



IN THIS ISSUE:

- 50 Years of Model Testing in Ice at HSVA
- Model Testing of Propulsion Improving Devices (PID) at HSVA
- Cavitation Research on a Very Large Semi Spade Rudder
- VIRTUE goes public
Major project presentation at SMM
- Combined Numerical Investigation of Cavitation on Propeller and Rudder
- HANDLING WAVES –
“Decision support system for ship operation in rough weather“
- Oblique towing and turning tests in deep and shallow water

Dear Reader,

A warm welcome to our latest edition of Newswave. With this Newswave we would like to invite you to meet us at SMM 2008 in Hamburg at our booth 260/261 in hall B4. There we will present an outline of our latest developments and our team is prepared to answer any questions you may have. The remainder of 2008 will be more challenging, nevertheless we feel that it will be another successful year.

High fuel cost, strong requirements concerning emissions and therefore the need to reduce the energy consumption forces us not only to think about but to realise different developments to improve the overall behaviour of your products. The key is still designing, building and operating ships more efficiently, but existing ships also need to be improved. Newswave shows how propulsion improving devices (PID) can help.

Optimisation of the rudder is another key point in the hydrodynamic design strategy. Have a look at the very large rudder model tested in HYKAT just this year, providing benchmark data for detailed RANSE calculations.

Offshore goes ice! Therefore, model tests concerning drilling operations in ice, new drill ship designs and the development of loading terminals in icy waters become even more important. In this Newswave we inform you how we prepare our ice in order to fulfil the very high requirements of such tests.

We all look forward to meeting with you at SMM 2008 in Hamburg.

Juergen Friesch
Managing Director



50 Years of Model Testing in Ice at HSVA

✍ by Walter Kuehnlein

When we talk about state of the art ice model tests, not only the model and the ice thickness is scaled, but also the ice parameters like ice strength (bending and/or crushing strength), fracture toughness, elastic modulus, and others need to be scaled.

HSVA started already in the 1930ies with ice model tests. At that time ice model tests were performed only in winter on frozen lakes, rivers or seas. These simple model tests could just compare the resistance of different hull shapes (models) in order to find the hull shape with the lowest resistance assuming that the full scale shape would also be the best of the tested model shapes. These qualitative assumptions are in general correct, but having the “best” shape does not help too much when it comes to the quantity, i.e. the power prediction for the full scale ice going vessel. Very soon, it became obvious that the results are not really adoptable to full scale problems. At that time the idea was already born that an indoor ice model basin would be required, where the ice could be generated independently of the outdoor temperature and ice parameters could be adjusted.

HSVA Ice Model Basins

1958	1 st ice tank at HSVA (already with model ice)
1972	2 nd ice tank (Arctic Environmental Test Basin)
1984	3 rd ice tank (Large Ice Tank)

Finally in 1958 Prof. Grim and Dr. Waas (well known for his Thyssen Waas Ice Breaking Bow) were able to built one of the first model ice basins in the world: 8 m long, 2 m wide, 1 m deep. At that time, no one had any knowledge about how to scale ice properties like bending strength, which is the most important value for normal ice going vessels. Therefore HSVA’s ice experts started to investigate different methods and ideas how to soften the model ice.



Fig. 1: HSVA’s first ice tank (1958)



Fig. 2: Model test in HSVA’s first ice tank

After some not very successful methods, they found the use of urea very suitable in order to lower the strength of the model ice. As these still very basic tests were very successful and the demand for more reliable power predictions for ice going vessels increased, a new larger ice model basin was planned.

The construction of this new basin was also supported by the demand of the offshore industry for ice model tests, which just started at that time. In 1972, HSVA put the second ice tank in operation. The basin is 30 m long, 6 m wide and 1.2 m deep. The air temperature can be regulated down to -20°C, allowing the simulation of typical arctic ice conditions such as level ice, broken ice, frazil ice and pancake ice, pack-ice, rafted ice and pressure ice ridges. Windows in the bottom of the basin and later on also an underwater video system allow visual observation and documentation of scenarios underneath the ice cover. Especially since Dr. Schwarz joined HSVA in 1975, this ice tank became very busy and the model ice generation was further developed. Quite some world first offshore structures in ice have been tested in this tank

and one of the highlights was the testing campaign for the German research vessel “Polarstern”. Four different model scales of the “Polarstern” have been tested. These investigations can be considered as a very fundamental and important research work concerning scale effects for ice model tests.



Fig. 3: German Research Vessel “Polarstern” (1982)

But the model tests for “Polarstern” demonstrated also the physical limitations of this model ice basin. As a consequence the “Large Ice Tank”, the third ice tank of HSVA was designed by the ice and offshore group. The 2nd ice tank is still existing and in use, as the



Fig. 4: Basic outline of HSVA’s 2nd ice tank

worldwide largest refrigerated Arctic Environmental Test Basin. In addition to the ice-making facilities, special features include a current generator and a mobile wave generator capable of producing wave heights of about 0.3 m.

HSVA's Large Ice Tank was officially opened during the 1984 International Association of Hydraulic Engineering & Research (IAHR) Symposium on Ice, which was hosted by HSVA. This tank has the dimensions: 78 m long, 10 m wide and 2.5 m deep and at the end a deep water section of 12m x 10m x 5m, which allows worldwide unique ice model tests.

