

IN THIS ISSUE:

- Design of Twin-Screw Appendages
- Sea Loads
- Ice Model Tests with an Arctic Tandem Offloading Terminal (ATOT)
- Post-Swirl Stator Reveals Efficiency Gain in HYKAT- Growing with Increasing Reynolds Number
- HSVA Seminar for Ship Owners and Operators
- VIRTUE News: The Numerical Tank delivers first results

Dear Reader,

It seems as if the extremely good maritime business continues to be full steam ahead.

Fortunately, we are approached by many clients and there is a continuous request concerning our services. This means that we need to be very flexible in order to accommodate the expectations of our customers. We are willing to do so and have employed more staff, but nevertheless the waiting times for tests have still increased.

More and more the dramatic increase in fuel cost calls for new ways to find optimum solutions. The key to survival is designing, building and operating ships more efficiently. An efficient ship is profitable and environmentally compatible.

The articles in this newsletter reflect some of our activities with respect to on-going projects as well as new and future developments. I hope you will find it interesting.

Technical innovations enter the market frequently and I would like to invite you to participate in our seminar for Ship Owners and Operators in November this year, where we will focus on the optimum hydrodynamic design of your product. We will show you how to navigate safely through the complicated network of hydrodynamic dependencies. The team of HSVA welcomes you to that seminar where we are prepared to answer the questions you may have. We are looking forward to fruitful discussions on all hydrodynamic orientated subjects.

Juergen Friesch
Managing Director

0.43
0.44
0.45
0.46
0.47
0.48
0.49
0.50
0.51
0.52
0.53
0.54
0.55
0.56
0.57
0.58
0.59
0.60
0.61
0.62
0.63
0.64
0.65
0.66
0.67
0.68
0.69
0.70
0.71
0.72
0.73
0.74
0.75
0.76
0.77
0.78
0.79
0.80
0.81
0.82
0.83
0.84
0.85
0.86
0.87
0.88
0.89
0.90
0.91
0.92
0.93
0.94
0.95
0.96
0.97
0.98
0.99
1.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19
-0.20
-0.21
-0.22
-0.23
-0.24
-0.25
-0.26
-0.27
-0.28
-0.29
-0.30
-0.31
-0.32
-0.33
-0.34
-0.35
-0.36
-0.37
-0.38
-0.39
-0.40
-0.41
-0.42

Post - Swirl Stator Reveals Efficiency Gain in HYKAT – Growing with Increasing Reynolds Numbers!

by Christian Johannsen
and Herbert Bretschneider

On behalf of Samsung Heavy Industries, Korea, the HSVA has carried out extensive model tests in HYKAT, HSVA's large Hydrodynamics and Cavitation Tunnel, to study the Reynolds number dependency of the propulsive gain that can be achieved by a post-swirl stator on a large container vessel.

In times of a progressively increasing oil price energy saving devices like pre- or post-swirl stators, rudder bulbs, boss cap fins, etc. become more and more attractive. Before such a device, however, delivers any additional thrust to save fuel, it has to overcome its own resistance first. Consequently, the determination of the achievable gain by model tests suffers from the exaggerated frictional resistance along those devices due to the low Reynolds number at model scale.

Even at high tunnel water speeds in HYKAT it is of course not possible to reach full scale Reynolds numbers. But the absence of a free water surface in this facility allows to vary the Reynolds number for one and the same propeller operating condition and this way to observe tendencies towards the full scale situation. The test procedure is simply based on the assumption that the ship driving force **Propeller Thrust (+ Stator Thrust) - Rudder Resistance** must be the same with and without the stator (Fig. 1). This procedure implies that the thrust deduction fraction doesn't change with the stator installation, which is a reasonable assumption not only for a post-swirl stator. First, the reference condition without stator is adjusted maintaining the thrust coefficient K_T found beforehand in a towing tank test. This is normal procedure in every cavitation test. The operating condition with stator can then be determined by readjustment the same tunnel water speed, followed by tuning the propeller speed until

$$\text{Ship Driving Force} = \underbrace{T_{\text{Prop.}} - R_{\text{Rudder}}}_{\text{without Stator}} = \underbrace{T_{\text{Prop.}} + T_{\text{Stator}} - R_{\text{Rudder}}}_{\text{with Stator}} = \text{const.}$$

is fulfilled. With a post-swirl stator attached to the rudder this procedure only requires measurement of the total axial rudder force, if mounted including the thrust provided by the stator. This can easily be done by a rudder force balance additionally installed in a normal cavitation test set-up. The gain simply results from the comparison of the model propeller delivered power requirement measured with and without stator. This test can be carried out at any tunnel water speed, i.e. at any Reynolds number achievable in HYKAT.

Together with the conventional test at low Reynolds number in the towing tank the

Samsung stator has been investigated and optimised at four different Reynolds numbers. The result is

shown in Fig. 2 for the best arrangement. The growing gain with increasing Reynolds number towards the full scale situation is encouraging. Of course it is impossible to conclude the exact full scale gain from the tendency given in Fig. 2. Nevertheless, the clear tendency shows that the gain determined in the towing tank might be a very pessimistic estimate for reality.

Similar tests have been carried out for other propulsion improving devices like high efficiency rudders in the past. Further investigations will certainly follow – as long as the oil price goes up progressively!

