HSVA NewsWave

The Hamburg Ship Model Basin Newsletter 2002/2

SMM PARTNER COUNTRY

C H I N A

Optimization of a 5.618 TEU Container Vessel for Chinese Yard Hudong-Zhonghua

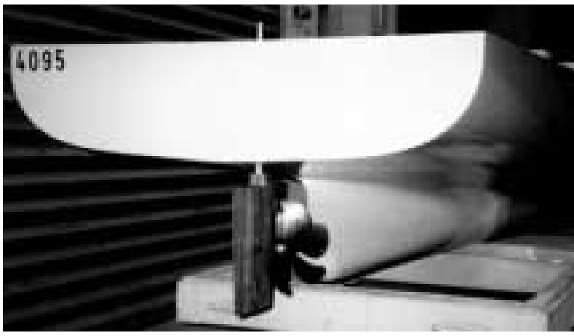
by Friedrich Mewis, HSVA, Wang Hengyuan, H&Z

The Chinese Hudong-Zhonghua Shipbuilding (Group) Co., Ltd. in Shanghai has developed and constructed a large container-vessel with 5.618 TEU capacity. This ship is the largest container vessel ever built in China. The keel for the first ship of this series was laid in May 2002.

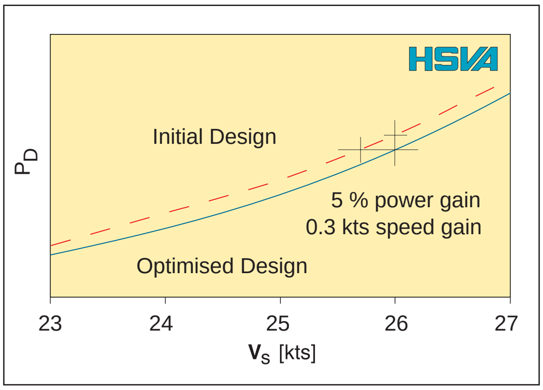
To accommodate such a large ship, the yard constructed a new very large dry dock with the dimensions of 360 m x 92 m, served by two new 600 t gantry cranes. New shops and steel panel lines, blasting and coating halls are under construction.

HSVA was selected to carry out the model tests and to optimize the hull lines for that ship. The investigations in the HSVA's large towing tank (300 m x 18 m x 6 m) included resistance, self propulsion, wake, paint flow and open water tests. The lines quality of the initial design was on a very high level in comparison with HSVA's data base. To reach the very high speed target a large number of model variants were investigated in the towing tank. The hull lines were pre-optimized at the computer using the proven HSVA potential flow code ν-SHALLO.

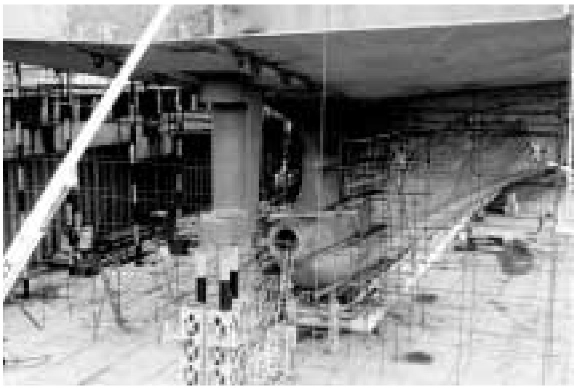
A second important target for this ship was an optimized propeller, with regard to minimizing the pressure pulse generation without loss of efficiency. Cavitation tests were carried out in HSVA's large cavitation tunnel HYKAT. The large dimension of this tunnel allows the installation of the whole ship model. This way the model propeller is operating in the realistic three-dimensional wake field. An optimized solution was reached after several steps of careful investigation.



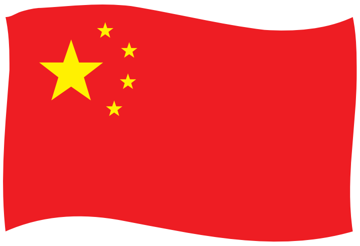
C/V - 5.618 TEU ship model, scale 1:33.3, in HSVA



C/V – 5.618 TEU, comparison of speed-power curves initial design with optimized design



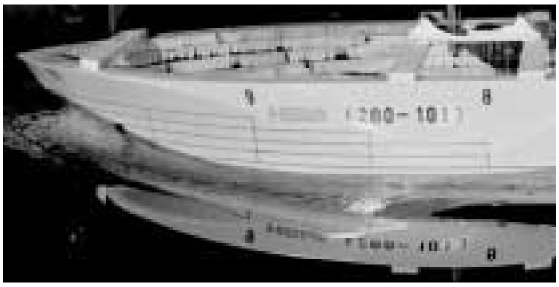
C/V - 5.618 TEU ship in construction in the new dry dock of Hudong-Zhonghua yard in Shanghai



A Close Cooperation

by Hilmar Klug

Over the past few years the Chinese shipbuilding industry has intensified the export of ship newbuildings. A large number of customers are from Europe and especially Germany. One of the major design companies working for the Chinese shipyards is the Shanghai Merchant Ship Design and Research Institute, CSSC (SDARI). The portfolio of SDARI covers a wide variety of ship types and sizes. HSVA started a close cooperation with SDARI. Following the current market SDARI and HSVA developed and optimised a number of bulk carriers and chemical tankers. The optimisation covered not only the resistance and propulsion performance of the vessel, but also the manoeuvring capabilities and the cavitation characteristics. Prior to model test in the towing tank and in HYKAT, the hull lines were optimised using HSVA's potential flow CFD software ν-Shallo. The very good results have encouraged both partners to extend this efficient and effective cooperation to future projects.



Research on Reduction of Skin Friction Drag by Tornado-Like-Technology (TLT)

by Martin Pohl

In the past many attempts were made to reduce skin friction drag below the boundary that is given by the well known empirical formulae for the friction coefficient, but practical application seemed to be impossible for long time.

Beginning in 1996 several research test series have been performed and are going to be continued in HSVA's Small and Medium Sized Cavitation Tunnel, which are dealing with the reduction of skin friction drag by means of the "Tornado-Like Technology" (TLT). A group of Inventors Network's scientists have been testing plates with a special surface structure, so called "dimples", which means flat spherical recesses. Initially dimples were applied in heat transfer technology, where it was found that the heat transfer in tube or plate type heat exchangers could be intensified, if the heated surface was provided with dimples. In heat transfer TLT has achieved numerous applications. The working principle can also be transferred to fluid dynamics. In the dimples a secondary flow structure, which has the appearance of a tornado-like vortex, is generated and maintained by the flow velocity. Figuratively spoken, the vortex influences the velocity distribution in the boundary layer by sucking boundary layer material from near the wall and transferring it into the outer flow.

The purpose of the tests at HSVA was to investigate certain details of this phenomenon and to demonstrate further applications of this technology in hydrodynamics as well as in aerodynamics. The tests comprised of force measurements, LDA-measurements (Laser-Doppler-Anenometer) and measurements of the pressure distribution. Various plates with different numbers of dimples, different dimple diameters and different dimple depths were investigated. Additionally, comparator plates with smooth surfaces were tested. The force measurements showed that at certain combinations of dimple diameter, dimple depth and flow velocity longitudinal force coefficients can be achieved, which are roughly 20 % smaller than those of smooth plates. The LDA-measurements confirmed these results by showing that the velocity gradient in the boundary layer of a dimple plate is smaller than that of a smooth plate.

Besides the continuation of the research work with dimple plates, tests are planned in the near future, where dimples will be applied to the surfaces of model propellers and model ship hulls.

SAVING ENERGY, CUTTING EMISSIONS - NO MORE AN ISSUE?

by Peter Schenzle

"Environmental matters? - Oh No!
We had that already, it's no more a topic".
That is the usual way, how media and even politics re-act on future issues in our society governed by present profit and fun.

On the other hand, it is still the main business of Ship Model Basins to find ways of cutting energy consumption and emissions in sea transportation. Interestingly, however, relevant progress is traditionally measured as a gain in speed rather than as a saving in energy. While ships have but a small share in the quantity of global exhaust emission, they are still allowed to burn the lowest quality of fuel, too dirty to be used for road construction.

And all that happens in spite of sea transportation being potentially by far the most energy-efficient mode of mass transportation at all - 10 times more efficient than rail & road and 100 times more so than air transport. This is valid, howeve,r only for mass transportation at reasonable speeds. Fast container-, RORO- and passenger vessels at 25-30 knots can easily reach the specific energy consumption of rail & road, and fast ferries at 40-50 knots can even overtake air transport in specific energy consumption at only 1/10 of air speed.

