Study on Assessment of Comfortability and Roll Stabilization for Passenger Ship

Jae-Han Kim(1), Yonghwan Kim(1)*, Dae-Woong Kim(2), Yong-Soo Kim(2)

(1) Department of Naval Architecture and Ocean Engineering, Seoul National University, Seoul, Korea
(2) Daewoo Shipbuilding & Marine Engineering Co.

ABSTRACT

This paper considers the assessment of comfortability and the motion control of cruise ship in waves. In the present study, MSDV (motion sickness does value) is chosen as a primary index to evaluate the passenger comfortability. MSDV is obtained by using a time-domain ship motion program, called WISH. Seasickness level is evaluated in a short period using the frequency-weighted RMS of vertical acceleration in a low frequency range, and then it can be used for long-term prediction. In addition, the present study includes the application of the roll stabilizing fin to cooperate with the evaluation of passenger comfort.

KEY WORDS: Passenger comfort; Seasickness; MSDV; Roll stabilization.

INTRODUCTION

The comfortability of passengers in ocean environment is one of the most crucial elements in cruise ship design. There is high demand of reducing seasickness of passengers and controlling ship motions even in rough seas. There are a few indices to evaluate the comfortability of cruise ship, and some regulations by classification societies for passenger comfort are available. However, most of them are defined in the forms which are not easy to predict or consider the frequency ranges over 5Hz, which hull vibration is of primary interest. Since the motion of ship makes disturbances which provoke motion sickness or seasickness, we need to consider a solution to the cause of the seasickness, i.e. ship motion responses in waves.

Many researches on motion sickness have been carried out by experimental or analytic ways. Irwin (1881) explained that motion sickness can be induced by sensory conflict. The etiology of sensory conflict is that sensory signals from the eyes and the organ of balance do not agree. A series of studies by O’Hanlon and McCauley (1974), McCauley et al. (1976) and Guignard and McCauley (1982) have produced models for the frequency and magnitude dependence of motion sickness due to vertical sinusoidal motion, using a three-axis motion generator. In these studies, it was found that the most nauseogenic frequency range was found to be from 0.17 to 0.33 Hz. Furthermore, the percentage of vomiting subjects, called the motion sickness incidence (MSI), was rated as a function of the duration, amplitude and frequency of the imposed motion. International Standard ISO 2631 (1985) presented guidelines for evaluating human exposure to whole-body vibration at low frequencies. It established limits on motion using severe discomfort boundaries which are defined by RMS accelerations, exposure times and frequencies. Lawther and Griffin (1987) described a procedure for estimating the incidence of motion sickness, which was expressed as the parameter called vomiting incidence (VI). British Standards Institution BS 6841 (1987) presented a quantitative guideline for estimating the incidence of motion sickness from parameter called the motion sickness dose value (MSDV). Colwell (1989) considered two aspects of motion induced problems, which are motion sickness and biodynamic problems. He also compared the motion sickness incidence and the vomiting incidence analytically. ABS (2001) presented the criteria and methods of assessment of whole-body vibration in low frequencies relating to passenger comfort. This was described as notation Comfort Plus (COMF+) in ‘Guide for Passenger Comfort on Ships’.

The excessive roll motion of ship can be controlled by some instruments. Nowadays roll motion is usually reduced using active fin stabilizers. When ship speed is above 10 knots, active fin stabilizer becomes the most effective method of roll stabilization. Retractable fin stabilizer equipped in most passenger ships has high aspect ratio, so that it makes relatively large lift force for a given fin area, that is, it is hydrodynamically very efficient. Allan (1945) carried out theoretical analysis and experiment in regular sea about lift force by fin stabilizer. Lloyd (1975) showed how fins lose lift when they interact with bilge keels. It included design of fin specification and controller.

In the present study, we aim to develop a computational method to predict and/or assess passenger comfort, which considers the frequency range of ocean waves. Particularly, MSDV (motion sickness does value) originated by Lawther and Griffin (1987) is chosen as a primary index to evaluate the comfortability. MSDV is defined as an averaged value of vertical acceleration in a specified time window. In this study, MSDV is obtained by using a time-domain ship motion program, called WISH which has been developed by Seoul National University. Seasickness level is evaluated in a short period using the frequency-weighted RMS of vertical acceleration in a low frequency range, and then it can be used for long-term prediction. Since the typical device to