The Specialist Committee on ICE

Committee Chairman: Dr. Jens-Holger Hellmann
Session Chairman: Dr. Harri Soininen

1. Overview

1.1 Agenda

As an opening the session chairman Dr. Harri Soininen, VTT, Finland, gave a brief overview of the past role of Ice Committees and their achievements at ITTC. The detailed was introduced at 1.2 Background.

Two present Committee members during the 25th ITTC introduced short reports of the performed work. Dr. Michael Lau, Institute for Ocean technology, Canada, presented IOT R&D Activities in Supporting the 25th ITTC ICE Committee Work and Mr. Roderick Sampson, Emerson Cavitation Tunnel, University of Newcastle, UK, presented Effect of Cavitation during propeller ice interaction.

For discussion two topics were selected for Impact of increasing Arctic and Antarctic marine operations on the ITTC as an implication of global warming. Dr. F. Mary Wlliams, NRC-Institute for Ocean Technology, Canada, gave opening contribution, presenting Model Testing in Ice : View Forward. Another topic in the light of the discussion was the future role of Ice Committee (The Committee to act as an unofficial discussion forum during 26th ITTC).

1.2 Background

Reviewing the ICE Committees and ice related work at ITTC from the early years, the session chairman Dr. Harri Soininen, VTT, Finland, pointed out the following matters about the Committee memberships as follows:

- The ice community has always been quite small.
- At its maximum 13 institutes responded to some questionnaire regarding methods applied in offshore structure testing.
- The Committee membership has often been a kind of a hobby of some interested individuals.
- In the 70´ies and 80´ies some strong individuals within the field dominated the work.
- The 23 rd ITTC saw a collapse in the committee membership, just four persons, five persons at 24th and 25th

He also introduced the past ICE Committee's history.

- The first time the heading ice emerges on the ITTC proceeding is Ottawa 1975, 14th ITTC – a group discussion.
- "Testing in Ice" and a "Panel of Testing in Ice" was established for the 15th ITTC and it gave its first report at the Hague 1978.
- Ice work within ITTC has always been the matter of just few interested parties – the community is small.

At the 15th ITTC Hague in 1978, areas of consideration were laboratory test, full-scale test and model-full scale correlation. For example the laboratory test covered a range of model material, modelling environment, testing procedures and analysis.

Areas of consideration (15th ITTC, the Hague 1978)

Laboratory tests
- Model material
  - similarity
  - preparation
  - properties
- Modeling environment
  - level ice
  - ridged ice
  - ice under pressure
  - broken channel ice
  - floe conditions

Areas of consideration (15th ITTC, the Hague 1978)

Laboratory tests
- Testing procedures
  - Towing
  - Self-propelled
  - Manoeuvring
- Analysis
  - Presentation
  - Format
    - » recommended standardized resistance equation
    - » units and symbols
  - Method and non-dimensional parameters

Areas of consideration (15th ITTC the Hague 1978)

Full scale tests
- Ice
  - Properties
  - Conditions
- Testing procedure
  - Continuous mode
  - Non-continuous mode
  - Manoeuvring

Areas of consideration (15th ITTC the Hague 1978)

Full scale tests
- Ship performance measurements
  - Trial
  - Voyage
- Analysis
  - Presentation
  - Format
    - » Recommended standardized resistance equation
    - » Units and symbols

Model-full scale correlation

Work after the Hague listed below also covered the following areas of consideration.

16th ITTC, Leningrad
- Friction
- Model ice properties, elasticity/strength
- LNG-carrier at four basins (30% difference in speed predictions)
- Preparations for comparative tests with a R-class icebreaker model
- Word offshore emerging
- List of symbols
- Theoretical work

17th ITTC, Gothenburg
- R-class comparative tests results –Power vs. speed 20-30% differencies
- Friction
- Ridges
- Propulsion tests

18th ITTC, Kobe
- More tests of R-class icebreaker
- Friction
- Offshore

19th ITTC, Madrid
- Friction
- Model ice properties
- Propulsion tests in ice
- Offshore structures, comparative tests with a cylindrical structure initiated
- R-class model some re-analysis

20th ITTC, San Francisco
- Analysis of cylinder tests
- Recommended methods for ice properties tests for level ice
- Ice load calculation methods
- Model propulsion tests in ice

21st ITTC, Trondheim
- Recommended procedures for tests in ice
- Parameters to be measured in various test types
- Recommendations for ship trials in ice

・Comparative cylinder tests, some reanalysis
・Propeller/ice interaction tests

22nd ITTC Seoul& Shanghai
・Model ice properties measurements
・Questionnaires: deformed ice tests, offshore structure tests

23rd ITTC, Venice
・3 procedures reviewed: ice model tests in general, resistance testing in level ice, model ice measurements,
・Uncertainty analysis in ice model testing
・A short discussion on iceberg impact tests

24th ITTC, Edinburgh
・Uncertainty analysis in ice model testing
・Numerical methods, questionnaire
・Remote sensing of sea ice

Work still to be performed

・Scale effect is not quite understood - the model tests are performed with a friction factor 0.05 between the hull and ice, in full scale the factor is 0.10-0.15

・The tests in broken ice are not standardised (speed in broken ice is an important information in practice) –modelling of broken ice mass in fairways is not well covered.