The uniquely low energy demand of sea transportation at appropriate speed offers the chance of a high rate of supply by the low density sources of wind and sun. We could utilize the chance together with the high availability of wind and sun at sea and their combined less fluctuating energy income, to develop a solar ship operation technology step by step with less and less emissions. This could be a multi disciplinary pilot project to develop and demonstrate the feasibility of intelligent energy management on a field, where it is already possible today.

Although we are well aware of the long term necessity of change, we still act according to the narrow and short term criteria of industrial economics. Starting now, in time before the developing problems will force us, is not a technical nor an economic question, it is our problem of long term thinking and responsibility for the next generations. Before we are ready to accept this responsibility, we can only try to develop and demonstrate sustainable technology and management in certain niches with sufficient fun factor, like pleasure yachting and cruising, where environmental issues are so obvious that it is hard to ignore the lessons to be learned.

Sydney Solar Sailor

Photo: Solar Sailor Holdings Ltd. and Advanced Technology Watercraft Pty. Ltd.

Fig. 1 Full Scale POD Arrangement

Fig. 2 Modell Test Arrangement

EC-PROJECT OPTIPOD

by Friedrich Mewis, John Richards, Jürgen Friesch, Peter Oltmann

HSVA is a participant in the EC-project OPTIPOD and is responsible for the work-package "Hydrodynamic Interactions" within the project.

OPTIPOD is the acronym for "Optimal Design and Implementation of Azimuthing Pods for the Safe and Efficient Propulsion of Ships". This project is part of the EC-Program GROWTH. The consortium consist of 14 members from 7 European countries. The main goal of the project will be the development of guidelines for the design and optimization of pod driven ships. The areas studied within the project are the general hydrodynamic interaction, safety and risk analysis, impact on environment, operational aspects, effects on general arrangement, cost and benefit predictions and finally pod propulsion design guidelines. The start of the project was in January 2000, it will be finished in December 2002.

The project is coordinated by "Chantiers de l'Atlantique" the large French ship yard. "Rolls Royce"-KaMeWa, one of the major pod manufacturer, plays an important role in the project.

Partners in the consortium are 2 ship yards, 2 shipping lines, 1 pod manufacturer, 2 universities, 3 consultant companies and 4 model basins.

Four ship types are being considered within the project: a fast ROPAX vessel, a cruise vessel, a cargo ship and a supply ship. With the exception of the cargo vessel, all ships have twin pod propulsion. In the ROPAX work, a conventional twin screw propulsion arrangement is compared with twin pod alternatives. For the cruise vessel, the performance of an existing cruise vessel is compared with that of an optimized design. For the cargo ship different pod arrangements will be investigated, and for the supply ship various optimizations will be done.

Propulsion Optimization

HSVA is responsible for the model testing work for the cruise vessel. The ship being used as a reference is the panmax cruise vessel MILLENNIUM which was built by Chantiers de l'Atlantique in Saint Nazaire (Fig.1). The MILLENNIUM has a length in the waterline of 274 m, a beam of 32.2 m and a draft of 8 m. The ship is driven by twin Rolls-Royce Mermaid pods with a propeller diameter of 5.75 m, and the service speed is 24 knots.

Models of the ship hull, the 2 Rolls-Royce Mermaid pods and the propellers were manufactured at HSVA to a scale of 1:25.111 (Fig. 2). The resulting 11 m long ship model is typical of the size used for powering tests with pod driven ships of this type.

The model test program included resistance and propulsion tests, tests in which the pod alignment and sense of propeller rotation were varied, wake survey, open water tests and cavitation tests.

After completing the model tests for the reference vessel, Deltamarin designed a new hull form in conjunction with their general arrangement work. For this new hull form, Rolls-Royce then provided a corresponding pod design.

The result of the optimization step was an improvement in open water efficiency of the pods as well as a reduction in required power.

Cavitation Investigations

The cavitation tests were carried out in HSVA's large cavitation tunnel HYKAT. The purpose of the tests was to investigate the influence of directions of rotation and different toe-in angles on the propeller cavitation behavior. In the cavitation tunnel HYKAT the cavitation behavior and the vibration and noise behavior of the units are tested behind

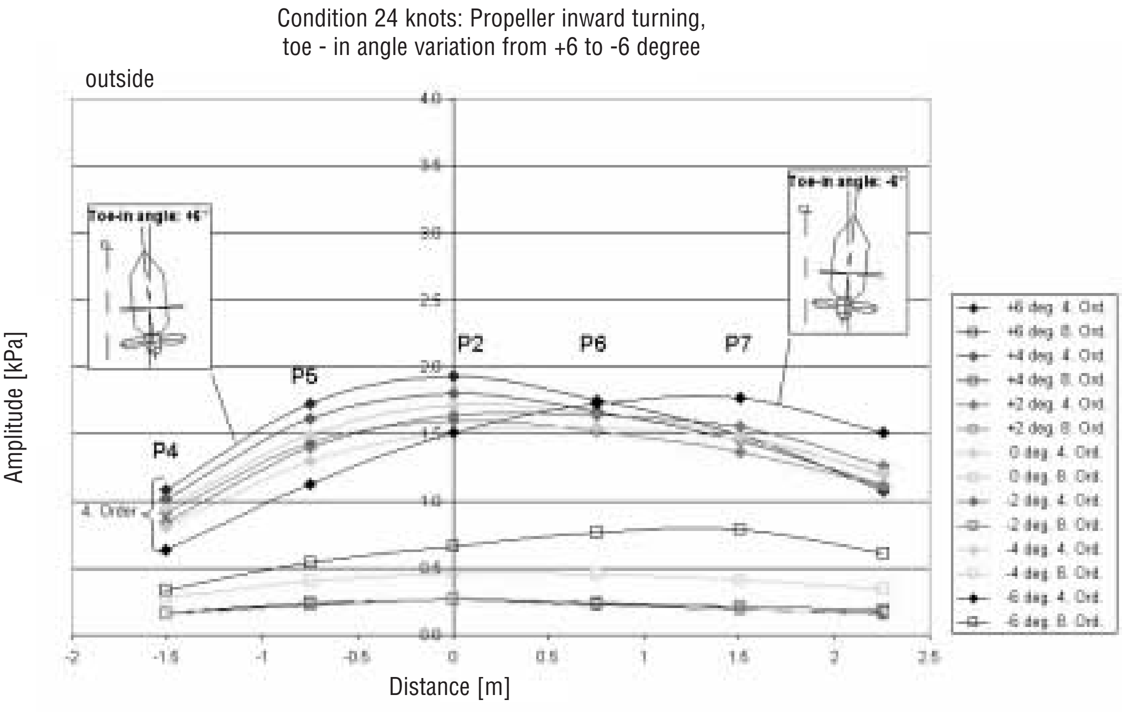


Fig. 3 Distribution of Pressure Fluctuations

the whole ship model which is used in the towing tank self propulsion tests. The drive units allow high propeller speeds of up to 35 revs per second. Together with the large model propellers these speeds lead to high Reynolds numbers, thus fulfilling the recommendations of the ITTC for cavitation tests and pressure fluctuation measurements.

The blade surface of the pod propellers is nearly free from any kind of cavitation. As a consequence of the very good wake field the cavitation pattern consists of only a very small area of sheet cavitation along the suction side leading edge merging smoothly and gradually into a rather thin cavitating tip vortex which is only visible few revolutions downstream.

The excited pressure fluctuations measured are rather low for both propeller turning directions. Inward turning propellers give about 30% lower pressure values. Increasing the toe-in angle of the pod will lead to an increase of cavitation and consequently to an increase of pressure fluctuations (Fig. 3). The pod angle found for optimum propulsion behavior is very close to the best from the vibration point of view.

Manoeuvrability Investigations

HSVA also performed two comprehensive series of manoeuvring model tests. The first series consisted of several zigzag manoeuvres with the free sailing ship model for two approach speeds. The second series contained captive model tests (force measurements) with the variation of parameters like longitudinal speed, sway velocity, yaw rate and pod angle. Both series served for the identification of the hydrodynamic coefficients of two different mathematical simulation algorithms. A comparison of numerically simulated zigzag manoeuvres with model test runs showed a good agreement for both simulation algorithms.

Of special interest is whether the manoeuvring performance of a pod driven vessel is comparable to the behaviour of a conventionally (propeller plus rudder) equipped ship. This question is answered in Fig. 4. It shows the 1st overshoot angle of two 10°/10° zigzag manoeuvres for the MILLENNIUM (diamonds) together with the corresponding data for two twin-screw, twin rudder vessels of different length. The figure shows that the manoeuvring behaviour of the cruise liner is comparable.

