Peninsula to the northwest, Fodu Island to the southeast, and blocked by Liuheng, Shrimp Zhi and Taohua Islands and Xiangshan Peninsula to the east and south, respectively, with excellent wave conditions in the project area [19]. However, the water depth outside Xiangshan Port on the west side of Meishan Island is relatively shallow, and the sand content of the water body will increase during strong winds and waves, and the sand-bearing water flow will flow through the project area and silt down. Therefore, the silt deposition intensity in the project area will increase during strong winds, and the silt on the silty coast is not easy to settle after suspension, and the starting time is longer, so there will be no sudden silt problem [20-21].

In addition, the front of the project wharf is basically in a siltation state, the average siltation amplitude is 2.3m, the maximum is 4.7 m, and the average annual siltation rate in the past 40 years is 6.22 cm/a. According to the comparison of the submarine topography profile (FIG. 1), the sediment filling amplitude of the seabed is about 0.5~2 m, and the overall state of micro-silt is presented

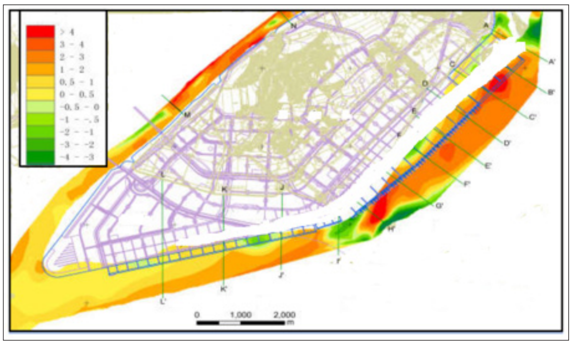

Figure 1: Distribution map of sea-bed erosion and deposition on Meishan Island

Characteristics of Submarine Topography Change

Survey Results of the Construction Period

According to the underwater topographic survey results of Ningbo Meishan Port Wharf engineering area in May 2017, the underwater elevation in the southern part of the actual survey area ranges from -11m to -23m (except for the absence of measurement data at ship berthing). The front of the construction area is the underwater bank slope area, and the underwater elevation gradually decreases with the increase of the offshore distance, and the terrain slowly declines. The underwater contour lines are basically distributed along the shore, and the horizontal distance of the contour lines is about 15 m ~ 20 m. The general trend is NE-SW, and the underwater terrain is generally high in the north and low in the south. In the south of the survey area, the topography between the contours of -15 m ~ -18 m is large, and the horizontal distance between the contours is small and the distribution is dense. The maximum underwater elevation in this area is -15.4 m. In addition, the contour lines in the eastern part of the survey area are relatively sparse and the terrain is relatively flat.

The underwater terrain in the northern part of the actual survey area is relatively complex, and the underwater contours are densely arranged. Among them, the sea area near the northern part of Qinglongshan Island has large topography ups and downs, the central platform is significantly depressed, and the contours form multiple closed circles. The lowest elevation value of the terrain is -30.9 m. The terrain in the northwestern part of Qinglongshan is also rugged, and the underwater contour lines are arranged in a compact manner, and the underwater elevation gradually increases, and the terrain then slowly rises, until the underwater elevation near the southwest side of Qinglongshan Island increases to -1.9m.

Survey Results after Construction

According to the results of the submarine topographic survey of the sea area of Meishan Port Project in Ningbo in May 2022, the underwater elevation in the southern part of the actual survey area (the front sea area of the project wharf) is roughly -18.0 m ~ -20.5 m. The terrain is relatively flat with no obvious fluctuation changes except for the measurement data at the ship anchorage, and the maximum underwater elevation in this area is -18.2m. In the eastern part of the actual survey area (from the east of the pier to the west of Qinglong Mountain), the underwater elevation is roughly between -2.0m and -16.0m, and the underwater elevation increases gradually from south to north, and the terrain rises gradually. The underwater contours spread roughly from south to north, and the horizontal distance of the contours is about 30 m to 60 m. The general trend is NW. The underwater terrain is generally high in the north and low in the south. The underwater terrain in the northern part of the actual survey area is relatively complex, and the underwater contours are densely arranged, especially in the waters near the northwest of Qinglongshan Island, where the topography has large ups and downs, the central platform is significantly depressed, and the contours are densely distributed in a circle, and the elevation value of the lowest part of the terrain is -21.4m. The terrain in the northern area of Qinglongshan is relatively flat, the overall underwater terrain is roughly low in the middle and high in the north and south, and the maximum underwater elevation in this area is -1.6m.

Analysis of Change Characteristics

In order to understand the impact of the wharf project in Gangmeishan Port Area on the seabed topography of the surrounding sea area, the underwater topography data measured in 2022 was compared with that measured in 2017. The results are shown in Figure 4: The overall situation of the actual test area is in a state of south flushing and north silting. The area of south scouring is about 400,000 m^2, and the scouring intensity is about 4.5m. The area of north silting is about 200,000 m^2, and the silting intensity is about 7.5m. From the east of the pier to the west of Qinglong Mountain, the sedimentation is slightly greater than the erosion. Overall erosion is greater than sedimentation in the actual test area. According to Surfer software calculation, the actual measured area of the silt area is about 357,000 m^2, the silt volume is about 1.638 million m^2, the erosion area is about 55.4m^2, the erosion volume is about 1.963 million square meters, and the overall net erosion volume of the actual measured area is about 325,000 m2 after the erosion and deposition balance.

Conclusion and Discussion

According to the field measured submarine topographic data, the analysis of seabed topographic changes in the surrounding sea area of Ningbo Meishan Port project shows that the sea area in the whole actual test area of Ningbo Meishan Port project is in a state of south rushing and north silting and erosion is greater than silting. After the construction of the dock project, the water depth decreases and the average velocity is adjusted, and finally the whole waterway reaches the balance. In addition, in the study area, the water in the southern area of the wharf front is relatively deep, the terrain is relatively flat, and there is no obvious fluctuation change. The terrain in the northern part of the survey area is relatively complex and is in a silted state. From the east of the pier to the west of Qinglong Mountain, the eastern topography of the sea rises gradually from south to north, and the siltation is slightly greater than the erosion.

From 2017 to 2022, according to the measured data, the total deposition of the sea area in the actual test area of Meishan Port project is about 1.638 million square meters, and the erosion is about 1.963 million square meters, and the overall net erosion of the actual test area is about 325,000 square meters after the erosion and deposition balance. Combined with the estimated value of the siltation amount of the project, the impact of the wharf project on the seabed topography of the surrounding sea area is slight, which meets the relevant requirements in the Technical Guidelines for Environmental Impact Assessment of Marine Engineering [22]. However, on the whole, the artificial engineering carried out in the sea area around the wharf project of Meishan Port area of Ningbo should also avoid significantly changing the hydrodynamic conditions, strengthen the verification of basic data, the verification of engineering construction, the implementation of "three simultaneous" acceptance pollution prevention measures and the implementation of Marine environmental protection measures, otherwise it will have an adverse impact on the Marine environment.

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