・Modelling ridge mass and accordingly tests in ridges are not very well covered
・The dynamics of level ice breaking in thin ice should be better understood –the achievable speed in thin ice is in practice an important information
・More understanding of effects of model ice properties to the ice failure modes against offshore structures

Conclusion

・**The greatest achievements:**
- R-class comparative test
- Cylindrical offshore structure comparative tests
- The three procedures (especially methods for measuring model ice properties)

・**A lot to do still:**
- Friction
- Propulsion tests
- Tests in deformed ice

・Navigation in ice infested waters and offshore activities in polar regions are a growing trend (global warming may accelerate this development) - for the ice community to be scientifically credible work should be done within ITTC

2. Extended Abstracts of Presentations

2.1 By Dr. Michael Lau, Institute for Ocean technology, Canada, on IOT R&D Activities in Supporting the 25th ITTC Ice Committee Work

Outline

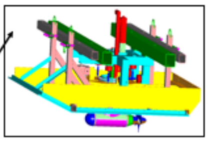
- ITTC ice committee mandate
- Overview of IOT's R&D activities in supporting the committee mandate

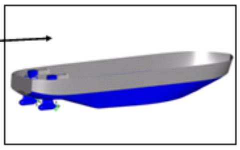
Recommendation from 24th ITTC

- (1) Develop a procedure for testing of podded propellers in ice
- (2) Develop a procedure for ship tank testing in brash ice.
- (3) Review existing testing procedures used to determine loads and responses of offshore structures in ice

IOT's R&D Activities Related to Committee's Mandate No. 1

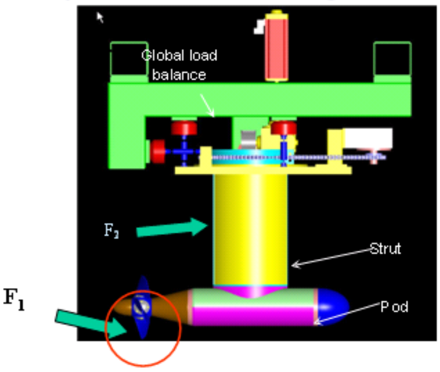
- Develop a procedure for testing podded propellers in ice tank
  - Phase 1: (a) development of pod model and measure of ice impact and milling load on podded propellers–Akinturk and Wang (2004-2007)
  - Phase 2: Simulating vessels driven by podded propulsors – Lau and Akinturk (2008)



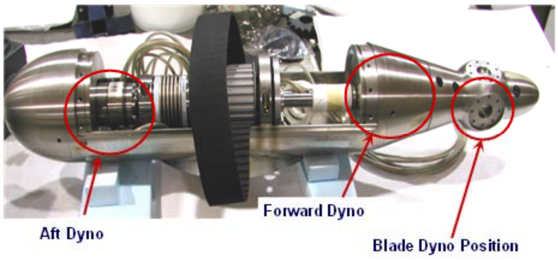


Phase 1: Ice Loads on Pods

Partially assembled model showing the measuring system

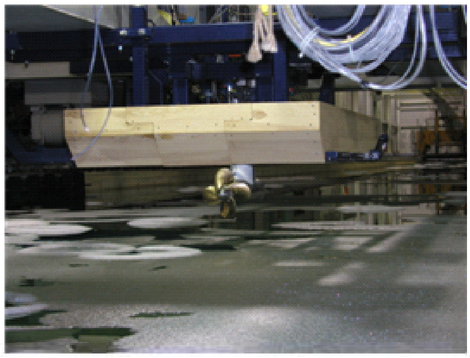


Pod Assembly

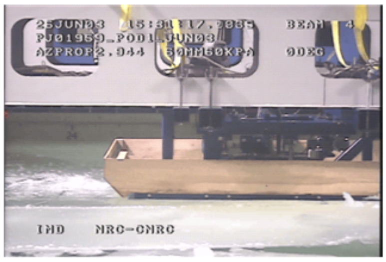


Ice-Pod Interaction Experiment

Fully assembled model



Example Run – ice impact load (pre-broken ice)

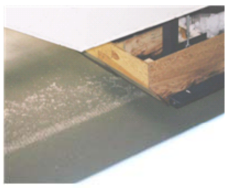


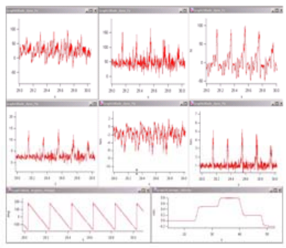
1 & 2 View from side showing false stern

3 View from below showing propeller breaking ice

4 Propeller hits the ice

Ice Milling Load Experiment



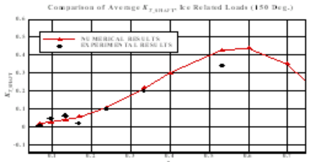


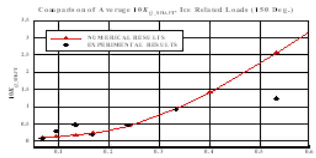
Sample time series data

Numerical Results

- Numerical prediction for the propeller ice milling load was performed (Wang et al, 2006)
- Ice related loads were calculated with the azimuthing angle between 180 and 90 for the tractor mode
- The numerical predictions have a good agreement with experimental results at low advance coefficients (less than 0.4)

Comparisons (Shaft, Ice Related Loads, 150 Deg.)





