Evaluation of Current Pattern with two Modules of HD and BW in Mike21 Software

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Abstract

In this paper, the stabilized jetty structure on the mouth of Kiashahr port located in southern Khazar in Iran country, Guilan province is evaluated using Mike21 package. Considering the results of Hydrodynamic model, it can be concluded that stabilized jetties disordered total flow in the vicinity of mouth in a manner that eastern waves-generated flows like to pass from the structure. Meanwhile north-western, northern and north-eastern waves-generated flows produce eddies turning around the mouth of port whereas increasing wind and waves height, velocity of waves shall grow and eddies will be stronger. To investigate the effect of jetty structure on Kiashahr port, current velocities are computed for port entrance for two distinct cases of prior and after the construction of jetty. Considering the littoral flow simulation in hydrodynamic model, the flows generated from north and north-west waves are aligned from west to east. The littoral flow velocity in coastal zone growing from breaking zone to border line and are limited between 0.1 to 0.5 meter per seconds. For flows of north east direction, the coastal flows are redirected from east to west. The result of hydrodynamic simulation indicates that for deep water conditions and in the vicinity of boundary conditions, the flow velocity is not changed considerably. The reduction of flow velocity is obvious in vicinity of jetties. Finally, the plots of flow velocity from hydrodynamic analyzing of two HD and BW modules show that at the entrance of port, flow velocity from BW is less than HD as a result of waves of this module have not broken yet and generated any flows.

1 Introduction

The process of developments inside sea environment with progressive construction of ports and other coastal structures have influenced the current coastal regime and its sediment transportation characteristics. Sediment transportation itself causes the problems of sedimentation and erosion in coastal zones and these will introduce problems on the efficiency of coastal structures or their facilities[1].

Jetties are used in order to prevent the interference of waves and currents in the river to sea links in the gulf and its domain. The Kiashahr lagoon in Iran is one of the challenging locations that will be studied in the present paper. Two jetties on both sides of Kiashahr lagoon will interface the current movement to Caspian Sea while they provide a navigation channel for ferry traffic on this location. Due to the complex effect of active Delta and Sefidrood river and the littoral currents from west to east of this lagoon, a lot of sedimentation are accumulated on the back of jetty [2].

Karami Khaniki et al. (2005) considered the capability of Mike 21 software for modeling of tidal currents at Zohreh estuary. In this study, the current velocity and their parameters on the water surface have been measured for 4 days and the measured data have been compared with the simulation model results. [3].

2 Model Descriptions

One of the famous mathematical models of the sea environment in the world is used in the mathematical model of MIKE21. This computer software has been programmed by Danish Hydraulic Institute and Water Quality Institute of Denmark and has been developed during last 20 years.

2.1 The Spectrum modules of waves induced by wind in nearshore area (NSW)

The flows induced by waves are the causes of stress gradient radiation in breaking zone while NSW module is capable of the radiation stress gradient analysis. The wave heights for three perpendicular directions with wind duration of 3, 6 and 9 hours are computed for both prior to jetty construction and after its construction. The topographical condition of study area is shown in Fig.1-2.

2.2 The Hydrodynamic modules (HD)

HD module is useable in extensive area of Hydraulic and its phenomenon. This module, includes modeling tide Hydraulic, wind, currents due to wave…. This module simulates currents in a single layer vertically equal fluid. Equations of this module include Continuity Equations and Averaged Momentum in depth. HD module runs for three perpendicular directions with wind duration of 3, 6 and 9 hours for both prior to jetty construction and after its construction same as NSW module.

2.3 The Boussinesq wave modules (BW)

There are two different modules of BW in MIKE21 software based on the numerical solution of Boussinesq equations in time domain. With inclusion of these terms on Boussinesq equations, the modules has been enabled to model wave train propagation from deep water to shallow water. The maximum ratio of depth to wave length is considered as h/L=0.5 for deep water conditions.

3 Environmental Conditions of Kiashahr fishing port

Kiashar fishing port is located in Guilan province with 51 km distance from Rasht city between Pounel and Langerood. The port is on geographic position of 39°, 57´ East Longitude and 37°, 27´ North Latitude.

The structural hydrodynamic characteristics of Kiashahr fishing port are given in Table 1.

