"Ax-Bow" : A New Energy-saving Bow Shape at Sea

1. Introduction

Much effort has been made to develop energy-saving ships in the last three decades, which reduced the necessary horsepower of the main engines. However, ship operators have recently pointed out that such energy-saving ships lose speed in comparison with conventional ships when traveling through waves. Ships with better performance in waves even with smaller horsepower are desired. In response, NKK started a research and development project several years ago, and recently succeeded in creating a new bow shape named "Ax-Bow". "Kohyohsan", which is the first vessel to adopt the "Ax-Bow", was delivered in June 2001 (see **Photo 1**). This is a 172,000DWT Cape size bulk carrier, whose GT and DWT are 87,493t and 172,564t, overall length is 289.0m and breadth is 45.0m, and her flag is that of Panama.

Photo 1 172,000DWT type bulk carrier "Kohyohsan"

2. General

When a ship sails in waves, incident waves are reflected and broken at the ship bow and the resistance is increased accordingly. With a blunter bow shape such as that of tankers or bulk carriers, waves are mostly reflected forward and so the resistance increases in waves (see upper figure in **Fig.1**). The increase in resistance in waves acting on such full-form ships with blunt bow, therefore, is larger than that on slender ships. For blunt-bow shaped full-form ships with smaller power engine, the speed loss is estimated to be larger than that for ships with conventional high power engine. To improve the performance in waves for ships with low power engine, the resistance increase in waves needs to be reduced.

To do this, the bow should be made less blunt. Results of a preliminary study on the effect of bow bluntness on the resistance increase indicated that the most effective way was to sharpen the bow shape above the still water level, where the wave surface is elevated and reflected. By sharpening this part, the incident wave is reflected mostly to the side, not forwards, thus reducing the wave resistance acting backward (see lower figure in **Fig.1**).

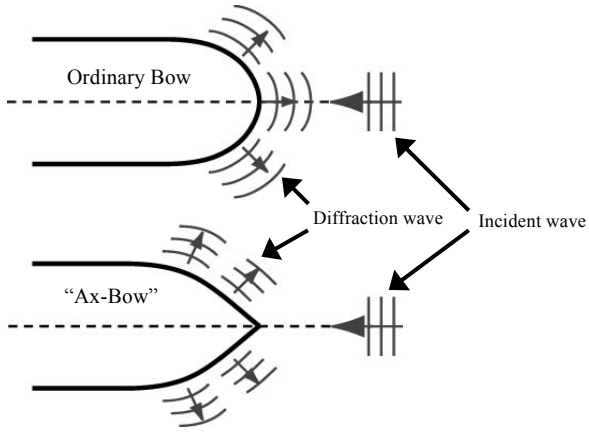

Fig.1 The principle of "Ax-Bow"

When the bow is sharpened like a beak, the overall length of the ship increases, yet overall ship length is generally limited by port regulations. Therefore, the bow shape was sharpened as much as possible within the range of such regulations. The lower picture of **Photo 2** shows the final shape of this design for the model ship of a 172,000DWT type bulk carrier, and the upper picture shows the model of the same bulk carrier with the ordinary blunt bow. Because the profile of the new bow shape looks like an ax, it was named "Ax-Bow".

Model tests in waves were performed for these two models shown in **Photo 2**. The results are shown in **Fig.2**, which plots non-dimensional resistance increase in regular waves against wavelength divided by ship length. White circles show the results for the ordinary blunt bow model, and black circles those for "Ax-Bow". This figure indicates that "Ax-Bow" can reduce the resistance increase in waves by 20 to 30% in almost the entire range of wavelength. This enables a 4 to 6% reduction of horsepower, or

fuel consumption, in the case of sea conditions corresponding to a 20% sea margin.

This new bow shape was applied to a bulk carrier, which was delivered in June 2001. Full-scale measurements are being performed on this ship and her sister ship with ordinary blunt bow, with the cooperation of their ship owner. The collected performance data will be used for verifying the effectiveness of "Ax-Bow" at sea.

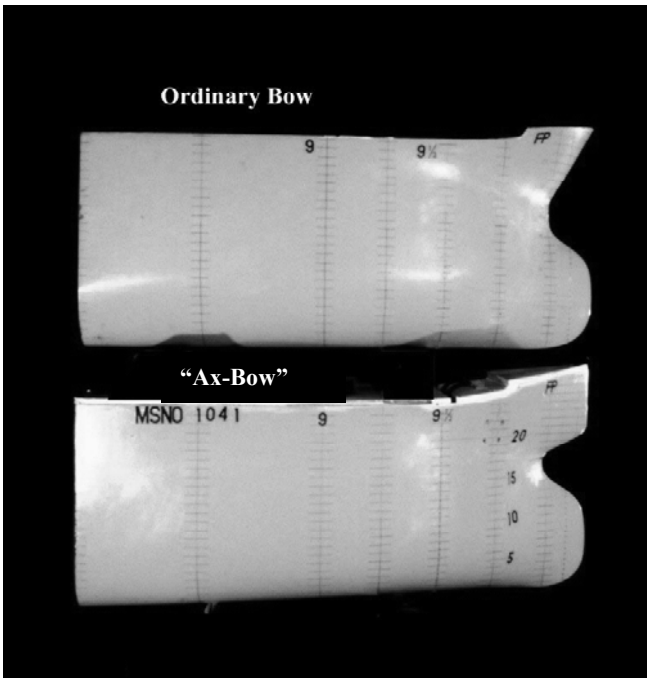

Photo 2 Ordinary Bow and "Ax-Bow" (models)

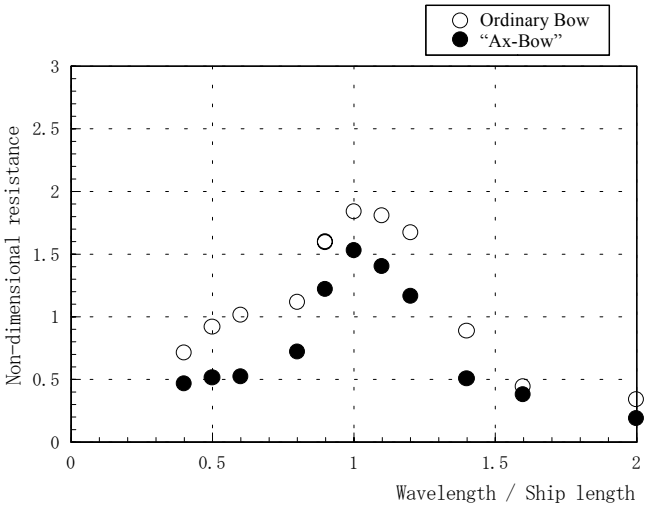

Fig.2 Resistance increase in waves

3. Conclusion

The development of "Ax-Bow" was the first attempt to improve ship performance at sea. We are grateful to professor Shigeru Naito of Osaka University who guided us and gave us many suggestions, comments, and discussions. A part of this study was supported by the Technology Development Fund of the Ship & Ocean Foundation.

The "Ax-Bow" ship and an ordinary blunt-bow ship are currently undergoing full-scale measurements while in service. We will use these data to verify Ax-Bow's performance and for future ship design work.

<Please refer to>
Koichiro Matsumoto
Hull Performance, Ships & Offshore Structures Planning Department
Tel : (81) 59-246-2210
E-mail : Koichiro_Matsumoto@tsu.nkk.co.jp