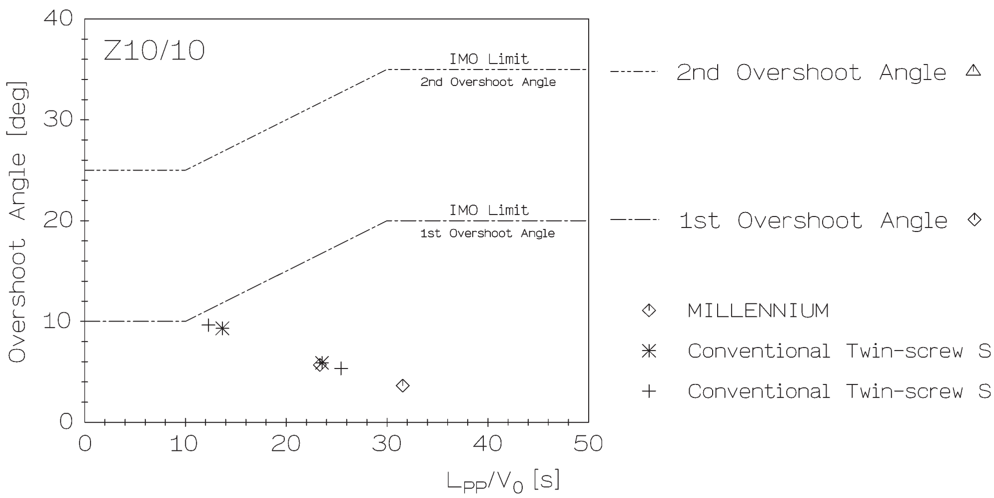


Fig. 4 IMO Criteria regarding overshoot angles at 10°/10° Zigzag Manoeuvre

Fig. 1 Lighthouse Norströmsgrund

Ice Force Measurements at Lighthouse Norströmsgrund in the Gulf of Bothnia

by Karl-Ulrich Evers & Peter Jochmann

Coastal structures in northern European waters as well as offshore structures for exploration and production of hydrocarbons from the European Arctic have to be designed to withstand the ice loads caused by level and rafted ice as well as pressure ridges. About the design loads there exist an uncertainty between the prediction by various scientists and engineers around the world - the predictions scatter by a factor of 10 to 15.

Due to indications that the forces are smaller than often predicted, under the leadership of HSVA seven research institutions from six European countries developed the RTD-project Validation of Low Level Ice Forces on Coastal Structures (LOLEIF), which was funded by the European Commission under the EU MAST III Program as PROJECT / CT 97-0098 and co-sponsored by the four international oil companies Statoil, Exxon, Mobil and Texaco.

The major task of this project was

- the observation of the ice structure interaction process
- the documentation of the failure mode
- the determination of ice force effecting parameter
- the measurement of ice loads

on a coastal structure a the European sub-artic region.

To meet this goal, the lighthouse Norströmsground, located 25 nm southeast of Luleå, Sweden, in the transition zone of the landfast ice and the high dynamic drift ice of the northern Bottenviken, was selected for the research work by the LOLEIF-consortium (Fig. 1).

The lighthouse was equipped with different type of sensors and a video observation system.

In order to determine the ice forces acting on the structure, Sixteen rigid and watertight ice force sensing panels, with two different load areas, were mounted to a polygon steel in the waterline of the lighthouse. The large panels, designed and manufactured by Luleå University of Technology, with a load area of 1.2 x 1.6 m and a capacity of 2 MN, consist of a rigid back plane, 4 strain gauge type load cells and a stiff cover plate. The smaller ones, developed by HSVA, have an individual normal load capacity of 1MN. The load area is 0.500 x 0.370 m and eight small panels are assembled to one segmented panel of almost the same size as the other 8 large panels. An azimuth angle of 162° is covered by the panels, i.e. from 351° (N) to 153° (SE) direction.

A short range upward looking echo sounder, type Mesotech MS 808A, was installed in 7 m water depth to profile the subsurface of the ice cover whilst

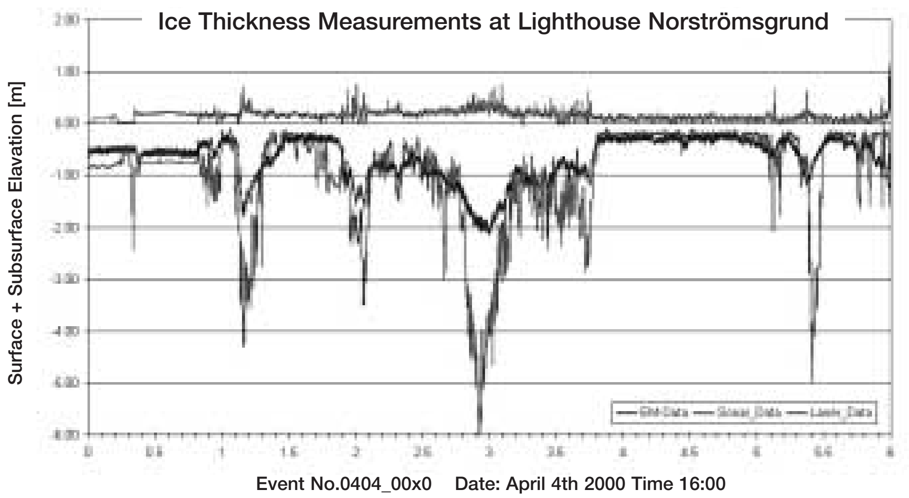


Fig. 2 History of ice thickness measurement at the lighthouse

the ice sheet is passing. The surface of the ice cover is profiled by a laser scanner system, type Sick LMS 210, mounted at the upper balcony of the lighthouse. The ice thickness was evaluated from the information sampled by these sensors. As a second method an EM device in combination with a laser distance meter was used to determine the ice thickness (Fig. 2). Ice charts were provided by FMI and SMHI to document the ice conditions in the Bothnian Bay (Fig. 3).

	Winter 98/99	Winter 99/00
Lighthouse occupation	23 days	55 days
Recorded raw data	abt 500 MB	abt. 3 GB
Recorded time laps video sequenses	abt. 600 h	abt. 1300 h
Ice structure interaction events	60/24	86/23

Two Video cameras placed in heated weather housings were mounted to the railing of the balconies. A third camera equipped with an electronic lens picked up the overall ice situation and could be focussed on special ice features or ice structure interaction events. All video signals are distributed to a multiplex unit, recorded in time laps mode on a long time video recorder and monitored on a TV-Screen. Lights were installed to make video observation possible even during night time.

The ice drift speed and direction was determined by image analysis of the video records.

During the two winters of lighthouse occupation, 1999 and 2000, data were collected during interaction with the following ice features

- level ice thickness of 15 to 50 cm
- rafted ice thickness up to 1.2 m
- hummock ice fields
- pressure ridges with a keel depth of more then 6 m