The wind conditions are estimated based on a return period of 30 years. The wind data of Synoptic station of Anzali port is used with 30 years data and the wind rosette is found for this zone. About 47.1% of the year, the wave climate is a calm condition and the prevailing wind direction is the north-west direction.

3.1 Characteristics of Wave Climate in Deep Water

In this research, the wave prediction graphs (calibrated for the study area) are determined from corresponding wind speeds. The position of study area will mean from certain directions, wave heights may be limited by fetch or water depth. The extreme mean wind data, the effective fetch length for different directions and statistical analysis of wind data for different directions are used in prediction of wave heights from empirical relationships. After the extreme wave data are obtained based on all corrections of SPM (Shore Protection Manual) and transformation of wind stress in SMB model.

3.2 Preparation of wind data for prediction of wave climate

The wind data for synoptic station of Anzali port are used in the prediction of extreme wave heights. The wind speed corrections consist of temperature and length corrections with total five correction factors for the estimation of wind speed. The modified wind speeds of three governing directions are given for three different intervals of 3 hours, 6 hours and 9 hours respectively.

4 Current Pattern Analyses

4.1 Current Pattern from HD Model

In this section, the HD module results are presented for two conditions of port without jetty and after its completion. The current patterns are computed by using radiation stresses of NSW module while the vectors in the plots are indicating the average wave currents for different conditions (Fig.3-6).

4.2 Investigation of Current pattern by BW module

In this section, the BW module of Mike21 is used for the estimation of Current pattern prior to the construction of jetty and after completion of them. The vectors are indicating the flow speed for different conditions and the counter lines are the wave height distribution (Fig.7-10).

5 Comparison of results of current pattern for BW and HD modules

In this section, two modules of BW and HD are compared for a section prior to the jetty construction and after completion of the jetties. The numerical results are compared for different wind directions (Fig.11-15).

6 Results and Discussion

6.1 Analysis of HD module

Depending to the wave velocity and its phase angle with coast line, different flows and directions of littoral currents are observed from wave breaking in coastal zones. According to the results of current pattern simulation in modeled zone, currents generated by north and north-west waves are oriented from west to east. Littoral current velocities near coast in wave breaking zone to coast line are greater than other and the flows are bounded from 0.1 to 0.5 m/s. Moreover, the results of present simulation indicate that after construction of the jetty, the littoral current velocity in deep water and at the points near to restricted boundaries would not have any remarkable changes. However, the reduction of current velocity in the vicinity jetties is obvious from simulation results.

6.2 Analysis of BW module

In this module, the wave characteristics and currents are studied including the breaking wave and coast line movement. The comparison of current velocity of two modules of BW and HD indicate that at the entrance of port, flow velocity from BW is less than HD because waves of this module have not broken yet and generated any flows.

References

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[2] Sohrabi M. (2005), "Effects of coastal currents and sediment transportation on Kiashahr enterance port with minimum length requirements of jetty plan", MSc thesis of Ocean Physics, Faculty of Marine Sciences, Marine Technical Science University of Khorramshahr.

[3] Karami Khaniki A. et al. (2005), "Investigation of effectiveness of Mike21 software in tidal currents of rivers estuary, (case study of Zohreh delta river), Fifth Iranian Hydraulic Conference, Kerman University.

[4] U.S. Army Corps of Engineers, Coastal Engineering Manual, Part V, Chapter 6, Sediment management at inlets (2005).

I. CHARACTERISTICS OF KIASHAHR PORT

Basin Depth (m)		Beneficial are of basin (m^2)	Turning Radius (m)	Arm Length (m)		The entrance width (m)	Berthing Length (m)
On port	Entrance			Western	Eastern	140	140
-4	-5	3000	80	993	350		

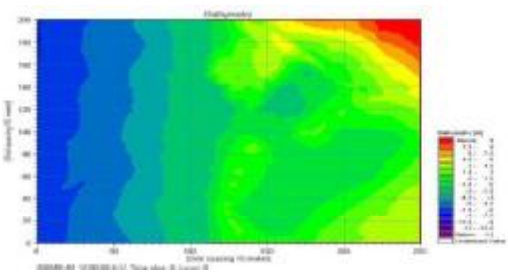

Fig.1. Topographical condition of study area, Prior to Jetty Construction

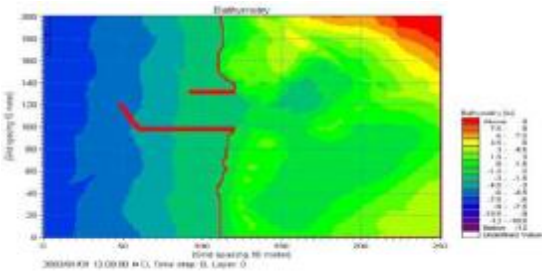

Fig.2. Topographical condition of study area, after construction of Jetties.

