Specialist Committee on Ice

Final Report and Recommendations to the 27th ITTC

1. INTRODUCTION

1.1. Membership and Meetings

The ice committee (IC) was appointed by the 26th ITTC in Rio de Janeiro, Brazil, 2011, and it consists of the following members shown in Figure 1:

- Mr. Peter Jochmann (Chairman), HSVA, Germany
- Dr. Michael Lau (Secretary), National Research Council of Canada, Canada
- Mr. Johannes Huffmeier, SSPA, Sweden
- Prof. Akihisa Konno, Kogakuin University, Japan
- Mr. Topi Leiviskä, Aker Arctic, Finland
- Mr. Rudiger von Bock und Polach, Aalto University, Finland
- Mr. J. Römeling, FORCE, Denmark
- Dr. Kirill Sazonov, Krylov, Russia
- Mr. Victor Westerberg, SSPA, Sweden
- Prof. Qianjing Yue, Dalian University of Technology, China
- Dr. Rod Sampson, Newcastle University, United Kingdom

Dr. R. Sampson resigned from the committee in September 2013 and Mr. J. Hüffmeier was replaced in October 2013 by Mr. V. Westerberg. Mr. J. Römeling passed away in 2012. Furthermore, P. Jochmann resigned in June 2014 as the chairman and Dr. M. Lau has been acting on the remaining of the term.

In performing their work, five physical committee meetings were held at different locations:

- HSVA, Hamburg, December 13th, 2011
- NRC/OCRE, St. Johns, October 25th - 26th, 2012
- AARC, Helsinki, June 13rd -14th, 2013
- Kogakuin University, Tokyo, November 25th -27th, 2013
- SSPA, Gothenburg, May 8th -9th, 2014

In addition to the physical committee meetings six online meetings were organized to discuss work results and to prepare for the physical meetings. Those online meetings were performed on the following dates:

- August 5th, 2013
- August 12th, 2013
- February 4th, 2014
- March 4th, 2014
- April 22nd, 2014
- August 21st , 2014

Two progress reports were prepared and submitted to the ITTC Secretary. They were sent to the Advisory Committee on September 18th, 2012 and August 15th, 2013, respectively.

Figure 1. Group photo of Specialist Committee on Ice (back row: A. Konno, J. Hüffmeier, T. Leiviskä, N. Fatieva, K. Sazonov, R. v. Bock; front row: G. Fengwei, P. Jochmann, M. Lau)

1.2. Recommendations of the 26th ITTC

The 26th ITTC recommended that the Specialist Committee on Ice for the 27th ITTC address the following technology areas:

(1) Review ice properties modeling (full scale and model scale) considering various conditions, ridges, and pressurized ice for both offshore structures and ships that includes:

- Review and update of the state of the art regarding new relevant ice conditions such as brash ice channels (related to Ice Class powering requirements) both in frozen channel and fresh channel
- Examination of methods to model and measure various ice properties
- Gathering information on degree of scattering in model ice properties within one ice sheet (statistical distribution)

(2) Define which existing ice related procedures need to be checked and if new ones need to be developed

(3) Look into operational conditions in frozen seas (in view of the climate change) relevant to modeling, e.g.:

- Brash ice channels
- Icing
- Ice, waves, wind and current
- Ice dynamics

(4) Review the existing numerical methods for offshore structures and ships concerning:

- Model ice failure
- Ice resistance and propulsion
- Maneuvering and ice loads
- Operational simulations, e.g., dynamic positioning in ice

1.3. Brief Description of the Task Execution

The tasks were grouped into the following three work elements:

- Review of existing *Recommendations and Guidelines*
- Preparation of an inventory list by development, distribution and analysis of a questionnaire
- Compilation of existing publications regarding numerical simulations

This report documents the work and the outcome in details.

2. GUIDELINES AND RECOMMENDATIONS

2.1. General

Following the recommendation of the Advisory Committee the committee members decided to review the following *Recommendations and Guidelines*:

- *General Guidelines (1999) - 7.5-02-04-01*
- *Model Ice Properties (2002) - 7.5-02-04-02*
- *Tests in Deformed Ice (1999) - 7.5-02-04-02.4*
- *Resistance Test in Level Ice (2002) - 7.5-02-04-02.1*
- *Maneuvering Tests In Ice (1999) - 7.5-02-04-02.3*

During the Helsinki meeting in June 2013 it was decided to remove *Guideline 7.5-02-04-02.4 Tests in Deformed Ice* without replacement. The *General Guidelines*, *Model Ice Properties*, *Resistance Test in Level Ice* were finalized and transmitted to the Advisory Committee for review while *Maneuvering Tests in Ice* could not be finished and was therefore postponed together with *Propulsion Tests in Ice* to the next committee.

As the workload for editing the old guidelines was already very high this committee was not able to start work on a new guideline regarding "*Brash Ice Tests*" and "*Dynamic Positioning in Ice*".

2.2. General Guidelines

Because all *Recommendations and Guidelines* were at least 12 years old with ice technology developed rapidly during the period, the *General Guidelines* were extensively revised. Two different types of model ice, fine and columnar grained, are used in the model basins; hence, it was decided to describe in details the production techniques of these two ice types.

2.3. Ice Properties

The guidelines *7.5-02-04-02 Test Methods for Model Ice Properties* have been updated and extended based on the state-of-the-art in science and ice tank operations. In the revised version all available methods to determine ice properties are listed and discussed in terms of precision, feasibility and validity.

The testing of ridge properties is added and the difference between test methods for compressive failure and indenter testing is clarified.

2.4. Resistance

Current procedures adopted in various ice tanks for resistance tests have been reviewed. Model towing methods practiced by ice model tanks are described. A method to determine the maximum force applied at model towing through the ice ridges is given. Description is given of the methods used for correcting ice resistance data with minor deviations from the design ice thickness and strength.

Empirical relations are most frequently used in ice model tank practices for the data correction. Based on experience and model ice used by individual ice tank, details of the correction method might vary. The general correction method for test data variations due to ice-model friction and the test data correction method used by various ice tanks are described as follows for further reference.

Correction of Minor Deviations in Ice Thickness. The following empirical relation between ice resistance and ice thickness based on results from experiments can be used as an approximation:

$$R_I \approx H_I^x \tag{1}$$

where H_I is the ice thickness.

The determination of the exponent in Equation (1) was usually based on historical data obtained from a particular ice basin or on statistical data obtained from the same model testing in ice of at least two different thicknesses. The latter is a more accurate approach. The exponent in Equation (1) may vary between 1.0 and 2.0; and the value 1.5 is commonly used.