Phase 2: Ice loads on Podded Propeller During Ship Maneuvering - Overview

- This study investigates the performance of ship model with podded propulsors (APP) in various (realistic) operating conditions: open water and different level ice and pack ice conditions, straight run and various manoeuvres using PMM
- The model used in this phase was the icebreaker Mackinaw equipped with twin podded propulsors
- Measurement include steering moment generated by the propulsors, thrust and torque of the propellers, and the force and moments on the hull body
- Preliminary results on the APP were presented by Akinturk and Lau (2008).

Experimental Set-Up

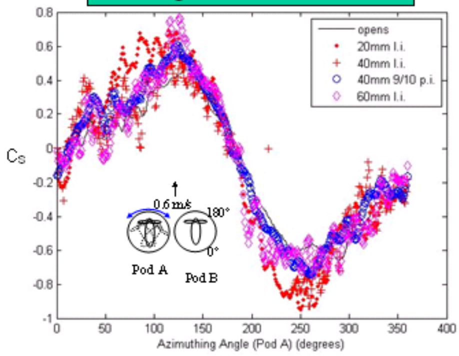
USCG Mackinaw Model

Planar Motion Mechanism

Example Run

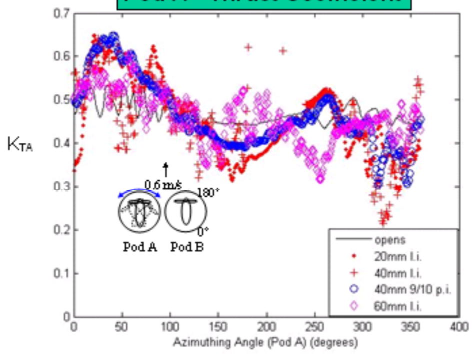
Results

Steering Moment Coefficient



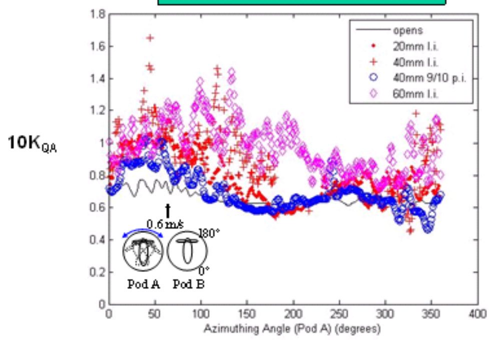
Results

Pod A - Thrust Coefficient



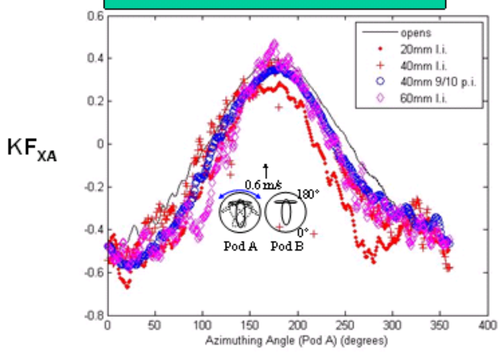
Results

Pod A - Torque Coefficient



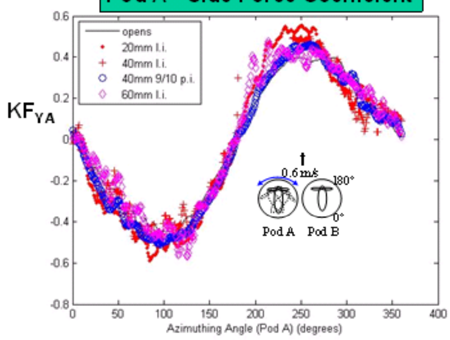
Results

Pod A - Unit Thrust Coefficient



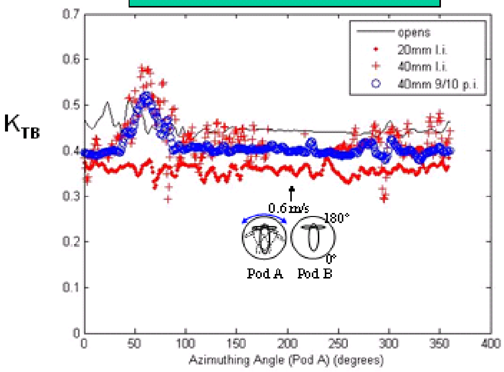
Results

Pod A - Side Force Coefficient



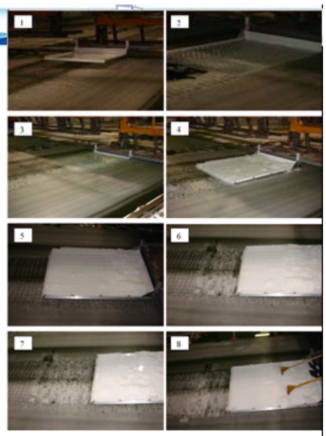
Results

Pod B - Thrust Coefficient



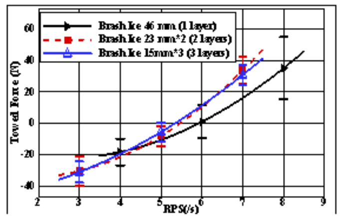
Brash Ice Test – Brash Ice Production

- For the present model tests, the influence of ice piece thickness or number of layers that makes up the brash ice channel was considered.
- Three parent ice sheets with thickness of 46mm, 23mm and 15mm, were used to make brash ice of one, two and three layers, respectively.