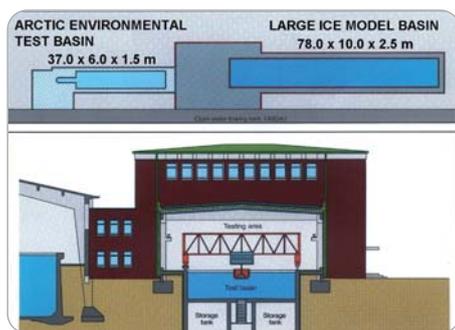


Fig. 5: Basic outline of HSVA's 3rd ice tank (1984)

The basin is also equipped with a shallow water bottom covering the entire ice basin. This bottom can be adjusted to simulate shallow water conditions or inland waterways. As a special and worldwide unique feature, the bottom elements including the grounded or moored model can be pushed through the ice, simulating grounded or moored structures in a confined ice environment (much wider ice sheet compared to the tank width). If suitable this type of model tests has quite some advantages compared to the normal method, where the model is fixed or moored and the ice is pushed against the model. But also these conventional tests can be performed if requested or if they are more suitable.

The Large Ice Tank was put into service with an improved "urea ice generation procedure" in order to scale (lower) the strength of the

model ice according to the chosen model scale. Parallel to the commercial use of the Large Ice Tank intensive research projects have been performed in order to improve the model ice generation technique. The strange smell of the urea (urine) was just one reason for doing this, but not the major one.

HSVA's model ice is grown from saline water with about 0.7% salt. During the ice freezing period the tank water, which is supersaturated with air, flows under pressure through a perforated pipe system. When the pressure drops tiny air bubbles release and are entrapped in the growing ice sheet. This treatment provides a relatively stiff and brittle model ice. For correct scaling of ice strength, the model ice will be tempered for several hours after freezing.

An air forced cooling system generates air temperatures as low as -20°C, by which the NaCl-doped water freezes at a rate of about 2 mm/hour. The mechanical ice properties of the model ice are correctly scaled in order to simulate the natural icebreaking processes.

This advanced technique to improve the mechanical ice properties was developed and patented by HSVA. This new model ice allows to simulate first year sea ice frozen from sea water with a salinity of about 3%. A snow coverage of about 20% of the ice thickness is taken into account for full scale performance prediction in level ice.

The following model ice parameters given in table I can be adjusted in order to simulate full scale ice of any region of the world.

Today, HSVA is the leading ice engineering facility, working in all worldwide ongoing major offshore and main ship development projects. The Large Ice Tank is fully occupied for the next six to eight months, being busier than ever. HSVA's unique model ice and the highly motivated and experienced staff in model tests, full scale measurements, ice trials and numerical simulations enables HSVA to perform ice model tests in a very realistic ice testing environment, which ensures the well known world class quality of our test results, advices and conclusions.

Level ice parameters

Level ice thickness	10 - 120 mm
Ice density	700 - 920 kg/m ³
Flexural strength	10 - 150 kPa
Compressive strength	20 - 500 kPa
Elasticity modulus	20 - 300 MPa
Ice friction coefficient – coated	0.04 - 0.25
Ice drift speed	0 - 3 m/s

Ridge parameters

Sail height	30 - 300 mm
Keel depth	120 - 1200 mm
Keel width	acc. client
Consolidated layer thickness and profile	acc. client
Calculated ice ridge cross-sectional area (underwater)	acc. client
Bending strength, consolidated layer	20 - 150 kPa
Compressive strength consolidated layer	40 - 500 kPa
Rubble int. friction (sail/keel)	acc. client
Rubble cohesion (sail/keel)	acc. client
Rubble porosity	0.5 - 0.8

Table I: Ice Properties and Parameters to be adjusted

Model Testing of Propulsion Improving Devices (PID) at HSVA

✍ by Uwe Hollenbach

As a reaction to the rapidly increasing fuel oil costs, many ship owners are demanding that all possible measures are taken to reduce fuel consumption for ship new building projects. State of the art for reaching this goal from the hydrodynamic standpoint is intensive hull form and appendage optimisation accompanied and confirmed by scale model tests.

However, even for optimised hull forms there are still propulsion losses which are normally not dealt with during the optimisation process. The most obvious are the substantial losses in the propeller slipstream. Means to recover that energy, such as the Grim wheel or contra rotating propellers have been considered too expensive or technically complicated. Energy recovering fins are simple and robust. Fins aft of the propeller (also known as thrust-fins or post stators) must be carried by the rudder or the rudder horn in an accelerated flow, where devices ahead of the propeller (ducts, fins, guide vanes or pre-swirl stators) are easier to integrate into the structure. In the following these devices are referred to as **Propulsion Improving Devices**, or PID.

Today primarily the large Korean shipyards including Daewoo Shipbuilding & Marine Engineering Co., Ltd (DSME), Hyundai Heavy Industries Co., Ltd (HHI) and Samsung Heavy Industries Co., Ltd (SHI) are investigating means for recovering the losses in the propeller slipstream. While HHI and SHI operate their own towing tanks in Korea and have only occasionally been clients of HSVA, DSME is a regular client for their container vessel projects. Several sizes of the latest container vessel developments of DSME have been tested and optimised at HSVA.

History

The development of devices placed aft or ahead of the propeller for improving the propulsion efficiency now dates back more than 100 years. In his paper "Retrospective and prospective view on the development of the contra-propeller" presented at the general meeting of the German Society of Naval Architects (STG) in the year 1929, Dr. Rudolf Wagner focuses on the developments of the contra-propeller since 1905.