The exponent in Equation (1) may depend on model towing speed. This effect may be taken into account using an empirical Froude number relation (HSVA Report):

$$x = 1.5 - 0.3 \cdot Fn_{HI} \tag{2}$$

where $Fn_{HI} = \frac{V}{\sqrt{gH_{I,target}}}$ - Froude number calculated for the target ice thickness $H_{I,\ target}$.

Correction of minor deviations in ice flexural strength. Ice resistance and ice strength are considered to correlate linearly with corrections of minor deviations in flexural strength of ice, according to Equation 3.

$$R_I = aR_{I,meas} + b\frac{\sigma_{f,target}}{\sigma_{f,meas}}R_{I,meas} \tag{3}$$

where σ_f is the ice flexural strength and a and b are the weight coefficients selected based on experience (for example, one can use values a=b=0.5).

The classic way to perform the corrections is to use a component breakdown of the ice resistance. (Jones et al. 1994, Riska et al. 1994, Izumiyama and Uto 1995):

$$R_I = R_B + R_V \tag{4}$$

where R_B is the speed independent ice breaking resistance component associated with ice failure and R_V is the speed dependent resistance associated with ice submerging and clearing.

The breaking component can be determined by means of a test in pre-sawn ice. In a pre-sawn ice test ice the ice sheet is pre-cut with an ice-breaking pattern simulating that observed during ice breaking. Hence, the ice breaking component, R_B, is eliminated from the total resistance, and therefore, R_B can be defined as the difference between the resistances measured in level ice and in the pre-sawn ice, for the same speed:

$$R_B = R_{IT,level\ ice} - R_{IT,presawn\ ice} \tag{5}$$

where $R_{IT,level\ ice}$ and $R_{IT,presawn\ ice}$ are the total ice resistance in level ice and pre-sawn ice, respectively.

The pattern of ice pieces in the pre-sawn ice field should resemble the real breaking pattern. Some compromises are, however, usually made and a typical pattern is shown in procedure *ITTC 7.5-02-04-01*. The centerline of the model should coincide with the centerline of the pre-sawn ice pattern. The recommendation for the test run length of the pre-sawn area is the same as for the level ice section. It is important that the pre-sawn area is slightly wider than the waterline breadth of the model ship. The breadth of the pre-sawn area may be defined by the formula:

$$B_{PS} = B_{WL} + nH_I \quad (6)$$

where B_{PS} and B_{WL} are the width of pre-sawn ice strip and the model waterline breadth, respectively; and the constant n should be between 3 and 4.

If the air temperature is below the freezing point or the ice is very cold there is a risk that the ice pieces may freeze together; therefore, it is important to minimize the time lag between the tests and preparation of the pre-sawn ice sheet, while such conditions exist.

Another method to determine R_B is to represent the experimental results by a speed dependent relation $R_I = f(V)$ and then obtain the zero test speed of R_I by extrapolation as illustrated in Figure 2.

Another method adopted by HSVA applies ice strength correction without ice resistance component decomposition. An empirical formula is used (HSVA Report):

$$R_{I,corr} = R_{I,meas} \frac{1+\left(\frac{\lambda\sigma_{f,targer}}{500}-1\right)/C}{1+\left(\frac{\lambda\sigma_{f,meas}}{500}-1\right)/C} \quad (7)$$

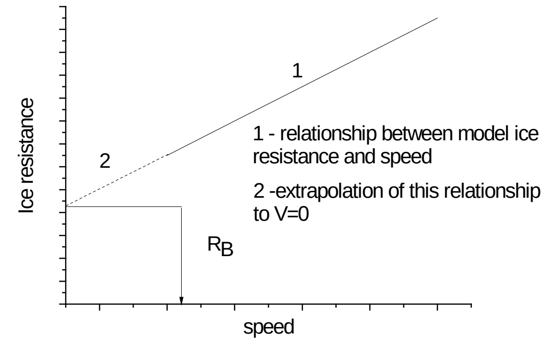


Figure 2. A method to determine ice strength dependent resistance component.

where $C=2.3 + 2Fn_{HI}$ and λ is the model scale coefficient. Ice strength α_f in this formula is measured in kPa.

Another methodology to obtain corrections is to assume that the ice resistance is dependent on the strength and the thickness of the ice:

$$R_I = a(V)\sigma_f H_I^2 + b(V)\rho_I H_I \quad (8)$$

where the speed dependent constants (a and b) are determined by regression analysis; and ρ_I is the ice density.

NRC/OCRE adopts a similar approach, but with a full regression analysis on the resistance measurements on a model with varied ice thickness and ice strength to obtain the relationship for ice resistance as function of ice thickness, ice strength, ice density, and model velocity (Spencer, 1992). The correction is performed accordingly.

Friction Coefficient Correction. Allowance for friction coefficient is usually introduced for overall ice resistance with the following formula:

$$R_{I,corr} = C_{\mu} R_I \qquad (9)$$

where C_{μ} is the correction coefficient.

The value of the correction coefficient C_{μ} is determined based on analysis of model and full-scale tests data. For them C_{μ} may be determined as given in the equations (10 – 12) (HSVA Report):

$$C_{\mu} = \frac{1}{0.6+4f_{ID}} \text{ - for level ice} \qquad (10)$$

$$C_{\mu} = \frac{1}{0.8+2f_{ID}} \text{ - for large ice floes} \qquad (11)$$

$$C_{\mu} = \frac{1}{0.9+f_{ID}} \text{ - for broken channel} \qquad (12)$$

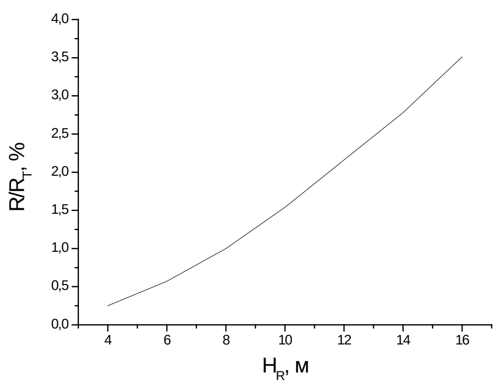
where f_{ID} is the model/ice friction coefficient.

