Numerical Modeling and Design of a Fishery Port Near Ezhimala Promontory

T. P. Dhanya and Kiran G. Shirlal

Abstract MIKE 21 BW is the state-of-the-art numerical modeling tool for studies and analysis of wave disturbance in ports, harbors, and coastal areas. MIKE 21 BW has been used successfully for the analysis of operational and design conditions within the port. For development of a port, it is of vital importance to consider the environmental conditions prevailing at the site of development. Proposed fishing harbor is at Puthiyangadi in Madayi Panchayath of Kannur District in Kerala. The current study addresses the modeling of two port layout through the use of Boussinesq wave model and selection of best layout and hence the breakwater design.

Introduction

Proposed fishing harbor at Puthiyangadi in Madayi Panchayath of Kannur District in Kerala is to the immediate south of Ezhimala Promontory. The new fishing harbor is proposed toward the west of existing fish landing center at Puthiyangadi. Considerable fishery activities are already present at this region. About 100 mechanized boats, 50 inboard vessels, and 150 OBM vessels (Harbor Engineering Department-August 2015) are currently utilizing the limited facilities available in the port. The layout of the breakwater to form the basin can only be arrived via proper model studies. Different methods are used to study shoreline changes in the coastal area. Among them, mathematical modeling is considered as an effective technique. (Santosh et al. 2015). MIKE 21 BW is the state-of-the-art numerical modeling tool for studies and analysis of wave disturbance in ports, harbors, and coastal areas. MIKE 21 BW has been used successfully for the analysis of operational and design conditions within the port and harbor. By the inclusion of surf and

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swash zone dynamics, the application range is extended further into coastal engineering. MIKE 21 BW is capable of reproducing the combined effects of all important wave phenomena of interest in port, harbor, and coastal engineering.

Objectives

The objective of the present study is to carry out numerical modeling using MIKE 21 BW model for the development of port near Ezhimala Promontory along with the design of breakwater.

Project Location

Proposed fishing harbor at Puthiyangadi in Madayi Panchayath District is to the immediate south of Ezhimala Promontory is shown in Fig. 1.

This promontory juts out into the sea for a distance of about 3.6 km from the shoreline and consists of rock cliffs of about 10–20 m height along the coastline. The new fishing harbor is proposed toward the west of the existing fish landing center at Puthiyangadi. This is an open beach, and beach landing is resorted to land