The contra-propeller at that time had been developed in various configurations, as guide vanes aft or ahead of the propeller and as rudders with twisted leading edge and as combinations of both. Depending on the individual characteristics these devices have been the forerunners of the asymmetric stern, pre-swirl stators, post stators, thrust fins and the rudders with twisted leading edge.

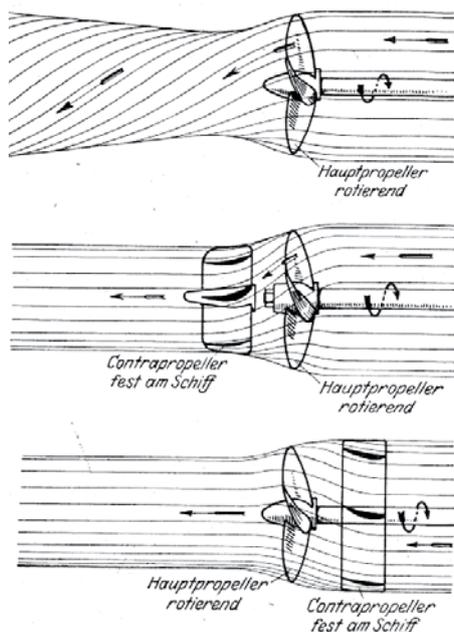


Fig. 1: Flow direction with contra-propeller aft and ahead of the main propeller

The common idea to all configurations was to eliminate the vorticity in the propeller slipstream, thus increasing the axial velocity and bundling up the slipstream of the propeller. This principle is shown in figure 1.

At that time not only devices ahead or aft of the main propeller had been investigated, but also combinations of both as well. Figure 2 shows the installation of a 2-bladed contra-propeller ahead and a 4-bladed contra-propeller aft of the main propeller. This was combined with a kind of integrated hub cap / rudder bulb. Today we would call this arrangement an "asymmetric stern and a rudder with twisted leading edge and a rudder bulb with post stator / thrust fins".

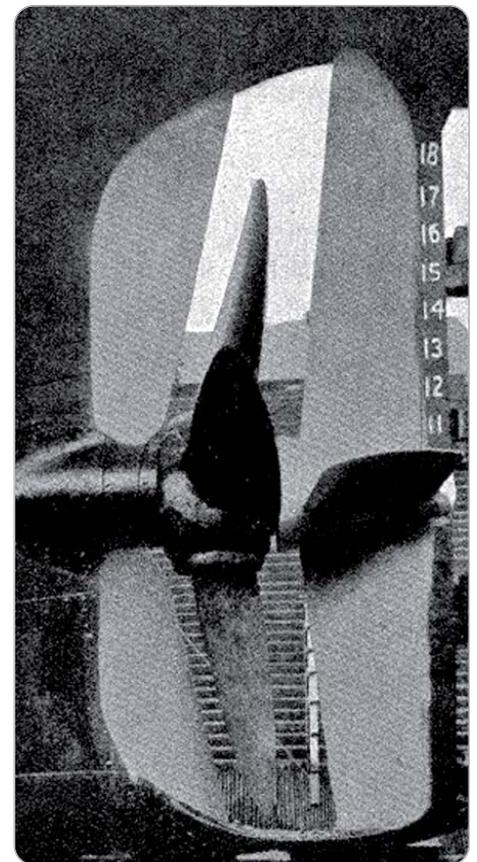


Fig. 2: 2-bladed contra-propeller ahead and 4-bladed contra-propeller aft of the propeller with hub cap

The Pre-Swirl Stator Concept

DSME has been developing the pre-swirl stator concept for more than 10 years now. The DSME pre-swirl stator concept consists of three to four stator blades mounted on the boss end of the hull in front of the propeller. The stator does not on its own save energy or create forward thrust, in fact it adds to the resistance. Despite the added resistance the stator blades induce a favourable asymmetric inflow to the propeller and thus improve the propulsion efficiency. In the case of a four blade stator as is typically for the Container Vessels, three blades are arranged on the port side and one blade is arranged on starboard side. The main role of the three blades on the port side is to reduce the slip loss of the propeller encountered when the blades pass upwards on the port side. The single blade on the starboard side is adopted to increase the wake fraction for higher hull efficiency while at the same time minimizing any unfavourable effect on propeller cavitation.



Fig. 3: DSME Pre-Swirl Stator

The Thrust Fin Concept

HHI has been developing the thrust-fin concept for several years. Both x-shaped thrust fin configurations with four blades and thrust fins consisting of only two blades have been investigated. The thrust fins are designed such that the blades generate thrust in the rotating propeller slipstream. The design of the twisted blades requires highly sophisticated numerical simulations and vast experience. During model tests the generated thrust can be recognised in a reduced thrust deduction fraction. This results in a higher hull efficiency and thus better propulsive efficiency.



Fig. 4: HHI Thrust-Fin

The Post Stator Concept

SHI is developing a Post Stator concept. X-shaped fins located aft of the propeller are combined with an integrated propeller cap and rudder bulb. This concept aims at reducing the losses due to propeller hub vortex and at recovering energy from the rotational losses in the propeller slip stream similar to the thrust fin concept. Compared to the pre-swirl stator, the post stator is relatively moderate in size (less than 80% of the propeller diameter) and does not have any effect on the propeller cavitation.

