Safety Evaluation Method of Ship Berthing at Pontoon under Strong Current from Viewpoint of Ship Motions

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ABSTRACT

The influence of tidal currents is a very important factor in port planning. However, there are still many ports that do not necessarily satisfy this fundamental rule, especially in small ferry berths. This study describes the present situation of Japanese ports under strong tidal currents. First, meteorological and oceanographic parameters have been observed to understand the properties of seawater and tidal currents. To evaluate a difficulty of ferry berthing, it is essential to take ship motion into consideration. This new numerical simulator makes it possible to reproduce motions of a berthing ship in tidal currents and winds while applying maneuvering forces. With this system, ship motions can be accurately reproduced, which makes it possible to quantify berthing criteria.

KEY WORDS: Tidal current, Ship operation, Port planning, Oceanographic observation, Ship Motions, Numerical simulation

INTRODUCTION

Harbor tranquility is an essential consideration in port planning. Many studies of waves have been undertaken, such as those that consider wave impact or the motions of moored ships (Shiraishi et al., 1996; Van der Molen et al., 2006). Such studies have made significant contributions to better wave management in the construction of ports. The applications are particularly focused on ports that face open seas. Studies have also been implemented to improve coastal environments. These studies consider the flow of water due to currents or tidal currents (Hibino et al., 2005; Komai et al., 2007). Shipbuilding technologies have been improved from the viewpoint of seaworthiness and maneuverability in recent decades (Okusu, 1996). However, the number of marine casualties has remained relatively steady. The findings suggest that there are still some problems to be solved in port planning and ship operations. Studies have not been thorough with regard to the problems associated with enclosed sea areas, where waves are relatively calm. In this study, we have focused on operational challenges to ferries in strong currents of the enclosed Seto Inland Sea in Western Japan. Because there are tens of thousands of islands in the enclosed sea, ferry transportation is frequently the only option. First, the present operational conditions were determined by field research that included a nationwide questionnaire. Secondly, field observations of tidal currents and ship motions were carried out to verify the current conditions. Numerical simulation models of ship motions are newly constructed to assess the safety of berthing under strong tidal currents and winds. Such simulations make the numerical evaluation of ship berthing possible, therefore, this new port planning method can finally be assessed against ports with strong tidal currents.

NATIONWIDE QUESTIONNAIRE AND FIELD RESEARCH OF PORT OPERATION UNDER TIDAL CURRENTS

Nationale questionnaires of port operation

Knowledge of tidal currents and their potential influence is essential in a berthing operation. There are a lot of ports under strong tidal currents in the Seto Inland Sea. Most of them are being used for small ferry transportation with short distances. Thirty companies responded to questionnaires on current ship operations. Figure 1 shows the percentage of operational difficulty due to tidal current during berthing.

Figure 1 Percentage of operational difficulty attributed to tidal currents during berthing

Twenty-four percent of respondents indicated that they were challenged by tidal currents during berthing, especially in spring tides. Figure 2 shows the percentage of relative angles between ships and tidal currents.