90 YEARS
HSVA
NewsWave
The Hamburg Ship Model Basin Newsletter 2003/2

90 Years of Ship Research History...

by Dietrich Wittekind

In 2003, the Hamburg Ship Model Basin is looking back at a 90 years history.

In early 1913, after about 12 years of discussions and investigations, the necessity of a large hydrodynamic test facility in Germany was recognized. In the same year, 16 German shipyards and Shipowners founded the Hamburgische Schiffbau-Versuchsanstalt GmbH (HSVA) and initiated construction of a large facility in Hamburg-Barmbeck with the main financial contribution from the state of Hamburg.

The Large Towing Tank was 350 m in length with two cross sections 16 and 8 m wide; and two towing carriages with up to 10 m/s maximum speed. The first models tested in 1915 were submarines for the German Navy.

In 1922, Dr. Kempf became director of HSVA. Recovery from the difficult post war times allowed new investments. The testing technology improved dramatically. A High Speed Tank for testing amphibious aircraft and a first cavitation tunnel were erected in 1929/30.

Hamburgische Schiffbau-Versuchsanstalt (HSVA)

At the same time, Dr.Kempf initiated a co-operation with other model basins for exchanging test results for common model shapes. The first international conference on "Hydrodynamic Problems of Ship Propulsion" in 1932 led to regular meetings of the model basin directors which became the ITTC.

HSVA was further extended shortly before and during the Second World War. A large Cavitation tunnel with 2.4 x 1.2 m^2 test section was erected but did not see operation due to bombing damage. The Large Towing Tank was extended to 450 m.

The last weeks of the war saw the most exciting test in HSVA: The task was to confirm the design of a jet fighter canopy scale 1:1 made of the new Plexiglas. For this the towing carriage was strengthened and its power increased by two aircraft engines, augmenting the thrust by 500 kg. An additional thrust of 1000 kg for 5 seconds was delivered by a set of rockets, leading to a maximum speed of the carriage of 9.6. m/s. While the resulting pressure waves destroyed the glass windows of the towing tank hall, the Plexiglas canopy remained intact.

After the war all facilities were dismantled or destroyed. The large cavitation tunnel was reassembled in the UK, where it is operating even today. HSVA staff founded an engineering company and worked in their field using foreign or own small makeshift facilities. One occupation was development of model basin facilities and equipment, led by HSVA's staff member Dr. Remmers, who, together with Dr. Kempf, later founded the company Kempf & Remmers. This highly innovative company became partner for HSVA and many other model basins in the world for decades.

In 1952 construction of the new facility commenced in today's location, 400 m away from the site of 1913. In large steps HSVA grew to the current capacity: Small Towing Tank (1952), Small Cavitation Tunnel (1954) Large Towing Tank (1957, 200 m length), Large Cavitation Tunnel (1960), Large Towing Tank (1965, extension to 300 m), Ice Tank (1972) Computerized Planar Motion Carriage CPMC (1975), Double Flap Wave maker (1980), Large Ice Tank (1985), Hydrodynamics and Cavitation Tunnel HYKAT (1989).

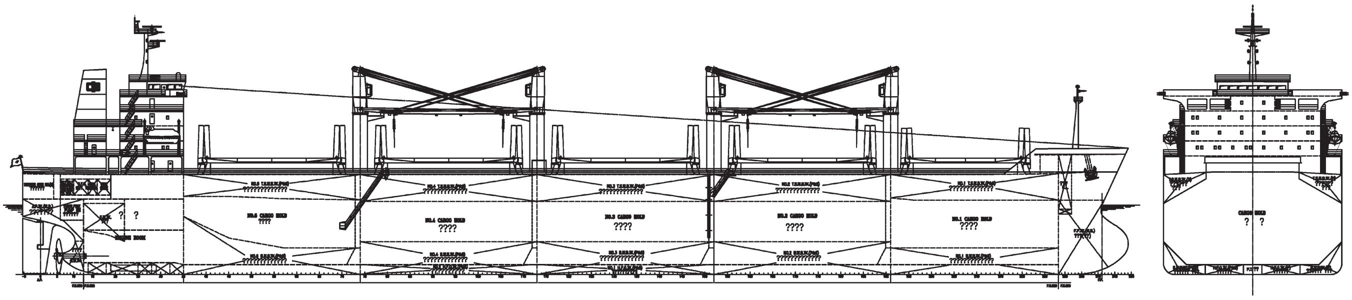
HSVA has seen many ups and downs ranging from being almost shut down in the 1920s to the golden times of ship building in the 1970s, and from a company working mainly in public interest to a mainly commercial consulting company during the 1990s, particularly marked by the continuous and rapid increase of orders from foreign customers in the last 5 years.

For HSVA, there is healthy future ahead. Testing will continue to be a necessity, although the development of CFD, where HSVA also drives the development, is increasing its importance. The testing methods also allow for new ideas leading to more precise and faster results for more complex ships.

Model Tests for a 57,300 DWT Super-Handymax Bulk Carrier

by Hilmar Klug

HSVA was contracted by a Chinese consortium consisting of the **Shanghai Merchant Ship Design And Research Institute (SDARI)**, the **Bohai Shipbuilding Heavy Industry Co., Ltd** and the **Shanghai Shipyard**, to optimise the hull lines design for a new 57,300 DWT Super-Handymax Bulk Carrier. Ten vessels of this type will be built by the named shipyards.