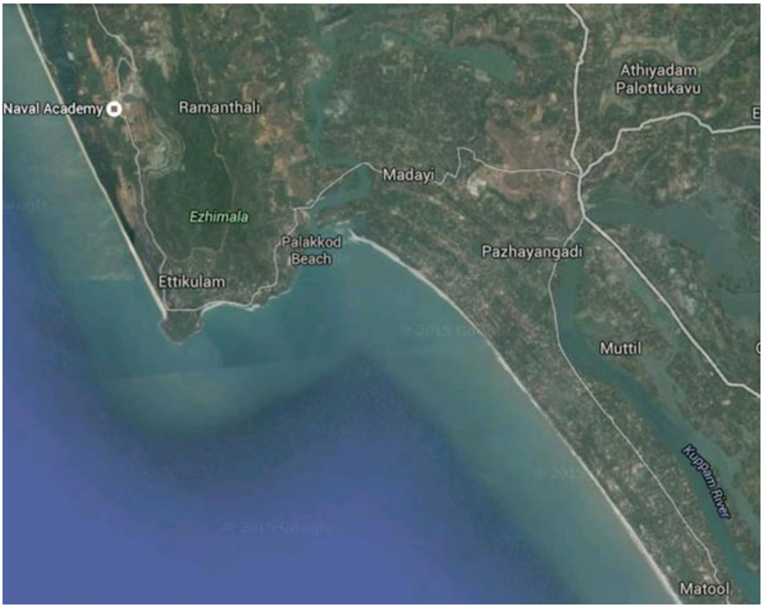

Fig. 1 Project location

the fish catch here. This area is about 1.5 km from the river mouth along the coastline toward the south. The least width of river just upstream of the river mouth is 74 m. The width of the river is less than 100 m for a length of about 300 m upstream of the river mouth. Since there is a bottle neck of less than 100 m width for a long stretch of 300 m near the river mouth, it will be dangerous and difficult to have mechanized fishing crafts navigate through this area, if a full-fledged harbor is made inside the river. This is another reason why the location of the harbor is chosen on the open sea coast near the existing FLC at Puthiyangadi (Harbor Engineering Department-August 2015).

Design of Fishery Port

The methodology adopted for the modeling of fishery port using Boussinesq model is given below.

MIKE 21 BW—Boussinesq Model

MIKE 21 BW is the state-of-the-art numerical modeling tool for studies and analysis of wave disturbance in ports, harbors, and coastal areas. MIKE 21 BW has been used successfully for the analysis of operational and design conditions within the port and harbor. By the inclusion of surf and swash zone dynamics, the application range is extended further into coastal engineering.

MIKE 21 BW is capable of reproducing the combined effects of all important wave phenomena of interest in port.

Bathymetry

Providing MIKE21 BW with suitable model bathymetry is essential for obtaining reliable result. Setting up the bathymetry requires more than specifying a 2D array of accurate water depth covering the area of interest. It also includes the appropriate selection of area to be modeled, the grid spacing, location and type of boundaries, etc. We are interested in determining the wave disturbance conditions in Puthiyangadi for the following offshore conditions (at 8 m depth CD):

Significant wave height, $H_{m0} = 3$ m
Spectral peak wave period $T_p = 8$ s

The data have been collected from the port and are shown in Fig. 2, and using this data the bathymetry has been prepared and is shown in Fig. 3.

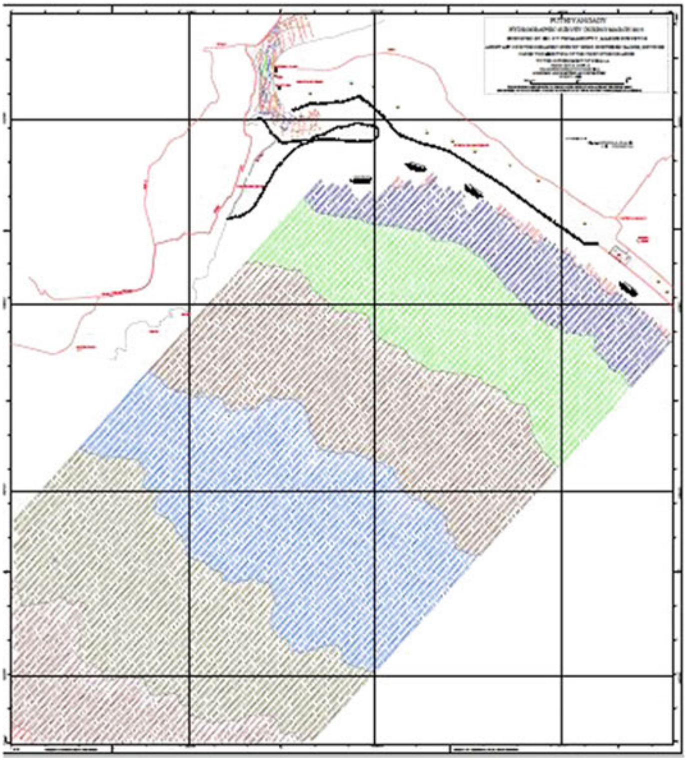

Fig. 2 Data obtained from the port

Sponge Layer

Sponge layer is providing for absorbing wave which is reflecting back to the offshore. In the present case, we will apply sponge layer along 3 offshore part of the model domain. Therefore, the land value at the shoreline has been changed from 10 to 5 along a section where sponge layer is needed, as shown in Fig. 4.

