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## A New Ice Simulation Tool Using a Multi-Model Program

Cyril Septseault, Pierre-Antoine Béal and Sébastien Le Yaouanq, Cervval, Alexey Dudal, Bureau Veritas, and Brian Roberts, Technip



### Abstract

In June 2012, Technip signed an agreement with Cervval (a specialist software company in Brittany) and Bureau Veritas (BV) to develop an ice-modelling simulation program. The long term aim is for the simulator to predict the flow of ice around both fixed and floating structures and calculate the ice-loadings on the platforms. The program will ultimately allow platform structures to be optimised, to minimise ice loadings and ice rubble build-up, prior to final design verification in an ice test basin.

Initially the program has been developed to predict ice behaviour in shallow waters since there are several projects imminent in the North Caspian but will be equally applicable in Arctic regions. Cervval has been developing the software with ice expertise input and verification from BV. The program is unique in the Arctic industry in that it uses a multi-model simulator which is able to cope with the complexity of calculating the kinematic and failure behaviour for the ice sheet and for each ice fragment that results from contact with the structure or from collision with other ice rubble particles for ice mechanical properties.

Currently the program is able to simulate the flow of an ice sheet as it encroaches on a conical structure, which is a type of platform design that Technip has developed specifically for projects offshore Kazakhstan. The design tool is able to predict vertical and horizontal loads on the structure with good accuracy. It also predicts the geometry of the ice accumulation in front of the structure above and below the ice sheet.

The next stage in the software development is to consider ice interaction with a straight sloping wall structure, then vertical walled structures (such as artificial islands) and finally a range of floating structures.

The paper presents details of the simulator, the status of the development & verification program and plans for the future. A typical set of ice simulations are shown and a comparison with ice basin test results is presented as a measure of the program's accuracy.

### Introduction

In June 2012, Technip signed an agreement with Cervval and BV to develop an ice-modelling simulation program. The long-term aim is for the simulator to predict the ice flow around both fixed and floating structures and calculate the ice-loadings on the platforms. The program will ultimately allow platform structures to be optimised, to minimise ice loadings and ice rubble build-up, prior to final design verification in an ice test basin.

The present paper describes the results of the first stage of the cooperation to simulate the ice loads exerted on conical fixed structures by a drifting ice field. A number of methods have been proposed to predict ice loads due to ice intraction with conical structures.

The analytical methods proposed by Ralston (1980) and Nevel (1992) are often used for determination of ice loads on cone structures. Both methods are based on the assumption of ice failure by bending. Nevertheless other ice failure modes on the cone are possible: crushing, splitting and shearing subject to other ice conditions.

The empirical methods are based on analysis and processing of ice model test results using regress-models. The basis of the regress-models using ice model tests results was presented in a paper by Alekseev et al. in 1998. The empirical methods allow accurate assessment of ice load components and extrapolation of the model tests results to full-scale conditions if ice strength or the ice thickness differs from required values. However the constructed regress-models cannot be