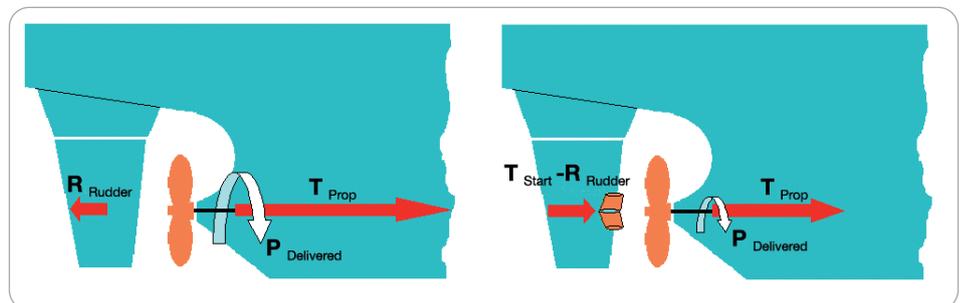


Fig. 1: Forces Acting With and Without Stator

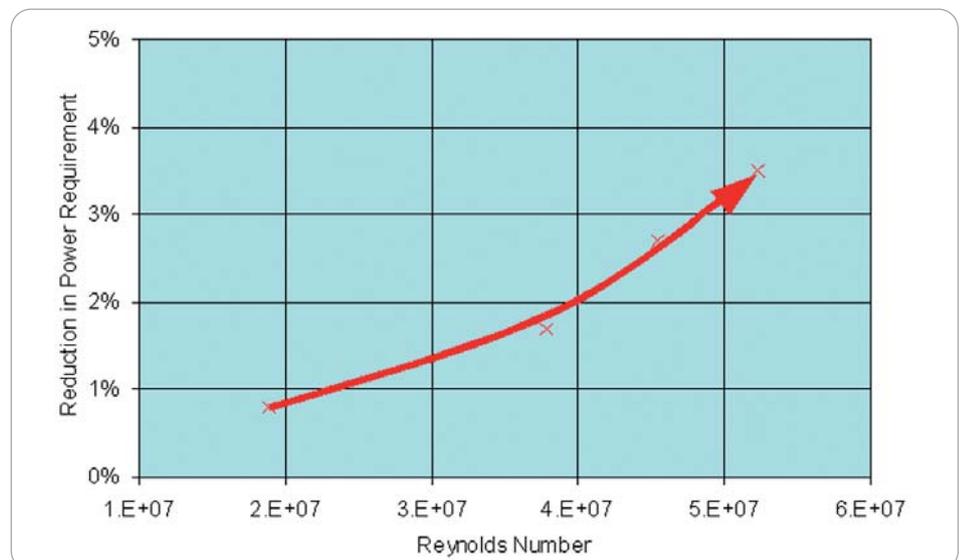


Fig. 2: Stator Gain Grows with Increasing Reynolds Number

Ice Model Tests with an Arctic Tandem Offloading Terminal (ATOT)

by Karl-Ulrich Evers

In the framework of the EU project HYDRALAB III, access was given to a group of researchers from the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway. Based on several PhD studies, several concepts have been proposed and the feasibility has been demonstrated. Further studies have led to the innovative hydrocarbon offloading concept ATOT. The concept includes an Offloading Icebreaker (OIB) moored on a turret buoy and shuttle tankers connected at the stern of the OIB for offloading. Model tests in an ice tank would give a good insight into the concept behaviour in different ice conditions and its feasibility.

The concept was tested in various ice conditions in HSYA's Large Ice Tank with a full mooring system included. In general the concept may operate either in shallow or deeper water. In the present study a full-scale water depth of about 30 m was simulated. The purpose of the ATOT model testing was to study:

- Loads, responses, accelerations of the ATOT concept (tanker plus an offloading icebreaker (OIB) with two azimuth propulsors at the bow and aft respectively in various ice conditions.)

- The performance of the concept in pre-defined operational conditions.

- The performance of the sub sea riser protection system.

- Effects of the propulsion system of the OIB in relation to turning in ice, and protection of the riser system / mooring lines.

The concept has several scientific aspects that have been addressed and revealed in this project. Some of these topics were quite new and unexplored and needed basic research

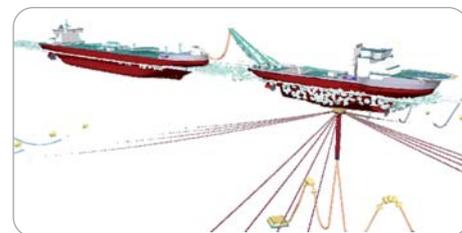
work, whereas others are further developments of existing knowledge. The most relevant research items are:

- Tanker in tandem behind a moored vessel in ice is not addressed in the literature. Ice impact and loading are relevant topics to address.

- Ice vaning of a vessel in ice, when the ice drift direction changes. Effects of the use of azimuth propulsion systems, with respect to ice breaking capabilities and clearing the ice.

- The mooring stability of the vessel and ice forces depend on several factors like stiffness of mooring system, ice conditions and vessel/hull geometry.

The ice model tests have been performed successfully and the detailed evaluation of data and test results is still in progress. However, the first preliminary results show that the concept is very promising and feasible. The work of this project was supported by StatoilHydro and by the European Community's Sixth Framework Programme through the grant to the budget of the Integrated Infrastructure Initiative HYDRALAB III, Contract no. 022441 (RII3).



Arctic shuttle tanker connected to the offloading icebreaker (OIB)



Offloading icebreaker (OIB) fixed on a mooring system turning in an ice rubble field



Arctic shuttle tanker connected to the offloading icebreaker (OIB) is passing a consolidated ice ridge

Determination of Service Speed Performance

by Uwe Hollenbach

Under the pressure of rising fuel oil costs – the price for the OPEC Reference Basket increased by a factor of almost four (4) during the last years – more and more ship owners and ship operators are interested in the service speed and the fuel oil consumption in service conditions of their vessel's and their fleet. Under certain circumstances on-board measurements can be used to perform a speed/power prognosis for the actual service conditions and to compare the predicted speed for these conditions with the actual achieved speed.

The aim of the evaluation of on-board measurements is:

1. Comparison of the (theoretical) expected speed under actual environmental conditions with the actual achieved speed for each voyage
2. Based on item 1. determination of the (theoretical) expected fuel oil consumption under actual environmental conditions and comparison with the actual fuel oil consumption
3. Identification of the most suitable point in time for docking and cleaning of the underwater hull surface and of the propeller or renewal of the anti-fouling paint system
4. Determination of a ship experience factor regarding the necessary sea-margin for the real environmental conditions for further new building projects
5. Demonstrate the vessel's performance in case of speed and/or consumption claims
6. Improving the prognosis method of the model basins

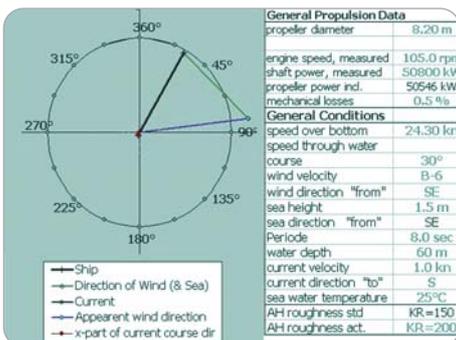


Fig. 1: Ships data recorded

Premises for the evaluation of on-board measurements are:

1. Speed measurements with DGPS & speed log
2. Power measurements with fixed power measurement system
3. Draught measurements either by on-board draught measurement system (preferred) or by evaluation of the individual loading condition with the on-board loading computer
4. Recording necessary environmental data either by automatic data acquisition (preferred) or by evaluation of reliable ship's log records

Based on the existing model test data (the model test data must cover the draught and trim range of interest) a speed power prognosis for the actual loading condition will be performed. Based on this a prognosis for the actual environmental conditions will be derived, taking into account

- Wind force and – direction
- Wave height and – direction, height of swell and direction (if any)
- Air, water temperature, water temperature and salinity
- Water depth
- Current force and direction

Environmental data which have not been recorded have to be estimated or must be neglected. Air and water temperatures and salinity can be estimated from statistics. Water depth can be gained from sea charts. Global direction and force of currents can as well be gained from hydrographical publications. For the evaluation of on-board measurements 24 hour log's at constant course and engine output are preferred. Coastal voyages with changes of ships course and speed as well as change of ambient conditions can not be used. Environmental data should be recorded at least every two hours. HSVA offers the evaluation of service speed measurements to determine the service speed performance of individual vessels or the whole fleet within an on-going research project. Assistance can be given for the on-board data acquisition of environmental data.

