

## Comparison of Local Ice Pressures on the CCGS Terry Fox with other Data

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### ABSTRACT

Local pressure data from bergy bit impacts with the CCGS Terry Fox off the north east coast of Newfoundland in June 2001 have been compared with other data. These data sources include the USCGC Polar Sea from operations in the Beaufort Sea and Chukchi Sea, and bergy bit impacts at Grappling Island. They have been put on a common basis and compared with the CCGS Terry Fox data. When factors relating to area, exposure and probability of exceedance are taken into account, the difference between the three groups of local pressure data becomes smaller. At the  $10^{-3}$  probability of exceedance and a single sub-panel of area about  $0.3 \text{ m}^2$ , the local pressure varied from 5 MPa (CCGS Terry Fox), in the range 4.2 MPa to 2.7 MPa (USCGC Polar Sea), to 1.7 MPa (Grappling Island). Smaller ice mass and lower impact velocities explain the lower pressures for Grappling Island data.

**KEY WORDS:** Local ice pressure, ships, ice types.

### INTRODUCTION

Local ice pressures that could be generated on ships impacting bergy bits are of concern for navigation in the ice affected waters of the Grand Banks. A field test program carried out with the CCGS Terry Fox off the north east coast of Newfoundland in the latter part of June 2001 (Gagnon et al., 2008) produced over 100 impact events on glacial ice from which local pressures and pressure distributions were obtained (Frederking and Johnston, 2005, Ritch, et. al., 2008) These data are the most directly applicable data in relation to ice impact loads and pressures on the shuttle tankers operating on the Grand Banks. The purpose of this paper is to compare the CCGS Terry Fox local ice pressure results with other data, and thereby extend the applicability of the data. The focus is on the relative pressures on a given area, rather than on the pressure-area relation.

### DATA SOURCES

In addition to the CCGS Terry Fox data, two other data sources were identified: Arctic trials of the USCGC Polar Sea and special field tests

carried out at Grappling Island on the Labrador coast. The Polar deployments of the USCGC Polar Sea to the Beaufort and Chukchi Seas are the most immediately comparable trials to the CCGS Terry Fox data because they involved impacts with multi-year ice. The size, thickness and strength of multi-year ice make it a possible base for comparison with the growlers, bergy bits and small ice bergs the CCGS Terry Fox encountered. The other data source examined was that from the iceberg towing experiments at Grappling Island on the southern coast of Labrador. This glacial ice was similar to that in the CCGS Terry Fox trials, but impacts were conducted on a special test structure instead of a ship. In addition to the local pressure data, the following sub-sections will describe instrumentation, test method, location and ice conditions for each data source.

### CCGS Terry Fox

The CCGS Terry Fox trials and instrumentation are described in Gagnon et al. (2008). The ship, of displacement 6800 t, was instrumented with strain gauges in the port side of the bow, from which local ice pressures were determined. The instrumented area was about 3 m high and about 3 m overall across, with an actual measurement area of about  $6 \text{ m}^2$ . The instrumented area was divided into 34 sub-panels which varied in size from  $0.08 \text{ m}^2$  for the smallest to  $0.25 \text{ m}^2$  for the largest. Since the smallest area was smaller than those normally used for design, the loading on these smaller sub-panels was apportioned to a simplified array of larger areas as shown in Fig. 1. Twenty parallelogram shaped sub-panels  $0.46 \text{ m}$  wide and  $0.76 \text{ m}$  high with a  $70^\circ$  included angle, area were available for analysis. Each sub-panel had an area of  $0.33 \text{ m}^2$ .

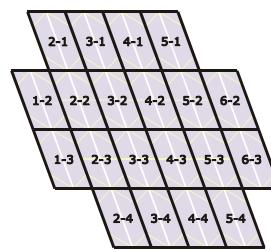


Fig. 1 Array of areas used for analysis of local pressures on CCGS Terry Fox