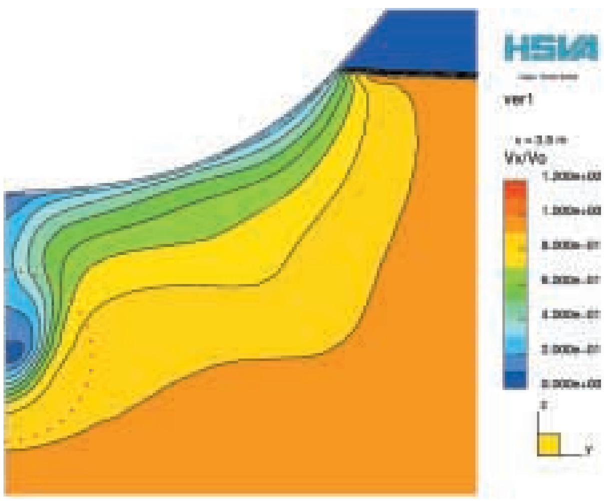


General Arrangement of the 57,300 DMT Super-Handymax Bulk Carrier

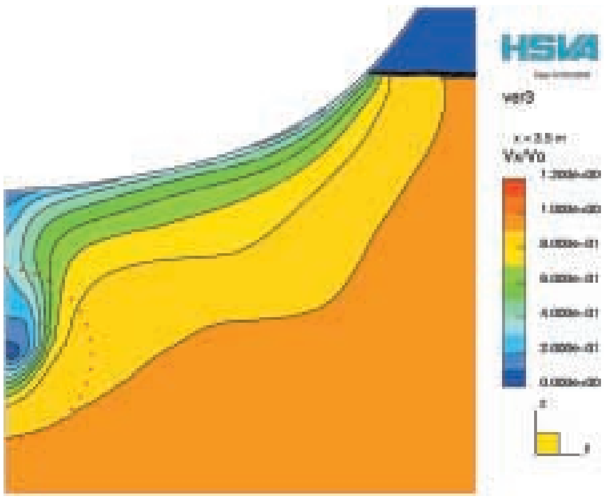
Prior to performing calm water model tests, HSVA's designers and CFD-experts analysed and improved the hull lines using CFD-calculations. These calculations were done with the CFD-software Comet, which takes into account viscous effects as well as the free surface, i.e. the wave pattern of the vessel. According to HSVA's experience, for high block vessels with very blunt waterlines the application of a viscous flow code is to be preferred in comparision with a potential flow code. Longer computing times must be accepted, but the advantages of using this code are clear: Not only the bulbous bow design can be optimised but also the wake field at the location of the propeller.

The model test program started with resistance and self-propulsion tests with a stock-propeller at four draughts. The next steps were a 3-dimensional wake field measurement, a paint test and manoeuvring tests and simulations. All these tests were performed in HSVA's 300 m long towing tank. The tests for this series of bulk carriers will be continued with self-propulsion tests with an actual design propeller and cavitation tests in the HYKAT.

Computed Wake Fields at the Location of the Propeller



Initial Lines Design



Optimised Lines Design

Ship Owners – An Increasing Share of Our Customers

by Christian Johannsen

Over the past ninety years HSVA has mostly been commissioned by ship yards and navies from all over the world. Of course, in most cases also ship owners have been sitting around the table, but as HSVA's customer they have been exceptional.

This sounds logic since it is the shipyard's responsibility to build the ship in agreement with the building specification. The shipyard pays for subsequent problem handling or for the penalty in case not all requirements are met. For this reason its a simple consequence of risk assessment, that the shipyard asks for the model basins expertise in order to minimize their own risk. But this is only one aspect for charging a model basin.

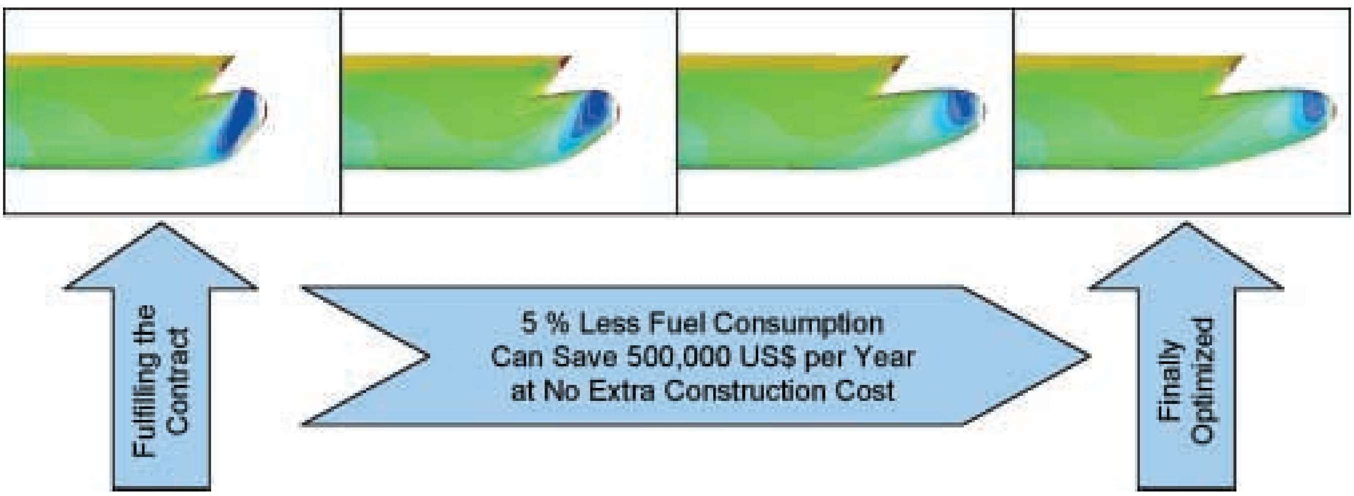
On the other hand it is a matter of fact that the shipyard's effort in ship optimization ends as soon as the vessel fulfills the building specification. This philosophy must not be condemned since it is just economy and a necessity for a shipyard in nowadays competitive shipbuilding market. Nevertheless, at this stage the vessel is as good as necessary from the shipyard's point of view indeed, but its not necessarily as good as possible from the standpoint of the ship owner's long term requirements. Of course a cost effective new building is important for the ship owner as well. But beside that the owner has to keep costs for operation and maintenance with in his mind.