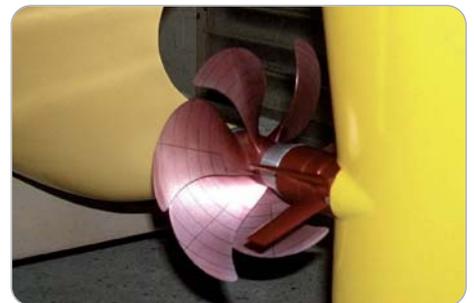


Fig. 5: SHI Post Stator

Model Manufacturing

There are basically two ways for manufacturing the PID in model scale: Either with fixed blades or with adjustable blades. In the case of fixed blades typically several models of a device are tested. Depending on the number of variants to be investigated, the model manufacturing can be costly unless rapid prototyping techniques can be used. On the other hand the different variants can easily be exchanged during the tests. The devices which are manufactured with adjustable blade pitch settings (or exchangeable blades) require a very high precision in the fabrication process. The model is manufactured such that the individual blades can be rotated around their own axes and independently fixed at given pitch settings within a range as discussed with the designer. The PID model must allow the blade adjustment to be done as accurately and as quickly as possible, because the alignment has to be changed between the test runs during the optimisation process.



Fig. 6: Detail of the Model Stator

Model Test Program

Model tests for optimising the blade settings are usually done at design draught and at design speed. The pitch setting is optimised by making a series of runs with different individual blade pitch settings. The starting point for the pitch settings is determined by the designer based on experience or numerical investigations.

During the pitch optimisation test, all conditions of blade pitch are investigated using a load varied propulsion test method. Following the optimisation a propulsion test is performed over a relevant speed range with the optimum PID configuration.

A reference propulsion test is performed for the same condition, but without PID. A comparison of these two tests reveals the gain to be expected by employing the PID. For the evaluation of both tests a resistance test without PID is used. For container ships a propulsion test with PID is also required for the sea trial draught in order to confirm the powering performance in full scale. The same holds for tankers for the ballast condition.

The cavitation test with PID is performed in the same manner as the cavitation test without PID. Performing the test in both conditions allows a comparison of the effect of the PID on propeller cavitation and pressure pulses.

Typical Gains by PID's

Between 2005 and 2008, HSVA has tested the following devices designed by DSME, HHI and SHI and other customers on different container vessel, multi-purpose and VLCC projects:

Year	Ship Type	Device	Gain in Propulsion Power	
			Design Draught	Ballast Draught
2008	16,000 TEU	Pre-Swirl Stator	3.8%	Not investigated
2008	13,050 TEU	Pre-Swirl Stator	4.5%	3.2%
2008	14,000 TEU	Pre-Swirl Stator	4.5%	4.7%
2008	Multi Purpose	Advanced Propulsor System	4.5 – 6.5% *	Not Investigated
2008	4,400 TEU	Pre-Swirl Stator	1.0%	Not investigated
2008	7,090 TEU	Pre-Swirl Stator	3.3%	0.4%
2007	VLCC	Pre-Swirl Stator	5.6%	5.5%
2007	6,300 TEU	Pre-Swirl Stator	3.3%	Not investigated
2007	8,000 TEU	Post Stator	3.9% *	Not investigated
2007	8,400 TEU	Pre-Swirl Stator	3.5%	1.1%
2005	VLCC	Pre-Swirl Stator	4.8%	Not investigated
2005	8,000 TEU	Thrust Fin	4.9%	Not investigated

* measured in HSVA's large cavitation tunnel HYKAT at higher Reynolds Numbers

Conclusions

As verified through a number of model tests for various sizes of Container Vessels, in particular the Pre-Swirl-Stator has proven to be reliable for further reducing the required power of already good hull form designs without any harmful effects on propeller cavitation.

It should be stated that the stator configuration (number of blades) and the blade settings have to be individually optimised for each hull form. The propeller as well must be designed for the chosen stator configuration, as the stator influences the propeller revolutions compared to the configuration without stator.

As can be seen from the above table, not necessarily all hull forms benefit from such energy saving devices. At present vessels with a high block coefficient such as tankers and bulk

carriers may gain more than the slender container vessels. The gain on design draught has proven to be slightly larger than on other draughts.

HSVA does not have full scale correlation data from its own performed sea trials for ships employing such energy saving devices. Information regarding model / full scale correlation for such devices is held by the developers of such devices, if they have performed dedicated model tests and corresponding sea trials. Recently, sea trials of the first VLCC equipped with a pre-swirl stator have been conducted by DSME and sea trials of a Container Vessel equipped with a Thrust-Fin have been conducted at HHI. The power gain claimed in both cases by the shipyards agree well with the model test results of HSVA for the same vessels.

Cavitation Research on a Very Large Semi Spade Rudder

by Thomas Luecke, Gerd Lammers,
Hanno Stoehrmann

In the first half of the year 2008 the national research project RUKAV has been finished successfully. The aim of this project was to investigate the scale effects of erosive cavitation on the pintle of semi spade rudders by use of two model scales. A typical erosion pattern in the way of the pintle can be seen in Fig. 1, which stands for several erosion patterns of that kind. We focused on an operating condition based on ballast draught at 27 kts, which represents a typical journey of a container vessel between Europe/USA and Asia.



Fig. 1: Erosion pattern at the pintle

The first model tests have been performed in the HYKAT with a rudder behind a complete ship model including propeller in usual scale 33.5. Besides cavitation observations, high-speed-video recordings and particle-image-velocimetry (PIV) measurements have been made.