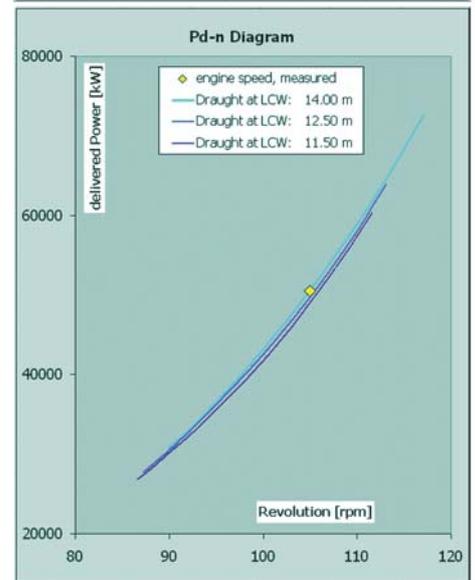
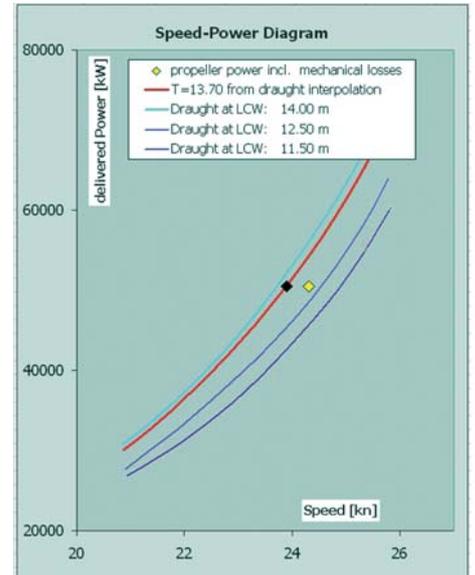


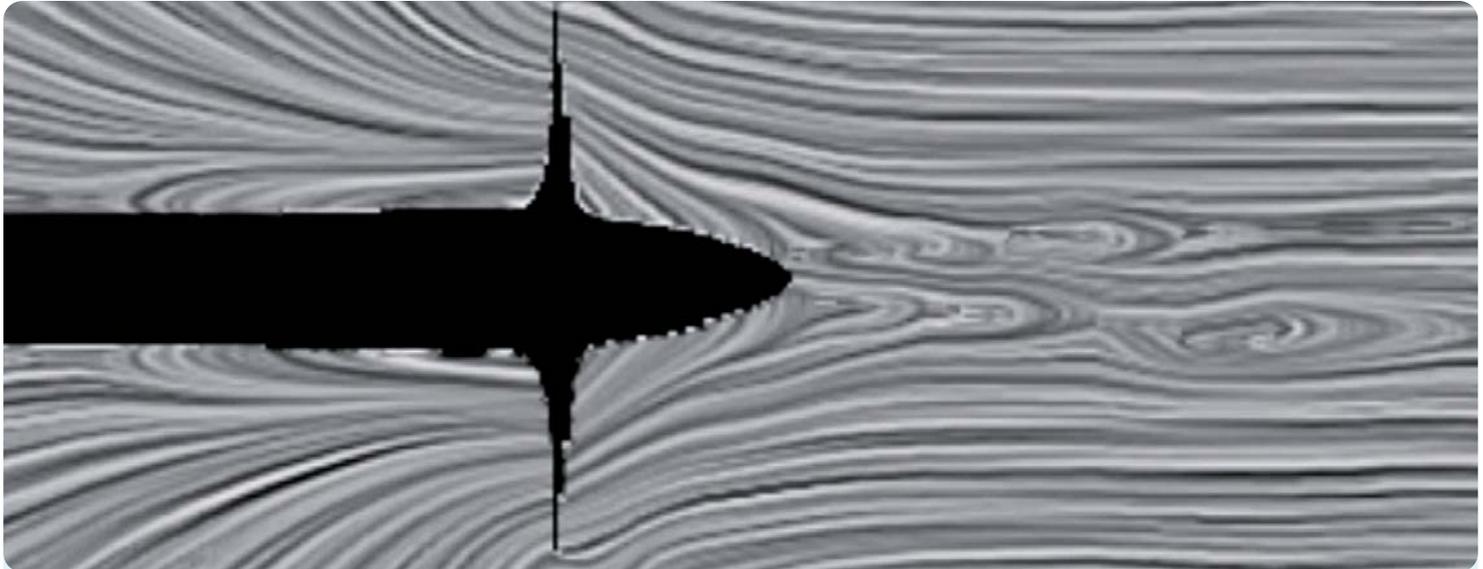
Fig. 2: Prediction for ambient weather conditions



Fig. 3: Example for a voyage with long legs and constant courses



Research News: The Numerical Tank delivers first results



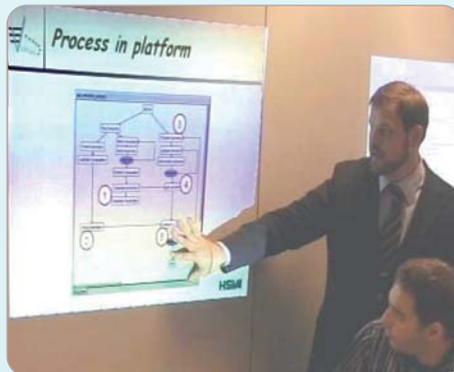
by Jochen Marzi and Scott Gatchell

This page is intended to keep or readers updated on latest developments performed in HSVA's major CFD development project, the EU funded "Virtual Towing Tank – VIRTUE".

In the last issue of NewsWave we have already announced the creation of the "VIRTUE Integration Platform – VIP" which is a major element of the entire concept of the virtual basin. Aiming at a flexible and extensible platform architecture, the VIP facilitates the interplay of numerous individual CFD tools which today live in separation and require large effort to interface. Introducing dedicated data translation modules and wrappers, the VIP now allows to easily generate complex process chains combining several interacting analysis tools.

