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Glacial Ice Loads for Large Bulk Carriers

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ABSTRACT

The objective of this work is to develop representative glacial ice loads for the bergy bits and growlers that are hard to detect and present them in a form that is suitable for use in finite element analysis. In this paper bergy bit and growler sizes are estimated. Collision scenarios are examined for a typical Cape Class bulker of both conventional and icebreaking shape. These scenarios predict the maximum forces that occur for a range of ship speeds and impact locations along the ship. Time-histories are developed for a few selected loads. Pressure distributions are developed for the selected time-histories. These pressure distributions are suitable for FEA input and vary in magnitude over the contact area. The contact area also changes in size as the time history develops.

KEY WORDS: Ice Loads, Glacial, Bulk Carriers, Ice Pressure Distribution

INTRODUCTION

In order to predict performance of a bulker through glacial ice–infested waters, two aspects must be considered: the probability of encountering undetectable bergy bits and growlers in the transit path and the effects of impacting such ice formations at speed. This paper focuses on the glacial loads and developing pressure distributions within the loads.

ICE CONDITIONS

Bergy bits and growlers likely to be found in vicinity of icebergs

It is reasonable to assume that large bergs will be detected and easily avoided; thus, striking these unexpectedly is not likely. It is the smaller, less detectable ice formations that pose the most risk. Consequently, determining the impact forces for a range of speeds for the growler or bergy bits that can unexpectedly (without prior detection) impact the ship is of greater importance.

The World Meteorological Organization (WMO) has defined an extensive set of terms to classify all types of sea ice. Glacial ice is considered ice of land origin and the smallest sizes of this type of sea ice fall under the category of growlers and bergy bits. These pieces of ice bergs are “calved” or split apart from a melting iceberg through thermal fracture and waterline erosion. An iceberg, as it moves from its launching point from a glacier to warmer waters leaves a trail of smaller pieces in its wake, the smaller of which we are discussing here, are extremely hard to detect. Therefore, the likely place to encountered growlers and berg y bits is where there is ice bergs sighted.

Glacial Ice Size

The WMO Standard Sea Ice Nomenclature (WMO, 1970) defines the smaller pieces that calve off ice bergs as follows:

10.4.4 BERGY BIT: A large piece of floating glacier ice, generally showing less than 5 m above sea-level but more than 1 m and normally about 100-300 sq. m in area.

10.4.5 GROWLER: Smaller piece of ice than a bergy-bit or floe berg, often transparent but appearing green or almost black in color, extending less than I m above the sea surface and normally occupying an area of about 20 sq. m.

Estimation of Size and Shape of Growlers and Bergy Bits

In this work, several different shapes were investigated see the trends in weight versus freeboard and waterplane area. A rectangular prism, a sphere and a cone were examined. Results are shown in Table 1, Table 2, and Table 3 for rectangular, spherical, and conical shapes, respectively. The rectangular prism was selected to estimate the weight for a given size because it had the most weight for a given freeboard and waterplane area. Three sizes were chosen for each category, growlers and bergy bits, which approximated the range of sizes in the WMO descriptions.