Reductions in fuel consumption of 5 % can often be achieved on ship owner's initiative by optimization beyond the contract requirements. For a 5000 TEU container vessel this means 10 tons less fuel per day or a saving of about 500,000 US$ per year. This pays back the additional costs for optimization within months and – if done in due course – does not cause any additional construction cost.

One might say that 5 % improvement beyond the contract requirement are achievable only if the contract requirement wasn't challenging enough. This is true indeed, but how to establish a challenging contract? Most ship owners have reduced their hydrodynamic departments to a minimum already. They need hydrodynamic assistance to establish a realistic but challenging contract – and that is another reason for charging HSVA as a ship owner.

Durability of a ship is another keyword. Naturally the shipyard's horizon for durability is the end of the warranty. But a ship lives on for decades. So life extending features like a low vibration level or a good-natured propeller cavitation behavior are essential for the ship owner only.

A progressively increasing number of ship owners has realized this potential for cost reduction. And consequently its a progressively increasing number of ship owners coming to HSVA – as a customer.



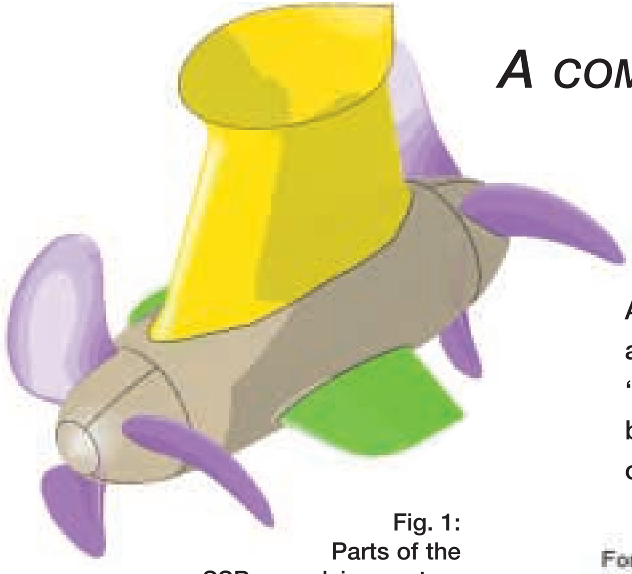


Fig. 1:
Parts of the
SSP propulsion system

A complete Numerical Model for Podded Propulsion

by Heinrich Streckwall and Scott Gatchell

A joint project on podded propulsion between HSVA and Siemens/Schottel investigated, how close the 'numerical towing tank' could come to the real tank in both aspects: completeness of modelling and quality of the calculated results.

For the validation of the computational approach, model tests for a pod driven vessel (equipped with SSP type pods, see Fig. 1) were used, which is still in the project phase. Calculations were done with the commercial RANS Solver 'Comet'. The grid generation was a decisive part of the project.

The approach towards the complete simulation of a podded propulsion was stepwise. A computer model for the open water performance was set up first, whereby moving sub-grids and sliding interfaces were used for the rotation of the propellers. Always with the free surface as part of the solution, the next steps were: bare hull performance prediction, body force propulsion, and finally the geometrically correct propulsion model, which included the rotating propellers.

Propeller open water thrust and torque, and the bare hull resistance could be calculated with good accuracy. In the open water case, not only the mean values of propeller forces and moments but also the fluctuations were resolved (Fig.2). The body force propulsion turned out to be a good tool for the prediction of the thrust required from the propulsor side. Mounted to the ship for the complete propulsion simulation, the podded propellers behaved qualitatively similar to the open water case. Two pod variants, one with and one without fins were investigated. To assure a reliable thrust and power prediction, much effort was spent on the calculation of the ship's wake, in other words the turbulence modelling.