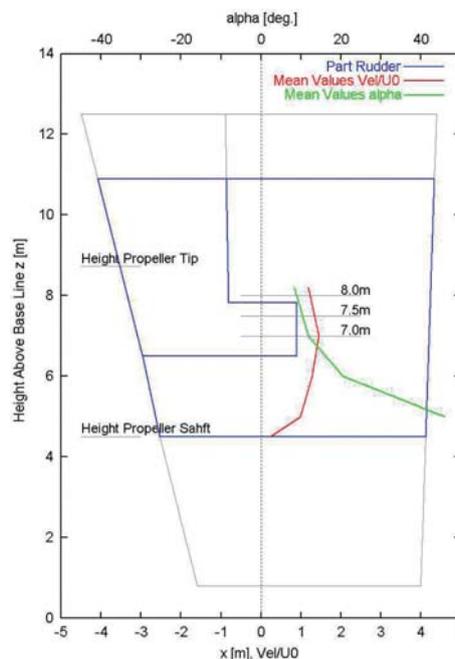


Fig. 2: Relation of the manufactured part rudder (blue) to the whole rudder (grey)

Particularly, these PIV-measurements of the velocity distribution were necessary to describe the inflow as the environment of the rudder within the propeller slip stream. The measurements are taken in several horizontal planes from an upward looking camera installed in the acoustic chamber underneath the test section. These measurements have been used for the second model test, in order to derive the proper boundary conditions for a very large partial model of a semi spade rudder in scale 4! (but without ship and propeller). Fig. 2 shows the whole rudder (grey) in full scale and its partial model (blue) which has been build from synthetic material. The colored lines show the velocity magnitude (red) and its inflow angle against mid ship (green).

The huge dimensions of the rudder model were a big challenge for the HYKAT crew. The inclined rudder for example generated lift forces up to 8 tons! These forces had to be conducted safely into the structure of the HYKAT.

Fig. 3 shows the partial rudder installed under the lid of the PMM (Planar Motion Mechanism); it has a mean chord length of 1.9m and a height of 1.5m. The draught marks are valid for full scale and they are used for orientation purpose. The rudder horn was fixed to the lid of the HYKAT, whereas the rudder blade was coupled to the PMM in order to allow rudder settings during the tests. The partial rudder was installed into the HYKAT with an inclination of 10° with respect to the longitudinal tunnel axis. This angle was derived from the velocity distribution out of the PIV-measurements, and it represents the induced transverse velocity in the propeller slip stream at the height of the pintle at a neutral angle (without rudder setting). Besides this neutral angle, a rudder-blade angle of 5° to starboard was investigated, which can be regarded as relevant for erosion since it represents the maximum angle used by an auto pilot for course keeping.



Fig. 3: Partial rudder under the lid of the PMM



Fig. 4: Cavitation pattern, rudder angle 0°



Fig. 5: Cavitation pattern, rudder angle 5°

At both rudder angles the cavitation behavior coincides acoustically and visually very well with the experience of full scale cavitation observations, even without propeller inflow. Figs. 4, 5 give an impression of the cavitation pattern around the pintle at 0° and 5° rudder angle, respectively. The vortical cavitation emanated at and out of the gaps. During the condensation process when the cavity

implodes further downstream, they hit the blade surface and induced strong vibrations. This cavitation pattern produced a typical sound like a crack of the whip in the air.

To visualize the flow pattern, which is responsible for the cavitation characteristic, PIV-measurements were also performed in the way of the pintle at the partial rudder.

The measurements have been made at cavitation-free condition. Figs. 6 and 7 show the velocity distribution as vectors and colored by magnitude on port side at the vertical gap of the pintle ($z=7.5\text{ m}$). One representative flow pattern at a particular time step is shown in Fig. 6 (rudder angle $\beta=5^\circ$). The pattern is dominated by several vortices, which could be seen in cavitating condition as cavitating vortex cores.