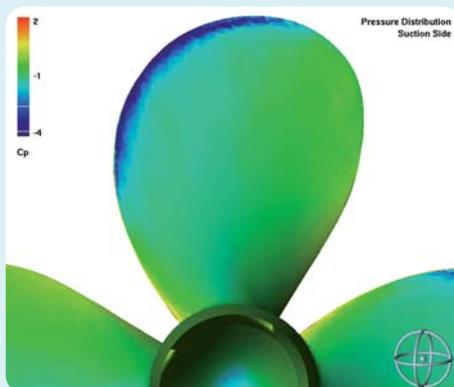
During a recent demonstration of the platform HSVA presented a propeller analysis and optimisation application making use of a combination of RANSE methods – used for the prediction of a ship wake – and a dedicated propeller panel method to compute thrust.

Another of HSVA's main activities in the numerical towing tank focuses on the prediction of

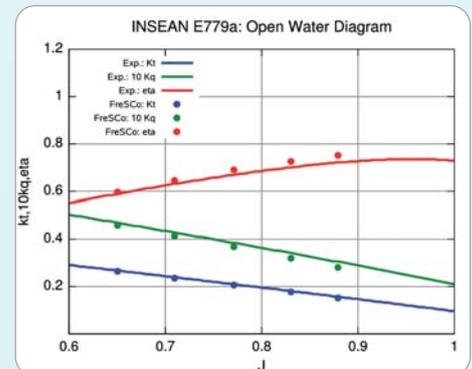


Scott Gatchell presenting the VIP

propeller flows. The new RANSE code FreSCo, a joint development with TUHH has been adopted for propeller predictions inside the VIRTUE project also by MARIN.



Pressure distribution (suction side)



Despite its rather short development time, FreSCo already now shows very encouraging results for propeller flows and cavitation.

The use of a completely unstructured mesh allows for relatively simple grid generation, hence fast model generation and shortened analysis times. In a recent open workshop performed by VIRTUE's propeller group, the code proved highly competitive.

HSVA will soon introduce FreSCo into CFD analysis practice and hence generate an immediate exploitation of project results.

Watch the project's web site at www.virtual-basin.org for any News and updates.

Design of Twin-Screw Appendages

by Hans Uwe Schnoor

Modern RoRo-Vessels, Cruise Vessels and High Speed Craft are designed with open shaft arrangements supported by a set of V- and/or I-type shaft bracket arms. The design of shaft bracket arms involves structure, vibration and hydrodynamic analysis and design. To support engineers in shipyards and design offices in the hydrodynamic design of twin screw appendages HSVA currently has undertaken a systematic investigation on different type of shaft bracket arm profiles.

The design goals are to reduce the resistance, to minimize strut shadow in way of the wake field and to avoid separation and cavitation. This leads to finding the best compromise between hydrodynamic, structure (strength, vibration) and fabrication (costs) requirements. The following profiles (fig. 1) have been investigated with different profile thickness (18%, 20%, 23%, 27%).

Depending on the ship's speed and the local immersion depth of the shaft bracket arm, a maximum pressure coefficient should not be exceeded to avoid cavitation (fig. 2).

For all type of profiles investigated the pressure distribution along the profile $CP = f(x/c)$ has been calculated for different entrance angles of the flow. As an example in the following figures the pressure distribution for the "NACA0023", the "Circle Segment – with sharp edge" and the "HSVA Standard Profile" are compared.

It is obvious, that the "Circle Segment – with sharp edge" has extremely high pressure coefficients at the forward end, especially at larger entrance angles of the flow. Compared to that the "HSVA Standard Profile" has a much lower maximum pressure coefficients in the same area. Plotting the pressure distribution for the same entrance angle allows a comparison of different types of profiles (fig. 4) and of different profile thickness (fig. 5) to select a suitable profile for the specific purpose.

