Characteristics of Stern Slamming Loads on an Ultra-large Containership in Regular and Irregular Waves

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ABSTRACT

Stern slamming is one of important issues in a design of ultra-large containership. In the WILS JIP-III (Wave Induced Load on Ships Joint Industry Project-III), stern slamming loads on a 10,000TEU containership were measured in order to see characteristics of stern slamming load. The ship model has six segments connected by a steel backbone and the scale is 1:60. For the measurement of stern slamming load, 5 load cells were distributed on the stern area. The stern slamming impact were measured towing the ship model in regular and irregular waves. Head and following sea conditions with different ship speeds were applied. Based on the measured data, characteristics of the stern slamming loads are presented and discussed in the present study.

KEY WORDS: Slamming; impact load; stern; ultra-large containership; regular waves; irregular waves.

INTRODUCTION

Recently, ultra-large containerships larger than 10,000 TEU appear which has very large flat bottom near the stern. Those flat bottoms are usually located near the free surface and extreme slamming impact can occurs on that areas during the seaway. As a result, stern slamming impact has been important issues in a design of ultra-large containership. However, it is not easy to estimate the stern slamming load in experimental and numerical approaches because the dead-rise angle is quite low on stern area. In addition, the slamming impact occurs on localized area within a millisecond. Therefore, there are not so many research papers on the stern slamming problem in experimental and numerical approaches as well as bow-flare slamming problem (Hermundstad and Moan, 2005; Dessi and Mariani, 2008; Kapsenberg and Thornhill, 2010; Hong et al., 2014, 2015).

Kapsenberg et al. (2002) distributed a large array of pressure sensors on stern area and measured slamming pressures of a 1/49-scaled cruise ship. They presented that the pressure due to whipping vibration is ignorable. Luo et al. (2007) measured stern-slamming pressures of 1/29-scaled containership in following sea conditions. They reported that stern-slamming load is decreased as ship speed is increased. Beside the previous studies, additional model test results in regular and irregular waves have been required to validate the numerical solutions and rules of ship classification societies. These were motivated to launch WILS JIP-III(Wave Induced Loads on Ships Joint Industry Project-III) and the project was carried out by KRISO, Korea. Before the WILS JIP-III, Phase I and II were also carried out to measure the structural responses such as springing and whipping (Hong et al., 2007, 2008, 2010, 2012). The main purpose of WILS JIP-III is to measure slamming impact loads rather than impact pressures on bow-flare and stern area of an ultra-large containership. The spatial and temporal distributions of bow-flare and stern slamming loads are the major concerns of the project. For this purpose, a containership equivalent to 10,000TEU was introduced and divided to six segments. Those segments were connected by U-shaped backbone where a large number of strain gauges were attached to measure structural loads. Many load cells which have fast responses were distributed on the bow-flare, deck, breakwater, and stern areas. The model ship was towed in regular waves with different speeds, wave lengths, wave heights, and heading angles. Irregular waves with different ship speeds, heading angles were also applied to the model test to see the characteristics of bow-flare and stern slamming loads. The characteristics of bow-flare slamming loads in regular and irregular waves including the repeatability, effects of heading angle & wave height, convergence of slamming load, and correlation between the slamming load and whipping vibrations were presented by Hong et al. (2014, 2015).

The present paper focuses on the characteristics of stern slamming loads in regular and irregular waves. Spatial distributions of stern slamming load in regular and irregular waves are presented and effects of parametric roll on the stern slamming is discussed. Convergence of stern slamming load and an extreme value are analyzed based on the measured data in irregular waves. Additionally, a correlation between the stern slamming load and vertical bending moment is investigated.

EXPERIMENTAL SETUP