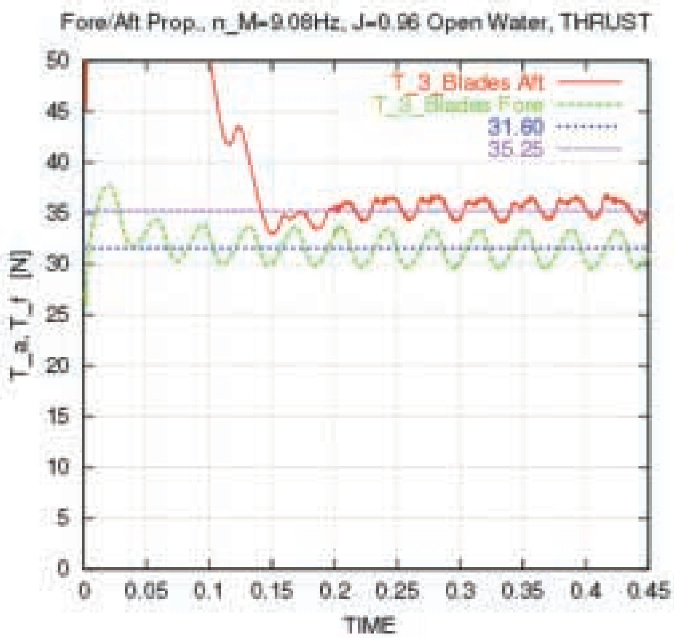


Fig. 2:
Time History
of Thrust,
J=0.96

Within the project we learned about the best strategies for combining the large time steps necessary for the wave making prediction of the hull with the very small time steps needed to simulate the propeller rotation. For the visualisation of the flow from the forward SSP propeller to the aft, new techniques were applied (Fig. 3).

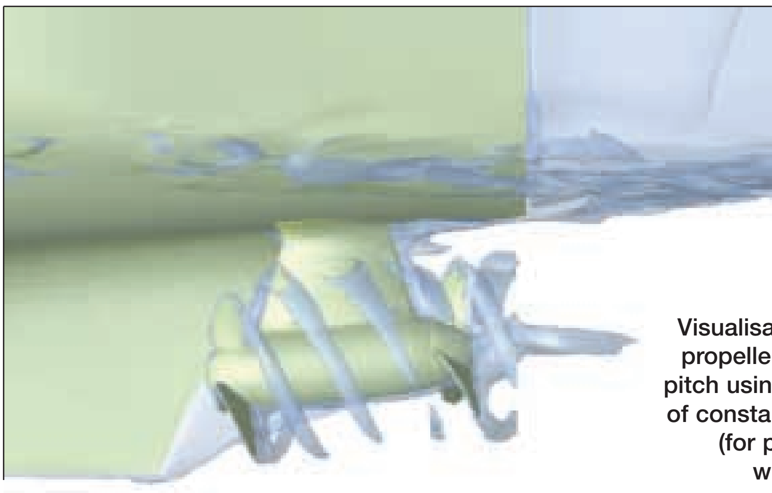


Fig. 3:
Visualisation of the
propeller slipstream
pitch using surfaces
of constant vorticity
(for pod variant
without fins)

Model / Full Scale Cavitation Correlation Investigations for a Twin Screw Cruise liner with conventional shaft arrangement

by Jürgen Friesch

Model / full scale correlation of cavitation, hull-pressure fluctuations and noise has been a subject of investigations for quite a long time. Full scale tests are a vital part in the research and development work of HSVA in this field since years.

The propeller is well known as one of the main exciters of ship vibrations. The high speed and large power of today's passenger, container and navy ships requires carefully designed propeller geometries working in a perfectly optimized wake field to keep this excitation as low as possible. Within a research project, funded by the German “Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie” cavitation observations, pressure fluctuation and wake field measurements on board of a 42.200 DWT Cruise Liner have been performed during the sea trials of the west part of the Baltic Sea between Wismar and east of Bornholm. The Cruise Liner is a twin screw ship with conventional shaft arrangement. The shipyard was involved in the development of the research test program from the very beginning.

The pressure fluctuation measurements were performed during the speed trials and additionally the cavitation phenomena were documented on video tapes. Photographing and viewing was carried out during the day and additionally at night with artificial lighting. Nine pressure pick-ups were installed in special inserts in the hull above the propeller. Eight pressure pick ups were located on portside, one pressure pick was located on starbordside.

During all tests the propeller shaft torque was determined with the help of strain gauges applied directly to the shaft. Parallely to these investigations speed, vibration and noise measurements were performed by the classification society Germanischer Lloyd (GL).

FULL SCALE RESULTS

The cavitation observations showed cavitation phenomena in form of tip vortex cavitation and stable and unstable sheet cavitation only. Extent and thickness of the sheet cavity was rather small, leading to low levels of propeller induced pressure fluctuations. No sign of a hub vortex and no hint for face side cavitation could be detected.

Fig. 1 Full Scale Tip Vortex Cavitation 100% MCR

The tip vortex (Fig. 1)started at a blade position of 160° (according to HSVA nomenclature 180° means 12o'clock position). The tip vortex is very thin and is visible up to a blade position of 270°. In a blade position 260° the tip vortex sometimes leaves the blade and is no longer attached. No bursting of the tip vortex could be observed.

Starting around 200° blade position small parts of stable sheet cavitation could be observed on the leading edge of the blade, close to the tip. Parts of unstable sheet cavitation could additionally be found on the blades between 0.7R and the tip of the blade. These phenomena were visible up to 240° blade position. Sometimes these patches have a cloudy character. Fig. 2 clearly shows that we are just at the onset of this type of cavitation. Sometimes no cavitation could be observed, a few revolutions later small parts of cavitation are visible.

The maximum height of the propeller excited pressure amplitudes was measured with 1.3 kPa for the first harmonic order for the 100% MCR condition. The higher harmonic orders are significantly lower and fully negelectable. These results clearly reflect the good cavitation behaviour of the propeller resulting in such low values of propeller excitation.

