

A site-specific CFD study of passing ship effects on multiple moored ships

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Abstract. A local-analytic-based Navier-Stokes solver has been employed in conjunction with a compound ocean structure motion analysis program for time-domain simulation of passing ship effects induced by multiple post-Panamax class ships in the exact condition of a real waterway. The exact seabed bathymetry was reproduced to the utmost precision attainable using the NOAA geophysical database for Virginia Beach, NOAA nautical charts for Hampton Roads and Norfolk harbor, and echo sounding data for the navigation channel and waterfront facilities. A parametric study consists of 112 simulation cases with various combinations of ship lanes, ship speeds, ship heading (inbound or outbound), channel depths, drift angles, and passing ship coupling (in head-on or overtaking encounters) were carried out for two waterfront facilities at NAVSTA Norfolk and Craney Island Fuel Terminal. The present paper provides detailed parametric study results at both locations to investigate the site-specific passing ship effects on the motion responses of ships moored at nearby piers.

Keywords: passing ship effects; site-specific; computational fluid dynamics; moving overset grids; coupled motion analysis

1. Introduction

A federal navigation channel passes to the west of the Naval Station (NAVSTA) Norfolk waterfront and to the east of Craney Island as shown in Fig. 1, with north to the left. The federal authority has launched a plan to reconfigure the channel to mitigate the passing ship effects resulted from the ever-increasing ship sizes after recent Panama Canal expansion. A detailed description of the facility layouts and passing ship scenarios can be found in Huang, Chen and Chen (2018).

Pressure pulses and wakes induced by passing ships are known hazards to moored vessels nearby. Excessive disturbances often interrupt ship operations at the pier or cause damages to ship hulls, pier structures, and interface outfits. Passing ships are normally regulated to cruise in designated lanes within allowable speed limits that do not hamper the efficiency of the waterway or compromise pier operations nearby. Key parameters dictating the passing ship effects include the lateral distance of ship lanes to piers, the size and speed of passing ships, the depth of

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