Extrapolation formula may also be obtained based on computations made with mathematical models of ship motion (Alekseev & Sazonov, 1993 and 1994) For example, Alekseev and Sazonov (1994) gave the following equation for extrapolation of model ice resistance in level ice to that of another friction coefficient:

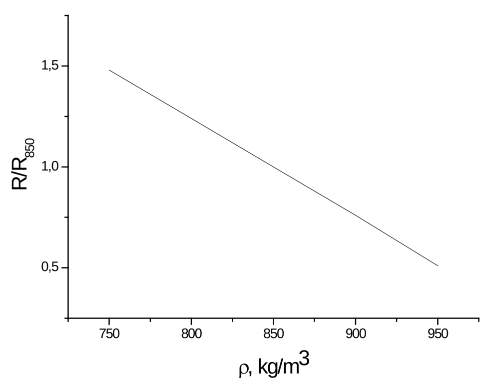
$$R_{I,corr} = \frac{0.61 + 1.34 f_{ID,target} + 5.9 f_{ID,target}^2}{0.61 + 1.34 f_{ID,meas} + 5.9 f_{ID,meas}^2} R_{I,meas} \qquad (13)$$

To correct model test data one can use ice resistance computations made with one or another mathematical model (Alekseev & Sazonov, 1993 & 1994).

Sometimes there is a need to correct test data from model towing tests performed in ice ridges. Mathematical models of the ship/ridge interaction process developed at ice basins are used for this purpose. For example, KSRC uses such model (Sazonov, 2013) as shown in Figure 3.



a)



b)

Figure 3. Effect of various factors on ice resistance. a) ridge keel depth variations and b) ice density variations; R_T is the resistance in ridge with keel depth equal to ship draft and R_{850} is the resistance at ice density $\rho_I = 850$ kg/m^3

3. QUESTIONNAIRE

A questionnaire for investigating the inventory of the ice basins was developed by Aalto University and The Hamburg Ship Model Basin. The questionnaire was distributed among the ice facilities in North America, Europe and Asia. The information from the returns was compiled by Aker Arctic Research Center in a spread sheet. The eight facilities surveyed are listed as follows:

- Aalto University
- Aker Arctic Technology Inc. (AATI)
- Hamburgische Schiffbau-Versuchsanstalt GmbH (HSVA)
- Japan Marine United Corp. (JMUC)
- Kyrylov State Research Center new ice tank (KSRC)
- Krylov State Research Center old ice tank (KSRC)
- National Maritime Research Institute (NMRI)
- National Research Council / Ocean, Coastal and River Engineering (NRC/OCRE)

4. REVIEW OF EXISTING NUMERICAL METHODS

4.1. Ice Resistance of Vessels

Numerical methods for determination of ship ice resistance were actively developed at the turn of 20th century. At that time various researchers developed numerical techniques based on mathematic description of the salient physical processes occurred during ship transiting in ice, i.e., ice breaking by ship hull, turning and submergence of ice pieces. In this context, the studies of Enkvist (1972), Lindstrom (1990), Alekseev and Sazonov (1993), Valanto (2000), Liu et al (2006) and other can be mentioned.

Recently, the research aiming at developing of new methods has diminished. The concepts of the earlier developed methods are widely used in addressing other ice technology issues, e.g. calculations of ice load on the ship hull and ice vibration, ship maneuvering (Lau, 2011), dynamic positioning, and in ice operations (Lau and Simoes Re, 2006) and personnel training.

A full list of recent papers is given in the reference section. It should be noted that one of the latest tendencies in the development of numerical methods for determination of ship ice resistance is application of Computer Aided Engineering. Most of the systems are not customized for computations related to ship resistance determination and require substantial adaptation. There are several research teams in Russia, (Ionov and Gramuzov, 2013; Lobanov, 2013), Europe (Valanto, 2009) and Canada (Lau, 2011; Daley et al, 2014) that are currently involved in these studies.

4.2. Loads on Structures in Ice

Investigation of loads on structures in ice using numerical simulation is not a new topic, but its review was not performed in the past committees. Earlier studies such as Lau (1999) and Izumiyama et al. (1992) combine beam theory, crack pattern approximation and ice force calculation to estimate ice load on a conical structure.

Recent studies, however, often use advanced numerical methods such as FEM (Finite Element Method) and DEM (Discrete Element Method). FEM simulations are often conducted using commercial software packages such as Abaqus/Explicit and LS-DYNA (Derradji and Lau, 1993). On the other hand, many researchers use DEM simulations with their own codes such as DECICE (Lau, 2011). Some of them implement physically-based modeling that can be considered a derivation of DEM.

Many studies conducted simulations of three dimensional and dynamic phenomena such as ice-induced vibration and motion of moored structures (Sayed et al, 2012; Karulin and Karulina, 2001).

Arctic Technology report in Proceedings of the 18th International Ship and Offshore Structures Congress, Vol. 2 (ISSC 2012) covers numerical simulation of ice. In particularly, Section "9.2 Ice-Structure Interaction and Discrete Element Method (DEM)" covers the related topic. Therefore, we reviewed mainly literatures after 2011. So far, we reviewed IAHR Symposium on Ice 2012, OMAE 2012, ICETECH 2012, POAC13. Proceedings of the 27th, 28th and 29th International Symposium on Okhotsk Sea & Sea Ice (2012, 2013, 2014 respectively) are also reviewed but no paper can be found that was directly related to loads on structures in ice. A full list of papers reviewed is given in the reference section.

4.3. Maneuvering and DP in Ice

With an increased interest of operations in Arctic and sub-arctic conditions the ability of station-keeping and manoeuvring in ice has been shown an increased focus. Dynamic positioning (DP) is widely used in ice-free water and open seas where the impacts from wind, waves and current are included in the force balance algorithms.

DP in ice conditions infers additional parameters such as the local and global ice loads on hull and the performance variations of propulsion systems. The increased number of variables together with discontinues nature of ice and its regimes puts new challenges on ship manoeuvring and the development of DP systems.

To understand and predict the ice forces acting on a DP vessel, a wide range of numerical simulation studies and development projects have been initiated throughout the years. The numerical simulations focus on a wide range of applications from hull and propulsion designs, DP capability limits, ice management and oil spill response capabilities evaluation to operational training for navigational officers.

A review of the latest numerical methods on dynamic positioning and manoeuvring in ice were performed which encompasses the wide span of disciplines from control systems and thruster force allocation to ice load computation on hulls. A full list of papers reviewed is given in the reference section.

Numerical modelling with DP and manoeuvring in ice is a relatively new research area. General approach to solve the problem numerically is yet to be developed, however, promising methods currently evolves. During the development of methods different components are addressed individually with various level of simplification. One of the biggest challenges at the time are to couple all relevant phenomena to attain a satisfactory level of accuracy and yet at a reasonable computing cost. The latest and promising trend in theoretical modelling is to use different commercial physics engines. However, increased complexity is often detrimental to real-time simulation capability.