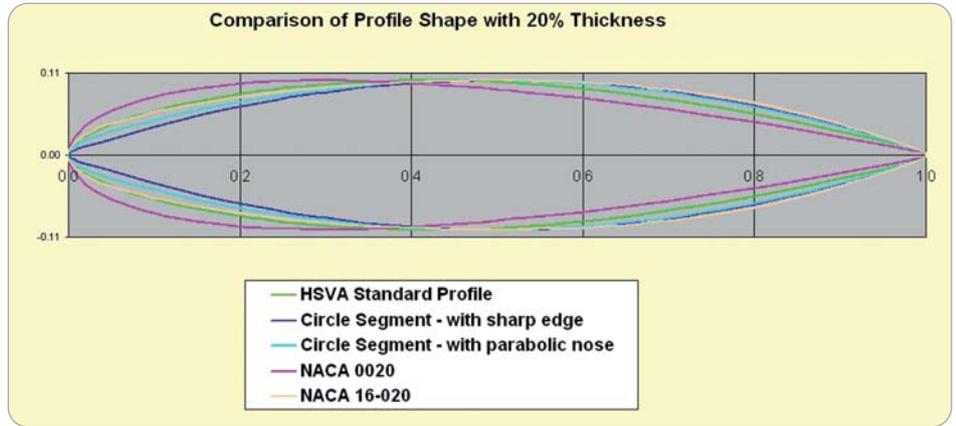


Fig. 1: Type of bracket profiles investigated

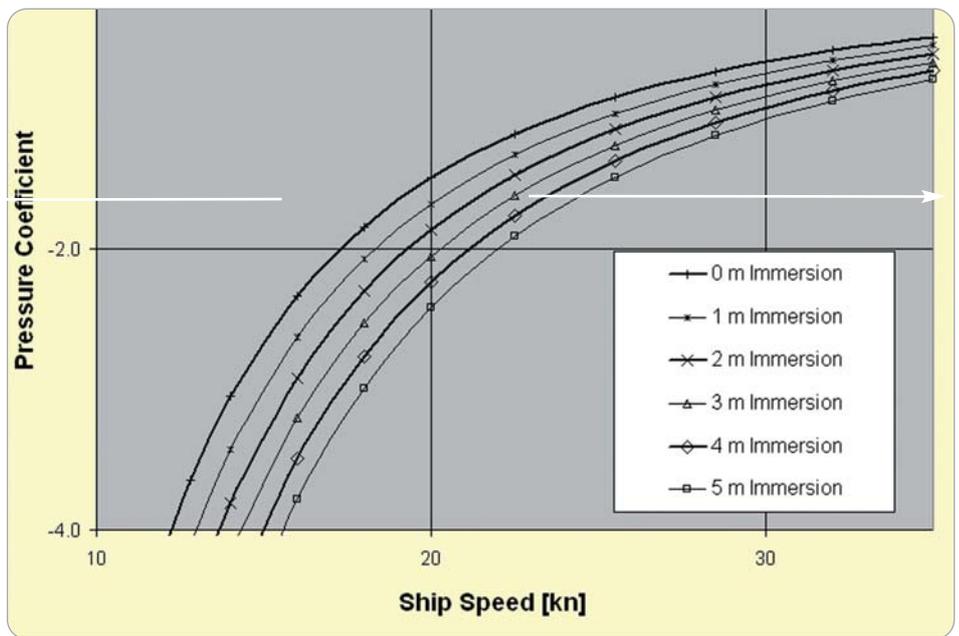


Fig. 2: Maximum pressure coefficient

From these figures it can be derived that the HSVA Standard Profile offers the lowest pressure coefficients at the largest entrance angles of the flow, and thus the lowest risk for cavitation. This profile is recommended for high speed vessels to avoid cavitation. The Circle Segment – with medium parabola is recommended for vessels operating at lower speeds, where cavitation may not be expected. In any case a parabolic nose part is highly recommended. The larger the profile thickness, the less sensitive the profile is to variations in the angle of encounter.

However, for faster ships the relative thickness of the profile should be as low as necessary for cavitation considerations. The length of the strut profile can be obtained from the absolute thickness required by the strength and vibration demand in combination with the relative thickness from cavitation requirement. HSVA offers the hydrodynamic design of twin screw shaft brackets together with hull form and rudder design and optimisation. The selected profile thickness has to be verified by the customer with respect to strength and vibration aspects.

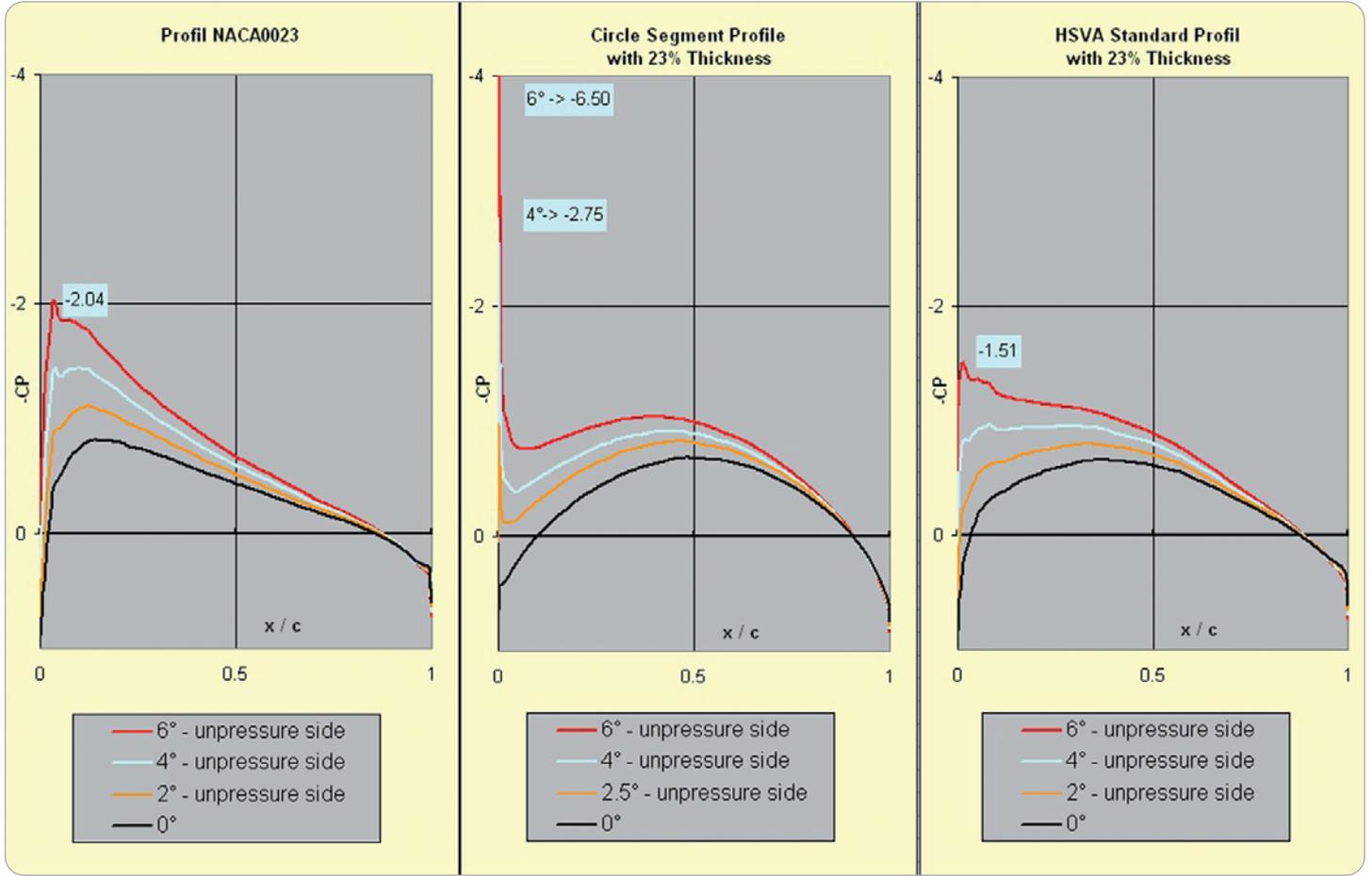


Fig. 3: $CP = f(x/c)$ for "NACA0023", "Circle Segment – with sharp edge" and "HSVA Standard Profile"