Brash Ice Test – Typical Test

- The data shows a good agreement of the towed force between the two- and three- layers constructions (self-propulsion point of 5.4 and 5.3 rps)
- For one layer brash ice, the self-propulsion point was at 5.9 rps possibly due to increased resistance.
- Structure of the brash ice layer is important



Propulsion test - towed forces as a function of propeller speed for one, two and three layers brash ice with the nominal thickness of 46mm

Ice loads on Podded Propeller – Further Work

- Complete data analysis with different hull velocity and maneuvers, including the loading on the hull
- Conduct additional tests with a second icebreaker (MOERI`s new icebreaker Arion) – also measure pressure distribution on hull
- Develop tools for performance prediction and simulator application
- Develop in-house standards and procedures governing ship testing (propulsion and maneuvering) with APP

Brash Ice Test – Summary

- We just start modeling brash ice in our tank
- Challenge is still existed in control and characterize the brash ice
- The procedure developed looks reasonable
- Benchmark test methodology and standard development are yet to be done
- The data suggested the importance of using multi-layers to properly model the ship resistance/propulsion in brash ice.

IOT's R&D Activities Related to Committee's Mandate No. 2 - Brash Ice Test

- Develop a procedure for ship tank testing in brash ice
  - Most test were performed by Arctic and HSVA to provide commercial testing of Baltic ice-going ships
  - First test in IOT
- Collaboration with MOERI to co-develop testing procedure and techniques to test ships in brash ice
- It involved ice tests of the CCGS Terry-Fox transiting in a brash ice channel conducted and analyzed as per IOT's standard for model propulsion in ice.
- The Finnish-Swedish Ice Class Rules (FSICR) class 1A was targeted
- New brash ice production techniques were introduced and the results of ship resistance and propulsion performance were summarized in Lee and Lau et al (2008).

General Summary

- IOT has performed R&D work to develop procedure to test APP and ships in brash ice in an ice tank facility
- Demand for performance evaluation of ships with APP and/or in brash ice increases greatly
- A few other facilities has procedure to perform tests with APP and brash ice; ITTC standards and guidelines are yet to be developed
- Recommendation to follow up work in these areas

2.2 By Mr. Roderick Sampson, Emerson Cavitation Tunnel, University of Newcastle, UK, on Effect of Cavitation during propeller ice interaction

Effect of cavitation during propeller ice interaction

Rod Sampson
Emerson Cavitation Tunnel, University of Newcastle, UK

Newcastle University

ITTC Specialist Committee on Ice

Podded Propulsor Performance in Ice

Papers published 2005 - 2008

Sampson, R., Atlar, M. & Sasaki, N. (2006a). Ice blockage tests with a dat tanker podded propulsor. In Technical advances in podded propulsion T-Pod 2006 , 18, Brest, France.

Sampson, R., Atlar, M. & Sasaki, N. (2006b). Propulsor ice interaction - does cavitation matter? In Sixth international symposium on cavitation (Cav2006), Wageningen, The Netherlands.

Sampson, R., Atlar, M. & Sasaki, N. (2007a). Effect of cavitation during systematic ice block tests. In Port and Ocean Engineering under Arctic Conditions (POAC)

Sampson, R., Atlar, M. & Sasaki, N. (2007b). Ice blockage tests with a podded propulsor - effect of recess. In 27th Offshore Mechanics and Arctic Engineering (OMAE)

Icebreaker Designs

Yermark 1903

Tempera 2003

Then and now - the bow propeller
1933 - 2008

Development of the bow propeller

- Podded vessels perform well when reversing into ice
- Vessel remains controlable due to pod azimuth
- Development of Mastera and Tempera (2003-4)
- USCG Makinaw (2005)
- Trend for Tankers and LNG carriers is set to rise
- Deliveries from Samsung 2007-9

The 'double acting' tanker concept

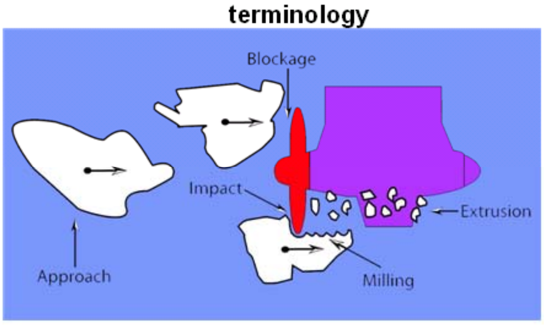
DAS vessels

- Clear benefit to DAS design
- Propulsion system exposed to less risk
- Icebreaking speed increased
- Propeller rotating continuously
- Wake is extreme posing a high risk of cavitation

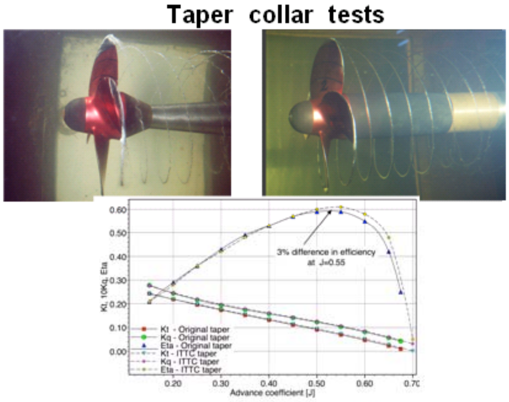
Research rationale

- Omission in the state-of the art
- Blockage test adopted as a quasi-static analysis
- Great insight into the process obtained
- Milling tests performed
- Tests of interest to ITTC specialist committee on ice and ITTC specialist committee on azimuthing podded propulsion