Depending on the application a particular modelling approaches may be favoured. For onboard integrated systems or training simulators real-time, or preferably fast time, simulation capacity are needed. To this end, less complex mathematical models may be implemented and supplemented with data obtained from model tests and sea trials.

To increase confidence on the numerical simulation, validation of its results against model test data and full scale measurements are needed. More complex problems and scenarios will probably be addressed further on to aid the industry with well based investigations for future design projects and operational issues. To be able to identify and determine operational limits for specific operations and minimise risks to ensure safe operations the ability of numerical simulations with high accuracy complemented by ice tank and full scale testing will be essential for future successful Arctic operations.

5. SUMMARY AND CONCLUSIONS

In August 2011 the Ice Committee was re-installed with 10 members. For various reasons only 7 were consistently contributing to the activities. In December 2011 the committee started work with a Kick-Off meeting in Hamburg, followed by 4 more physical meetings and 6 video conferences.

After completion of a questionnaire and compilation of a new inventory list of the existing ice model basins the committee concentrated on review and editing of some ice basin work related guidelines and procedures. Two of them were finished and accepted by the Advisory Committee for publication.

Another work element during the three years mandate was to establish a numerical simulation database on ship- and structure-ice interactions as well as on maneuvering and dynamic positioning in ice. Papers and articles related to these areas were reviewed and assessed. The results of this work are compiled in the report.

Although the scope of work given by the Advisory Committee was not completely fulfilled, the members believe that the 27th ITTC was successful and should be continued during the 28th ITTC. Therefore the committee members recommend the installation of another Specialist Committee on Ice or make it a permanent committee. This position is supported by increased activities in arctic regions and its resulting work load in ice models basins.

The members also like to emphasis that the ice committee covers several model test types for which special committees exist for open water testing. Therefore, the members feel that it would be appropriate to install a standing ice committee.

6. RECOMMENDATIONS FOR FUTURE WORKS

The committee recommends that the ITTC completes:

- Review of existing Recommendations and Guidelines
- Preparation of new Recommendations and Guidelines
- Review of numerical and prediction methods
- Establish a joint research project on maneuvering testing methods

These recommendations are briefly discussed in the following sections.

6.1. Review of Existing Recommendations and Guidelines

The Recommendations and Guidelines include:

- *Maneuvering Tests in Ice - 7.5-02-04-02.3*
- *Propulsion Test in Ice - 7.5-02-04-02.2*
- *Ship Trials in Ice - 7.5-04-03-01*
- *Experimental Uncertainty Analysis for Ship Resistance in Ice Tank Testing - 7.5-02-04-02.5*

We recommend continue working on these recommendations and guidelines in next committee period.

6.2. Preparation of New Recommendations and Guidelines

These Recommendations and Guidelines include:

Brash Ice Channel Tests. Currently there is no quality control for brash ice channel testing except the ice coverage, thickness and distribution; however, the resistance in brash ice is also affected by the cohesions of the ice bits, their density, strength and size. The FSICR (Finnish-Swedish Ice Class rules) requires the bending strength of the parental ice sheet, which may however be of minor significance for the brash ice channel tests. The significant parameters should be identified and there practicality as applied in day-to-day tank operations should be investigated.

Beside the resistance in level ice, propeller ice interaction is of significance to powering prediction. The FSICR provides formulations for powering assessment, which may be compared to the results from ice tanks tests. Furthermore, guidelines on measurement (e.g. sampling frequency) and powering extrapolation methods should be described. The guideline may further be discussed in terms of equipment used (constant torque, constant rpm, or constant power, which is an idealization of the actual MCR characteristics).

<u>Dynamic Positioning in Ice.</u> Not all ice model basins are able to perform Dynamic Positioning in Ice. The next committee should either develop new Recommendations and Guidelines for this test type or include dynamic positioning issues into the guidelines *7.5-02-04-02.3 Maneuvering Tests In Ice.*

<u>Scalability.</u> The performance of ice model testing and the ice property testing is based on scaling model test results to full scale. The experimental procedures in both environments may however differ significantly, which may also limit the scalability of model test data. Therefore, procedures for full-scale ice property testing should be reviewed and evaluated against model test data to assess their scalability in connection with the procedures *7.5-02-04-02 Test Methods for Model Ice Properties*. The ultimate goal should be new guidelines on full-scale ice property testing, which refers to and accounts for the procedures in model scale ice.

<u>Offshore Structures.</u> As testing of offshore structures currently cover 30-50% of model ice tests Guidelines should be developed for fixed and floating structures.

<u>Numerical and Prediction Methods.</u> A state-of-the-art review should be performed to assess and evaluate the availability of numerical environments and tools. The simple evaluation may be conducted with aim to answer a few central questions such as:

- Is the method validated?
- Is the method still under development?
- Is the tool based on commercial tools and can it be made available?

Semi-empirical prediction methods should also be reviewed as part of the numerical tools assessment.

In order to keep impartiality ITTC may not give recommendation.

<u>Maneuvering Tests.</u> A joint research project should be considered to investigate the correlation of test results obtained from different modeling facilities and methodologies adopted. Of special interest are turning circle and break-out tests.

Ice model basins, except Aalto University and MOERI, do not usually provide enough width to conduct a full turning circle test. The turning circle has to be extrapolated from a pitch circle. Comparative model tests with a standard model conducted in the wide Aalto or MOERI basins and the other narrower basins can be used to assess the quality of the extrapolation methods that in turn deliver input to the Maneuvering in Ice guidelines.

We know that in nature the channel edge is stronger than the surrounding level ice. This aspect is not considered in breakout tests and the possible impact of this omission to test results should also be assessed.

7. RECOMMENDATIONS TO THE FULL CONFERENCE

The 27th Specialist Committee on Ice recommends to the Full Conference to:

- Adopt the revised procedure *7.5-02-04-02 Test Methods for Model Ice Properties*
- Adopt the revised procedure *7.5-02-04-02.1 Resistance Test in Ice*
- Remove procedure *7.5-02-04-02.4 Tests in Deformed Ice*

8. LIST OF PUBLICATIONS

8.1. Resistance and Propulsion Tests in Ice

Akinturk, A. and Lau, M., 2011. Manoeuvring performance of podded propulsors behind a ship. Ship and Offshore Structures, v.6, No 3, pp. 223-230.

