Characteristics of Bow-flare Slamming Loads on an Ultra-large Containership in Irregular Waves

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ABSTRACT

Bow-flare slamming has been attracting major ship classification societies because it causes local damage and severe whipping vibration that affect the ultimate strength and fatigue life of ships. In the present study, a series of experimental investigations has been made on bow flare slamming loads under irregular wave conditions, which was a part of WILS JIP-III (Wave Induced Load on Ships Joint Industry Project-III). A 10,000 TEU containership model with six segments was used and a number of load cells were distributed on the bow-flare and deck areas in order to capture temporal and spatial distributions of slamming load. Based on the measured data, characteristics of the bow-flare slamming loads in irregular waves are presented and discussed.

KEY WORDS: Slamming; impact load; bow flare; ultra-large containership; irregular waves.

INTRODUCTION

The size of container ships has been rapidly increasing, which consequently increases the risk of failure caused by impulsive resonant behaviors such as springing and whipping vibrations. WILS JIP-I and II (Wave Induced Loads on Ships Joint Industry Project-I and II) were conducted by KRISO(Korea Research Institute of Ships and Ocean Engineering), (Hong et al., 2007, 2008, 2010, 2012), aiming to provide validation data of wave loads on a large containership such as springing and whipping as well as linear and nonlinear global wave loads. Recent design trend with large bow-flare and stern areas for ultra large containerships larger than 10,000TEU leads to increased occurrence of bow-flare and stern slamming, which give rise to higher risk of slamming failure. It was reported that slamming-induced whipping can cause critical structural failure of a ship(Storhaug, 2009). So the slamming loads should be taken into account in the design of large vessels such as ultra-large containerships and cruise ships.

As a timely response to this technical issue, WILS-III has started with aiming to measure slamming impact loads on bow-flare and stern area of an ultra-large containership. Spatial and temporal distributions of slamming force were mainly focused in the project. Hong et al.(2014) and Kim et al.(2014) presented the characteristics of bow-flare slamming loads and structural responses in regular waves based on the measured data.

After then, additional model tests were made to investigate the characteristics of bow-flare and stern slamming loads distributions in irregular waves. Different ship speeds and heading angles were considered and 3 hour duration records were made. For this purpose, 24 force sensors were distributed on the bow-flare, stern and deck areas of a 10,000 TEU containership. Model test was carried out using a towing system of CPMC(Computerized Planar Motion Carriage), in the Ocean Engineering Basin at KRISO.

There were a few experimental studies on the bow-flare and stern slamming impact loads (Kapsenberg et al., 2002; Rousset et al., 2005; Hermundstad and Moan, 2005; Desi and Mariani, 2008; Kapsenberg and Thornhill, 2010). In the previous studies, regular wave conditions were mainly considered on cruise ships, Ro-Ro vessels, and ferry. Luo et al. (2007) carried out a model test using a large containership with a 2-segmented model. However, they focused on the slamming impact pressure in regular waves.

The present study considers the bow-flare slamming loads on an ultra-large containership in irregular waves. There are many undisclosed uncertainties on the bow-flare slamming load on an ultra-large containership in irregular waves, the present study investigates a front-edge impact as well as bow-flare impacts. In addition, convergence of bow-flare slamming load in irregular waves are discussed based on the measured data. A relation between the slamming load and structural responses is also discussed.

EXPERIMENTAL SETUP

Test Model

A 10,000 TEU containership with six segments was used for the model test. Main particulars of model ship and ship model are presented in Table 1 and Fig. 1. The scale ratio is 1/60 and the model hull was made of FRP. The mass distribution was already introduced by Hong et al.(2014) and Kim et al.(2014).

<table>
<thead>
<tr>
<th>Item</th>
<th>Real</th>
<th>Model</th>
</tr>
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<tbody>
<tr>
<td>Scale</td>
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<td>1/60</td>
</tr>
<tr>
<td>LBP (m)</td>
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