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Recent Trend in Design Parameters of Ice-transiting Vessels

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In this study, the design parameters of the world's ice-transiting vessels, currently in service or under construction, were collected and a database of principal particulars for each ship was established. To understand the recent design trend, ice-transiting vessels were categorized into 4 groups: conventional icebreakers, icebreaking tug/supply/research vessels, icebreaking passenger/car ferry and ice-strengthened cargo vessels. The changes in the principal particulars for each group were reviewed and summarized. It was found that the most significant change in the design of ice-transiting vessels was the increment of large commercial cargo vessels. It is believed that the recent hike in oil prices and the booming Russian economy have resulted in the need for year-round operations with bigger ships in the Baltic Sea and in the Sea of Okhotsk as well as along the Northern Sea Route in the Russian Arctic Sea.

INTRODUCTION

The Northern Sea Route connecting Northern Europe and East Asia is 30% to 40% shorter than the Suez Canal Route. Also the Russian Arctic holds an enormous amount of oil and natural gas, and recently sea transportation by Ice Class cargo vessels has become preferred (Ostreng, 1999). With the recent hike in oil prices and the booming Russian economy, the shipping routes along the Northern Sea Route, and in the Baltic Sea and the Sea of Okhotsk, have become more economical than ever before. But operations in ice-infested seas require ships to overcome extremely harsh climate and the ice environment. The world's major shipping companies and shipbuilding industries are interested in maintaining an appropriate size of icebreaker fleets and also in constructing Ice Class cargo ships.

According to the Clarkson Research studies (Brewer, 2005), 262 Ice Class 1A ships are operational today, equivalent to DWT 4.2 million tons, and 70% to 80% of them are under DWT 20,000 tons. Plus, 234 vessels with ice-strengthening are on order and some 165 are Ice Class 1A and 3 are Ice Class 1A Super. It can be expected that high demand for oil from Russia and other Arctic countries will drive levels of investment in Ice Class cargo ships to new heights over the next decade.

In view of this prediction, it would be timely to investigate the design trend of Ice Class vessels. In this study, the design parameters of the world's ice-transiting vessels, currently in service or under construction, were used for a database, which includes the principal particulars of ships, such as length, breadth, depth, draft, tonnage and engine power. In addition, the icebreaking capability on level ice was surveyed for each ship. In this study, the ice-transiting vessels were categorized into 4 groups: conventional icebreakers, icebreaking tug/supply/research vessels, icebreaking passenger/car ferries and ice-strengthened cargo vessels. The changes in each group's principal particulars are briefly summarized, with a special focus on the ice-strengthened cargo vessels.

ANALYSIS OF DESIGN PARAMETERS

Numerous references to the design features of conventional icebreakers and icebreaking tug/supply/research vessels were found in publications from the early 1970s on. However, the data for ice-strengthened passenger/car ferries and cargo vessels built mostly after the '70s are not sufficient because they lack published references.

The principal particulars for the conventional icebreakers and icebreaking tug/supply/research vessels were collected from various sources dealing with ice resistance and ice force estimation formulas combining laboratory and field measurements (for example, Kashteljan et al., 1968; Lewis and Edwards, 1970; Levine et al., 1974; Kotras et al., 1983). There were also good references for ice-ship interaction issues (Nozawa, 1994; Sodhi, 1995; and Mulherin, 1996). The design parameters used for somewhat older ice-strengthened cargo vessels (such as *Arctic*, *Manhattan*, and Russian *SA-15*), were collected from Baker and Nishizaki (1986), Ostreng, (1999); and Spencer and Jones (2001). Recent data for the ice-strengthened cargo vessels come from numerous websites of major shipping companies and shipbuilding industries. Official and/or unofficial reports from individual companies also have contributed to the database for design parameter analysis. Data for a total 211 ice-transiting vessels including many series ships were gathered for the database; Table 1 summarizes a part of the data.

Length, Breadth and Draft

Fig. 1 plots the length, breadth and draft data collected for all the 211 ice-transiting vessels in the 4 vessel groups. In terms of size, the cargo vessels are generally much larger than the other 3 groups, so those data fall far right in the figure, while data for the other 3 groups fall in a single cluster rather than in 3 different clusters. Ships longer than 250 m are often found in the cargo vessel group. Icebreaker and supply/tug/research vessel groups are usually smaller than the other 2 categories. The length of icebreakers and supply/tug/research vessels ranges from 50 m to 150 m; the breadth, from 12 m to 30 m.

Fig. 2 shows the relative values of length/breadth (L/B) and length/draft (L/D) ratios for all 4 categories. The L/B ratios of all 4 groups range from 3 to 9. For entire cargo vessels, they fall between 5.4 and 9.0, but for most cargo vessels they fall between 5.4 and 7.5, except for a few ships of extraordinary dimensions. It is found that the L/B ratios for most of the newer oil tankers built in the past 10 years tend to be smaller than 5.8. However,

KEY WORDS: Northern Sea Route, principal particulars database, icebreakers, icebreaking supply/tug/research vessels, icebreaking passenger/car ferries, ice-strengthened cargo vessels.