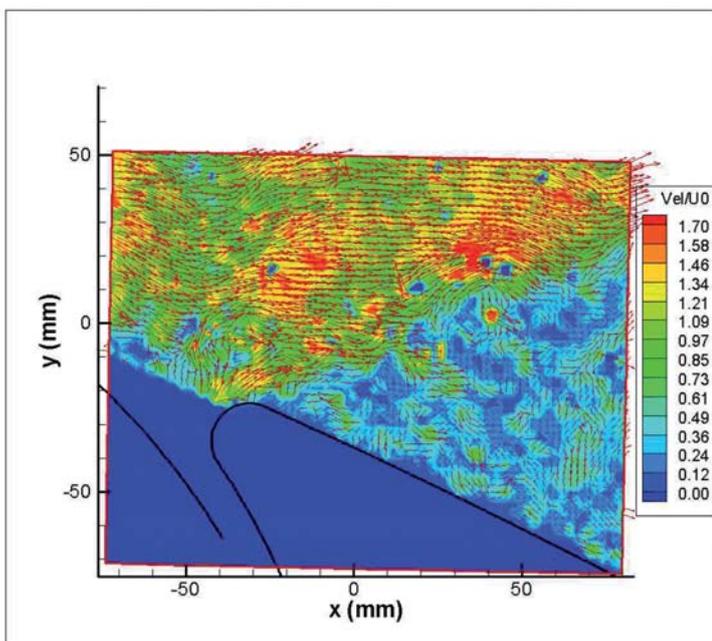


Fig. 6: Instantaneous flow field, rudder angle 5°

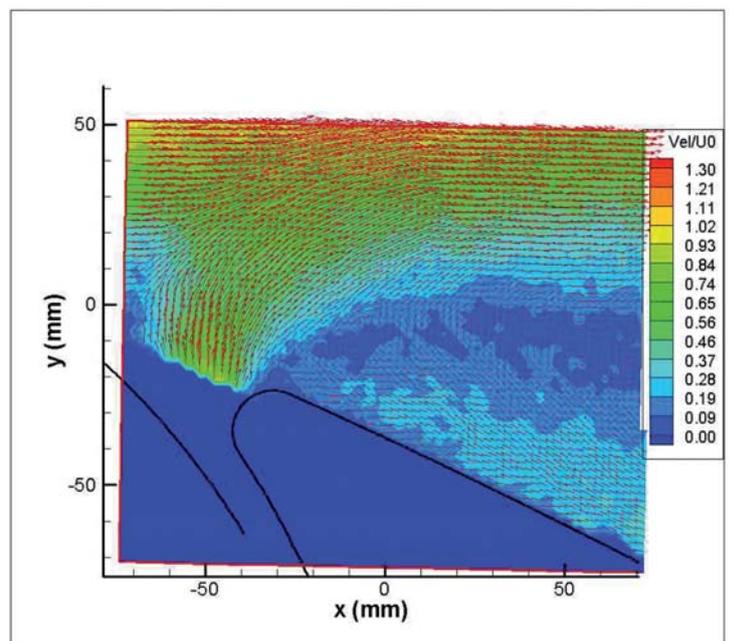


Fig. 7: Quasi-stationary flow field, rudder angle 5°

VIRTUE goes public

Major project presentation at SMM

✍ by Jochen Marzi

In order to express the flow field in a stationary manner, without such strong fluctuating vortex pattern, 100 measurements at different time steps have been averaged to one quasi-stationary flow field. This result is shown in Fig. 7. It is obvious, that there exists a strong horizontal cross flow in the vertical gap, which leaves the gap on the suction side of the rudder and hits onto the encountering main flow. The cross flow velocity has about the same magnitude as the outer flow at the upper edge of the figure (green, $Vel/U0=0.8$). Behind the gap at the rudder blade a separation or recirculation zone exists, with corresponding low velocities. At this part the dynamic pressure will be high enough, that no sheet cavitation occurs. Only the induced velocities and corresponding low pressures of the vortices induce local cavitation on the blade.

So the main outcome of these extensive model tests is, that the highly unsteady flow pattern and its vortices at the gaps will cause the main contribution to the cavitation and to its erosive character. The self-induced fluctuations and separations suffice already for this cavitation pattern, even without the inflow variation due to a running propeller! The findings build a valuable base for better understanding and investigation of remedies against erosion problems due to rudder cavitation.

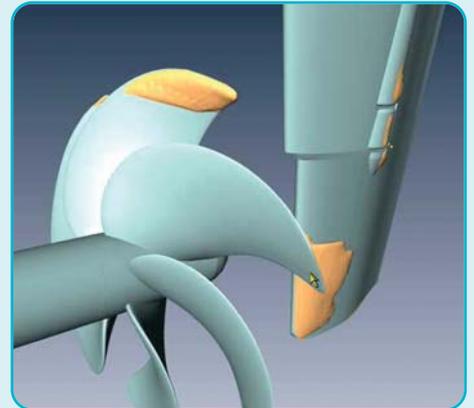
As a side effect of the project, the available steel construction from the part rudder, and the ready to use PIV-Installation allows us to investigate other models of this kind and size also for industrial projects.

Approaching its final stages, the VIRTUE project will perform a major public presentation of results achieved so far during the SMM – Shipbuilding – machinery & marine technology International Trade Fair (http://www.hamburg-messe.de/smm/smm_de/start_main.php) exhibition in Hamburg from 23rd to 26th September 2008. We will be present with our own booth in **hall B4 (B4.EG.261)** and welcome visitors with on-line demonstrations of the work performed on CFD and integrated analysis workflow. Besides this, a wealth of information material will be available at the booth.

In addition, a full day **Public Workshop** will be held on **24 September**. This will feature presentations from all work areas in the project, i.e.

- **The Virtual Towing Tank**
- **The Virtual Seakeeping Tank**
- **The Virtual Manoeuvring Tank**
- **The Virtual Cavitation Tank**
- **The Integration Platform.**

Researchers from all active areas will report latest findings and give an overview of the results achieved during the past period.



The workshop will be held in Hall B6, Room B6.4, starting at 10 a.m. on 24 September. It will provide a unique opportunity to meet Europe's leading maritime CFD experts and discuss latest developments and applications of maritime CFD.

Watch the project's web site at
www.virtual-basin.org
 for the full workshop programme and further News.



Combined Numerical Investigation of Cavitation on Propeller and Rudder

✍ by Heinrich Streckwall and Scott Gatchell

Since some years ago cavitation experiments for commercial ships (at HSVA and elsewhere) were focused on a detailed investigation of propeller cavitation. The rudder behind the propeller, though mounted in the experimental setup, was not investigated that carefully. The situation changed when the usual speed of large container ships and fast ferries reached or exceeded 26 to 27 kts. Erosive cavitation on rudders was reported in parallel with the speed increase. As a consequence, even existing rudders had to be modified or strengthened. For full scale it was concluded that rudder cavitation already occurred under course keeping conditions and first efforts were undertaken to widen the bucket of cavitation-free rudder angles.

It was clear that a change of the rudder section type could help to some extent and it was also obvious that non-symmetrical (twisted) sections lead to further improvements. The problem was to quantify these measures in order to keep the costs of the improved rudders within reasonable limits. A rudder design procedure was strongly required, but not readily available due to the complexity of the flow problem.

