Numerical Simulation and Measurement of Artificial Flow Creation in Reclamation Projects

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ABSTRACT

Through artificial flow generation, the problem of poor water circulation in the enclosed artificial bay can be effectively solved and water pollution can be avoided. CFD technology is applied to establish a full-scale 3D model of the reclamation project. And a combination method of numerical simulation and full-scale measurement is used to analyze the artificial flow in the target waters. Under different artificial flow conditions, the flow velocity and flow line in the enclosed area are simulated and compared with the measured data, to study the distribution of the flow velocity and direction. The study shows that the flow field and flow line of the simulated and tested are basically consistent. And the measured data are slightly less than the numerical results, due to the wind and the seafloor topography. The artificial flow creation can effectively promote the movement of seawater in the enclosed area. The purpose of improving water quality can be achieved.

KEYWORDS: Artificial flow; reclamation project; hydrodynamics; full-scale measurement.

INTRODUCTION

Meishan Channel is located between Meishan Island and Chuanshan Peninsula in Beilun District, Ningbo City, and adjacent to the East China Sea in the south. In 2016, Meishan Channel was closed by the dragon mouth. Thus, the sea area of Meishan Bay was officially isolated from the open sea, forming a closed "clear water area". After reading the literature, no other cases of artificial flow induced by reclamation projects were found. Faggiano et al. (2005) found that reclamation projects would have a negative impact on the hydrodynamic environment and water environment of offshore waters. For tourism purposes at muddy sea, a narrow stretch of seawater between an island and the mainland was dammed, forming a 'clear water area' along the coast, as shown in Figure 1. As a result, a still water bay with an average depth of 7 meters and a length of roughly 760 meters north to south has been formed next to the artificial beach. The flow of water in the study area can be controlled by a gate in the normal exchange water body. But part of the curved beach in the southwest is the blind area of water flow, which is easy to form water pollution. To solve this problem, we can use artificial flow to achieve a large area of water circulation, so that the water body in the blind area can flow and exchange with the external water body, to achieve the purpose of improving water quality.

Much research is reported to analyze artificial flows by using the computational fluid dynamics (CFD) method. Wu et al. (2022) said that artificial flow creation can be used to achieve a large area of water circulation, so that the water in the blind part can flow and thus exchange with the outside water for the purpose of improving water quality. Wang (2019) studied the hydrodynamic characteristics of Zhifu Bay under the influence of reclamation using numerical simulation methods. Li et al. (2022) studied the hydrodynamic enhancement effect of the river-lake connection in the abdomen of the Lixia River in Jiangsu, also using numerical simulation. Ji et al. (2015) used two-dimensional modeling to analyze the overall coastal structure and hydrodynamic performance of the reclamation area in the Shengn island fishing port reclamation project. Lu et al. (2012) used aeration, oxygenation, and artificial flow generation techniques to optimize water quality in a narrow river channel. Guo (2016) studied the mutual influence of the Jiaojiang River estuary on the sea reclamation project. And analyzed the geomorphological and hydrodynamic conditions of the estuarine coast, to solve the ecological and environmental problems brought about by the reclamation project. Li and Gu (2003) expanded hydrological applications of the ANN modeling technique to sediment yield predictions. Fei (2022) conducted an in-depth study on the hydrodynamic characteristics of Longkou Bay. And analyzed its response to the construction of an artificial island. Wang et al. (2021) studied the effect of lake and reservoir water quality improvement based on hydrodynamic simulation methods. Suzuki et al. (2013) suggested that CFD is a method that can provide a better theoretical basis to support the study of hydrodynamic performance, which is difficult to measure in practice. To some extent, the reclamation works would have adverse effects on fishery resources, plankton, self-purification capacity of seawater, based on the research by Lu et al. (2012) and Wang (2018). However, Meishan Waterway, after being closed as an artificial beach, would not bear the function of fishery and aquaculture. The reduction

(a) Before closure in May 2015

(b) After closure in October 2021

Fig. 1 Comparison of the strait before and after damming.