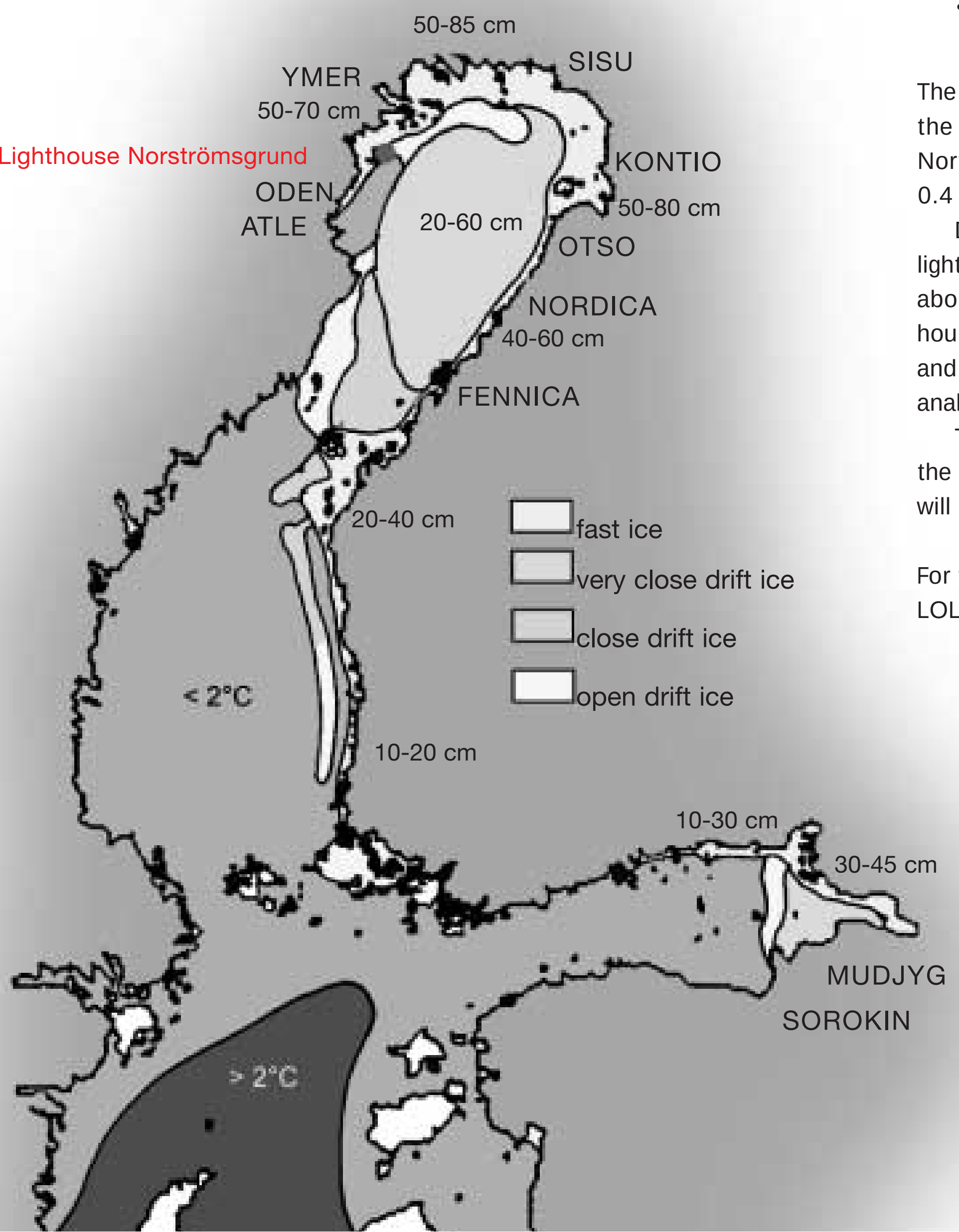
The predominant ice drift direction of the analyzed events was from Northeast and the ice drift speed up to 0.4 m/s.

During the two winter periods the lighthouse was occupied at 88 days, about 3.5 GB of raw data and 1900 hours of time laps videos were recorded and 47 of 146 defined ice events were analyzed.

The results of the project, especially the ice forces, are still confidential but will become public at the end of 2003.

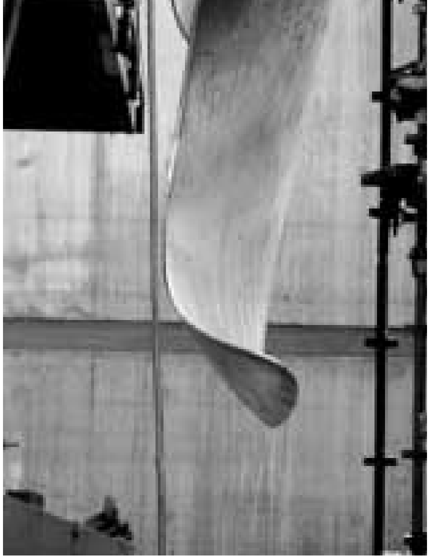
For further information please visit the LOLEIF web page www.hydromod.de/loleif

Fig. 3 Ice chart (FMI, 03. 04. 2000)



First Full Scale Apllication of the Kappel Propeller

by Jürgen Friesch



The KAPPEL propeller blade geometry based on the principle of non-planar lifting surfaces

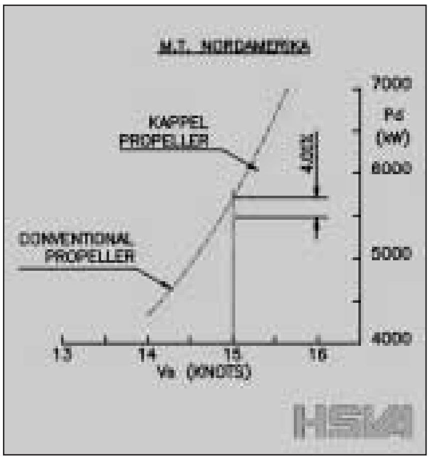
The EU funded KAPRICCIO project has now been brought to a satisfactory conclusion with the successful sea trials of the first full scale KAPPEL propeller on the vessel M.T. NORDAMERIKA owned by D/S NORDEN A/S of Copenhagen.

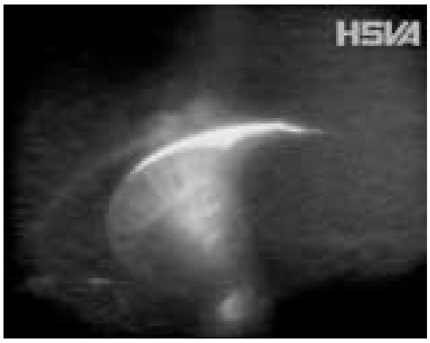
A first set of trials was carried out with the conventional propeller fitted. Prior to these trials the vessel was dry-docked for hull cleaning and propeller polishing. A second set of trials was carried out immediately after re-docking the ship to exchange the conventional propeller for the KAPPEL propeller.

Both sets of trials were carried out under the supervision of HSVA in good weather conditions and included a comprehensive range of double run speed trials plus turning circles. The vessel was fitted with a differential GPS system for measurement of ship speed and track, together with instrumentation for the accurate measurement of shaft powers and speeds. In addition, windows were installed in the hull to permit full scale cavitation observation, whilst pressure transducers and accelerometers were used to monitor pressure impulses on the hull and local structural vibrations.

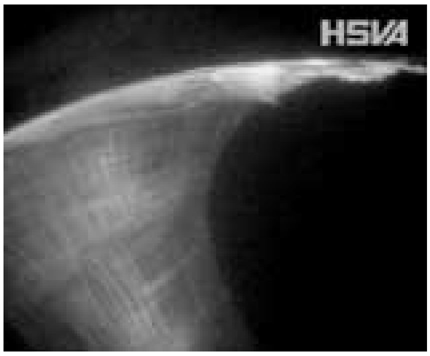
These trials have clearly demonstrated the superiority of the KAPPEL propeller.

At the 15 knot condition the vessel's power requirement was reduced by approximately 4%. This will result in a corresponding reduction in fuel consumption, fuel costs and exhaust emissions.



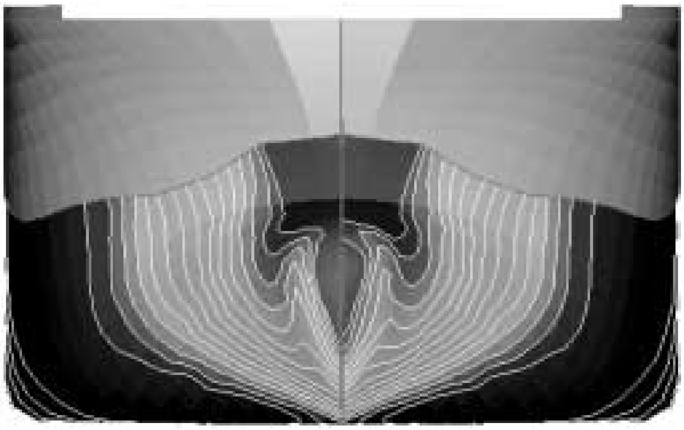


Full Scale Cavitation Behavior at 15,4 kts (90% MCR)



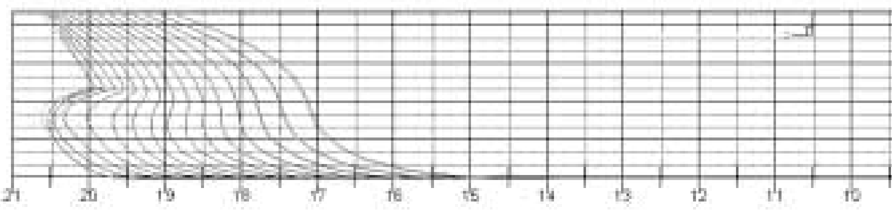
The observed cavitation phenomena showed an improvement compared with the conventional propeller, and consequently excitation forces arising from the action of the propeller were also improved.

The full scale results were a resounding confirmation of the improvements which had been predicted by HSVA and mean that owners and builders may now with confidence take advantage of the benefits offered by this new technology



Pressure distribution for original (left) and modified (right) hullform

AUTOMATIC HULLFORM OPTIMISATION USING CFD CRITERIA



by Jochen Marzi

The desire to perform interactive or automatic hullform variations and instantly check the effects on the hydrodynamic properties of a ship may well be as old as the foundations of scientific shipbuilding. It is only now that due to fast and sufficiently accurate numerical methods – CFD – and the use of powerful computers this wish is likely to become true in the very near future.