Porosity Layer Map

A porosity layer map is used to model either partial reflection or transmission through various types of structures. If porosity values are backed up by land, partial reflection will take place. The typical procedures to change the bathymetry value from the initial land value to another value that is 8 along all structures having partial reflective properties are shown in Fig. 5.

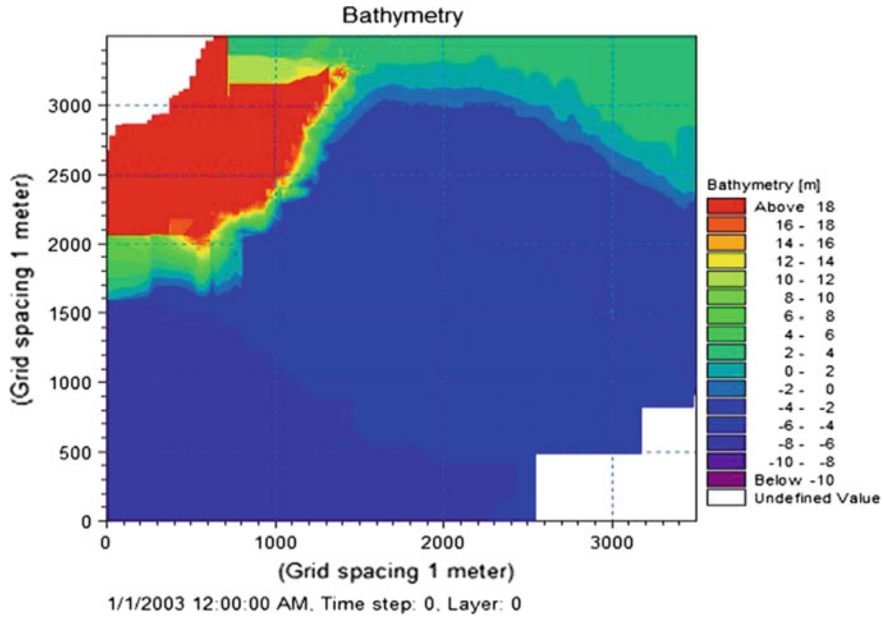

Fig. 3 Bathymetry

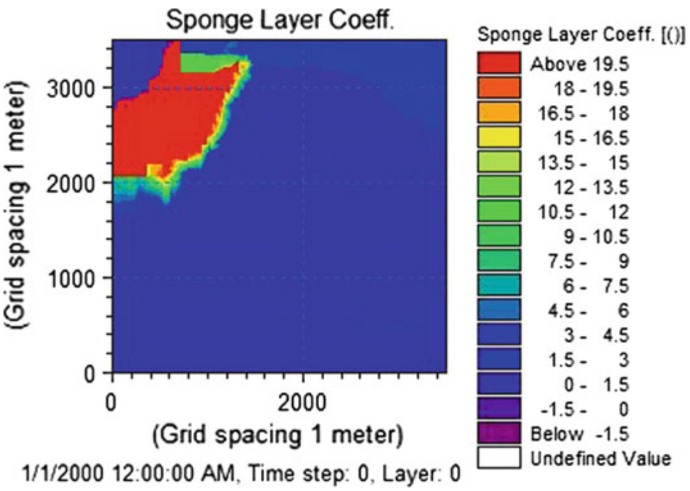

Fig. 4 Sponge layer

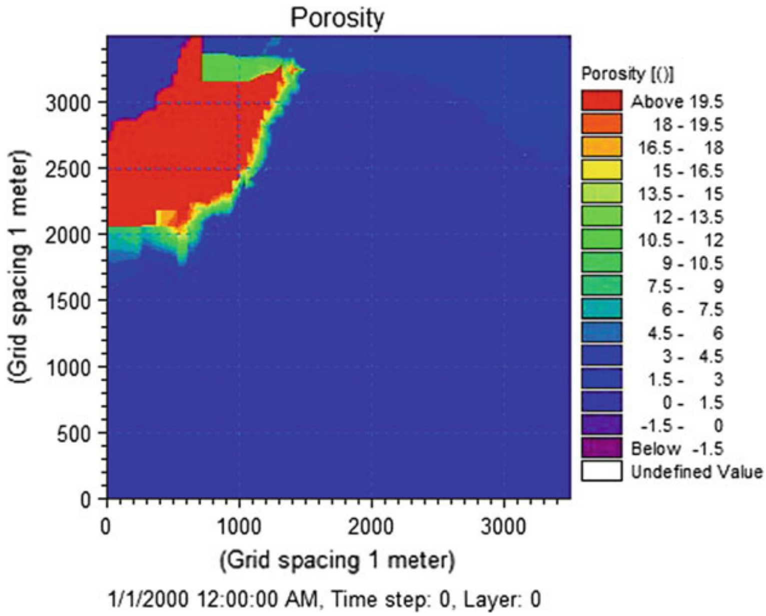

Fig. 5 Porosity layer map

Internal Wave Generation Data

The offshore waves are specified as internal wave generations of the incident wave field along a specified generation line. The advantage of using internal generation is that sponge layers can be placed behind the generation line to absorb waves leaving the generation domain as shown in Fig. 6.