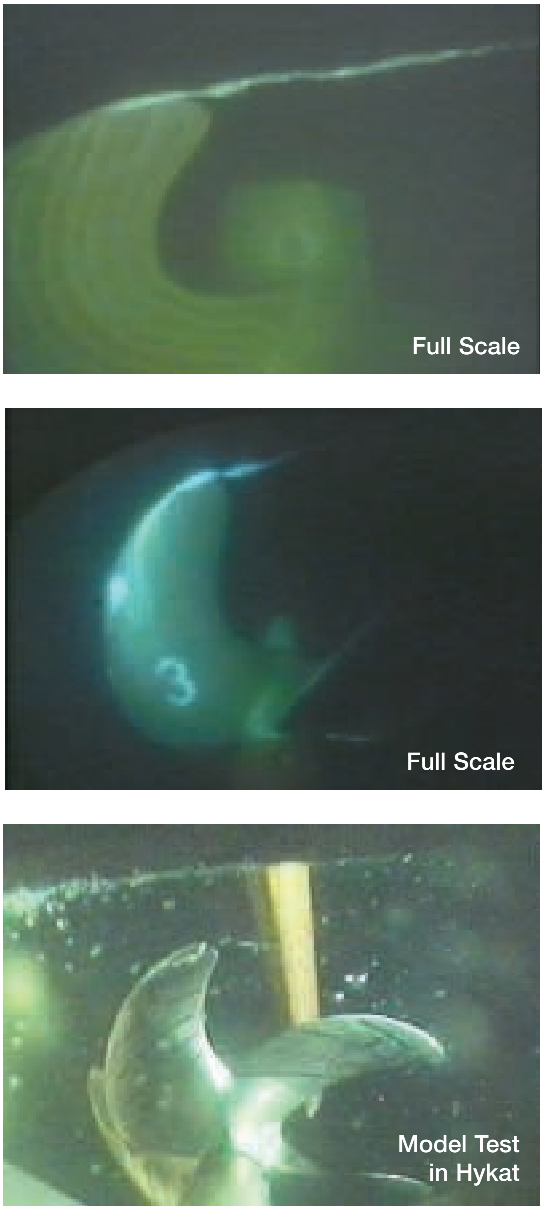


Fig. 2
Comparison
of Cavitation
Phenomena
Full Scale / HYKAT

COMPARISON WITH MODEL TESTS

Detailed cavitation tests had been performed in HSVAs large cavitation tunnel HYKAT both during the development phase of the ship and after the trials. The correlation is very satisfactory. The full scale results were a full confirmation of the data which had been predicted by HSVA based on the different model tests. This holds true for both, the observed type and extension of the cavitation phenomena and the predicted pressure fluctuations. Fig. 3 shows as an example the comparison of model and full scale pressure fluctuations data for the 100% MCR condition.

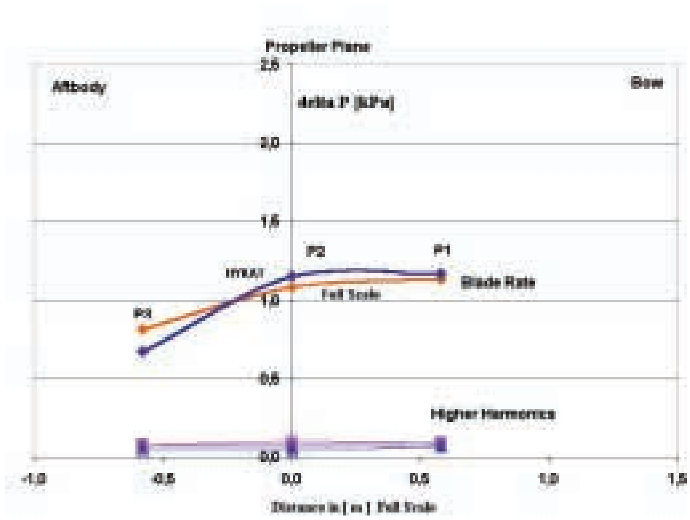


Fig. 3 Comparison of Pressure Fluctuation Data Full scale / HYKAT

HSVA's New Innovative Deterministic Seakeeping Model Testing Technique

by Kay-Enno Brink and Walter L. Kuehnlein

Various seakeeping and capsizing tests have been performed at HSVA in the past. Self propelled, free running models were hand operated by a helmsman accommodated on a sub-carriage. As a result of this former test procedure time histories of different ship motions have been determined.

Because of the impossibility of wave measurements at the position of the model, the ship motions could not be related to the actual waves encountered. This imperfection was of minor interest for former investigations as the safety of ships against capsizing was determined for seaways which had been described by their statistical properties.

HSVA's new innovative deterministic model testing technique fulfils the following requirements:

- Reproducible model seaways are described and measured as a function of time and place in the model basin.
- In order to perform accurate, reproducible model tests each single test run is completely computer controlled including the rudder of the model. The main objective of the computer control lies in the temporal co-ordination between wave maker and model ride, the piloting of the model and the control of main-carriage and subcarriage following the model.

Investigation of radio controlled free running models without any connecting cables

The models made of GRP are equipped with watertight decks and simplified superstructure. During the tests the models are fitted out with a propelling motor, a rudder machine and batteries as a power supply. In absence of any connecting cables the models are completely free in their motions.

