HSVA Newswave 2011/1

THE HAMBURG SHIP MODEL BASIN NEWSLETTER

DP Controlled Model of the Stena DrillMAX ICE in HSVA's Ice Tank

IN THIS ISSUE:

- Adjoint Geometry Optimisation of Ships with Active Propulsion
- Optimization and Integration of Twin Screw Shaft Supports
- HSVA's Ice Tank: First DP Model Tests in Ice Successfully Performed for Stena Rederi AB
- HSVA's New Side Wave Generator: Demonstrator now Operating
- Successful Development and Validation of the Becker Mewis Duct®
- Advanced Slamming Measurements with new Panels
- Full Scale Cavitation Observations – Various Options for any Purpose
- Optimisation of the 63500 DWT Bulk Carrier CROWN 63
- Advanced Model Measurement Technology for the EU Maritime Industry (AMT'11)

Dear reader,

Sincere greetings to all our clients, partners and colleagues. 2010 was again a challenging year to all of us. Fortunately, we managed to be successful, even in these critical times.

Additionally we took the time to improve our services further and in 2010 mainly our hardware was upgraded. We improved, automized and optimized further our cooling system for the large ice tank, to minimize the time for freezing the ice and also to minimize the time our staff has to be available during these times. Parallel to that we improved our capabilities in Dynamic Positioning (DP) in ice by offering the possibility for DP system providers to work together and connect to HSVA's model system controller and thus steer the model.

After two years of intensive planning, designing, engineering and manufacturing our new Side Wave Generator (SWG) is now installed and ready for operation. It is mounted on the long side of the tank wall in the centre of the Large Towing Tank. It is a snake wave generator consisting of 80 flaps each having the width of 0.5m. Due to new design standards and performance requirements on safety as well as on economic aspects of ships in seaways it is essential for us to be prepared for the new and more sophisticated testing requirements. With the new Side Wave Generator, HSVA increases its sea keeping test capabilities significantly for meeting these requirements.

Besides interesting projects for our clients much research was performed and new European research projects started. These projects again are examples of how HSVA collaborates with our European partners to improve our expertise further and how collaboration can make things happen. You will find some information on these projects inside this issue.

Even though we are again fully booked at the moment we will do our best to accommodate all your expectations within a short time. Our innovative staff has the ability to find new ways, to see new possibilities and to react flexibly to meet our customers needs and deadlines.