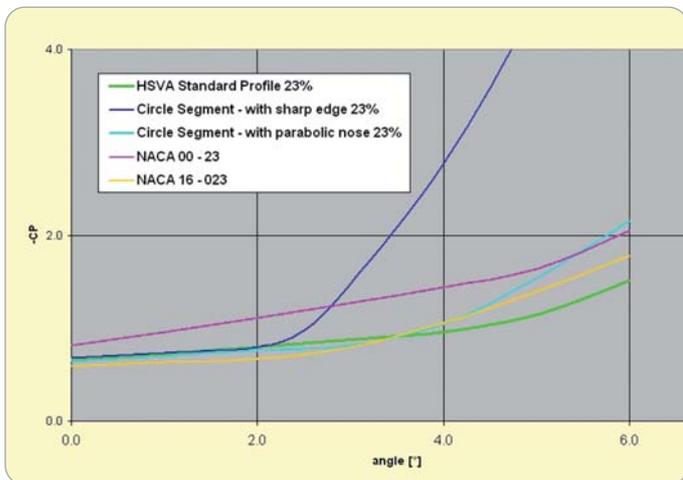


Fig. 4: Comparison of different type of profiles

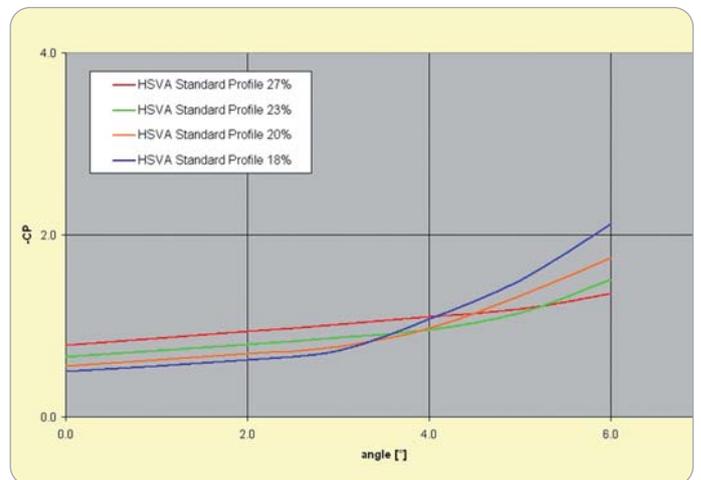


Fig. 5: Comparison of different profile thickness

Sea Loads



by N. Ludwig and A. Schumacher

Ship designers have traditionally focussed on the optimisation of ships in calm water conditions. Seakeeping has only been accounted for by means of coarse safety factors in combination with experience, although seagoing ships seldom operate in calm water. However, in face of increasing ship sizes leading to new technical issues regarding sea loads, and due to the requirement to keep the time schedule regardless of weather conditions, the demand for seakeeping tests has increased significantly in recent years.

Wave induced forces and moments have different magnitudes and centres of effort depending on ship size and hull form. Sea loads on a ship can roughly be divided into global and local stresses.

An example of global stresses is the longitudinal bending moment acting on the hull, especially in head or stern seas. This moment reaches maximum values amidships and changes sign from wave crest (Hogging) to wave trough (Sagging), Fig.1. The maximum longitudinal bending moment is fundamental for dimensioning the main frame section and is generally laid down by the classification society. A ship will be subjected to additional stresses and distortions in head and stern quartering seas.

For instance, a large torsional moment might arise when waves come in at an incidence angle. Seakeeping tests with segmented ship models at HSVA allow for measuring all force and moment components at the main section. The model then consists of two parts (aft and fore body) connected by a six component force balance.

In addition, it is possible to investigate the loads acting on a bow section for instance. For this purpose the bow section is built separately and connected to the hull by the force balance.

Local stresses, like panting stresses and wave impact loads, mainly occur in harsh sea conditions and result from hydrodynamic water pressures. Wave impact loads (slamming) for instance, can lead to local deformations or damage to shell plates and stringers. Bow slamming mainly occurs in head or head quartering seas to ships with pronounced bow flare. Several types of vessels having flat bottom plates at the bow are susceptible to bottom slamming. Finally, ships with a barge type stern tend to stern slamming. Local stresses like slamming not only affect the involved hull area but can lead to whipping, i.e. vibration of the entire ship.

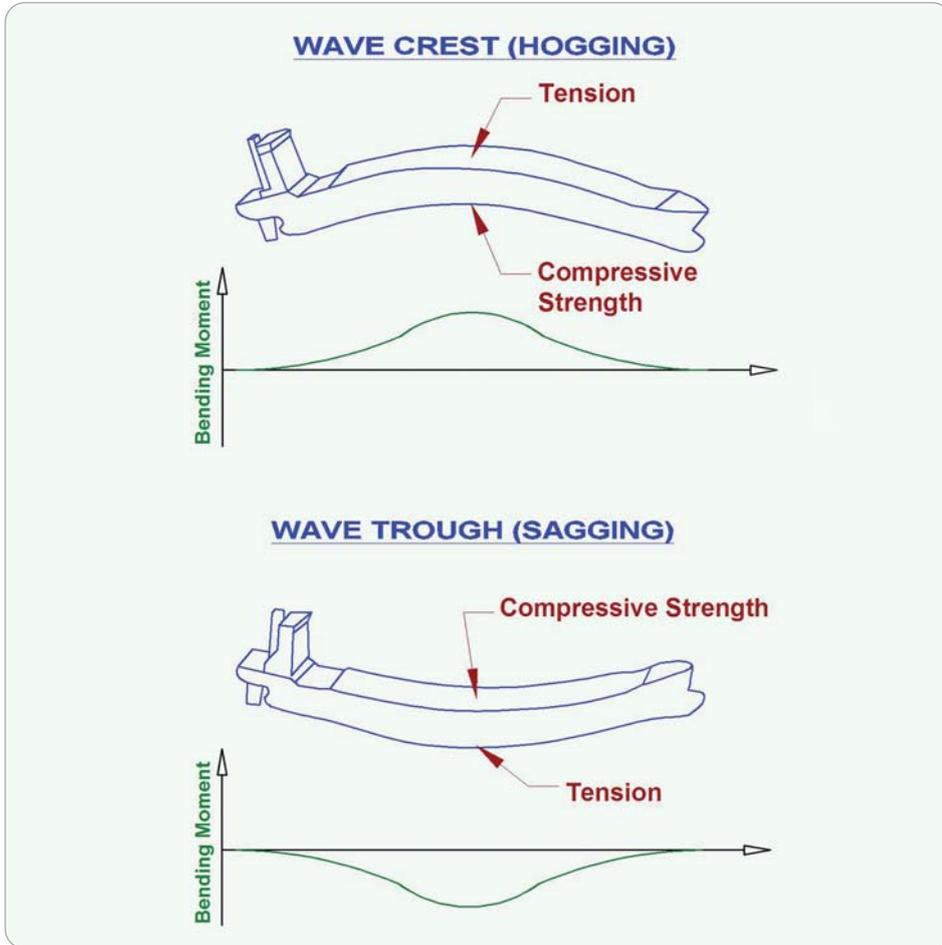


Fig. 1: Longitudinal stress on a ship on in hogging and sagging condition

Within a recent research project and several industrial projects, HSVA has developed different methods to predict wave induced loads on a ship. HSVA's model techniques allow the measurement of static and dynamic water pressures. Fig. 2 shows an example of a pressure time history measured during a model test in rough wave conditions using pressure sensors.

These measurements help to evaluate the hull design and to assess the magnitude of the local stresses which can be checked with regard to the hull structure. Alternatively to pressure sensors a "force measuring panel" can be used to measure the resulting force on a certain plate field at the bow of the vessel.