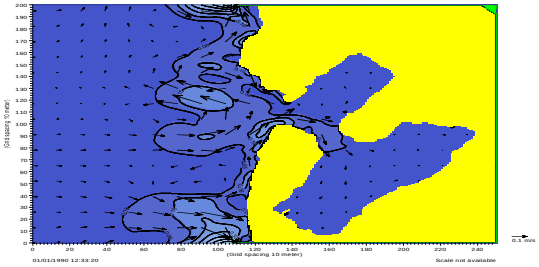

Fig. 3: Current pattern for wind velocity of 11 m/s, 3 hours north direction

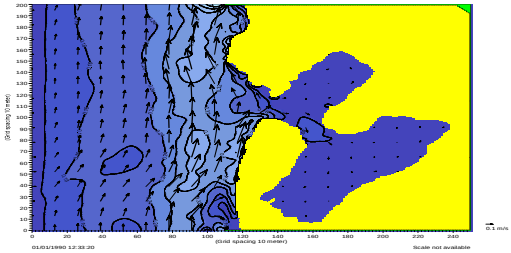

Fig. 4: Current pattern for wind velocity of 14 m/s, 3 hours north west direction

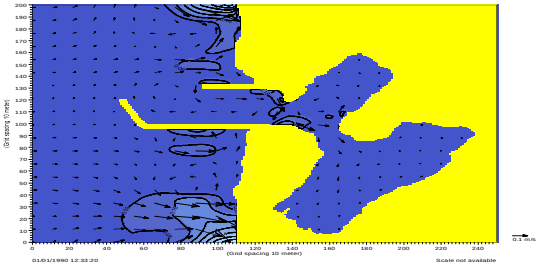

Fig. 5: Current pattern for wind velocity of 11 m/s (after jetty construction), 3 hours north direction

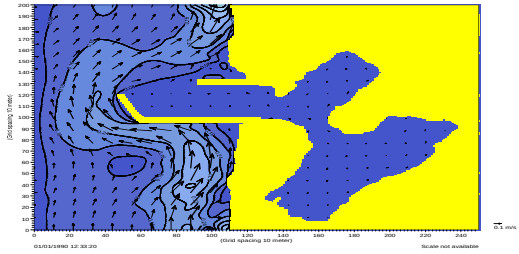

Fig. 6: Current pattern for wind velocity of 14 m/s (after jetty constructrion), 3 hours north west direction

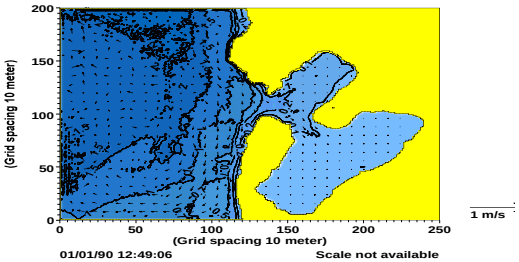

Fig. 7: Wave heights and current with BW module for wind velocity of 11 m/s, 3 hours north direction

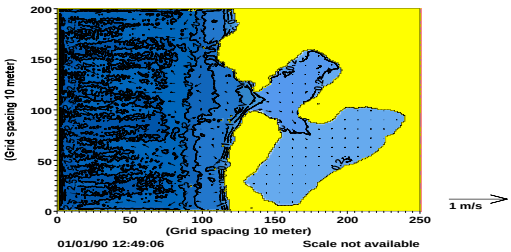

Fig. 8: Wave heights and current with BW module for wind velocity of 14 m/s, 3 hours north west direction

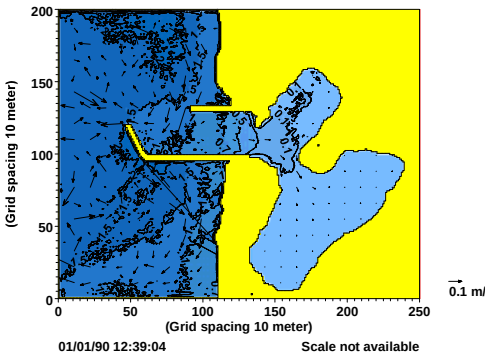

Fig. 9: Wave heights and current for wind velocity of 11 m/s, 3 hours north direction

