Shallow Water Effects on Ship Performance of a Full Ship Model in Arctic Operations

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ABSTRACT

The Northern Sea Route (NSR) has been open up to the seaborne trade between Europe and Asia. Along the NSR, there are several straits, and among them the Sannikov Strait was a choke point of the southern route of the NSR, particularly for large vessels. By the global warming blessing, large vessels have now been able to sail via the northern route of the NSR. However, since the southern route lines the coast, shipping companies are still interested in this route. Some of them would like to examine the shallow water effects on passing vessels through those straits. In response to their requests, resistance, self-propulsion test results and stopping ability test of a tanker model were presented to grasp the fundamentals of the effects of shallow water on ship performance of full ships with large block coefficients.

KEY WORDS: Northern Sea Route; southern route; shallow water; strait; full ship; tanker; model test.

INTRODUCTION

Nearly a hundred of merchant ships have sailed via the Northern Sea Route (NSR) for these three years, blessing by the global warming. The two NSR routes are recommended by Russia, a coastal or southern route and an offshore or northern route. There could be many other routes in the NSR, but the sea ice in winter has seriously hindered the hydrographical survey in Arctic seas. The Russian government has carried out the survey along the recommended routes. The southern route passes through a series of straits; Yugorskiy Shar, Kara Gate, Vilkitsky, Shokalskiy, Dimitry Laptev, Sannikov and Long Straits, as shown in Fig 1. Many of them are both narrow and shallow. In addition to geographical constraint, considerable tidal variation in the straits carries considerable risks in navigations (Kitagawa, ed., 2001).

However, the southern route has a contradictory feature. The narrow and shallow straits cause a difficulty in navigation, but on the other hand, it is told that seafarers, especially Asians, will feel secure, supposing that sailing ships might be able to expect a swift rescue in the case of emergency, or be able to disembark, using rescue boats, even after having gained the information concerning the poor and deserted coastal area along the NSR.

Shallow water problems of ships broke out a long time ago, when full ships begun to pass through the Strait of Malacca. Larger ships bring greater profit. Up to the present, this is the principle in marine transport. Shipping industry has then occasionally worried about shallow water problems of ships, especially when a new shallow shortcut passage has become available, although the danger has always lain in navigations in the shallow coastal waters, including ports and harbors.

Model tests in shallow water at a ship model tank (towing tank) would be able to provide useful information of shallow water effects on ships. However, shallow water conditions are not achieved at every model tank and it usually takes a lot of time for costly tests and their preparations. For a full ship with a block coefficient as high as 0.8, relatively larger model is required to reduce the scale effects due to separation of laminar flow areas, vortex shedding and unstable features in running. A large model testing at a relatively small tank invites adequate consideration for tank wall effect on the results obtained. These are primary reasons there are few papers published on full ship model tests in shallow water (Barass, 1979, etc.). It should be noted that the waves generated by running small models were not far from the range of capillary waves and the relatively large portion of flow around the models might remain in laminar flow, even with turbulence stimulators.

Contrary, concerning shallow water problems, there have been a