In conclusion, in order to avoid damage and costly repairs it is advisable to put more emphasis on the seakeeping behaviour of the ship in the early design stage. HSVA can predict not only the motions of the vessel but also sea loads on the ship by means of improved experimental techniques.

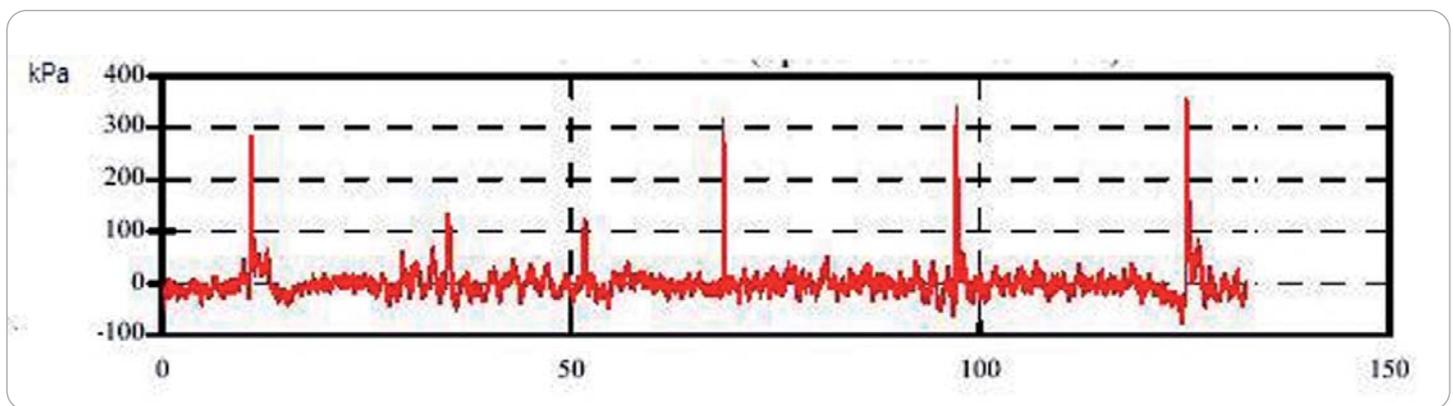


Fig. 2: Pressure on superstructure of a cargo ship at 18 kts in 8 metres waves

SAFEICE – An EU-Sponsored Project to improve Safety and Economy of Arctic Shipping – yields good Results

by Petri Valanto

Introduction

The HSVA plays an active role in the EU-sponsored project SAFEICE as the lead organization of the Work Package 6 "Load Modeling". The project started in September 2004 and ends in October 2007. The project goals are to improve the safety and cost-effectiveness of arctic shipping and to reduce the potential risk of the environmental impact of navigation in the Arctic. In spite of hazardous conditions, an increasing number of ships is making their way through the ice covered waters of the Baltic or the Arctic. An important artery for export of Russian oil goes through the Baltic Sea and the traffic in other ice covered Arctic seas is expected to increase in the near future, not least due to climate change. The project carried out research in three complementary areas: ice loading on ships, elastic-plastic analysis of ship structures under ice loading and an integrated traffic control infrastructure.

The participation of research organizations from Canada, Japan and Russia in the EU-Sponsored project SAFEICE has helped the work by providing complementary know-how on many areas related to the analysis of full scale data, model testing of ice loads and numerical modeling. Considerable progress was achieved in SAFEICE with improved modeling of the ice loading itself and of the response of typical ship structures to ice loading.

Spatial ice load distributions on the ship hulls

Individual measurements of ice loads on various locations of ship hulls have in general been available for a long time, but no overall picture of how the ice loads spatially distribute on the hull during different modes of operation has been available. The design load distributions used in ice class



A 110 000 dwt oil tanker in ice in the Gulf of Finland. Image H.Heikura, www.hs.fi

rules are relatively simple and do not in all cases reflect the true shape of the ice loads on ship hulls: For very classical icebreaking hull forms the design ice load distributions in the rules may appear reasonable. For ships having a hull form more suitable for open water the design load distributions of the ice rules clearly deviate from the corresponding load distributions computed by HSVA with the computer code VENICE. This can lead to sub-optimal ice strengthening and to increased cost of the ship. Although most SAFEICE results are not yet public, first results on the spatial ice load distributions on ship hulls were already published in a research paper by the author in the ICETECH2006 conference. Another shortcoming of the present ice rules is that they do not directly reflect how the ice load distribution changes, when the vessel turns in ice. Such a frequent maneuver has gained more emphasis with the introduction of the podded propulsions units, which allow for tighter turns in ice and result in higher iceloads on the ship hull. Specially the cargo ships, which have a larger length to beam ratio than classical icebreaking ships, may develop high loads on the aft shoulder,

when turning or breaking out of an ice channel. With increasing transport of oil in ice covered waters with large tankers this issue gains even more interest.