Propeller ice interaction terminology

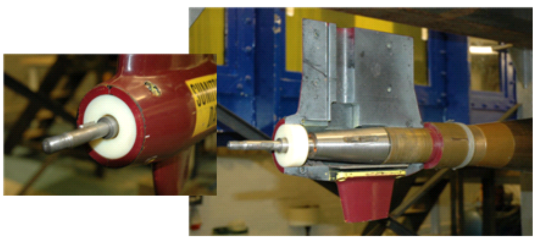


Taper collar tests

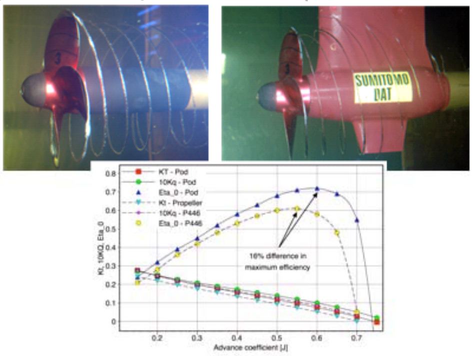


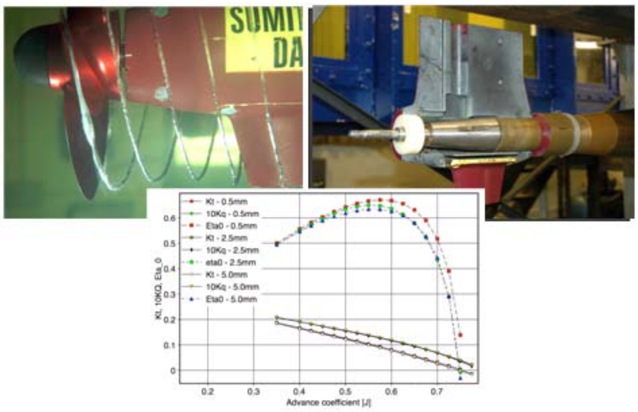
Pod mounting on the K&R H33 Dynamometer

- **Pod introduced to modify the propeller wake**
- **Unconventionally mounted on dynamometer**
- **Blanking disk to limit circulation inside pod body**

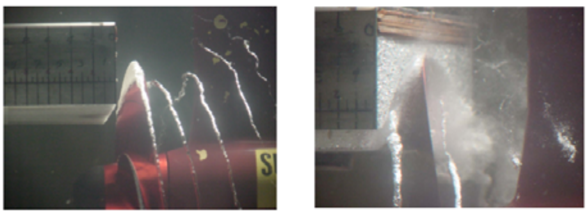


Open water' performance (shaft loads only)





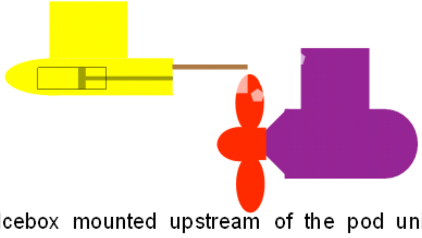
Types of propeller loading



Blockage - static
(due to obstructed flow)

Milling - dynamic
(blade contacts the ice)

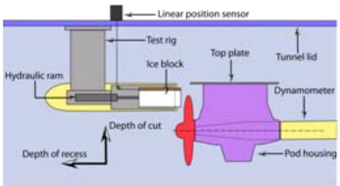
Experimental test rig principles

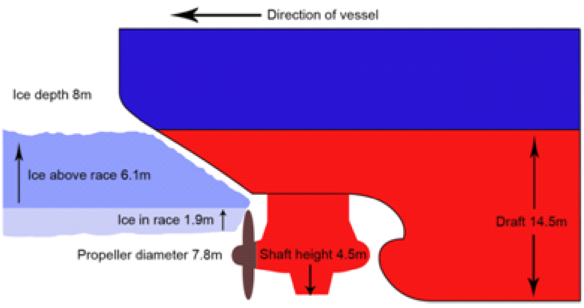


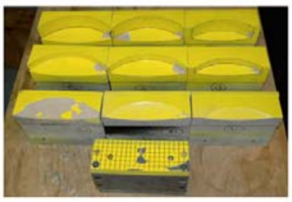
- Icebox mounted upstream of the pod unit
- Hydraulic ram forces blockage toward propeller
- Ice block modifies the inflow to the propeller
- Ice block impacts the propeller and is milled

Experimental test rig

- Icebox mounted on the measuring section lid
- Pod body mounted around the dynamometer
- Blockage tests performed at fixed distances
- Milling tests used hydraulic feed



