Full Scale Measurements of Ship Ice Loads and Performance on Board R/V Akademik Fedorov on Her Voyages in Antarctica and Arctica

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ABSTRACT

The full scale measurements of ship ice loads and performance in polar ice conditions are presented. The measurements were conducted on board an icebreaking research vessel Akademik Fedorov during her voyages in the Weddell Sea, Antarctica 1991-92 and on the Northern Sea Route, Arctica 1994. The instrumentation and calibrations of the measuring system are presented. Ship's route and ice conditions on the voyages are described. The measured ice loads, ice pressures, hull stresses and ship performance are analysed for different sea areas. The extreme values and statistical predictions are given. The results in Antarctica and Arctica are compared with each other.

KEY WORDS: Ship ice loads, ice pressures, ship structures, ship performance, polar ice conditions, Antarctica, Northern Sea Route

INTRODUCTION

The main aim of the long-term measurements conducted on board R/V Akademik Fedorov was to gather statistical data in order to evaluate the most severe ice loadings encountered by ships navigating in polar ice conditions. These kind of measured data are important for ship design and development of polar ice rules. For these targets it was an extraordinary interesting possibility to measure ice loadings on a ship, which navigated both in Antarctica and Arctica.

The ice load measurements and ice navigation studies were made in Antartica during the Finnish Antarctic Expedition (FINNARP-91). R/V Akademik Fedorov made two voyages 6 November 1991 - 5 March 1992 from South America to Antarctica. The ship was chartered to supply the Finnish, Swedish and Norwegian research stations in the Queen Maud Land on the coast of the eastern Weddell Sea. Another major goal of the season was the foundation of the American-Russian ice station Weddell-1 in the western Weddell Sea. It was the first reasearch station founded on drifting pack ice in the Antarctic Ocean (Gordon et al., 1993).

The voyage on the Northern Sea Route was conducted in connection with the Swedish-Russian "Tundra Ecology-94" expedition 9 June - 1 September 1994. The ship navigated then through the Pechora Sea, the Kara Sea, the Laptev Sea and the East-Siberian Sea up to the Shelagski Cape (70° 14' N, 170° 22' E), from where she returned to Murmansk. So, the main part of the Northern Sea Route was covered back and forth.

The measurements and analysis were made by the scientists of the Maritime and Mechanical Engineering research area of VTT Manufacturing Technology. The ice condition data in Antarctica were collected in co-operation with the scientists from VTT and the Arctic and Antarctic Research Institute of St. Petersburg (AARI). The ice condition data on the Northern Sea Route were gathered by the scientists of AARI.

SHIP DESCRIPTION

R/V Akademik Fedorov is a multi-purpose icebreaking vessel, which carries polar expeditions, supplies research stations and performs marine research. The ship was delivered to the Russian owner in 1987 by Rauma-Repola Oy, Rauma Shipyard, currently a part of Aker Finnyards Ltd. The ship has diesel-electric propulsion machinery utilising the principle of power-station operation. The total output of the main engines is 17 500 kW. Two electric motors are connected to one propeller shaft. Their combined nominal power is 2 x 6000 kW. The propeller shaft rotates four-bladed fixed pitch propeller, whose diameter is 5.1 metres.

Length, overall
Breadth, max.
Draught, max.
Depth to main deck
Speed

141.2 m
23.5 m
8.5 m
13.3 m
16.5 kn

Fig. 1. The main characteristics of R/V Akademik Fedorov.