In 2000 HSVA launched a research project aimed at a series of automatic hullform modifications (ruled by user interaction) and subsequent CFD analysis. This is integrated into an optimisation environment controlling the entire process through the application of search strategies such as SIMPLEX or others.

CFD analysis is presently confined to potential flow computations. HSVA's ν-SHALLO code is extensively used here. At a later stage also RANSE methods are envisaged for introduction into the optimisation process.

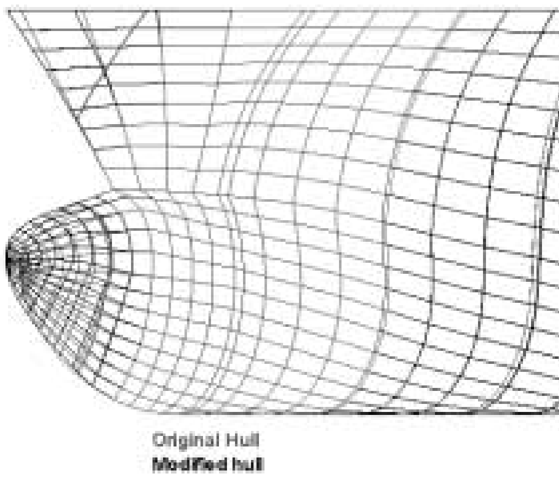
A new geometry module has been developed that allows a simple hullform modification based on only few parameters.

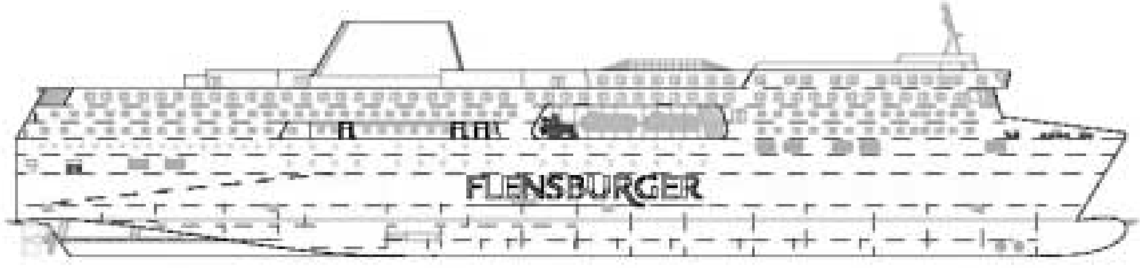
The new programme – PANIPUL – works on the basis of an existing panel file for a potential flow computation. Based on a few input parameters, the hull may be deformed in certain areas of interest. This modular programme presently allows for

- global changes, e.g. B/T variations or an LCB shift
- local modifications, focussing on changes in the bulb/forebody geometry of a given hull.

Other modification functions can easily be implemented. In their automatic configurations PANIPUL and ν–SHALLO are integrated in a global optimisation environment based on the FRONTIER programme from Esteco. Running on HSVA's parallel Linux, cluster this combination allows to analyse a larger number of incremental design alternatives in very short time and find a design optimum within the given set of constraints. A number of test cases have been run in the meantime. They show substantial improvements in (wave-)resistance.

Due to the superior speed, especially of the panel code, this method may even be applied in a conceptual design phase, determining principal dimensions of a ship to be customised for a specific trade.





The modern RoPax design by FSG used in the simulations.

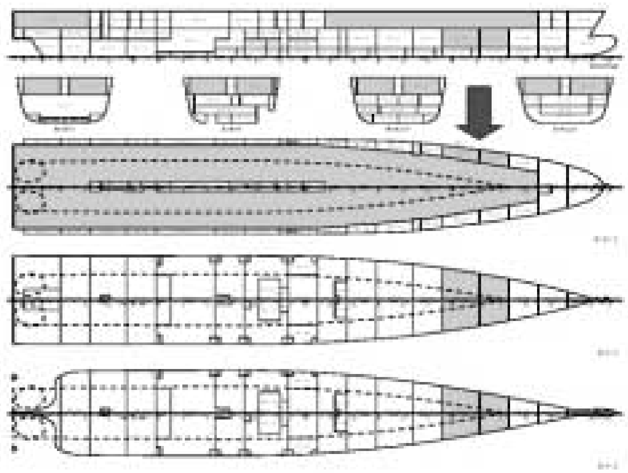
Time-Dependent Survival Probability of a Damaged Passenger Ship

by Petri Valanto

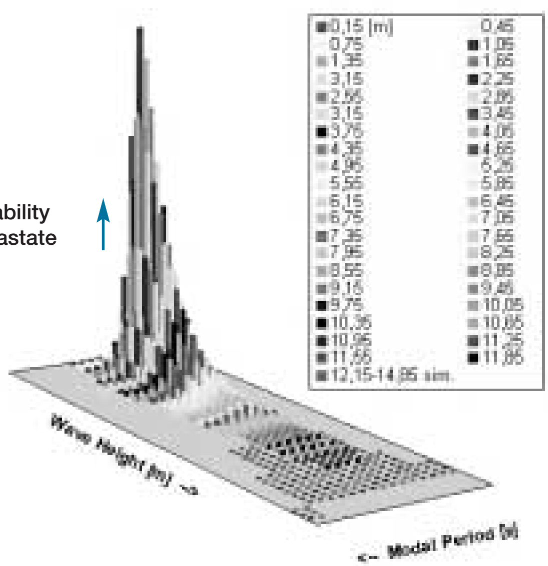
According to the regulations presently valid passenger ships need to have sufficient hydrostatic stability to survive certain damage cases (flooding).

The required damage stability does not guarantee in all cases the survival of the ship over longer periods, specially if the accident takes place at unfavorable weather conditions. New safety criteria, in which the probable evacuation times would be compared with corresponding survival times of the ship, would be a significant improvement, as the survival times reflect most essential conditions related to the damaged ship and probable sea states in the area of operation.

In the framework of the project "Time-Dependent Survival Probability of a Damaged Passenger Ship", for the Federal Ministry of Traffic, HSVA elaborated a practical tool for the estimation of the survival probability of a damaged passenger ship. A method was developed to evaluate the average survival times after a collision at sea as a function of the cumulative probability based on wave statistics. It is possible to evaluate the survival times for different types of ships, subdivisions, loading conditions, types, extents and locations of the damage, and the probable sea states in the operations area. The subdivision of the ship into compartments is modeled and plays an important role in the simulations of the damaged ship and thus the merits between different designs can be found out.



Example of the hydrostatic damage calculations done by SDC, HSVA's subsidiary. The data is used as input for the computer code Rolls. The red arrow shows the opening due to the collision. The flooded compartments are marked with blue.

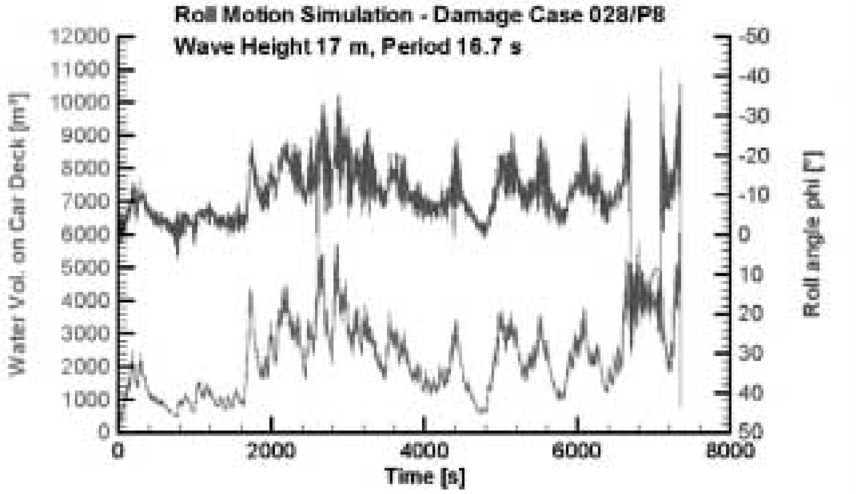


A 3-D Wave scattergram. The steeper waves used for the simulation are shown with red markers.

The simulation of the ship motions in the seaway together with the time-dependent flow in and out of the damaged compartments and vehicle deck was carried out with the program ROLLS. The simulation of ship motions in irregular seas is based on combining the method for intact ships with the simulation of liquid flow in ship compartments and on decks. The ship is considered as a six-degree-of-freedom system traveling at a given mean angle relative to the dominant direction of a stationary seaway. For the heave, pitch, sway and yaw motions, the method uses response amplitude operators determined with strip method, whereas the roll and surge motions of the ship are simulated using nonlinear equations of motion.

