Identification of Characteristic Wave Groups Causing Parametric Rolling for C11 Container Ship in Irregular Head Seas

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ABSTRACT

Ship parametric rolling is one of the five failure modes of intact ship dynamic stability, and has become a hot topic in the field of ship stability research. The container ship has a large geometric flare at the bow and stern area, which has greater probability to happen parametric rolling when it is sailing in seas. The wave group method is introduced in this paper for the random parametric rolling analysis in order to identify the important wave property, which leads to the occurrence of the ship parametric rolling.

KEY WORDS: container ship; parametric rolling; ship stability; wave group; irregular waves

INTRODUCTION

When the ship is sailing in real sea, the ship always encounters random wave environment due to the random excitation of the wind. The study of ship parametric rolling behavior in irregular waves is very important for identifying dangerous sea conditions and ensuring ship safety. An example of the ship suffering from parametric rolling of C11 containership is shown in Fig. 1.

When the ship is sailing in head or follow waves, the wave height passing through the ship will change with time, which will lead to the ship waterplane area changing and the initial stability of the ship time varied thereafter. When the encountering wave frequency is above twice of the natural roll frequency and the encountered seas is relatively heavy, it is likely for the ship to have a sudden continuous larger roll motions, it is regarded as ship parametric rolling. Because container ships need to keep a large amount of cargo, they usually have a large geometric flare at the bow and stern area, it is easier to suffer from the transverse stability changing in waves, and are more prone to parametric rolling. Therefore, the parametric rolling is concerned about the stability of container ship.

Ship parametric rolling is a dangerous phenomenon that may cause ship instability or even capsizing. The numerical simulation and model test are mainly used to study parametric rolling at present. In either cases the first step is to set the wave conditions around the ship. Therefore, the selection of wave environment is the basis for studying ship parametric rolling. When irregular waves are regarded as the wave conditions, we can more accurately simulate the ship sailing conditions as in the actual sea area. Nowadays, more and more scholars devote themselves to parametric rolling filed. Bulian, Francescutto and Umeda (2008) studied the influence of the initial conditions and found that the uncertainty in the statistical estimation from the time history of rolling motion can be significantly larger than those for pitch motion and incident wave. Lee and Kim (2016) used the semi-analytical formula for parametric rolling numerical simulation, the accuracy compared with the instantaneous hydrostatic approach (direct calculation) for the geometry-induced nonlinear relationship between GM and GZ in waves for all heel angles is enhanced relative to the conventional methods. Bu, Lu and Gu et al. (2017) carried out a study on the rolling parameters of irregular crest wave based on the three-dimensional time-domain mixed source method and the effectiveness of the proposed method is verified by the experimental results.

Due to the randomness of waves, it is necessary to run a large number of different wave realization in order to accurately study the influencing