Comparisons of Tidal Flow Simulation between Eastern and Western Coasts of Taiwan

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ABSTRACT

This study is a part of an integrated project of real-time monitoring sea surface conditions around Taiwan coasts. Establishment of effective tidal simulations used to predict flow conditions around commercial harbors is the main objective of this part, in which comparisons of tidal flow simulation between Eastern and Western coasts of Taiwan will be presented here. Eastern coasts of Taiwan facing the Pacific Ocean is subjected to direct effect of tidal waves added with regular ocean current moving north. On the other hand, tidal waves entering the Taiwan Strait from both north and south openings change tidal characteristics to partial standing waves on the western coasts. It is interesting to see how to simulate tidal flows with different flow patterns mentioned above. Typical harbors, namely, Hualien and Taichung located on the two coasts are selected to demonstrate the results that include tidal analysis recorded at corresponding tidal station, selecting numerical computation domain and boundary conditions in numerical tidal model, verification of computational results, and interpretation of numerical results. Comparisons of tidal simulation on eastern and western coasts indicate that (1) selecting tidal analysis is important to provide basic information, (2) tidal direction and phase are critical to induce flow pattern, (3) tidal characteristics are different on both side of coasts. Represented flow patterns of high and low tides, and velocity flows fields will also be presented in the results.

KEY WORDS: Tides; Depth-Integrated flow model; Numerical simulation; Hualien Harbor; Taichung Harbor; Taiwan coasts.

INTRODUCTION

Taiwan is located at west Pacific Ocean with its east and west coast facing the Pacific Ocean and the Taiwan Strait separately. When tide rising the flow encounters Taiwan's east coast first, and then tidal flow enters Taiwan Strait from both north and south ends. Due to this geographic nature, tide characteristics on the two sides of Taiwan are different. In this study the Hualien Harbor on the east coast and Taichung Harbor on the west coast are chosen for numerical simulation. It is expected that in the tide hydrodynamic modeling for the two harbors, there should be different measures to resolve tide differences as far as numerical computation is concerned. In the computation a depth averaged tidal model is used, and the problem domains are selected according to the tidal monitoring stations available. Thus, tidal observation data are analyzed and corresponding boundary conditions are selected for numerical simulations.

POSITION OF HUALIEN AND TAICHUNG HARBORS

The location of Haulien and Taichung Harbors are shown by the flag in Fig. 1 taken from Google Map. The former is located at central eastern coast of Taiwan (N 23°59′11″, E 121°37′35″) with a length of 6245 meters and maximum tidal variation of 2.55 meters. A satellite image of Haulien Harbor is shown in Fig. 2. The latter is located the central western coast of Taiwan (N 24°17′23″, E 120°31′01″) with a total area of 3,793 hectares. A satellite image of Taichung Harbor is shown in Fig. 3.

NUMERICAL MODELLING

The numerical model used in this study was established based on Connor (1975) using the Finite Element Method. A brief description of the model is given in the following. The problem considered is a real harbor located on a real coastal line, as indicated in Figs. 2 and 3.

The momentum equation and continuity equation can be expressed as