Trial Calculation of Design Ice Loads on an Arctic Structure for Offshore Sakhalin

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ABSTRACT

In this study, a trial calculation of design ice loads on a candidate arctic structure for offshore Sakhalin is conducted. Estimation of the design ice loads is performed using a probability based method proposed by the author. This method calculates a probability density of ice loads by the Monte Carlo simulation and produces a return period - ice loads relation from the simulated probability density.

The method proposed is briefly explained. Two important elements of the method, the ice load models for possible ice - structure interactions which are specified in interaction scenarios associated with offshore Sakhalin are determined and probability density functions for variables associated with ice and sea condition at offshore Sakhalin are also determined. Some trial calculations are done. And some necessities to apply the method are discussed.

KEY WORDS: Ice loads, arctic structure, offshore Sakhalin, Monte Carlo simulation

INTRODUCTION

Japan Oil Industries Association (hereafter, JOIA) has been organizing a research program. The first phase of the program mainly concentrates to establish methods for calculating ice load on arctic structures which have rather simple geometric shapes such as conical and vertical structures. The first phase seems to be successful, then JOIA has decided to proceed his research activity toward more practical aspects.

One of new tasks to be dealt with the JOIA research program is an application of obtained knowledge to design a structure in offshore Sakhalin. Ishikawajima-Harima Heavy Industries Co., Ltd. (hereafter, IHI) is assigned to develop a method to set a design ice load. IHI has developed a method for setting a design ice load to be applicable to a structure in Beaufort Sea. This method is named IDIFES and reported in ISOPE'92 conference (Kato, 1992a).

IDIFES sets a design ice load based on probabilistic considerations using the Monte Carlo simulation. Some modifications are necessary in order to apply IDIFES to a structure which would be used in offshore Sakhalin. These modifications are mostly made on probability density functions (hereafter P.D.F.) for variable defining the ice and sea conditions at the region in question. These variables are needed for calculating the ice load through an equation, which is named the ice load model in IDIFES.

In this report, a basic idea and procedure of IDIFES are briefly introduced. For a trial calculation, one of candidate arctic structures for offshore Sakhalin is introduced. The ice load models for the structure in question are discussed. The ice load model is defined as an equation to allow us to calculate an ice load deterministically when every variables are specified. Then, every P.D.F. for variables associated with ice and sea conditions in offshore Sakhalin are discussed. Trial calculations are performed using the ice load models and P.D.F.'s of the variables obtained in the previous discussion. And a discussion on the results of trial calculation is made. Future works which are necessary to adopt the proposed procedure are also discussed.

BASIC IDEA AND PROCEDURE

Ice features which would interact with an arctic structure have a wide range of properties. Ice thickness would have a wide range, if we limit our consideration only to interactions with first year level ice (hereafter, FYL). It would be better to consider a probabilistic distribution of FYL thickness than to take a certain conservatively determined design ice thickness.

An Ice load, \( F \), exerted on a structure during an interaction with an ice feature can be expressed by a general form as,

\[
F = f(v_1, v_2, \ldots, v_n)
\]

\( v \)'s are variables to define ice and sea conditions, a structure shape, etc. It is recognized that each of the variables mostly has a wide range of variation in nature. It could result in an overestimation of ice load, if one would use conservative values of all the variables for setting a design ice load.

In IDIFES, each of the variables needed in the equation (1) is developed to a random data array which has the same probabilistic nature as the variable has. A set of elements from the random data arrays are used to calculate a trial ice load through the equation (1).