Special emphasis in the present version of the program Rolls is placed on simulating realistically the motion of water on deck and in the internal compartments. The rate of inflow and outflow of water through any opening is estimated from the motion of the internal and the external water surface relative to the openings at each time step. The openings can be located at the shell of a ship or at internal subdivisions between compartments; they may be intended as openings, or they may be produced by damage, e.g. due to a collision. The forces and moments due to the interior fluid motion in partly flooded rooms and on the vehicle deck are also determined and added to the other moments due to wave excitation, wind etc.

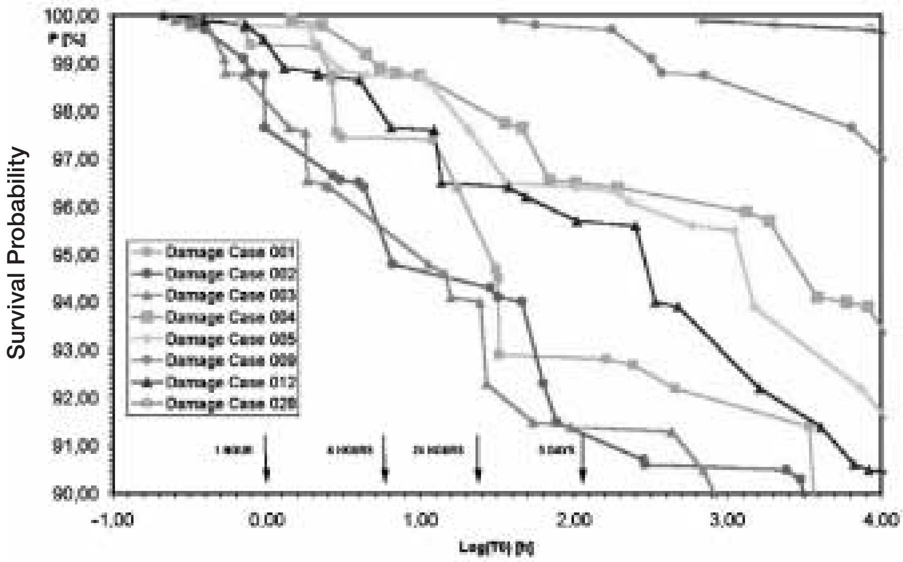
The estimation of the ship capsizing time for real seaway parameters is known to be extremely ineffective in terms of computation time, while the capsizing times are very long for the required time integration and in many cases the ship would not capsize in any reasonable time period. Therefore the capsizing simulations were carried out in higher (and steeper) waves, with the same significant wave period. The computed capsizing times are then extrapolated to the real seaway height.



Simulated time-history of the roll angle and the volume of water on the vehicle deck until capsize. Notice the almost perfect correlation.

The figure below shows differences between the most severe damage cases chosen based on the minimum GM required by SOLAS. The order of the curves in the figure shows also that the minimum required GM is a good indicator of the severity of the damage, but it does not order the damage cases according to severity correctly like the more sophisticated capsize simulations do. The most severe damage cases 001, 002, and 003 are all located at midship. The cases at stern (005, 012) are almost as severe as in the midship, which most likely reflects the fact the that the ship has full breadth at the stern, in contrast to the areas of the least severe damage cases (009, 028) at the bow. The full breadth at the stern allows an easier inflow into compartments than in the bow.

The basic idea to design the ship so that the evacuation (or rescue) is possible in the time prior to capsizing is a very good one, and its application should also lead to safer ships. It should, however, not be limited only to comparing different designs, but should also used to define an improved safety standard for ships carrying a large number of passengers. For this HSVA is more than willing to give its contribution.



Survival times of the ship with all computed damage cases 001-028 in the North Sea. All year wave statistics is used.

INNOVATIVE CFD TOOLS

by Andres Cura Hochbaum and Mathias Vogt

Traditionally, ship motions and loads are calculated using methods based on the slender body theory or panel methods. These methods rely on potential flow theories and most of them can not handle steep and/or breaking waves.

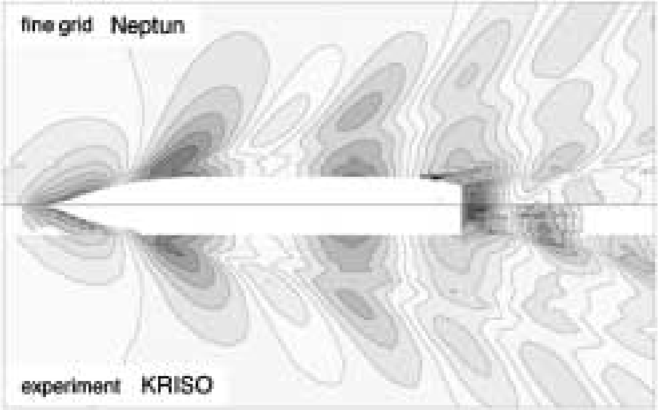


Fig. 1 Computed and measured wave patterns of the KCS at Froude number Fn=0.26. Blue areas denote crests and grey areas troughs.

Thus, they are not suitable for motions significantly influenced by viscosity, e.g. surge and roll, and cases where slamming and green water occurs. In order to account for all relevant hydrodynamic aspects involved in ship motions during rudder manoeuvres and/or caused by oncoming waves, steps have recently been taken at HSVA towards the simulation of Seakeeping and Manoeuvring based on free surface viscous flow computations. To our flow solver Neptun we have added a numerical wave generator and the six degrees of freedom equations of motion of the ship.

In this method the fluid flow around a moving ship is considered to be the flow of a single fluid with two immiscible incompressible phases: water and air.

The interface between both phases represents the free surface. By solving the Reynolds-average Navier-Stokes equations (RANSE) the viscous water and air flow around the ship and the forces and moments acting on the hull are predicted. Reynolds stresses are approximated with a k-ω turbulence model and the free surface is determined with the Level Set technique.

At the CFD Workshop in Gothenburg 2000, the prediction of the free surface flow around one of the reference ships, the KRISO container ship (KCS), achieved with this method was considered top ranked, Fig.1.

Integrating the computed pressure and skin friction on the hull yields the hydrodynamic forces and moments acting on the same. Forces and moments stemming from the propeller are approximated with a simple model.

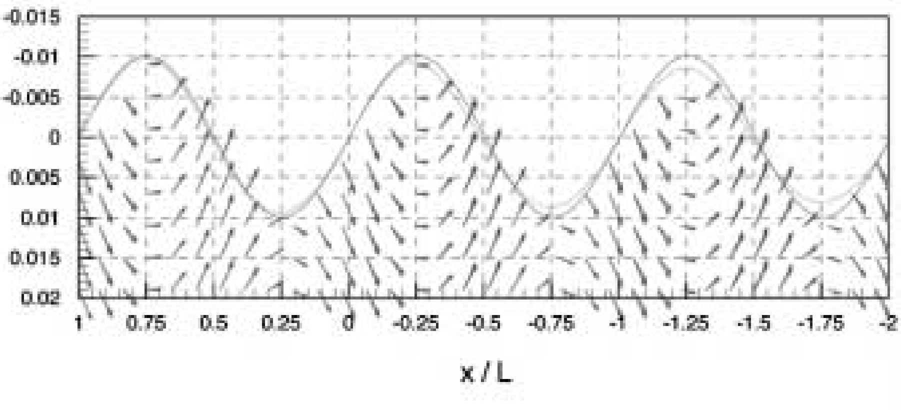
Then the right hand sides of the ship motion equations are known and these equations can be numerically integrated in time to get the position and velocities of the ship for a new point of time. For this, known ship velocities and angular velocities from the previous time step are used.

Now, the inertial forces that appear in the fluid equations using a ship fixed coordinate system and the boundary conditions are updated in order to solve the RANSE again in the next time step, thus closing the cycle of the time marching procedure used.

Oncoming waves are generated through the boundary conditions at the inlet of the computational domain. There, the height of the free surface and the orbital velocity components of harmonic waves are given at all points of time according to the potential flow theory.

Arbitrary sea states can also be generated using this technique by superposition of harmonic waves. The waves are considered to be already fully developed at the inlet boundary. They can be regarded as having been generated far in front of the grid and pass the inlet into the computational domain without disturbance. As can be seen in Fig. 2, the implemented technique proves to be very good.

Fig. 2 Snapshot of a computed harmonic wave superimposed to a uniform flow (in red) compared with the corresponding profile and velocity distribution of the potential theory (in blue).



Simulations of the Series 60 ship moving straight ahead in harmonic head waves at Fn = 0.316 show that the pronounced wave system of the ship is only moderately distorted by the long, small oncoming waves considered in this case, Fig. 3 and 4.