Juergen Friesch
Managing Director

Adjoint Geometry Optimisation of Ships with Active Propulsion

FORM-PRO flings open a new door to automated optimisation

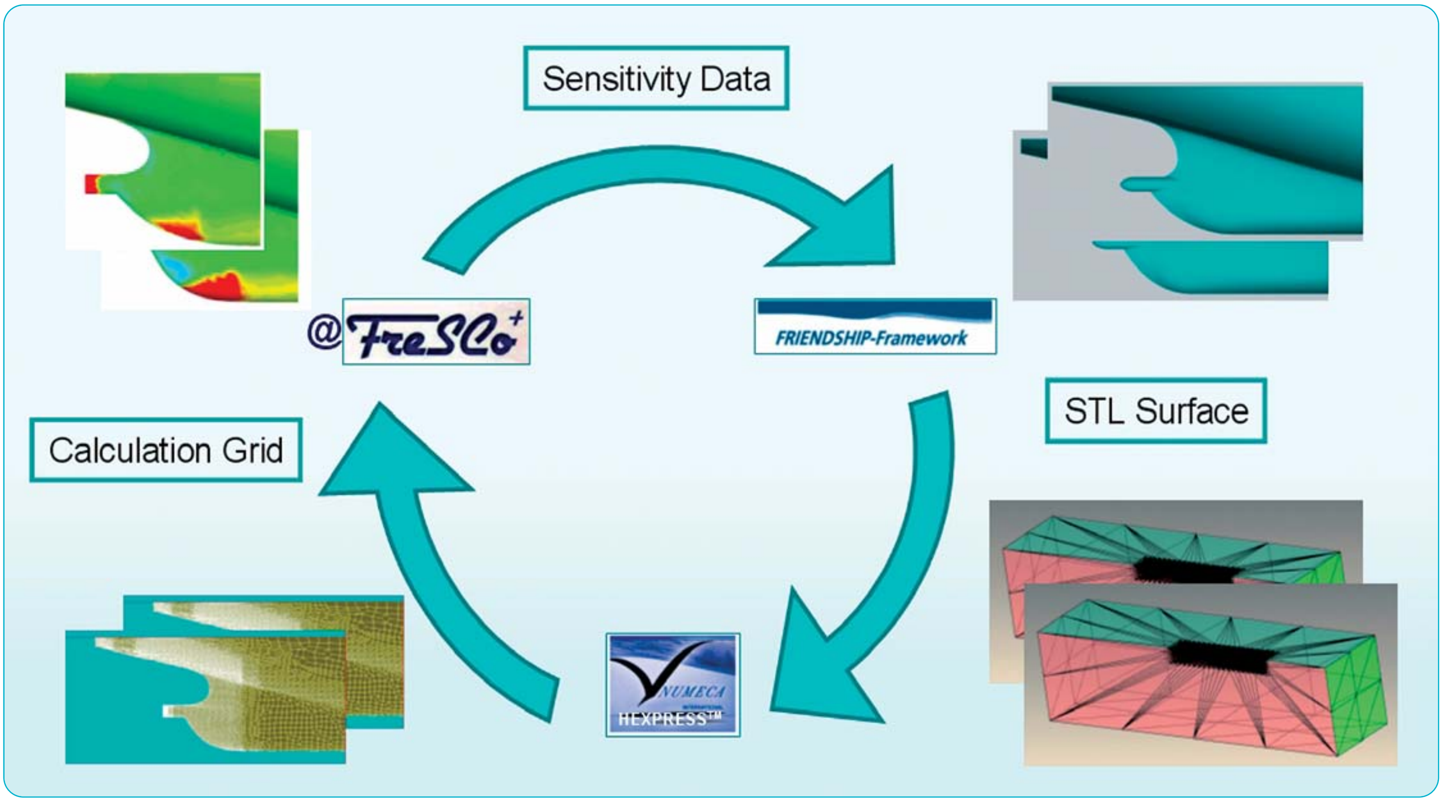


Fig.1: FORM-PRO optimisation loop

by Grete Ernst and Scott Gatchell

CFD analysis has become a valuable tool for optimising ship geometries in recent times. The interpretation of the results, however, requires some experience. This is where the FORM-PRO project takes action. By introducing an adjoint RANS solver to the flow analysis and translating its sensitivity results into needed deformation of the geometry, a fully automated optimisation process can be performed.

FORM-PRO is a national research project, funded by the German Federal Ministry of Economics and Technology (BMWi). Partners in this joint project are HSVA, TUHH department of fluid dynamics and FRIENDSHIP Systems, where HSVA is in charge of the management. The FORM-PRO project started in December 2009 with a duration of three years.

FORM-PRO aims to develop a fully automated optimisation loop by coupling a CAD tool with a grid generation tool and a CFD analysis tool - by name: FRIENDSHIP Framework, HEXPRESS and AdFreSCo+.

The FRIENDSHIP Framework is a CAD tool for parametric geometry modelling. What makes it most attractive in the FORM-PRO context is the possibility of performing local as well as global geometry deformations automatically without changing the hull's topology and therefore running it in a fully automated optimisation loop. Furthermore, constraints for the optimisation can be defined to create only feasible form variations.

The grid generation tool HEXPRESS can be run by scripts, which allows automated remeshing of the calculation area in each optimisation loop. The hull geometry combined with the computation domain is exported from the FRIENDSHIP Framework as a water-tight STL surface.

The adjoint RANS solver AdFreSCo+ is a further development of the RANS solver FreSCo+ developed by HSVA and TUHH. The adjoint solver calculates sensitivity data on the hull surface in relation to a given objective function. In the optimisation loop this sensitivity data is read by the CAD tool and translated to needed parameter changes for improving the geometry. This leads to a targeted variation of the hull geometry enabling an optimisation in a small number of loops.

The definition of the objective function allows a multi-objective optimisation. Each component of the function can be weighted and therefore each objective can be given a different priority. FORM-PRO aims to formulate an objective function which includes parameters from various fields in ship design such as resistance, wake quality, tangential flow in the propeller plane and propeller thrust as well as manoeuvring performance and sea keeping.

Two different test cases are defined for the FORM-PRO project: a Bulk Carrier and a Ferry with two propellers. Propulsion is introduced into the viscous solver via a body force model. The forces are derived from a propeller panel code. For both cases an aft body optimisation shall be performed. In summer 2011, the fully automated optimisation loop is planned to be running, and compete in a field test against traditional, manual optimisation.

