Estimation of ship bridge collision probability by use of Monte Carlo simulations

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Abstract

This paper suggests a new method for risk assessment in maritime environment. The method is developed in close collaboration between SSPA and the Norwegian Public Road Administration for application to the planned fixed crossing of the Bjørnafjord in Norway. The method is based on principles from big data analysis and inspired by the Monte Carlo simulation technique. The basic idea is to simulate millions of representative vessel movements with stochastic failures in four degrees of freedom aiming to get a geometric distribution of the collision locations and probabilities.

Keywords: Risk analysis, Monte Carlo simulations, bridge collision, energy estimations and failure modelling.

1 Introduction

The method has been developed in a cooperation between SSPA and the Norwegian Public Road Administration, NPRA, in order to find design criteria for a fixed crossing over the Bjørnafjord, south of Bergen. A construction, a bridge or a tunnel, crossing the fjord is expensive and vulnerable to vessel collisions, since the fjord is 5 km wide and 5 – 600 meter deep. The method developed, makes it possible to assess and compare alternative design solutions for the crossing from a geometric risk perspective. For each alternative design, including some runs with different risk control options, two million vessel movements were simulated. The result of these simulations indicates that a collision is likely to happen every 400 – 1 000 years. The method is able to take various fairways, vessels, vessel speeds, failure types etc. into consideration. The output from the method gave NRPA a good understanding of the collision probability and the geometric risk distribution. This paper describes the method and summarises some of results in the Bjørnafjord case.

2 The method

The idea of the method is to use data from Automatic Identification System, AIS [1], as a base to understand the amount and behaviour of the vessels that operates in the area. When the behaviour is known, the area is modelled (including new routes adapted to the new infrastructure) millions of vessels with failures are placed along the routes

2.1 Background

Risk assessments within maritime infrastructure are often analysed by probabilistic approaches. Some are based on the work of Fujii [2] and Macduff [3] which generally estimated the frequency of accidents as:

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