Investigation on the Scale Effect of Maneuverability Based on Model Tests and Sea Trials of a Ship

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ABSTRACT

In this article, the comparing research on ship maneuvering between full scale ship and the model was done for the YUKUN training ship, and related papers are very few in the literature. The sea trial such as speed tests, turning tests and zigzag tests was carried out and the trajectory, roll, pitch, RPM and the power of the main engine were obtained. Based on the data of both sea trial and model test, the trajectory, roll, pitch, RPM and the power of the main engine were compared. The model correction for predicting the full scale ship maneuvering such as the advance, the tactical diameter and the overshoot angle was finished for YUNKUN training ship. Some suggestions were made to further develop the study such as a series of model, model size, the control of the RPM.

KEY WORDS: full scale ship; sea trial; model test; ship maneuvering; scale effect.

INTRODUCTION

The scale effect between full scale ship and model has not solved on ship maneuvering though many scholars have done their best by model tests and numerical calculation for many years(Ueno, M and Tsukada, Y(2013), Shin, S, Ahn, K, Sung, Y and Oh, S(2012), Wang, YC, CAI, RZ, LI, XB(2005)). At present, the data of model test has to be directly applied to predict full scale ship maneuvering, and it is impossible that the characteristic parameters such as the advance, tactical diameter and overshoot angle were underestimated, which will have a large effect on the seagoing ship. It is very difficult and complex to solve the scale effect in model tests for predicting the full scale ship maneuvering. For dozens of years, this problem is an eternal topic in ITTC reports. Some critical factors to scale effects such as model size, model self-propulsion point (MSPP) and ship self-propulsion point (SSPP) have to take in consideration(). To apply a self-propulsion point different from MSPP in free running model tests, it is necessary to equip the ship model with an auxiliary device to apply a towing force. Wang, SL et al(1998) put forward the calculation method of correspondent rudder angle comprising rectify method. Sun, M et al.(2012) presented research on the influence of the Reynolds number on the hydrodynamic coefficients in submarine model tests. Tsukada Y et al. (2013) developed a prototype of an auxiliary thruster that assists free running model ships' propellers. Therefore, it is not easy to establish a standard full scale extrapolation method from maneuvering tests in the near future, like a full-scale powering prediction method.

In this work, YUKUN training ship was chosen as the ship of sea trial and some tests including powering performance, turning circle tests and zigzag tests were carried out. During tests, ship trajectory, roll pitch, RPM, the power of the shaft of the propeller were measured. At the same time, the model tests of the ship were planed, and the same tests were finished and the same parameters were measured. And then the results of full scale trial tests and model tests were compared for YUKUN training ship and some corrections for predicting the maneuvering of the full scale ship were made. As usual, the data of the full scale ship maneuvering is very difficult to obtained, and there are very few publications about the comparing the sea trial and model test of ship maneuvering.

This paper was divided five parts. Firstly, YUNKUN training ship was introduced. Secondly, the sea trial including powering performance, turning circle tests and zigzag tests were performed and some results were shown. In the third part, the model tests in a lake were finished by wireless technique, some pictures were captured and the results were obtained. In the fourth part, the results of sea trial and model tests were analyzed and compared. Finally, some suggestions to decrease scale effect were made.

PRINCIPAL DIMENSION OF THE SHIP

YUNKUN training ship with single propeller and single rudder attached to Dalian Maritime University was chosen as sea trial ship, because the university can supply all the information including the body plan, the rudder and the propeller for model test. Besides, the university is eager to develop some researches for the ship and support the researchers to carry out the experiments on the speed and power, ship maneuvering, environment pollution. The scale of the ship model is 1:20, and the principal dimensions of the full scale ship and ship model about the hull, the rudder and the propeller are shown in Table 1, Table 2 and Table 3 as followed.