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# Evaluation Method of Passenger Comfort and Its Application to a Ship with Anti-Pitching Fins

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## ABSTRACT

**A new evaluation method of seakeeping performance from the point of view of passenger comfort is deduced on the basis of experimental work on the training ship *Kagoshima-maru*. In the experiments, ship motions are measured during a voyage and the feelings of trainees are surveyed by questionnaires. The relationship between vertical acceleration and seasickness is represented by a simple mathematical model that is expressed by the product of amplitude of vertical acceleration, its frequency and exposure duration. It is confirmed that the correlation coefficient between the results of the predicting method and the questionnaires given to the trainees shows a fairly similar result. In the second part of this paper, the method is applied to evaluate the effect of anti-pitching fins on ship motions from the viewpoint of passenger comfort. Model experiments were conducted to evaluate the effects of anti-pitching fins on ship motions. A calculation method is developed to estimate the motions for a ship with anti-pitching fins. By using both the calculation method and the evaluation method of passenger comfort, the most efficient area of anti-pitching fins can be designed from the viewpoint of passenger comfort.**

## INTRODUCTION

A wave length is usually 1 to 2 times as long as the length of small vessels in coastal seas. This results in severe pitching motion of small vessels. It is also hard to improve the pitching motion by moving ballast weights. The reduction of the pitching motion of ships by means of the anti-pitching fins at the bow is analyzed both qualitatively and quantitatively, through theoretical and model experiments. Abkowitz (1959) examined the extra resistance of anti-pitching fins at the bow in still water and the effect of anti-pitching fins on ship motions in slamming conditions. Ochi (1961) conducted model experiments to improve the vibration characteristics of anti-pitching fins. Vibration characteristics could be improved by drilling holes on the hull above the fin to equalize the distribution of pressure on the fin. Sonoda (1963) reported that holes on the fin improved the vibration characteristics and did not reduce its performance. Besso et al. (1973) discussed the idea of reduction on ship motions by the anti-pitching fins at the bow and stern. The area of fins exceeds 10% of the water plane area of a ship at design draft. The results were validated with model experiments of a container ship. On the other hand, in terms of the relationship between ship motions and seasickness, Ikeda et al. (1995) discussed the effect of anti-pitching fins at the bow from the viewpoint of passenger comfort. As pitching motion was reduced by 10%, the ratio of vomiting was reduced by 20%.

The purpose of this study is to evaluate the effect of anti-pitching fins from the viewpoint of passenger comfort. The idea of the authors is that an anti-pitching fin at the stern will improve passenger comfort. This has 2 major advantages. First, the maximum force acting on the fin at the stern is smaller than that at the bow in slamming conditions. Second, since the fin at the stern is at the wake of the hull, the extra resistance of the fin at the stern is smaller than that at the bow. Model experiments were conducted to evaluate the effect of anti-pitching fins on ship motions. The calculation method is developed to estimate the ship motions for a ship with anti-pitching fins. Also, a new evaluation method of passenger comfort is proposed to improve the accuracy of estimating the ratio of seasick persons during a long voyage. This method takes into account the exposure duration, amplitude of vertical acceleration and frequency of acceleration. Both the measurement of the ship motions and a survey of passenger comfort were conducted to investigate the relationship between ship motions and seasickness.

Using the present methods, the most efficient area of anti-pitching fins from the viewpoint of passenger comfort can be proposed adequately.

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KEY WORDS: Seasickness, anti-pitching fins, vertical acceleration, frequency of acceleration, exposure duration.

## EVALUATION OF PASSENGER COMFORT

### Measurement of Ship Motions and Survey of Passenger Comfort

The measurements of ship motions and the survey of passenger comfort were conducted in the training ship *Kagoshima-maru* of Kagoshima University. Her side profile and principal dimensions are shown in Fig. 1 and Table 1. Since almost none of the trainees had ever experienced a long voyage, they could be considered typical passengers. Vertical and lateral accelerations, angular velocities of rolling and pitching motions were measured at the

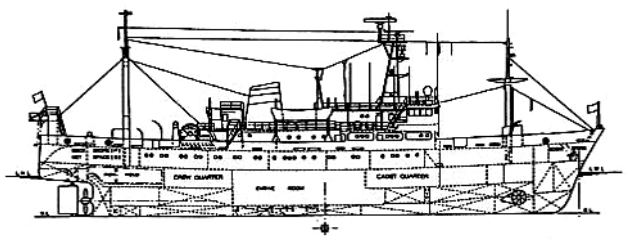

Fig. 1 Side profile of *Kagoshima-maru*