Alternative Port Layout

Considering all the requirements and preliminary technical details of the site, two suggestions have been proposed.

Suggestion-1

The main breakwater PQRST starts from the beach at 500 m north of the existing fish landing center and follows the streamlined path in such a way that deposition of sediments inside the basin near the curved portion is minimized since the direction of the sediment movement is from the river and along the coastline. So the main

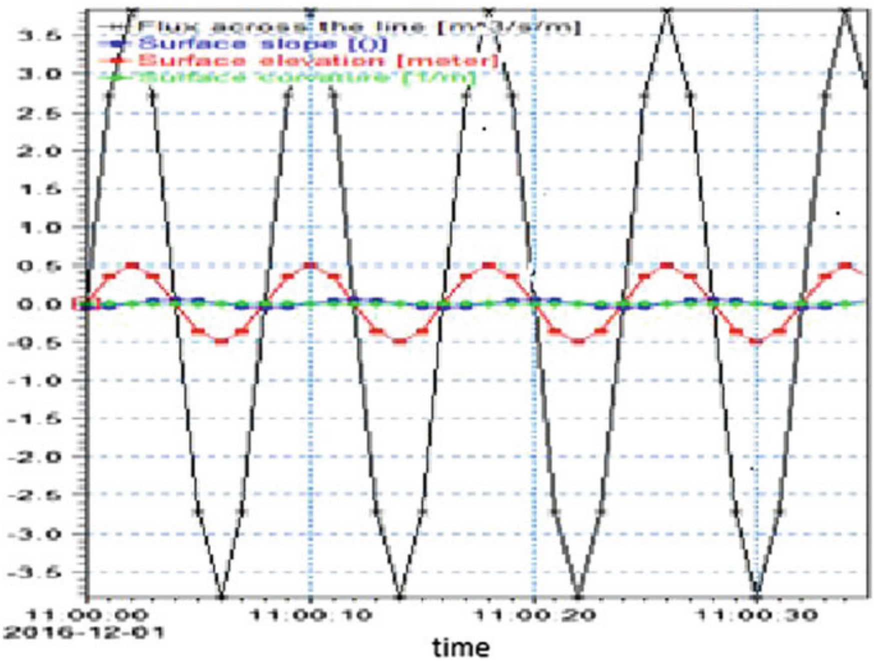

Fig. 6 Internal wave generation data

breakwater PQRST prevents the accumulation of sediment inside the breakwater. It has a total length of 870 m, and the head reaches up to 4 m depth from CD. The harbor entrance is 100 m wide. The leeward breakwater is 375 m long. The harbor basin is 500 m wide at the land side and has a total area of 14 ha. It is shown in Fig. 7.