Alekseev, Y.N. and Sazonov, K.E., 1993. Method for ship level ice resistance computation. Proc. 12th Int. Conf. on Port and Ocean Eng., POAC 93, Hamburg, vol.2, pp. 755-762.

Alekseev, Y.N. and Sazonov, K.E., 1994. An investigation into the effects of ice cover parameters upon ship resistance. Proc. of POLARTECH 94, Lulea, Sweden, pp. 49-55.

Cho, S., Jeong, S. and Kang, K., 2013. Experimental study of frictional coefficient between model ice and a model ship. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, Espoo, Finland.

Dobrodeev, A.A. and Sazonov, K.E., 213. Experimental investigation of interaction between of co-axial propellers with ice. Proceedings of Krylov State Research Centre, issue 73(357). pp. 99-104. (in Russian)

Goncharov, V., Klementieva, N. and Sazonov, K., 2013. Interaction of ships under traffic within navigable ice channel. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, Espoo, Finland.

HSVA Report Performance and Analysis of Ship Model Tests in Ice.

Izumiyama, K. and Uto, S., 1995. Ice resistance of three bow forms for the NSR cargo ship. Proc. of INSROP Symposium, Tokyo, Japan.

Jones, S., et al., 1994. Icebreaking performance from model scale tests. Proceedings of the 5th International Conference on Ships and Marine Structures in Cold Regions, ICETECH1994, Calgary, Alberta, Canada.

Karulin, E.B. and Karulina, V.V., 2011. Numerical and physical simulations of moored tanker behavior. Ship and Offshore Structures, 2011, v.6, No 3, pp. 179-184.

Krupina, N., Chernov, A., Likhomanov, V., Maksimova, P. and Savitskaya, A., 2013. The ice tank study of ice performance of large LNGC in the old channel.. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, Espoo, Finland.

Külaots, R., Kujala, P., von Bock und Polach, R. And Montewka, J. , 2013. Modelling of ship resistance in compressive ice channels. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, Espoo, Finland.

Pashin V.M., Appolonov E.M., Belyashov V.A. and Simonov, Yu.A., 2011. Scientific promotion of 60 VW general-purpose nuclear icebreaking designing. Ship and Offshore Structures, v.6, No 3, pp. 185-193.

Peddle, A., Dang, J. and Terwisga, T. V., 202. Towards a model for propeller ice interaction Proceedings of the 31st International Conference on Offshore Mechanics and Arctic Engineering OMAE2012, Rio de Janeiro, Brazil.

Riska et al. 1994. Assessment of ice model testing techniques. Proceedings of the 5th International Conference on Ships and Marine Structures in Cold Regions, ICETECH1994, Calgary, Alberta, Canada.

Sazonov, K.E., 2013. Calculation of the maximum force on ship in ice ridges. Sudostroenie, No. 5, pp.30-32.

Sazonov, K., Appolonov, E., Dobrodeev, A., Klementieva, N., Kudrin, M., Maslich, E., Petinov, V. and Shaposhnikov, V., 2013. Studies to develop technologies for making a wider channel in ice. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, Espoo, Finland.

Spencer, D., 1992. A standard method for the conduct and analysis of ice resistance model tests, Proc 23rd ATTC, New Orleans.

Su, B., Riska, K., Moan, T. and Berg, T.E., 2012. Full-scale and model-scale simulations of a double acting intervention vessel. 21st IAHR International Symposium on Ice, Dalian, China.

Suominen, M. and Kujala, P., 2013. A study of measured line load lengths and maximum ice loads on model ship hull. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, Espoo, Finland.

Suominen, M. and Kujala, P., 2012. Ice model tests in compressive ice. 21st IAHR International Symposium on Ice "Ice Research for a Sustainable Environment", Li and Lu (ed.), Dalian, China.

von Bock und Polach, R., and Ehlers S., 2011. Heave and pitch motions of a ship in model ice: An experimental study on ship resistance and ice breaking pattern. Cold Regions Science and Technology, v. 68, pp. 49-59.

Wilkman, G. and Leiviskä, T., 2013. Forty three years of ice model testing in Finland. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions,

Zhou L, Riska K., von Bock und Polach, R., Moan T. and Su B., 2013. Experiments on level ice loading on an icebreaking tanker with different ice drift angles. Cold Regions Science and Technology, v. 85, pp. 79-93.

8.2. Ice Mechanics and Ice Properties (Model Scale and Full Scale)

von Bock und Polach, R. and Ehlers, S., 2013. Model-scale ice - Part B: Numerical model. Cold Regions Science and Technology, no. 94, pp. 53-60.

von Bock und Polach, R. and Ehlers, S., 2014. Model-scale ice - on the scalability of model-scale ice experiments Proceedings of the ASME 2013 33rd International Conference on Ocean, Offshore and Arctic Engineering OMAE2014, San Francisco.

8.3. Dynamic Positioning in Ice

dal Santo, X., and Jochmann, P., 2012. Model DP system for ice tank research. Proceedings of the 31st International Conference on Offshore Mechanics and Arctic Engineering OMAE2012, Rio de Janeiro, Brazil.

Haase, A. and Jochmann, P., 2013. Free running model technology for dynamic positioning in an ice model basin. Proceedings of the AMT´13 – The 3rd International Conference on Advanced Model Measurement Technologies for the Maritime Industry, Gdansk, Poland

Haase A. and Jochmann P., 2013. DYPIC - Dynamic positioning in ice – second phase of model testing. Proceedings of the ASME 2013 32nd International Conference on Ocean, Offshore and Arctic Engineering OMAE2013, Nantes, France.

Haase A. and Jochmann P., 2013. Different ways of modeling ice drift scenarios in basin tests,.Proceedings of the ASME 2013 32nd International Conference on Ocean, Offshore and Arctic Engineering OMAE2013, Nantes, France.

Haase, A., Jochmann, P., and van der Werff, S., 2012. DYPIC – Dynamic positioning in ice – First phase of model testing. Proceedings of the 31st International Conference on Offshore Mechanics and Arctic Engineering OMAE2012, Rio de Janeiro, Brazil.

Hals, T. and Jenssen, A., 2012. DP ice model test of arctic drillship and polar research vessel. Proceedings of the 31st International Conference on Offshore Mechanics and Arctic Engineering OMAE2012, Rio de Janeiro, Brazil.

Jochmann, P. et al, 2012. DYPIC – A Multinational R&D project on DP technology in ice. MTS Dynamic Positioning Conference, Houston, TX, USA.