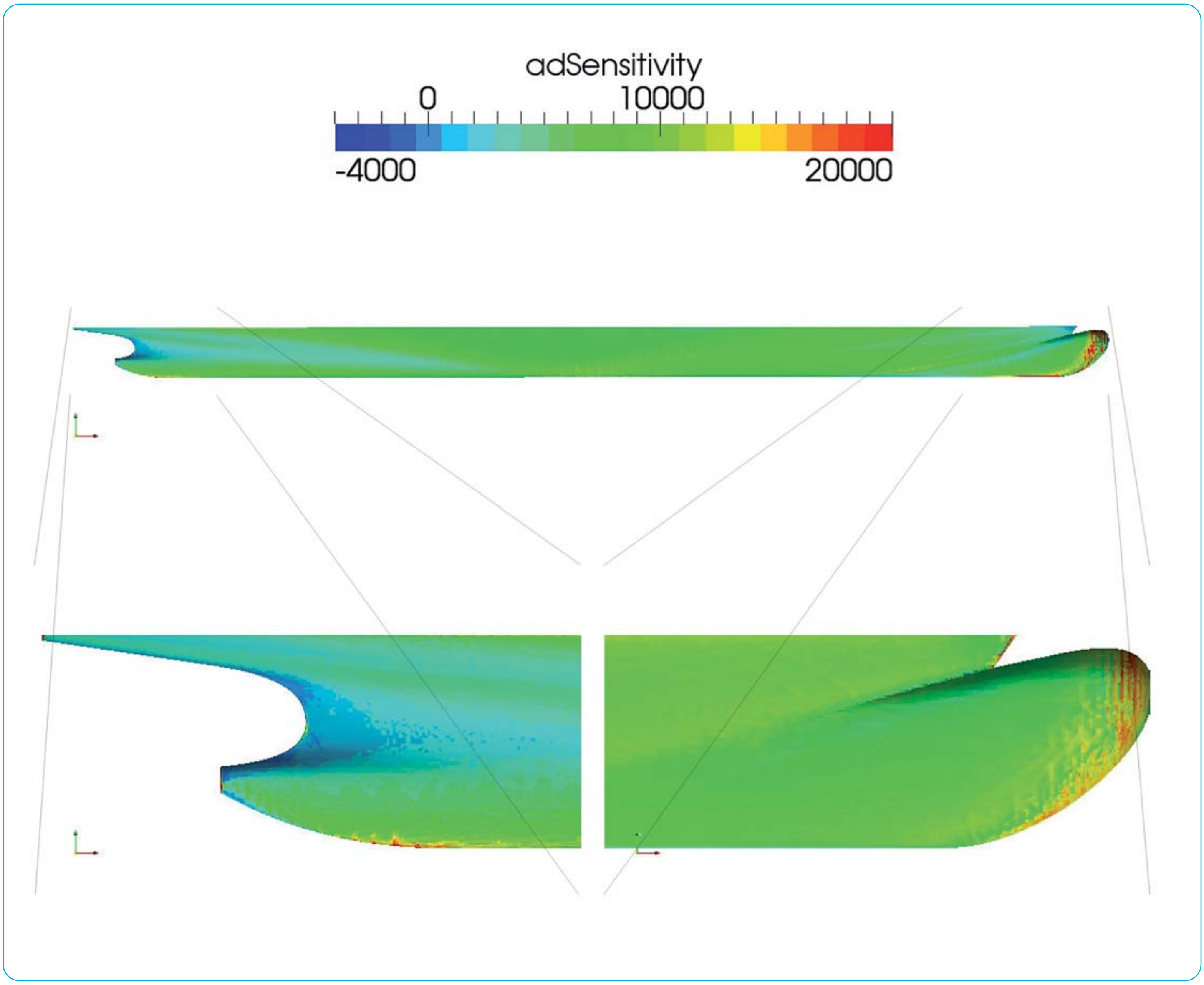


Fig. 2: Sensitivities for a Container Vessel (Objective: Total Resistance)

Optimization and Integration of Twin Screw Shaft Supports

by Heinrich Streckwall, Hans-Uwe Schnoor and Scott Gatchell

Under water appendages may not only contribute to the resistance of the ship, which in itself already justifies a careful integration, but may also influence the flow to the propeller. In the latter case we may even be faced with excessive propeller cavitation and noise, if appendages strongly reduce the wake quality. In particular the free shaft and the shaft supports of twin screw vessels should be arranged with special attention to their effect on the flow to the propeller. This problem is not trivial, particularly if the shaft line is inclined in vertical and/or horizontal direction.

