ABSTRACT

Container ships operate with large number of unit containers on the deck, and then they have many kinds of external ship forms due to the position of them depending on need for delivery demands. In the operation of the ships, wind load mostly works as resistance. The estimation of wind effect has important role for calculation of economical cost for operation. There is, however, no simple method to calculate the wind load for those container ships with crested or lacked containers without carrying out wind tunnel experiments. In this paper, ease estimation method for wind load on such kinds of container ships is proposed using experimental investigations.

KEY WORDS: Ship; Container; Wind load; Estimation; Experiment; Operation.

INTRODUCTION

Large-scale container ships, which have 6000TEU more over containers onboard and 300m length over, are built one after another recently. A large container structure above sea level is largely affected from wind at sea. Assessing navigational performance of the ships, it is important to estimate wind effect exactly.

Ordinary, specification of a ship external form in case of a tanker, a bulker, a PCC etc. doesn’t change excluding the main hull’s thickness that means the height from sea level to main hull deck top. The estimation methods of wind load often used basically target fully loaded or ballast ships’ condition (Yamano, T and Saito, Y, 1970; Isherwood, 1972; Fujiwara et al., 2005a, 2005b, 2006 etc.).

On the other hand, container ships have many kinds of ondeck forms depended on the number of containers. Under these situations, it is difficult to reflect individual shape influence on the deck of the ships in the estimation methods, since the methods on the basis of regression analysis are basically proposed using fully loaded or ballast ships’ experimental results and only use some simple ship external form parameters, that is, lateral projected area, center potion of the projected area above sea etc. for calculation. There is no estimation method to calculate the wind effect easily by only the external ship specifications including the crest or lack influence of the containers at some areas on deck.

Then, the authors carried out the wind tunnel experiments of a container ship for many kinds of stowage of containers on deck in order to grasp aerodynamic specification. Using the experimental results, the estimation method for wind load on no fully loaded container ships is considered.

At first, the problem of the original estimation method of wind load by one of the authors (Fujiwara et al., 2005a) is shown in this paper. The experimental model and setup at wind tunnel are explained in the next chapter. After them, the basic characteristics of wind forces acting on the containers are understood from experimental results, and the way of assessment of wind forces needed at the stages of departure and delivery planning etc. is shown. Finally, the calculated results of comparing with experimental ones and the steady ship speed reduction under strong wind are presented using the original and new-presented estimation method of wind forces under one container arrangement as a example.

ORIGINAL WIND FORCES ESTIMATION METHOD

Coordinate system of wind forces

Fig. 1 defines the Cartesian x-y coordinate reference system. The origin is located the amidship at the intersection of the still water place and on the longitudinal line of ship symmetry. Fig. 1 also provides definitions and associated sign conventions for the longitudinal force $F_x$, the lateral force $F_y$ and the yaw moment $N$. The apparent angle of attack of the wind relative to the positive x-axis of the ship is defined as $\Psi$. The non-dimensional form of the longitudinal & lateral forces and yaw moment are defined as follows:

$$C_x(\Psi) = \frac{X_x(\Psi)}{q_x A_p}$$
$$C_y(\Psi) = \frac{Y_x(\Psi)}{q_x A_L}$$
$$C_N(\Psi) = \frac{N(\Psi)}{q_x A_L L_{cos}}$$

(1)