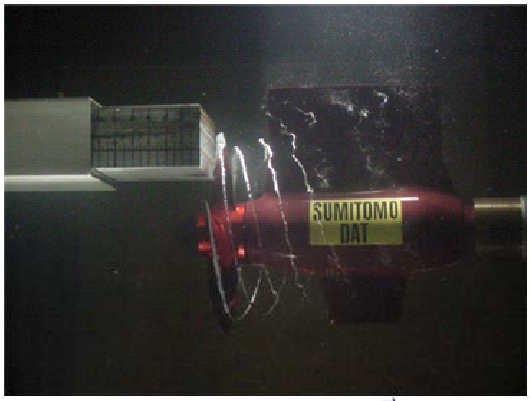




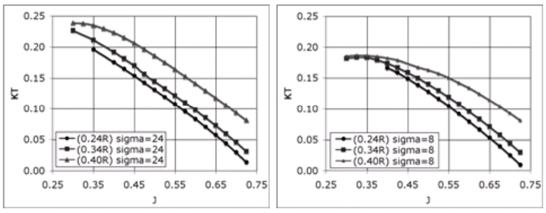
Blockage test - parameters

Depth of cut (mm)	50, 43, 20
Gap (mm)	3
Tunnel speed (m/s)	3, (1.94)
Vacuum (mm/Hg)	atmospheric, 150, 300, 450
Cavitation numbers	24, 17, 12, 8

Blockage test

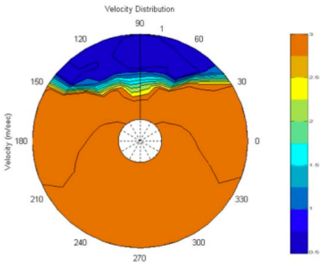


Changes in depth of cut (KT sigma = 24 & 8)



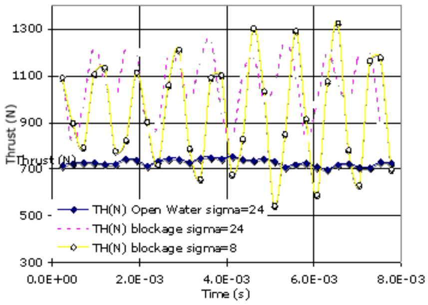
Sigma = 24, 12, 8 for DOC = 40% J = 0.3

Wake of the blockage



- Extreme blockage wake
- 3m/s free stream
- 0.5m/s behind blockage
- Measured axial flow only

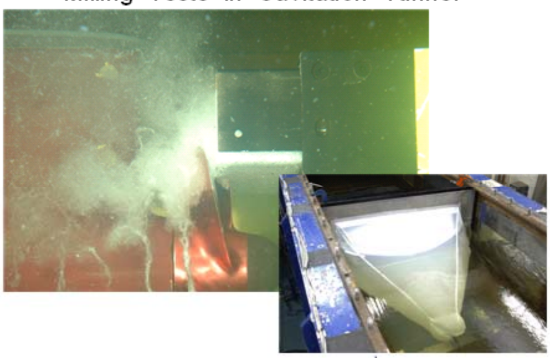
Pod / Propeller open water comparison



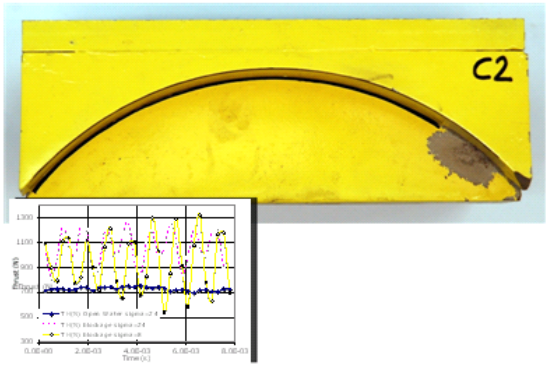
Milling Tests in Cavitation Tunnel

- Milling tests built on blockage results
- Styrofoam type material used
- 170Kpa strength equivalent to first year ice
- Tests covered design J conditions
- Tests expanded to study near bollard pull

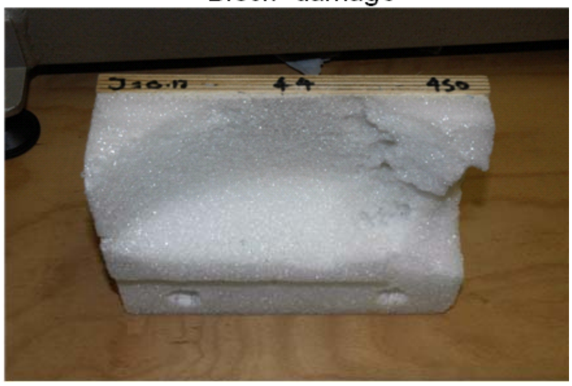
Milling Tests in Cavitation Tunnel



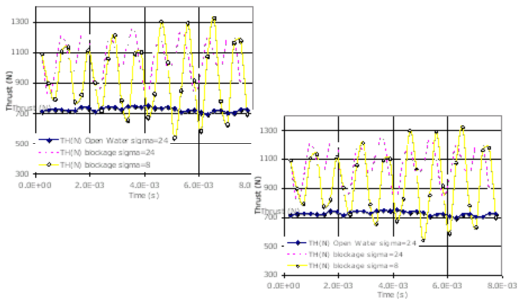
Block damage



Block damage



Propeller damage due to cavitation



Summary

The blade loads show dramatic oscillations about the mean load during blockage; this was attributed to the highly unsteady wake due to the blockage. The amplitude of the oscillations increases dramatically with reducing cavitation number

The long term implications of these loadings on podded drives is unknown. All in service vessels have performed well, however with such a short window of service further study is required.