Kerkeni, S. et al, 2014. DYPIC project: Technological and scientific progress opening new perspectives. Proceedings of the Arctic Technology Conference, ATC, Houston, Tx. USA.

Kerkeni, S., Metrikin, I. and Dal Santo X., 2013. Dynamic positioning in ice: Comparison of control laws in open water and ice. Proceedings of the 2nd International Conference on Ocean, Offshore and Arctic Engineering, OMAE2013, Nantes, France.

Kerkeni, S., Metrikin, I. and Jochmann, P., 2013. Capability plots of dynamic positioning in ice. Proceedings of the 32nd International Conference on Ocean, Offshore and Arctic Engineering, OMAE2013, Nantes, France.

Metrikin, I., Borzov A., Lubbad, R. and Løset, S., 2012. Numerical simulation of a floater in a broken-ice field: Part II - Comparative study of physics engines, Proceedings of the 31st International Conference on Offshore Mechanics and Arctic Engineering, OMAE2012, Rio de Janeiro, Brazil.

Metrikin, I., Borzov, A., Lubbad, R. and Løset, S., 2012. Numerical simulation of a floater in a broken-ice field – Part II: Comparative study of physics engines. Proceedings of the 31st International Conference on Ocean, Offshore and Arctic Engineering, OMAE2012, Rio de Janeiro, Brazil.

Millan, J. and Wang, J., 2011, Ice force modeling for DP control systems. Proceedings of the Dynamic Positioning Conference, Houston, TX, USA.

Nguyen, D. T., Sørbø, A. H. and Sørensen, A. J., 2009. Modelling and control for dynamic positioned vessels in level ice. Proceedings of the World Congress of the International Federation of Automatic Control (IFAC),. Guaruja, SP, Brazil, pp. 229-236.

Rohlén, Å., 2009. Relationship Between Ice-management and station keeping in ice. Proceedings of the Dynamic Positioning Conference. Houston, TX, USA.

Wilkman, G., Suojanen, R.A., Saarinen, S., Mattsson, T. and Leiviskä, T., 2009. DP in ice conditions - Challenges and opportunities. Proceedings of the Dynamic Positioning Conference. Houston, TX, USA.

8.4. Full Scale Ice Trials

Appolonov, E.M., Belyashov, V.A., Sazonov, K.E., Skryabin, D.S. and Igoshin, E.V., 2011. Investigation of ice performance of “Saint-Petersburg” icebreaker in Kara Sea. Shipbuilding, No 4, pp. 9-12. (in Russian)

Cok, L., Sazonov, K.E., Belyashov, V.A., Shaposhnikov, V.M., Nesterov, A.B. and Putortì, E., 2011. Ice going capability of a small unconventional vessel in the Kashagan field, Proceedings of the 21st International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2011, Montréal, Canada.

Iyerusalimskiy, A., Choi, J., Park, G., Kim, Y. and Yu, H., St. John J., 2011. The interim results of the long term ice loads monitoring on the large arctic tanker, Proceedings of the 21st International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2011, Montréal, Canada.

Kim, H.S., Lee, C.J., Choi, K.S. and Kim, M.C., 2011 . Study on icebreaking performance of the Korea icebreaker ARAON in the arctic sea. International Journal of Naval Architecture and Ocean Engineering.

Kim, H.S., Kim, M.C., Choi, K.S. and Lee, C.J., 2013. Full scale ice sea trials of Korean ice breaking research vessel 'Araon' on the big floes near Antarctica. Journal of Marine Science and Technology.

Krupina, N.A., Likhomanov, V.A. and Chernov, A.V., 2013, Estimation of ice capability of research vessel «Akademik Tryoshnikov» Problems of Arctic and Antarctic, No. 3(97), pp. 57-66. (in Russian)

Lee, C.J., Jeong, S.Y. and Kim, H.S., 2011. The ice field tests of Korean icebreaker research vessel. Proceedings of the 21st International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2011, Montréal, Canada.

Leisti, H., Kaups, K., Lehtiranta, J., Lindfors, M., Suominen, M., Lensu, M., Haapala, J., Riska, K. and Kouts, T., 2011. Observation of ships in compressive ice. Proceedings of the 21st International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2011, Montréal, Canada.

Lubbad, R.,van Raaij, E., Løset, S. and Eik, K., 2013. Oden arctic technology research cruise 2012. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

Nyseth, H., Frederking, R. and Sand, B., 2013,.Evaluation of global ice load impacts based on real time monitoring of ship motions. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

Simões, Ré, A., Veitch, B., Kuczora, A., Barker, A., Sudom, D. and Gifford, P., 2011. Field trials of a lifeboat in ice and open water conditions. Proceedings of the 21st International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2011, Montréal, Canada.

Simões Ré, A.J. and Veitch, B., 2013. Evacuation in ice: ice loads on a lifeboat during field trials. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

Suominen, M., Karhunen, J., Bekker, A., Kujala, P., Elo, M., von Bock und Polach ,R., Enlund, H. and Saarinen, S., 2013. Full-scale measurements on board PRSV S.A. Agulhas II in the Baltic Sea, Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

Wilkman, G., Ranki, E., Leiviskä, T. and Heinonen, T., 2012. On full-scale onboard ship measurements in various ice conditions, a review of existing database at aker arctic technology. Yamauchi, Y., Mizuno, S. and Tsukuda, H., 2011. The icebreaking performance of SHIRASE in the maiden Antarctic voyage. Proceedings of the 21st International Offshore and Polar Engineering Conference, POAC2011, Maui, Hawaii, USA.

8.5. Model Tests of Offshore Structures

Bereznitski, A., 2011. A Novel design of mobile offshore drilling unit for arctic conditions. Proceeding of the ASME 2011 30th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2011, Rotterdam, The Netherlands.

Blagovidova, I.L., Sazonov, K.E., Dobrodeev ,A.A., Klementieva, N.Yu., Kovalyov, M.V., Kolchenko, L.V. and Blagovidov, L.B., 2013. Model testing of turret-based drill ship in ice conditions. Proceeding of the ASME 2013 32nd International Conference on Ocean, Offshore and Arctic Engineering, OMAE 2013, Nantes, France.

Evers, K.U. and Jochmann, P., 2011. Experiences at HSVA with model testing of moored structures in ice covered waters. Proceedings of the 21st International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2011 Montréal, Canada.

Huang, Y., Ma, J. and Tian, Y., 2013. Model tests of four-legged jacket platforms in ice: Part 1. Model tests and results. Cold Regions Science and Technology, v. 95, pp. 74-85.