Within a project funded by the German Ministry of Education and Research HSVA studied the system ship/propeller/rudder in a rigorous numerical way. The focus was on rudder cavitation and the related danger of erosion. Our numerical tool was the commercial RANS solver 'Comet'. We generated grids that included a rotating propeller and a semi balanced rudder with symmetrical sections. The rudder was modeled with all gap details. To keep the response time of the approach within acceptable limits, we substituted the ship by the nominal wake field taken from the wake survey. The wake was applied to an inlet area located roughly one diameter in front of the propeller.

Together with a contour plot for the pressure, Fig. 1 gives the calculated instantaneous cavitation pattern for the rudder and the propeller. In

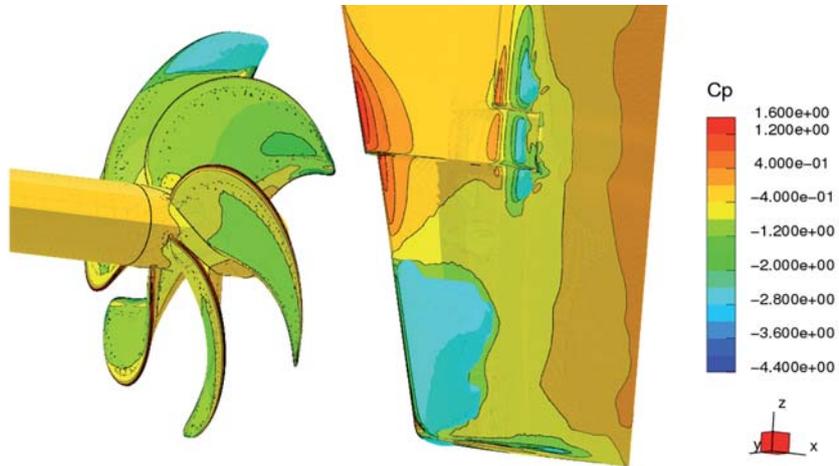


Fig. 1: Calculated instantaneous cavitation pattern for the rudder and the propeller (cyan) together with the pressure contours (red/green).

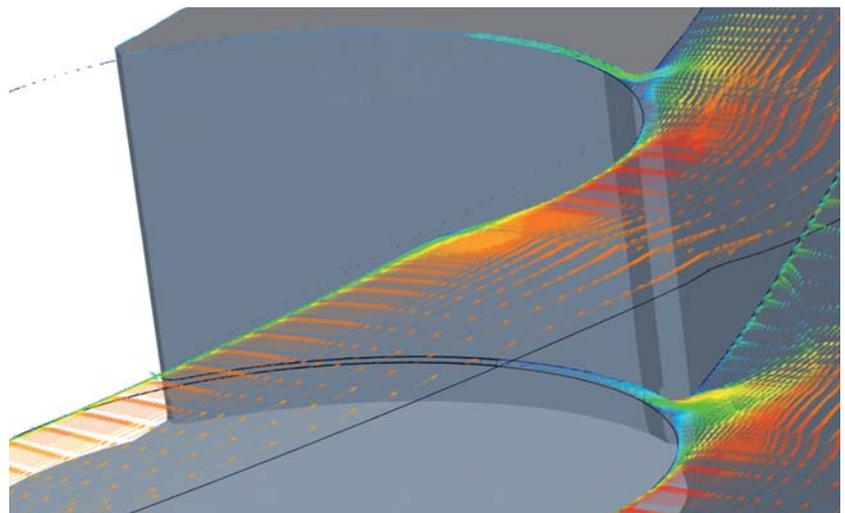


Fig. 2: Velocity vectors in two planes cutting a semi-balanced rudder at the pintle (the blade is present, the horn is removed).

comparison with the experiment we could show that we are able to obtain the right pattern for rudder sheet cavitation. Using this approach we can principally modify the rudder iteratively in order to control the sheet cavitation on the blade. For semi balanced rudders there will be some further work necessary until we can predict the gap cavitation to the same quality as the sheet cavitation. The gap flow is complex and partly jet-like as indicated by Fig. 2, showing velocity vectors in two planes cutting a semi-balanced rudder at the pintle (the blade is present, the horn is removed).

With the results from the current study we also established a reference case so that we can review and improve our in house rudder design methods. They are less complete in terms of flow modeling but superior in view of the response time. As the current approach also gives a very complete picture of the flow from in front of the propeller to behind the rudder we can further consider the propeller/rudder system in terms of the energy balance. In a next step it is planned to identify the conditions for propeller and rudder that maximize the recovery of the rotational losses at the propeller.

HANDLING WAVES – „Decision support system for ship operation in rough weather“

by Arndt Schumacher



Since January 2007 a group consisting of universities, shipping companies, a classification society, a ship

yard and HSVA work together within the European Integrated Project HANDLING WAVES on the development of an on-board decision support system. The decision support system will help the master to make tactical decisions for the ship handling in waves in order to improve the ship performance and to minimize the likelihood of structural damage. Near term changes in motions and loads that would arise from any change in course and speed by the shipmaster have to be predicted, in particular under rough weather conditions.