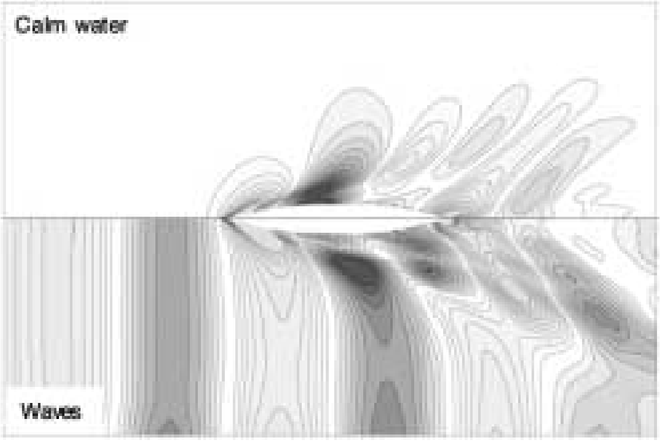


Fig. 3 Computed wave patterns of Series 60 ship in calm water and in head waves

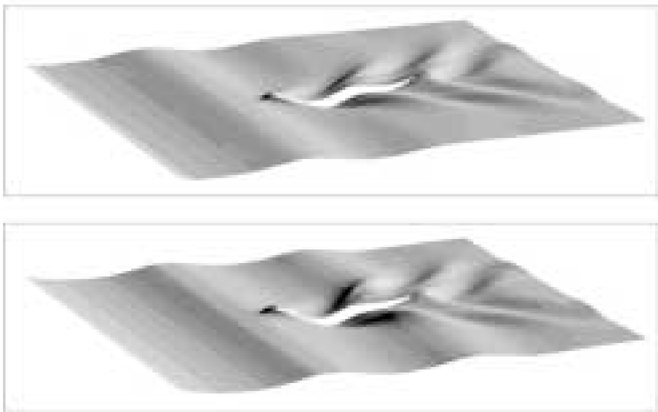


Fig. 4 Two snapshots of the simulation of the flow around the Series 60 ship in head waves

The agreement between the computed and measured longitudinal force acting on the model of a modern container ship moving straight ahead in oncoming harmonic waves is surprisingly good, considering that a coarse grid was used, Fig. 5. A snapshot of the same simulation at the moment when the wave crest is at the bow is compared with a photo of the experiments in Fig. 6. The qualitative agreement is striking and even the wave breaking is captured fairly well.

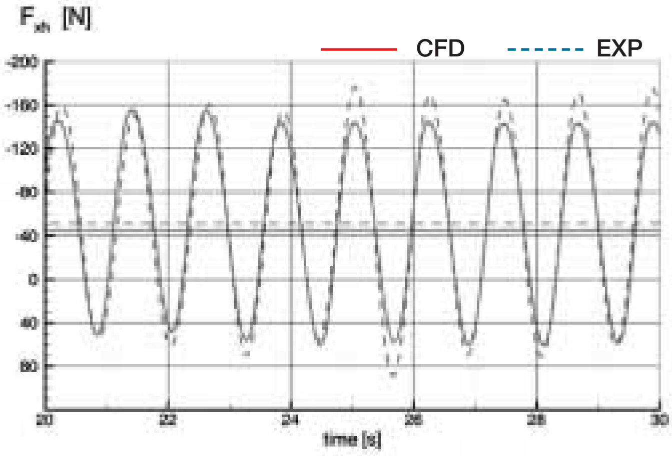
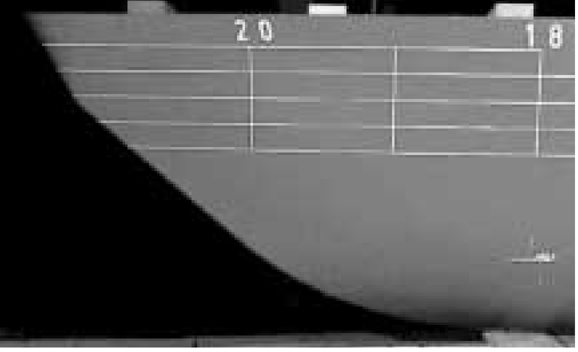


Fig. 5 Computed and measured longitudinal force at a container ship model in head waves

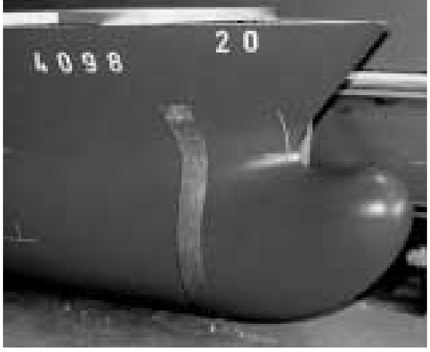
Fig. 6 Snapshot of the flow simulation for a container ship in head waves compared with a photo of the model test

A short sequence of the simulation is depicted in Fig. 7. Starting on the top of the figure from a slightly positive trimmed position this covers a period of the surge, heave and pitch motions.

Fig. 7 Simulation of the motions of a container ship in head waves



Classical icebreaking stem



Conventional bulbous bow

Icebreaking bulbous bow

Hull Form Optimisation

by Karl-Heinz Rupp, Volker Bertram

Ship hulls which combine good open-water characteristics with ice-breaking abilities have been developed within a major research project at HSVA sponsored by the BMBF (Bundesministerium für Bildung und Forschung).
The German shipyard Lindenau GmbH Schiffswerft & Maschinenfabrik was involved in this development from the very beginning. The shipyard evaluated the developed lines in a global design context (production, economics).

The envisioned ship represents a tailored compromise for regions with seasonal ice. During winter periods such a ship could operate during an extended winter navigation period without ice-breaker assistance, saving time and therefore money. In summer it is expected be superior to classical ice-breaking designs. In sum, this may well result in an overall economic benefit for certain regions, e.g. in the Baltic Sea.

The bow shape is decisive for the attainable speed in ice. Therefore different bow shapes were investigated:

- ❒ A conventional bulbous bow designed for open-water conditions as a basis
- ❒ An ice-breaking bulbous bow
- ❒ A classical ice-breaking stem

Photos above show the three bow shapes.

To allow a quantitative comparison all three forebodies were equipped with the same aftbody. The design of the aftbody was based on a project general arrangement plan of the Lindenau shipyard for a twin-screw 8000 tdw product tanker. The ship featured a double-hull structural design with two separated, completely redundant engine rooms.

The developed ship hulls were "optimized" in successive numerical simulations employing HSVA's latest wave resistance code ν-Shallo, before model tests in HSVA's large towing tank and ice tank commenced. These numerical and experimental investigations supplied the data needed for economic analysis for specific routes.

Results of model tests

- ❒ The comparison of the three models in calm open water at CWL draft showed practically identical propulsion power at the speed of 15 knots. This was possible for the classical icebreaking design by lengthening the vessel. The result is shown in Fig.1. In order to compare the results with other models of HSVA's database, the test results of selected models were scaled to the same displacement. The result was that the three investigated models have a better performance compared to existing models.
- ❒ In level ice the vessel with the conventional bulbous bow needs 2.5 times more power to sail at the same speed than the two icebreaking models. (Fig. 2)
- ❒ In ice floes there were only small differences in propulsion power for sailing ahead between the models. The vessels were able to shift ice floes aside. Within this sense the ice breaking ability of the model was no longer the defining parameter – its ability to shift ice floes was more important.
- ❒ Sailing in ice floes astern was tested with submerged and emerged vertical transom. With submerged transom ice floes were pushed and ice accumulated at the stern. Therefore the vessel needs 2.5 times propulsion power of the model with emerged transom. (Fig. 3)

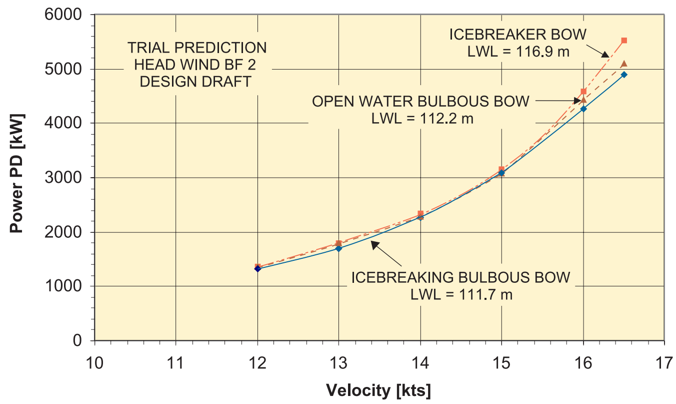
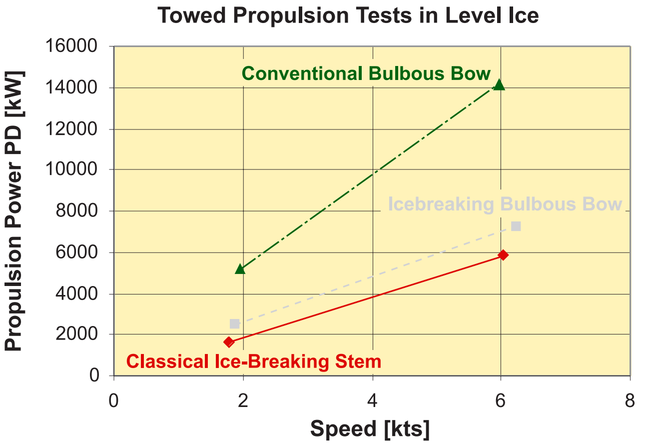