Trials of *Norilsky Nikel* published by Wilkman (2007), the vessel (with a 9m draught) was reported to operate in continuous level ice of 0.5-1.5m.

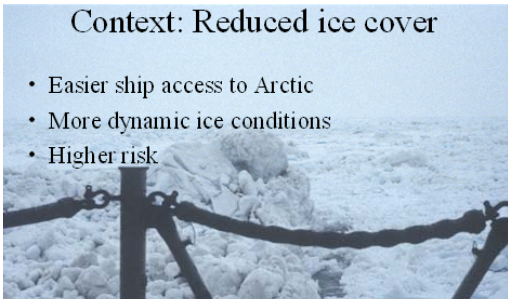
On ice trials conducted between Murmansk to Yenisey River in March 2006, Wilkman reported trials in ridges with ice thickness of 5-10m. The vessel was able to penetrate these fields at a speed of 1 knot at 13MW, (full power) for 5 Nautical Miles, or 5 hours transit in restricted/blocked flow conditions.

It is clear therefore that blocked and restricted flow conditions capable of reaching the propeller do exist and are not always transient.

2.3 By Dr. F. Mary Williams, NRC-Institute for Ocean Technology, Canada, on Model Testing in Ice's view Forward

Model Testing in Ice:
View Forward

F. Mary Williams
NRC - Institute for Ocean Technology
Canada



Context: Energy Market

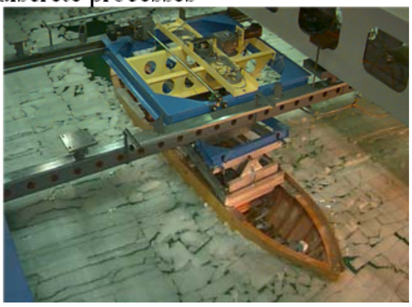
- High price of oil promotes investment & exploration
- High cost of fuel promotes efficient operations

Physical Modeling in Ice

Continuous & discrete processes

Multiple modeling constraints

NOT A TOW TANK WITH ICE



Mature Technologies

- Ship resistance in level ice
- Ship propulsion in level ice
  - Power prediction – different methods
  - Loads on propellers – different definitions
- Mean global load on structure
- Model ice production
  - No common standard

Modeling Challenges - 1

- Failure modes
  - Ride up or pile up?
  - Floe splitting or rubbling?
  - Piece size
- Ice pressure distribution
  - Structure integrity – local ice pressures
  - Turning moments – pressure along ice line

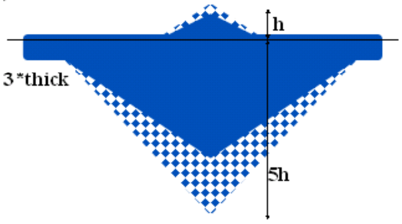
Modeling Challenges - 2

- Load dynamics
  - IIV – ice equivalent of VIV
  - Slender structures (jack-ups)
  - Wide structures (Molipak)
  - Moored structures
- Podded propulsion in ice

Modeling Challenges - 3

Continuous/discontinuous ice

- Pack ice => concentration 6/10 to 10/10
- Rubble (brash) => concentration 10/10 to 30/10
- Ridges => h > 3*thick



Opportunities

- Predictive capability @ low risk
- First test for math models
  - FEM
  - DEM
- Unique capacity to deal with multi-phase
- Attractive to client => dynamic & visual

Summary

- Opportunities for ice tanks
- Role for ITTC
  - Collaboration on technology development
  - Common standards

3. DISCUSSIONS

3.1 Discussion to the 25th ITTC ICE Committee by Ahmed Derradji, NRC-IOT, Canada

How the material properties of foam effect the quality of the test results, namely trust and torque?

As you did, Ice is not a foam. It behaves differently and it fractures differently, and scaling only the strength of ice may not be a good representation for the actual behavior of ice.

Note: Really good work and I appreciate it.

3.2 Discussion to the 25th ITTC ICE Committee by Carl Trygve Stansberg, MARINTEK, Trondheim, Norway

With the knowledge that the Ice Committee will disappear for the coming ITTC, I am glad to know that its field is brought further through a working group. Based upon the expected increased activities in the Arctic and Antarctic areas, it should also be considered whether a further ITTC activity on this should include a broader range of activities than just ice tank modeling. This could include several topics, such as e.g. more knowledge about the complete metocean conditions including combinations of both ice, (including also icebergs and bergy bits dynamics), waves, current, wind and temperature.

3.3 Discussion to the 25th ITTC ICE Committee by Dr. Manfred Mehmel, Schiffbau Versuchsanstalt Potsdam GmbH

Thanks for the fine presentation. I am interested in the papers of Dr. Sampson and Dr. Lau.

The first question to Dr. Sampson : How influence the foam particles the water characteristics and following the cavitation behavior?

The second question to Dr. Lau : How big are the forces on the pod housing under azimuthing condition if the ice hits the housing?

3.4 Discussion to the 25th ITTC ICE Committee by Martin Renilson, Australian Maritime College, Australia

Thank you very much for some very interesting presentations. In presentation, as a non-specialist in the field I found Dr. Williams' presentation very interesting. It certainly demonstrated the need for more work in this field.

The question I have to ask is: "Does the ICE community believe that there is a need for more ICE tank?"

3.5 Discussion to the 25th ITTC ICE Committee by M. Atlar, Newcastle University, UK

Due to circumstances, unfortunately, this committee has not been able to conduct their tasks.