For the prediction of ship motions and loads the decision support system will mainly use synthetic information derived from systematic numerical calculations. For the calibration and validation of the used seakeeping codes, especially for the obtaining of reliable calculation results even in rogue waves, model test have to be performed. Within the scope of the project's Work Package 2 HSVA performed model tests with a small container vessel and a RoRo cargo vessel. Forced roll motion tests were conducted in order to achieve roll damping coefficients which will

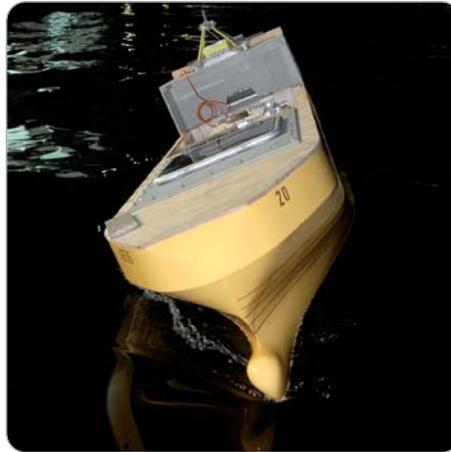


Fig. 1: RoRo Cargo Vessel
Parametric Rolling in Irregular Stern Seas



Fig. 2: RoRo Cargo Vessel
Parametric Rolling in Regular Stern Seas

be included in the seakeeping codes in order to predict the roll motion behaviour of the vessels with high accuracy for a wide range of different operational conditions.

Furthermore extensive seakeeping tests were performed. The objective was to identify conditions that lead to large roll angles like: loss of stability at the wave crest, resonant excitation, parametric rolling or broaching. Various metacentric heights and ship speeds were studied in head and stern seas. During the model tests, time series of the ship's global loads as well as the ship's position and orientation were recorded in six degrees of freedom. By means of the measured time series of ship motions and global ship loads the numerical model will be validated.

A completely computer controlled seakeeping model test procedure which is combined with deterministic wave group techniques was applied. For the seakeeping tests segmented, watertight and radio controlled models were used. The two segments were connected by a 6-component force balance in order to measure the global ship loads at midship section.

By participating in this integrated project HSVA will further advance and establish the sophisticated computer controlled test procedure for the performance of deterministic seakeeping model tests.



Fig. 3: Small Container Vessel - Test Run in Rough Head Sea Condition

Oblique towing and turning tests in deep and shallow water

by Henning Weede

Within the R&D project SLOWMAN, HSVA performed oblique towing and turning tests with combinations of drift angle, yaw rate, heeling angle and speed with models of a tanker, a container vessel and a RoPax. The shallow water tests were performed in the ice tank, where shallow water can be established with removable parts. Fig. 1 shows the tanker model, equipped with the six-component force balance, attached to the towing carriage of the ice tank in front of the removable shallow water bottoms, ready for a towing test at 135° drift angle.

The results include inflow from any direction, i.e. any drift angle, combined with rotation in either sense, heeling to either side, and several water depths. This gives HSVA the possibility to simulate many types of slow manoeuvring situations as well as station keeping and dynamic positioning in future.



Fig. 1: Tanker model in front of the shallow part of HSVA's ice tank

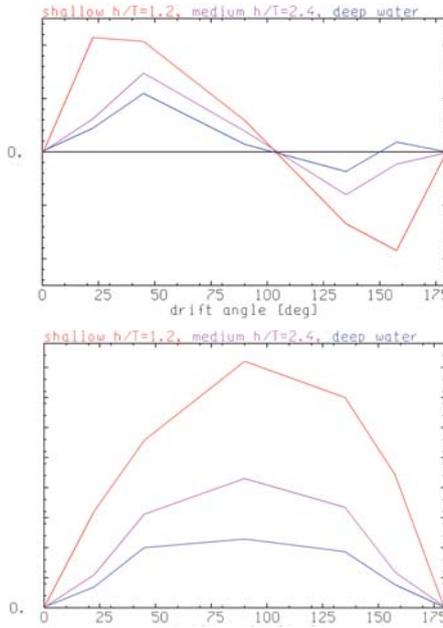


Fig. 2: Oblique towing test results for a container vessel

As an example, Fig. 2 shows oblique towing test results for the container vessel, i.e. how the lateral force and yawing moment depend on the drift angle and water depth.

Accompanying RANS calculations are performed for validation. Never before RANS calculations simulating manoeuvring vessels have been performed for such large drift angles. Additionally, the R&D project includes a new fast method to calculate the approximate planar lateral potential flow around the individual sections also in shallow water to obtain hydrodynamic masses as a pre-requisite to simulate e.g. harbour manoeuvres.

Member of staff



Thomas Lücke joined HSVA in 1998 as a project manager in the Propellers & Cavitation department. His main activities involved cavitation testing in the HYKAT, propeller design and numerical propeller analysis. Besides commercial projects he is involved in several research projects. In 2004 he was appointed as deputy head of the Propellers & Cavitation department.

Thomas Lücke started studying architecture before he changed to naval architecture and received his diploma in 1997 from the University of Hamburg. His interest in hydro- and structural dynamics came at the university already, when he prepared his diploma thesis on the numerical prediction of fluid structure interactions. Right after that he worked at Blohm & Voss in the field of stress analysis until he switched over to hydrodynamics at HSVA.

In his spare time he enjoys his family, wind surfing, traveling or if possible combining all of these.



SMM 2008 Congress Center Hamburg

From 23rd till 26th September 2008 the Shipbuilding, Machinery & Marine technology international trade fair (SMM), the most important exhibition in Europe, takes place at the Hamburg Congress Centre.

HSVA is looking forward to seeing you at their booth Nos. 260 and 261 in hall B4, to present their actual research projects as well as recent developments.