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PII: S0165-232X(16)30392-5
DOI: doi:10.1016/j.coldregions.2016.12.006
Reference: COLTEC 2344

To appear in: *Cold Regions Science and Technology*

Received date: 27 July 2015
Revised date: 18 November 2016
Accepted date: 7 December 2016

Please cite this article as: Kotilainen, Mikko, Vanhatalo, Jarno, Suominen, Mikko, Kujala, Pentti, Predicting ice-induced load amplitudes on ship bow conditional on ice thickness and ship speed in the Baltic Sea, *Cold Regions Science and Technology* (2016), doi:10.1016/j.coldregions.2016.12.006

Predicting ice-induced load amplitudes on ship bow conditional on ice thickness and ship speed in the Baltic Sea

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Abstract

Transportation in ice prone waters is a timely topic due to the pursuit for arctic natural resources and sea routes. One important safety aspect in designing ships that enter ice prone waters is to determine the ice-induced loads on ships. However, ice is a particularly inconsistent material; therefore it is difficult to predict the occurring loads when the ship hull breaks the ice. We propose a novel probabilistic, Bayesian, method for modeling and predicting ice load distributions in different ice and operational conditions. We assume the ice loads to be generated from a random process whose parameters change as a function of ice thickness and ship speed. We test four alternative hierarchical Gaussian Process models. The best model shows good performance in predictive validation tests. According to the results the probability of high ice loads increases with increasing ice thickness and increasing speed. The model can be used to predict continuously ice loads in different ice thickness and speed conditions and, with further development, has potential to be utilized in determining the safe way to operate ships in different conditions.

Keywords: ice loads; ice conditions; ice thickness; prediction; Bayesian statistics; Gaussian process

Abbreviations

CV cross-validation

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