Vessel-Induced Surge Model Validation Using High-Resolution AIS Data and Field Measurements in a Complex Harbor

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ABSTRACT

Large ships moving in narrow waterways generate complex hydrodynamic phenomena, which can cause extreme forces and moments on berthed vessels, and hydrodynamic hazards to small craft. Deep-draft cruise ships with large windage areas can maneuver at high speeds, and induce harbor seiche/oscillations. Particular focus is paid in the present paper to further validation of the Vessel Hydrodynamics Longwave Unsteady (VH-LU) modeling system (Fenical et al. 2006) for these complex hydrodynamic phenomena, in particular sloshing and resonance of vessel-induced waves in the harbor at Port Canaveral, FL. Over a period of many years, Canaveral Port Authority has participated in advanced analysis of these phenomena during multiple studies to ensure safe navigation and berthing/mooring in the harbor. This paper summarizes two field measurement campaigns and utilization of high-resolution AIS data to provide detailed input for model validation. Analysis indicates that the modeling system is able to reproduce water level oscillations generated by individual vessels, oscillation interactions within the harbor, and interactions between separate basins in the harbor over time. Previous publications have provided information on validations performed with the VH-LU modeling system (e.g. Fenical et al. 2011). The model has been shown to accurately reproduce hydrodynamics and berthed vessel forces on tankers in open water conditions, hydrodynamics and loads on berthed Panamax containerships against a vertical quay wall, and supercritical flow and broken bore formation and propagation. This paper will summarize the complete range of model validations with the highest-quality openly available laboratory data, and provide recommendations for future studies and research based on observed needs from practical applications.

Two field campaigns were performed, in May 2015 and May 2016, to provide high-quality water level data for use in model validation and provide greater confidence in model predictions. The field campaigns were conducted at multiple locations within Port Canaveral, FL. Surge effects are known to occur within the harbor, are regularly observed, and the large amount of passenger vessel traffic allowed a relatively short field campaign duration. Detailed passing ship maneuvering characteristics were used as

input to the validation simulations for more accurate reproduction of measured surges in the harbor. High-frequency AIS data were collected during the measurement period to allow incorporation of accurate passing ship maneuvering behavior, such as complex passing routes, variable ship speeds and accelerations as a function of time and location, and varying drift (crab) angles. Cruise ship hull models were automatically generated for each passing event based on the vessel identification information in the AIS data. For all validation simulations, the latest hydrographic survey data were incorporated into the modeling domain which was representative of harbor conditions at the time of the measurements.

Modeling results for both validation periods indicate that the VH-LU model was able to successfully reproduce the measured surge effects (i.e. water surface fluctuations) in the field, within a very complex harbor and for a wide array of passing cruise ships. The validations showed that the model successfully reproduced the initial drawdown and surge, as well as the surge wave free propagation in the harbor and interaction between the Middle and Trident Basis of the harbor. The successful validation of the VH-LU model has built strong confidence in its application, which has been instrumental in understanding the potential changes in harbor conditions that may be generated during channel deepening or introduction of new vessels to the harbor.

The conference presentation also summarizes key developments in the modeling system, including recent incorporation of a MMG-type real-time maneuvering simulator to accurately describe complex passing routes, incorporation of high-resolution AIS data for simulating historical maneuvers/traffic, comparison of the VH-LU modeling system with predictions by commercial CFD codes, and application to development of a new cruise terminal at Port Canaveral, FL.

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