Huang, Y., Yu, M. and Tian, Y., 2013. Model tests of four-legged jacket platforms in ice: Part 2. Analyses and discussions. Cold Regions Science and Technology, v. 95, pp. 86-101.

Karulin, E., Karulina, M., Toropov, T. and Yemelyanov D., 2012. influence of ice parameters on managed ice interaction with multi-legged structure. 21st IAHR International Symposium on Ice, Dalian, China.

Karulina, M.M., Shkhinek, K.N. and Thomas G.A.N., 2011. Theoretical and experimental investigations of level ice interaction with four-legged structures. Proceedings of the 21st International Conference on Port and Ocean Engineering under Arctic Conditions, Montréal, Canada.

Lu, W., Serré, N., Høyland, K., Evers, K., 2013. Rubble ice transport on arctic offshore structures (RITAS), Part IV: Tactile sensor measurement of the level ice load on inclined plate. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, Espoo, Finland.

Lu, W., Lubbad, R., Høyland, K. and Løset, S., 2014. Physical model and theoretical model study of level ice and wide sloping structure interactions. Cold Regions Science and Technology, v. 101, pp. 40-72.

Nord, T., Määttänen, M. and Øiseth, O., 2013. Frequency domain force identification in ice-structure interaction. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, Espoo, Finland.

Sazonov, K.E., Dobrodeev, A.A., Kaytanov, Yu.S., Magarovskii, V.V., Magitov and V.S., Drozdov, I.V., 2013. Model tests of ice fixed platform's sub-structures. Proceedings OF RAO / CIS Offshore, St.-Petersburg.

Serré, N., Høyland, K., Lundamo, T., Bonnemaire, B., Evers, K. and Gürtner, A., 2013. Rubble ice transport on arctic offshore structures (RITAS), Part I: Scale-model investigations of level ice action mechanisms. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, Espoo, Finland.

Serré, N., Lu, W., Høyland, K., Bonnemaire, B., Borge, J. and Evers, K., 2013. Rubble ice transport on arctic offshore structures (RITAS), Part II: 2d scale-model study of level ice action. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, Espoo, Finland.

Tian, Y., Huang, Y., 2012. Model tests of ice induced vibrations on four-leg jacket platforms. 21st IAHR International Symposium on Ice, Dalian, China.

Yap, K. and Palmer, A., 2013. A model test on ice-induced vibrations: structure response characteristics and scaling of the lock-in phenomenon. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

8.6. Numerical Studies of Ship Resistance in Ice

Daley, C., Alawneh, S., Peters, D. and Colbourne, B., 2014. Simulation of managed sea ice loads on a floating offshore platform using GPGPU-event mechanics", ICETECH 2014

Ionov, B.P. and Gramuzov E.M., 2013. Ship propulsion in ice. Sudostroenie, 504 p. (in Russian)

Jeong, S.Y., Choi, K., Cho, S.R.,Kang, K.J. and Lee, C.J., 2013. A study of the resistance prediction method in level ice. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

Konno, A., Nakane, A. and Kanamori, S., 2013. Validation of numerical estimation of brash ice channel resistance with model tests. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

Konno, A., 2009. Resistance evaluation of ship navigation in brash ice channels with physically based modeling. Proceedings of the 20th International Conference on. Port and Ocean Engineering under Arctic Conditions, **POAC 2009**, Luleå, Sweden.

Lau, M., 2006. Discrete element modeling of ship manoeuvring in ice, 2006, 18th International Symposium on Ice.

Lau, M and Simoes Re, A., 2006. Performance of survival craft in ice environments. Proceedings of the 7th International Conference and Exhibition on Performance of Ships and Structures in Ice, ICETECH2006, Banff, Alberta, Canada.

Lau, M, Lawrence, K.P. and Rothenburg, L., 2011. Discrete element analysis of ice loads on ships and structures. Ships and Offshores Structures, v. 6, No. 3, pp. 211-221.

Lobanov, V.A., 2013. Evaluation of ship ice qualities using CAE-systems, N. Novgorod, 296 p. (in Russian)

Lubbad, R., and Løset, S., 2011. A numerical model for real-time simulation of ship-ice-interaction. Cold Regions Science and Technology, v. 65, pp. 111-127.

Sawamura, J., Kikuzawa, R., Tachibana, T. and Kunigita, M., 2011. Numerical investigation of the ice force distribution around the ship hull in level ice, Proceedings of the 21st International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2011, Montréal, Canada.

Su, B., Riska, K., Moan, T., 2011. Numerical simulation of local ice loads in uniform and randomly varying ice conditions. Cold Regions Science and Technology, v. 65, pp. 145-159.

Su, B., Riska, K., Moan, T., 2011. Numerical Simulation of ships operating in level ice. Proceedings of the 21st International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2011, Montréal, Canada.

Tan, X., Su, S., Riska, K. and Moan, T., 2013. A six-degrees-of-freedom numerical model for level ice-ship-interaction. Cold Regions Science and Technology, v. 92, pp. 1-16.

Valanto, P., 2009. On computed ice load distributions, magnitudes and lengths on ship hulls moving in level ice. Proceedings of the 20th International Conference on. Port and Ocean Engineering under Arctic Conditions, **POAC 2009**, Luleå, Sweden.

Zhou, L., Riska, K., Moan, T. and Su, B., 2013. Numerical modelling of ice loads on an icebreaking tanker: Comparing simulations with model tests. Cold Regions Science and Technology, v. 87, pp. 33-46.

8.7. Numerical Studies of Ice Loads on Structures

Barker, A. and Sayed, M., 2013. Multi-leg structures in ice – Examining global loading uncertainties. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

Bekker, A.T., Uvarova, T.E., Pomnikov, E.E., and Shamsutdinova, G.R., 2012. Numerical simulation of ice abrasion on offshore structures. Proceedings of the 21st International Symposium on Ice, IAHR2012, Dalian, China.

Derradji-Aouat, A. and Lau, M., 2005. Ice load on electric power generating stations to harness ocean energy in the Belle Isle Strait, POAC05.

Fenz, D..M. and Kokkinis, T., 2012. Loads on downward breaking cones from managed ice floes. Proceedings of the 10th International Conference and Exhibition on Performance of Ships and Structures in Ice, **ICETECH 2012**, Banff, Alberta, Canada.

Hendrikse, H.and Metrikine, A., 2013. The influence of friction at the interface on ice induced vibrations. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

Izumiyama, K., Kitagawa, H., Koyama, K. and Uto, S., 1992. A numerical simulation of ice-cone interaction. Proceedings of the 11th International Symposium on Ice, IAHR1992, Banff, Alberta, Canada.