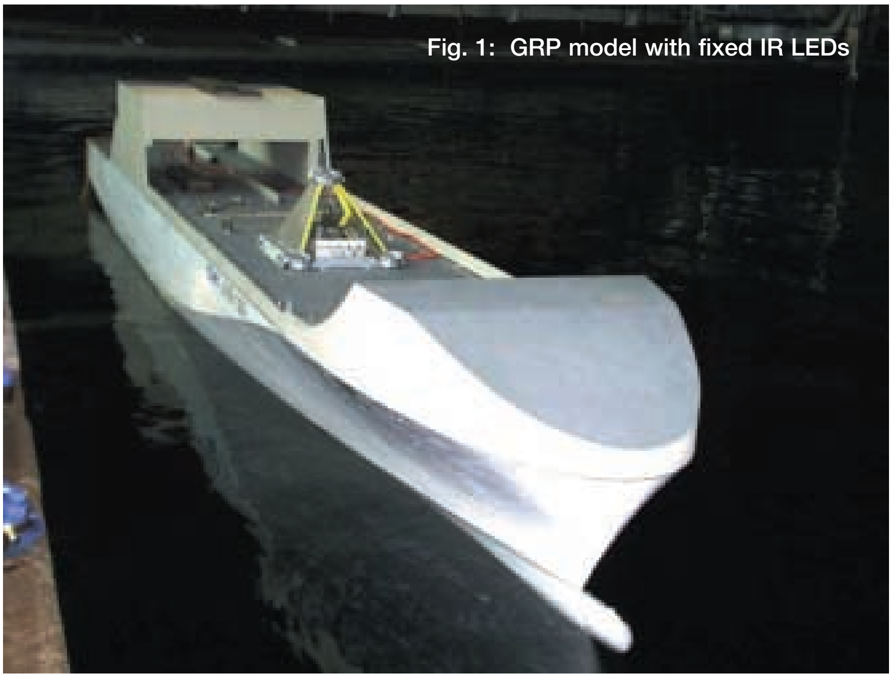


Fig. 1: GRP model with fixed IR LEDs

Use of a contactless measurement system for the determination of model position and orientation

A camera-based system measures the model position and orientation in six degrees of freedom in relation to the sub-carriage. The contactless measurement system includes a camera unit consisting of three linear cameras, which are located on the sub-carriage. Therewith X, Y and Z co-ordinates of model fixed IR LED's are measured at high resolution in real time (see Fig. 1). The camera unit and the model fixed LEDs are radio controlled.

Precise measurement of main-carriage and sub-carriage position and speed

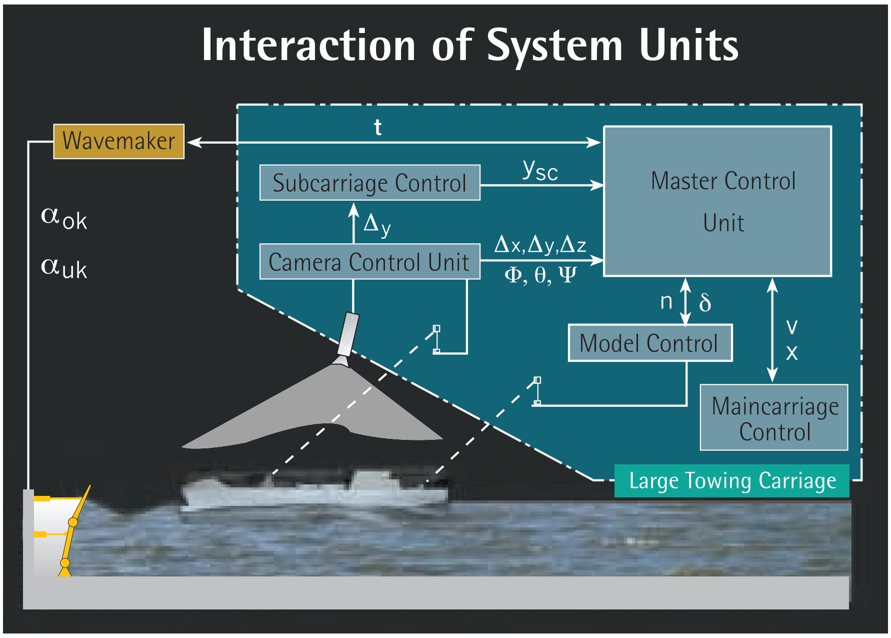
In order to allow a synchronisation of the measured seaway data and the time histories of the model's motion behaviour, the position of the main- and sub-carriage are measured and controlled accurately during the model tests. As the model position relative to the carriage is known, its absolute position in the tank is known at any time. Therewith the model response can exactly be related to the belonging data of the seaway.

Use of an integrated data acquisition system connecting the different system components

During the test runs the master control unit has the temporal control about the double-flap-wavemaker (time t), is piloting the model (propeller rate n, rudder angle δ) and drives the main-carriage (speed v, position x). Meanwhile the camera control unit evaluates the longitudinal and lateral position of the model relative to the sub-carriage (Δx, Δy), the heave motion (z) and the roll, pitch and yaw angles of the model (Φ, Θ, Ψ). During the tests the sub-carriage position is controlled by the lateral position of the model relative to the sub-carriage. Fig. 2 illustrates the communication scheme of the system, which integrates all different components.