Suggestion-2

The second breakwater is also proposed by considering the movement of sediment so that it prevents the accumulation of sediment inside the breakwater. The main breakwater AB and CD starts from the beach at 500 m north of the existing fish landing center. It has a total length of 600 m, and the head reaches up to 4 m depth from CD. The harbor entrance is 100 m wide. The harbor basin is 500 m wide at the land side. It is shown in Fig. 8.

Considering all the analysis undertaken by inputting bathymetry, sponge layer, porosity layer map, internal wave generation data in MIKE 21 BW, it is concluded that suggestion 1 layout is the best layout.

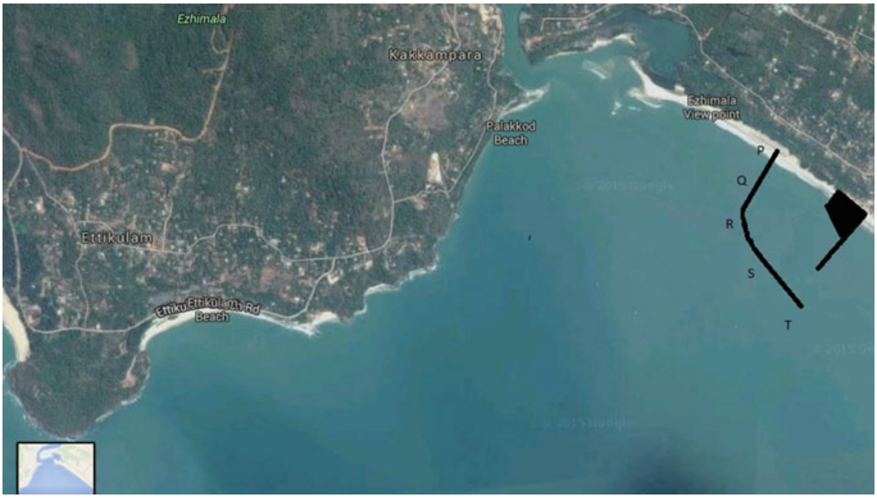

Fig. 7 Breakwater layout—suggestion 1

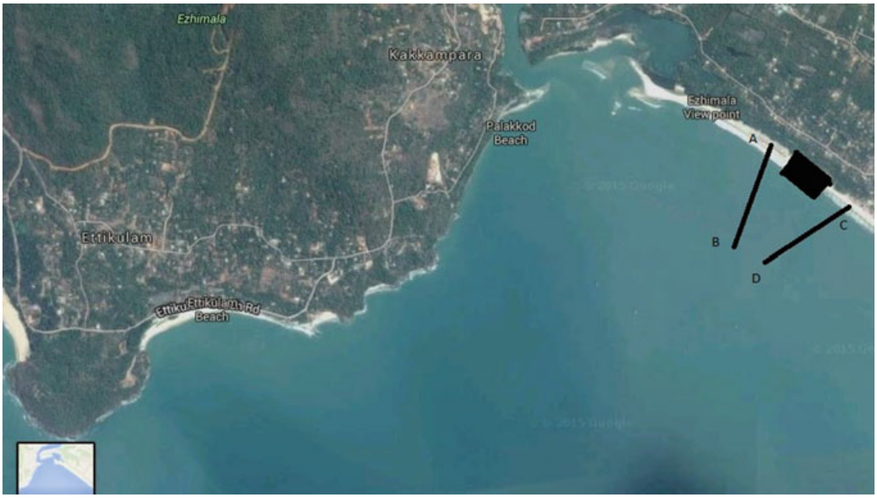

Fig. 8 Breakwater layout—suggestion 2

Recommendation

Preliminary studies undertaken and based on that two port layouts have been suggested. In order to select the best layout, numerical modeling/physical modeling is required. Numerical modeling has been undertaken, and it is obtained that layout 2 is the best layout. It has been determined that equivalent cube size of the armor unit of the breakwater is 1.002 m and the mass is 2.66 T.

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