Jussila, V., Popko, W. and Heinonen, J., 2013. Interfacing of ice load simulation tools for cylindrical and conical structure with ONEWIND simulation tool for offshore wind turbines. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

Karulin, E., Karulina, M., Toropov, E. and Yemelyanov, D., 2012. influence of ice parameters on managed ice interaction with multi-legged structure. Proceedings of the 21st International Symposium on Ice, IAHR2012, Dalian, China.

Lengkeek, H. J. and Besseling, F., 2013. Combined translational and rotational sliding of gravity based structures due to ice loads. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

Lau, M, 2001. A three dimensional discrete element simulation of ice sheet impacting a 60-degree conical structure. Proceedings of the 16th International Conference on Port and Ocean Engineering Under Arctic Conditions, **POAC 2001**, Ottawa, Canada.

Lau, M., 1999. Development and verification of a 3-D model for ice forces on conical structures. OMAE1999.

Liu, J., Daley, C., Yu, H.C. and Bond, J., 2012. comparison of analytical and numerical models of glancing ship-ice collisions. Proceedings of the 10th International Conference and Exhibition on Performance of Ships and Structures in Ice, **ICETECH 2012**, Banff, Alberta, Canada.

Lu, W., Løset, S., and Lubbad, R., 2012. Simulating ice-sloping structure interactions with the cohesive element method. OMAE 2012.

Lu, W., Lubbad, R., Løset, S., and Høyland, K., 2012. Cohesive zone method based simulations of ice wedge bending: a comparative study of element erosion, CEM, DEM and XFEM. Proceedings of the 21st International Symposium on Ice, IAHR2012, Dalian, China.

Metrikin, I., Lu, W., Lubbad, R., Løset, S., and Kashafutdinov, M., 2012. Numerical simulation of a floater in a broken-ice field: Part I - Model Description. Proceedings of the 31st International Conference on Offshore Mechanics and Arctic Engineering OMAE2012, Rio de Janeiro, Brazil.

Metrikin, I., Borzov, A., Lubbad, R., and Løset, S., 2012. Numerical simulation of a floater in a broken-ice field: Part II - Comparative study of physics engines. Proceedings of the 31st International Conference on Offshore Mechanics and Arctic Engineering OMAE2012, Rio de Janeiro, Brazil.

Nord, T. S., and Määttänen, M., 2012. Modal analysis in ice-structure interaction: deciphering ice induced vibrations, Part 2. Proceedings of the 21st International Symposium on Ice, IAHR2012, Dalian, China.

Sayed, M., Kubat, I., Wright, B., Iyerusalimskiy, A., Phadke, A.C. and Hall, B.K., 2012. Numerical simulations of ice interaction with a moored structure. Proceedings of the 10th International Conference and Exhibition on Performance of Ships and Structures in Ice, **ICETECH 2012**, Banff, Alberta, Canada.

Shkhinek, K., Zhilenkov, A. and Thomas, G., 2013. Vibration of fixed offshore structures under ice action. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

Tsarau, A., Lubbad, R. and Løset, S., 2013. Numerical studies of floating structures in broken ice. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

8.8. Numerical Studies of Maneuvering and Dynamic Positioning in Ice

Kerkeni, S., Metrikin. I. and Jochmann, P., 2013. Capability plots of dynamic positioning in ice. Proceedings of the ASME 2013 32nd International Conference on Ocean, Offshore and Arctic Engineering OMAE2013, Nantes, France.

Lau, M., 2011. ship manoeuvring in ice modelling software OSIS-IHI. Proceedings of the 21st International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2011, Montréal, Canada.

Liu, J., Lau, M. and Williams, F. M., 2006. Mathematical modelling of ice-hull interaction for ship Manoeuvring in ice simulations. Proceedings of the 7th International Conference and Exhibition on Performance of Ships and Structures in Ice, ICETECH2006, Banff, Alberta, Canada.

Martio, J., 2007. Numerical simulation of vessel's manoeuvring, performance in uniform ice. Helsinki University of Technology, Ship Laboratory.

Metrikin, I., Kerkeni, S., Jochmann, P. and Løset, S., 2013. Experimental and numerical investigation of dynamic positioning in level ice. Proceedings of the ASME 2013 32nd International Conference on Ocean, Offshore and Arctic Engineering OMAE2013, Nantes, France.

Metrikin, I. and Løset, S., 2013. Non-smooth 3D discrete element simulation of a drillship in discontinuous. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

Metrikin, I., Loset, S. and Jenssen, N. A., 2012. Numerical simulation of dynamic positioning in ice. DP Conference, Houston, TX.

Metrikin, I., Lu, W., Lubbad, R., Løset, S. and Kashafutdinov, M., 2012. Numerical simulation of a floater in a broken-ice field: Part I — Model description. Proceedings of the 31st International Conference on Offshore Mechanics and Arctic Engineering OMAE2012, Rio de Janeiro, Brazil.

Metrikin, I., Borzov, A. , Lubbad, R. and Løset, S., 2012. Numerical simulation of a floater in a broken-ice field: Part II — Comparative study of physics engines. Proceedings of the 31st International Conference on Offshore Mechanics and Arctic Engineering OMAE2012, Rio de Janeiro, Brazil.

Millan, J. and Wang, J., 2011. Ice force modeling for DP control systems. DP conference, Houston, TX.

Sawamura, J., Tsuchiya, H., Tachibana, T. and Osawa, N., 2010. Numerical Modelling for Ship Manoeuvring in Level Ice. IAHR2010.

Su, B., Kjerstad, Ø., Skjetne, R., Berg, T., 2013. Ice-going capability assessment and DP-ice capability plot for a double acting intervention vessel in level ice. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

Tsarau, A., Lubbad, R. and Løset, S., 2013. Numerical studies of floating structures in broken ice. Proceedings of the 22nd International Conference on Port and Ocean Engineering under Arctic Conditions, POAC2013, Espoo, Finland.

Zhan, D. and Molyneux, D., 2012. 3-dimensional numerical simulations of ship motion in pack ice. Proceedings of the 31st International Conference on Offshore Mechanics and Arctic Engineering OMAE2012, Rio de Janeiro, Brazil.

Zhou, Q. and Peng, H., 2013. A numerical simulation for operating a dynamic positioned vessel in level ice. Proceedings of the 23rd Annual ISOPE 2013 Conference, Anchorage, Alaska, USA, ISOPE2013.