Fig. 1 Performance tests in calm open water



Ice-Going Coaster
Loaded Draft,
Tf = 7.50 m

Level Ice:

Ice Thickness	0.40	m
Flexural Ice Strength	600	kPA

Fig. 2 Performance tests in level ice of 0.4 m ice thickness ahead

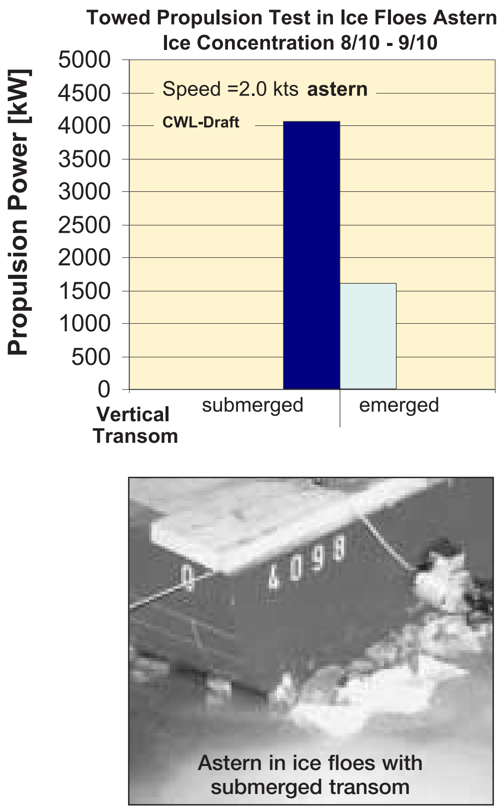


Fig. 3 Performance tests in ice floes of 0.4 m ice thickness, astern with submerged and emerged transom

Model test results are only one part in the economy of a vessel. In order to find the most economic vessel for a specific ship route an economic analysis program is being developed.

This project shows that with HSVA's experience, design ideas, CFD calculations with ν-SHALLO and model tests good results for vessels operating in open water and in ice could be achieved.

Testing of a Multidisciplinary Antarctic Benthic Laboratory (MABEL) in Cold Environment

by Karl-Ulrich Evers

In the framework of the Italian Antarctic Programme, a group of Italian and German research institutions and companies (Istituto Nazionale di Geofisica e Vulcanologia-(INGV), TECNOMARE SpA, Istituto Nazionale di Oceanografia e Geofisica Sperimentale (OGS), Technical University of Berlin (TUB), Technische Fachhochschule Berlin (TFH) are developing a multidisciplinary benthic laboratory (MABEL), for continuous and long-term measurements of geophysical, oceanographic and chemical parameters in Antarctic waters.

MABEL's scientific instrumentation will allow to record in time local and teleseismic earthquakes, seismic noise, and to measure earth magnetic field, sea currents and main chemico-physical parameters.

The first mission of MABEL is scheduled in the Weddell Sea, within the framework of a scientific co-operation between INGV and Alfred Wegener Institut (AWI) that includes the use of R/V Polarstern.

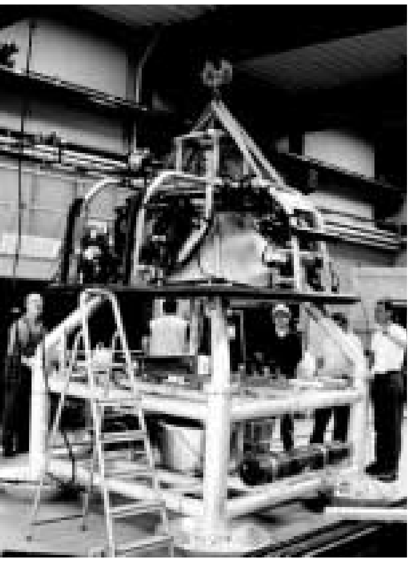
The observatory MABEL is composed of:

1. an instrumented ground station (GS), approximately 2.5x 2.5 x 2.5 m, weight is 15 kN in air, working depth is 4000 m below MSL
2. a recovery vehicle (MODUS), a special ROV capable to handle the ground station (GS)
3. surface equipment, including power generator, control units
4. scientific payload mounted on the observatory
5. a dedicated electromechanical cable and winch

In order to ensure complete operational reliability of the observatory in the extreme conditions of Antarctica, a dedicated phase of tests has been carried out in July/August 2002 in the deep water section of our Large Ice Model Basin.

The aims of these tests were:

1. simulation of the operational sequences (deployment, mission, recovery) at Antarctic temperatures, inside and outside water



The recovery vehicle MODUS is docked to the ground station (GS)

2. verification of the overall functionality of the observatory when exposed to Antarctic seawater conditions.

The tests demonstrated the capability of the observatory and its components to operate in Antarctic conditions. All the tests carried out in the Large Ice Model Basin were successfully performed; long-term series of data collected from all scientific packages installed (OAS E-2PD hydrophone, Sea Bird SBE 37-SI MicroCat CTD, FSI 3D-ACM single point current meter). At the same time the main status parameters were monitored (internal temperatures, battery voltage and currents, etc.) and found in the expected ranges. After the observatory was submerged and parked on the bottom of the ice tank, the observatory has been interrogated via Underwater Acoustics.

An experimental package developed for the detection of chemical parameters has been qualified in cold environment too.

The access to the facility ARCTECLAB is financially supported by the Improving Human Potential Programme (IHP) of the EU through contract HPRI-CT-1999-00035.

RECENT RETIREMENT

Dr. Peter Oltmann

Peter Oltmann, an appreciated scientist known worldwide in the field of manoeuvring has left HSVA to take early retirement. He joined HSVA in 1964 as a research engineer within the Research Department and was engaged in investigations on the reduction of ship's frictional resistance, interactions between passing ships, and the design of lateral thrusters.

From 1972 to 1980 he worked for a special research pool for ship technology at the Institute of Naval Architecture of Hamburg University. Thereby he was substantially entrusted with the development of HSVA's Computerized Planar Motion Carriage (CPMC) put into operation in 1975. In 1978 Peter Oltmann published his remarkable doctoral thesis which still is present: "Determination of Manoeuvring Characteristics from Trajectories of Free-Running Ship Models".

In 1980 he returned to HSVA and since then he has been responsible for manoeuvring related problems. Peter Oltmann's high international reputation is based on his major contributions to this topic.

Between 1981 and 1990 he was member of the International Towing Tank Conference (ITTC). Since 1988 he has been chairman of the Manoeuvring Committee of the German Society of Naval Architects (STG).

Peter Oltmann will continue to support HSVA in the future, but his new main interest is manoeuvring a small round vessel into a small hole, an activity (also known worldwide) as playing golf. For this undertaking we wish him as much success as he had in the field of ship manoeuvring.

MEMBER OF STAFF

ANDRES CURA HOCHBAUM

Dr.-Ing. Andrés Cura Hochbaum has recently been appointed as Head of Manoeuvring. He joined HSVA in 1993 as a project manager within the CFD Department. His main activities involved the further development of CFD methods including the development of the RANSE code NEPTUN.

This code is international well recognized and demonstrated its outstanding performance and accuracy during international workshops.

Andrés Cura Hochbaum changed in 1998 to the department of Seakeeping and Manoeuvring where he worked together with Dr. Oltmann on manoeuvring related problems. He successfully reactivated the model testing technique with captive models fixed to the Computerized Planar Motion Carriage (CPMC) in order to measure the resulting forces for prescribed model motions. Dr. Cura also applies his RANSE Code NEPTUN as a supplement and/or alternative to manoeuvring model tests.

At present Dr. Cura and his group develop among other research projects a CFD code for EADS (Airbus) which simulates the ditching of airplanes (emergency landing on water) under consideration of cavitation and ventilation effects.

Andrés Cura Hochbaum who was born in Montevideo (Uruguay) received his diploma in naval architecture from the University of Hamburg where he stayed as a research engineer and obtained his doctoral degree working for Prof. Söding.