The new seakeeping model testing technique allows HSVA to perform seakeeping model tests where the model meets a tailor made wave train at a pre-defined location and time with predestined course and speed. And please note, all these tests are 100% reproducible!

Fig. 2: Communication Scheme



Ships Speed Trials

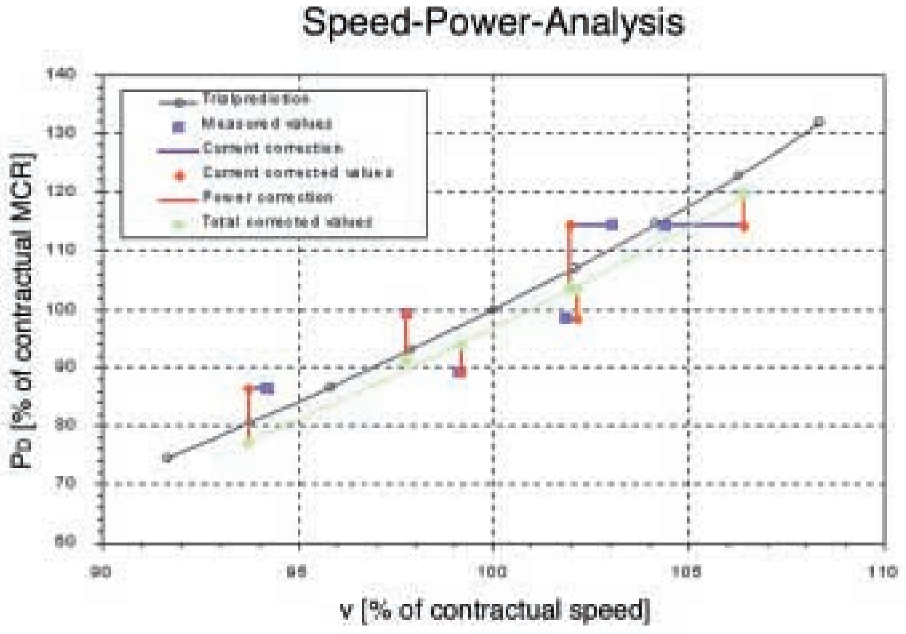
by Peter Schenzle and Kai-Enno Brink

A Matter of Technical Validation or of Conflict Settlement?

'Speed trial analysis is not a technical matter, but a problem of conflict settlement', as Prof. Schmiechen uses to comment the related discussions.

In fact, the task of a proper performance and analysis of speed trials is often squeezed between the competing interests of the involved parties: designers, builders, suppliers, owners and operators. The Model Basin is a party with only weak share in terms of economic interest but with strong interests in technical validation and feedback. This feed-back is not only vital for the improvement of the basin's power prediction service, but can be the basis to solve the technical problems which may be underlying a dispute between the directly interested parties.

A proper technical performance and analysis of the ship's speed trial enables the Model Basin to play an efficient role as a moderator in conflict situations, by bringing the discussion back to the technical point, where solutions for the problem can be developed. That is why the quality of speed trials should be regarded to be in the well understood interest of all involved parties.



HSVA SPEED TRIAL ANALYSIS

In order to improve the significance of full scale measurements HSVA developed a detailed speed trial analysis. The quintessence of the evaluation procedure lies in the analysis of a number of interrelated and fully documented trial measurements, which meet the following requirements:

> At least three double runs at different engine loads, with and against the wind are conducted;

> Reliable measurements of ground speed, shaft speed, shaft torque and apparent wind are carried out;

> Contract conditions regarding draft, trim, hull and propeller conditions are met;

> Favourable environmental conditions with moderate wind and waves and deep water during the trial.

A method was developed for a stepwise analysis and correction of the trial measurements in order to evaluate the speed power characteristics of the vessel. Thereby small deviations of the measured results for alternating reverse runs are used to calibrate directional influences. The detailed speed trial analysis in general is made according to the following procedure:

1. Determining speed through the water by adapting smooth functions for the current component versus time and torque coefficient versus apparent advance ratio. Correcting speed for shallow water influence if any.

2. Calibration of apparent wind measurement by adapting smooth functions for true wind speed and direction versus time. Converting true wind from measurement level to effective centre of frontal area.

3. Calculation of wind and wave added resistance and correction of delivered power for small differences between trial- and contract conditions of prediction with respect to wind, waves, draft, water temperature and salinity.

4. Check of corrected power for smooth function of speed and adjustment of assumed parameters in correction procedure if possible.

5. Calculation of shaft speed for corrected propeller power and speed through the water according to the above determined propeller torque characteristics.

SUMMARY

By the HSVA trial analysis procedure full scale measurements are corrected for all relevant influencing factors and environmental effects. As opposed to most speed trial evaluation methods commonly in use, each single trial run is analysed separately in order to arrive at the corrected operating condition of the vessel in the contractual situation.

The HSVA Speed Trial Analysis is a rational approach for the evaluation of speed trial measurements, which can be generally accepted by the different parties involved in the commissioning of a ship.