Germanischer Lloyd 
OPERATING 24/7

1918  TALLINNA TEHNIKAÜLIKOOL
TALLINN UNIVERSITY OF TECHNOLOGY

CHALMERS 
Chalmers University of Technology, Sweden

 National Research Council Canada  Conseil national de recherches Canada

 Sjöfartsverket  National Maritime Research Institute

HSVA   Finnish Maritime Administration

 HUT  ÅAMH

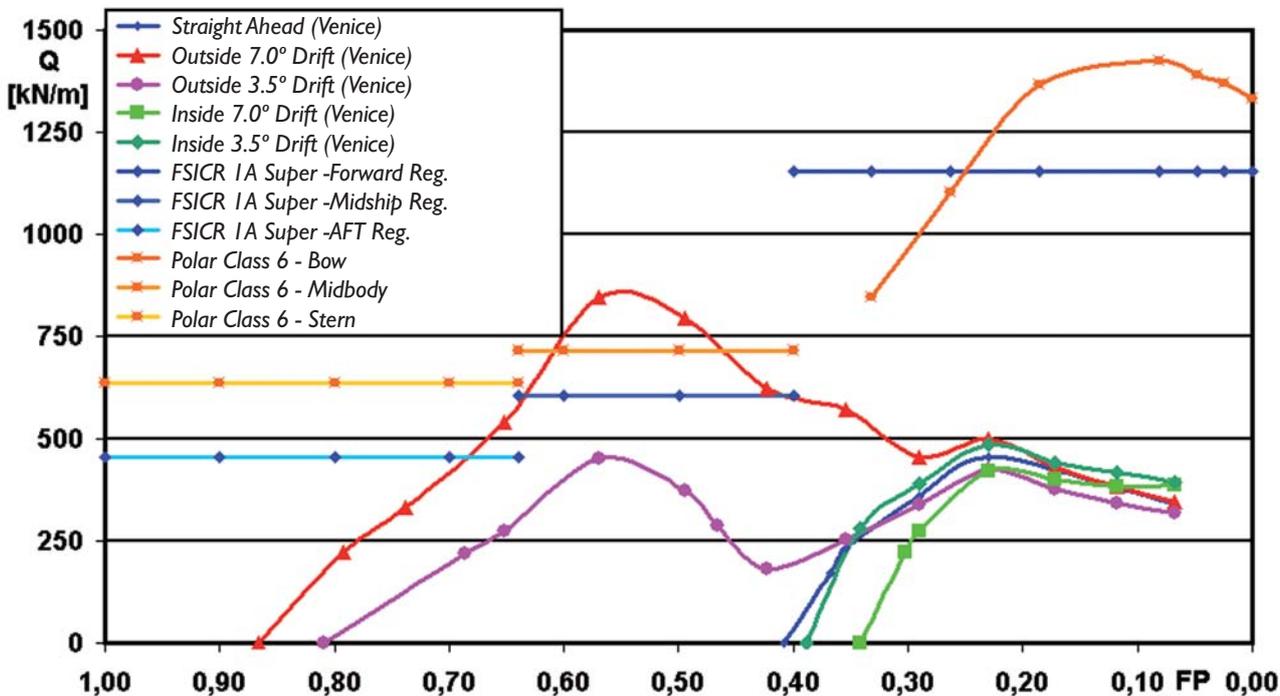
For these reasons the HSVA computer code VENICE was modified to handle also the turning motion. The SAFEICE framework offered the possibility to validate the computed results with ice load data measured on turning ship models at the NMRI of Japan. The correlation between the measured and computed short term ice distributions is very satisfactory. Both the NMRI tests with free running ship models and the HSVA numerical computations show remarkably high ice loads on the aft shoulder area, even with very moderate turning radiuses. With the modified program VENICE the HSVA can now compute such cases for any customer needing assistance in design or operation of icegoing ships.

Altogether the computations with VENICE can provide spatial ice load distributions in level ice for a ship advancing straight ahead, astern or turning. The computed ice loads are deterministic and their magnitude corresponds well with short term ice loads measured in level ice in full scale or obtained with model tests in ice. In full scale a vessel transiting in ice encounters in the bow area considerably more ice impacts than the stern shoulder does. Therefore the long term ice loads at the bow should be considerably higher than the short term ones, whereas at the stern shoulder the situation may not be so clear. The ice rules of course need to reflect the long-term ice loads, but in case of the stern shoulder the safety reserve in the rules may not always be sufficient.

Trends

As the extent and thickness of sea ice in the arctic in general are likely to decrease in the near future, it can be assumed that the arctic shipping will increase. The economic aspect in shipping will take care that the ships will transit faster, and it requires them to be as economical in open water as possible. Both the higher speeds and the hull forms better suitable for open water transit will also have an effect on the ice loads these ships are going to encounter. Useful new information on these loads was developed in SAFEICE and more can be done with the improved version of the program code VENICE in the HSVA.

Line load - IB OTSO Level ice 100cm turn with drift



Arctic shuttle tanker connected to the offloading icebreaker (OIB) is passing a consolidated ice ridge



Further information on SAFEICE can be found in www.tkk.fi/Units/Ship/Research/SafeIce/Public/Kotka/

Marintec China 2007

Shanghai New International Expo Centre

From 27th till 30th November 2007 the Marintec China, the most important exhibition in Asia, takes place in Shanghai New International Expo Centre.



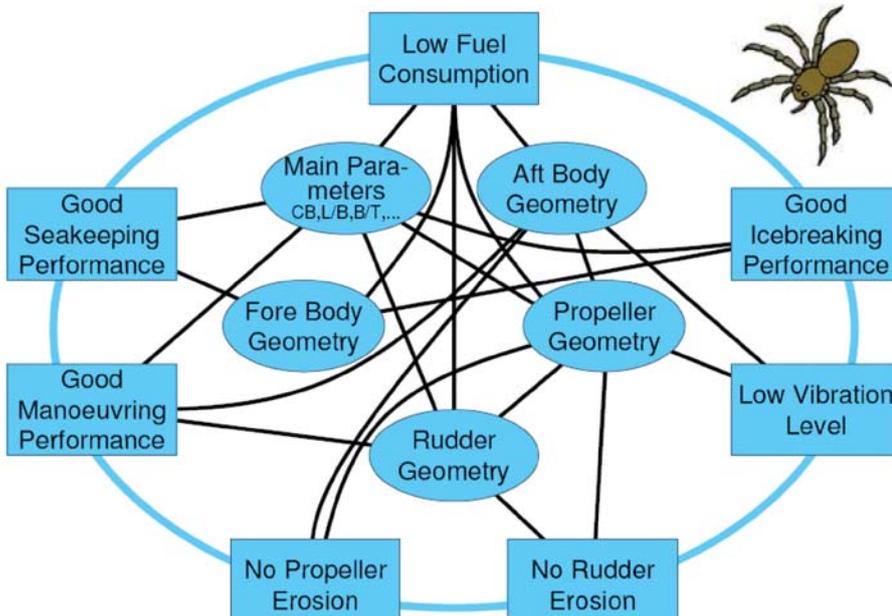
More than 1,000 exhibiting companies and 30,000 visitors are expected to take part in the fast-growing Chinese maritime industry and to exchange their new technologies and maritime products.

HSVA is looking forward to seeing you at their **booth No. 2E31-2** in **hall W2** of the **German pavillion** to present their actual research projects and recent developments.



HSVA-Seminar for Ship Owners and Operators

With HSVA Safely Through the Hydrodynamic Spider Web



November 20th, 2007 (TKK building)

The seminar will focus on economic and safe ship operation from the technical point of view. Aspects such as propeller cavitation vibration, seakeeping manoeuvring and performance of ships in ice will be tackled.

Member of staff



Arndt Schumacher joined HSVA in May 2001 as a project manager in the Seakeeping and Manoeuvring Department. Right from the start he has been involved in challenging projects, e.g. on Americas Cup Sailing Yachts, and he is now responsible for seakeeping model tests and calculations. Besides commercial projects he is involved in the development of numerical tools for seakeeping tasks and in research projects dealing with extreme wave/structure interactions and parametric induced roll motions and capsizing phenomena of vessels.

Mr. Schumacher studied naval architecture and received his engineering degree in the year 2000 from the University of Hamburg. His interest in ship hydrodynamics began already at the university where he prepared his master's thesis on the comparison between experimental and computed breaking wave phenomena.

In his spare time he enjoys sailing, travelling, hiking in the mountains and long warm summer nights on the balcony.