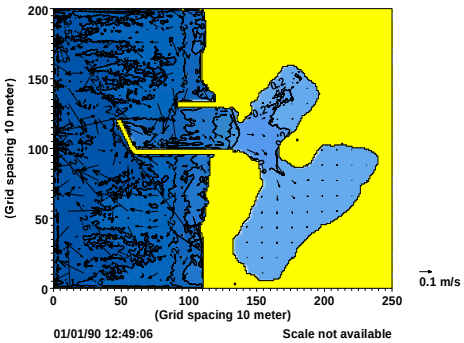

Fig. 10: Wave heights and current with BW module for wind velocity of 14 m/s (after jetty construction), 3 hours north direction

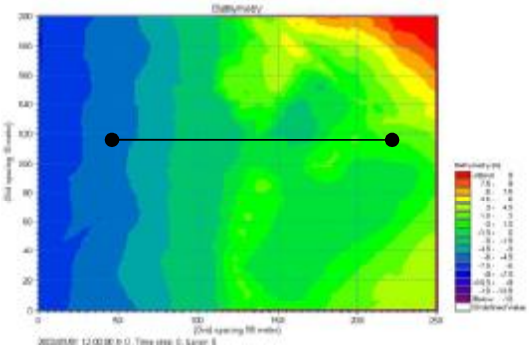

Fig. 11: Comparison of two modules of BW and HD

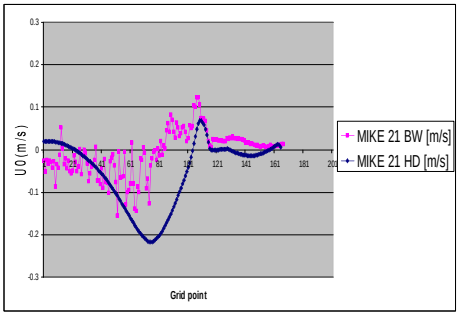

Fig. 12: Horizontal current velocity comparison for BW and HD modules for wind velocity of14 m/s, 3 hours north direction

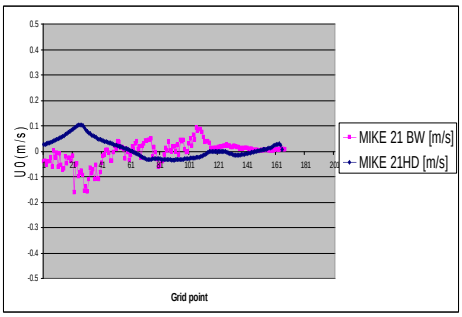

Fig. 14: Horizontal current velocity comparison for BW and HD modules for wind velocity of 14 m/s, (after jetty construction)3 hours north west

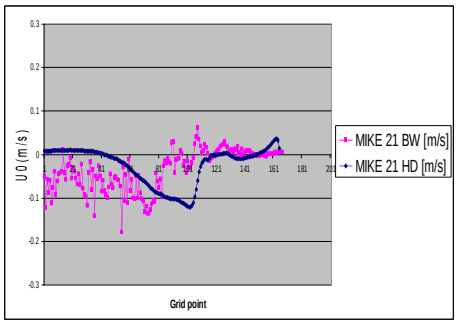

Fig. 13: Fig. 18: Horizontal current velocity comparison for BW and HD modules for wind velocity of 14 m/s, 3 hours north west direction

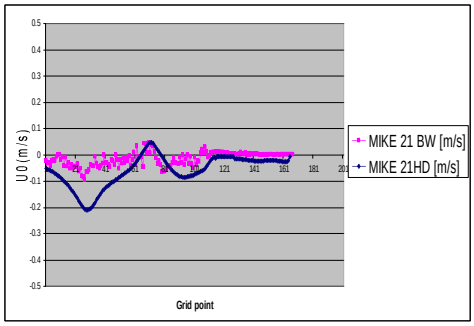

Fig. 15: Horizontal current velocity comparison for BW and HD modules for wind velocity of 14 m/s, (after jety construction)3 hours north east direction