However, we have a situation now there will not be any Ice committee for the next three years while there are increased activities on the arctic front and ice tanks are really busy.

I think, as ITTC, we should ask and take the responsibility whether it is a sensible thing to have a 3 year break for this important area of work or not! I hope that the AC will take more responsible role in improving this situation and make this committee to be an effective one.

4. COMMITTEE REPLIES

4.1 Reply of the 25th ITTC ICE Committee to Ahmed Derradji

The failure of ice in full scale is governed by many unique parameters including ice mechanics, temperature and ice strength properties. EG/AD/S ice, popular in ice basins today does model this with a reasonable level of accuracy but it is far from ideal. The Styrofoam tests at Newcastle University were different to EG/AD/S in Canada, which requires great care and attention to manufacture and manipulate ice sheets before each test. The compressive strength of EG/AD/S ice changes hour to hour and test to test as described by **Searle(1999)**. The composition, ice thickness and micro-bubble level used to control its properties, often changes between tests, the Styrofoam equivalent on the other hand has constant homogeneous properties that were the same run after run whatever the temperature.

Therefore, it was not the intention of the UNEW tests to model ice failure, resistance, and self-propulsion. Instead the hydrodynamic aspects of a podded propulsor were studied in isolation and in particular – the effect of cavitation. The UNEW tests were systematic and repeatable. The Styrofoam provided a constant quantity, which against a rigorous test matrix ensured that any variability in the measured loading was due to inseparable hydrodynamic loads such as cavitation, allowing a unique aspect of propeller ice interaction to be studied.

Within this context, we are therefore exploring the hydrodynamic effect rather than the mechanical ones. So whether it is foam or ice what effect it would make on the hydrodynamic interference would not be so critical in understanding the phenomenon.

Searle, S., Veitch, B. & Bose, N. (1999). "Model ice class propeller performance in ice of varied strength". Port and Ocean Engineering under Arctic Conditions (POAC99

4.2 Reply of the 25th ITTC ICE Committee to Carl Trygve Stansberg

It is indeed considered that a working group will be needed to elaborate the terms of reference for a further Ice Committee. In this respect your remark is valuable for the new working group to consider – especially having in mind the global warming and its potential effect in ice and weather conditions at polar seas.

Session chairman

4.3 Reply of the 25th ITTC ICE Committee to Dr. Manfred Mehmel

Reply to the question to Dr. Sampson

The Newcastle University (UNEW) ice tests used crushable Styrofoam to simulate sea ice. The foam behaved sufficiently well in failure to justify its use in the tests and it has been a big success. The spawl generated from the milled ice was collected after each run by filtering the tunnel water. Depending on the advance coefficient and ice feed rate, the size of the particles varied. This failure is comparable to that seen in full scale during ice milling, and also observed in the ice tank reported by **Koskinen (1996)**. It is therefore a fundamental part of the ice interaction process.

Pushtoshny (2001) found that the most significant cavitation developed on podded propulsors in full scale was tip vortex cavitation. Similar cavitation patterns were observed on the podded propulsor in the Newcastle University (UNEW) tests at open water conditions. However based on the UNEW work it is clear that tip vortex cavitation is not the most dominant form of cavitation experienced during propeller ice interaction at correct cavitation numbers. Sheet, cloud and mist cavitation were commonly observed during the interaction, often at atmospheric conditions.

According to **Gindroz (1995)**, blade surface cavitation which is common in propeller ice experiments is less susceptible to nuclei distributions than tip vortex or bubble cavitation. As UNEW does not have the ability to measure nuclei distribution; this oversight is not important for the current research. In addition the tunnel water contains Sodium Nitrite as a rust inhibitor.

Strasberg (1955) showed that use of this chemical changes the viscosity of the water and hence the inception point. For the ice milling research the inception point was irrelevant, the nuclei distributions were therefore disregarded. In essence, during the UNEW tests different types of well-developed cavitation patterns were so dominant and so severe and therefore it is hard to justify any discernable effect of the small particles in the water on the cavitation behaviour observed. What was important was that the cavitation eroded and damaged the model propeller after only 4 hours of operation.

Gindroz, B. (1995). "Practical advantages of mastering cavitation nuclei". Magazine du Bassin D'Essais des Carenes , 4, 16–20. 44

Koskinen, P., Jussila, M. & Soininen, H. (1996). "Propeller ice load models". Research Notes VTT Research notes 1739, Technical Research Centre of Finland.

Reply to the question to Dr. Lau.

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4.4 Reply of the 25th ITTC ICE Committee to Martin Renilson

From the perspective of the IOT ice tank, there certainly is increasing demand from clients in the energy sector for the type of experiments that can only be performed in an ice tank.

From the perspective of a technology developer: The requirement to reduce risk creates an opportunity for prediction models – both numerical and physical. Validation of numerical models with full scale measurements in an ice environment is challenging. The tank provides an intermediate step.

4.5 Reply of the 25th ITTC ICE Committee to M. Atlar

It is unfortunate indeed that we are in a situation where we do not have an Ice Committee for the next three years. The scientific credibility of the ice model testing community suffers from this.

However, AC recommends strongly that an ice working group will be formed and prepare achievable terms of reference for the AC to consider for an Ice Committee for 26th ITTC. (IOT is willing to host the first meeting of that working group).