R&D-PROJECT ANCON - PREDICTION OF THE PROPULSION POWER OF VERY LARGE CONTAINER VESSELS

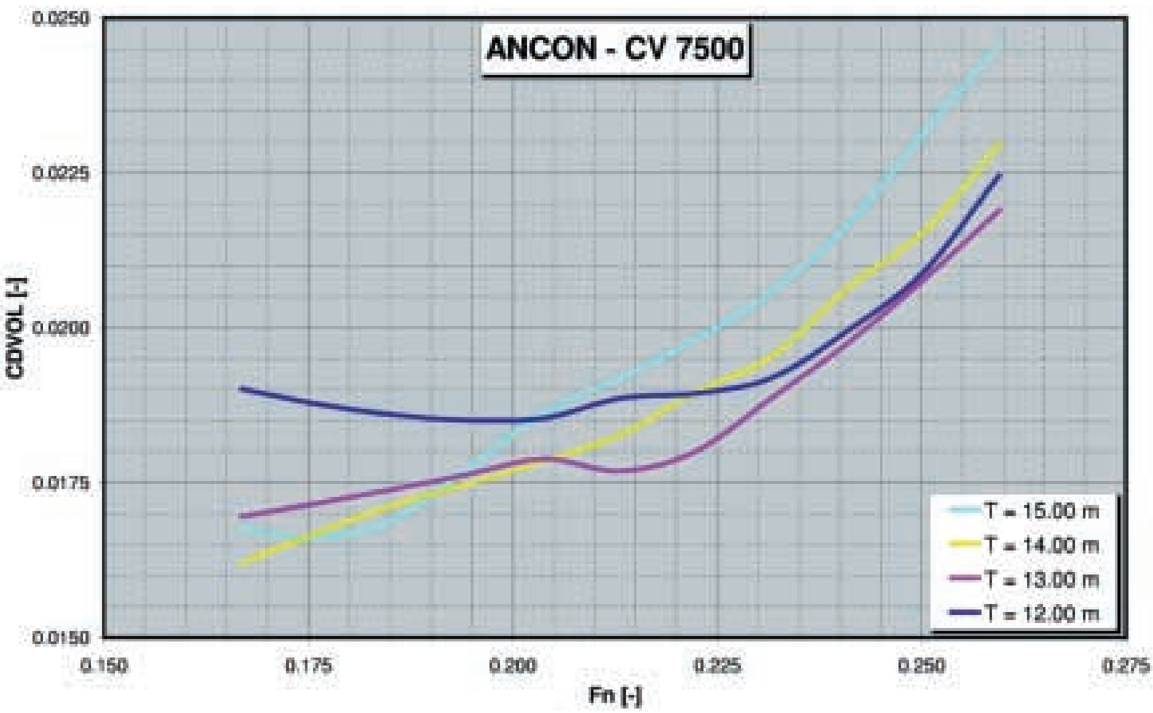
by Friedrich Mewis

HSVA is currently developing a new and simple method for the prediction of the propulsion power of very large container vessels (VLCV). The method will be applicable for single screw container vessels with container capacities up to about 10,000 TEU. Due to the required high service speeds, which are closely related with high propulsion power, even larger container vessels are very likely to be twin screw instead of single screw vessels.

The R&D-project ANCON is partly funded by the German government and incorporates model tests for a number of different VLCVs at various even keel draughts as well as the development of a simple and easy to use software tool for the preparation of speed/power-predictions in the early project phase.

For this project HSVA is cooperating with three German shipyards: Aker MTW Werft GmbH, Aker Warnow Werft GmbH and Nordseewerke GmbH.

The diagram below shows the specific power consumption for a 7,500 TEU vessel at various even keel loading conditions. It can easily be seen that the bulbous bow has a negative effect when it is only partly submerged.



P3

by John Richards

In December of 2001 Chantiers de l'Atlantique initiated a unique research project concerning the correlation of speed-power predictions for pod driven ships. For this purpose a self-funded consortium comprised of the ship yard and six leading European model testing facilities was founded. Using one of the shipyard's ongoing cruise vessel new-building projects as a subject vessel, model tests were performed at the involved model basins, all using the same ship hull, pod and propeller models, which were shipped from basin to basin for the tests. At the end of the project all results will be analyzed in detail and compared with the full scale sea trial data. The investigation will provide better understanding of hydro-dynamic phenomena specific to pod drives. It also documents the importance of quality assurance for the involved parties.

notes

On May 8th, 2003 another very successful

SEMINAR FOR SHIP OWNERS AND OPERATORS has been held in HSVA.

New developments emanating from discussions between HSVA, Ship Owners and Equipment Suppliers are already on test in HSVA's facilities today. HSVA will continue its seminar sequence in 2004.

This year HSVA joints the **MARINTEC CHINA** exhibition in Shanghai for the first time. You can contact us on Stand No. 1B33 in the German National Pavillion in Hall No. 1.

MEMBER OF STAFF

HILMAR KLUG

Hilmar Klug joined HSVA in 1995 as a student and was involved in the development of software tools for the performance and analysis of resistance and self-propulsion tests. Following a cooperation with KCS in Hamburg and Newcastle he worked for the Blohm + Voss shipyard in Hamburg.

In 2000 Mr. Klug came back to HSVA's Resistance & Propulsion Department. He is one of HSVA's project managers and is involved in model testing and consulting work for commercial projects. Mostly he cooperates with customers from the Far East, Europe and South America.

Mr. Klug studied naval architecture in Hamburg and received his degree Dipl.-Ing. Schiffbau from the University of Hamburg.

In his spare time he enjoys his family life with his baby daughter and his wife.