The numerical work performed prior to the model tests for a new-building project demonstrates our general approach to optimize the shaft supports. The shaft line was indeed inclined horizontally and vertically. In this case we remained in close cooperation with the shipyard and finally agreed on an elongation of the middle skeg to allow for a perfect position of the shaft supporting struts. The computational approach was based on our in-house RANS-method 'FreSCo'. Using the commercial grid generator ‚HEXPRESS' of Numeca International, various grids were produced and processed.

The rear support of the shaft was supposed to be a v-bracket with both struts meeting the hull in the area where the lines are directed more or less horizontal. At the shaft outlet it was intended to be held by a wedge.

Figure 1 shows the initial wedge geometry (view from behind, Port side) and the final solution (Stb side). Figure 2 gives the different wakes in the propeller plane that would result solely due to the wedge modification. Here axial velocities are given by contours and the crossflow is to be taken from the vectors. Figure 2 also gives (virtually) the initially designated v-bracket (Port) and the improved strut arrangement (Stb), characterized by a complete separation of shaft wake and expected wake from the struts. The latter solution also required a moderate elongation of the middle skeg to support the inner bracket arm.

Figure 3 shows (in view from behind) the complete final shaft support solution (on Port) and the related velocity field obtained in the propeller plane (on Stb). Again the axial component is given by the contours and the crossflow components by vectors. The individual bracket arms were in addition turned slightly around their axis to fit perfectly into the general flow around the hull. Typical angles for this measure are 5°, tail to shaft for the inner arm and 9°, tail to shaft for the outer arm. Reviewing the process we can draw the following conclusions from the sequence of adjustments that led to the very satisfying shaft support result:

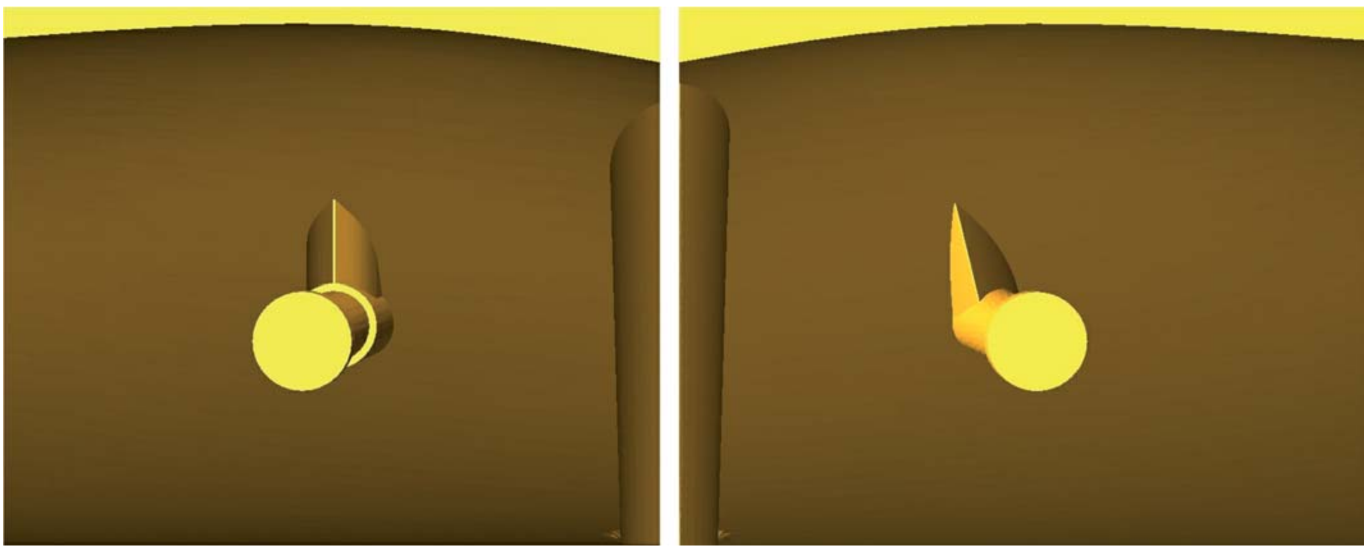


Fig. 1: Wedge alternatives at shaft outlet (view from behind, propellers and struts removed).

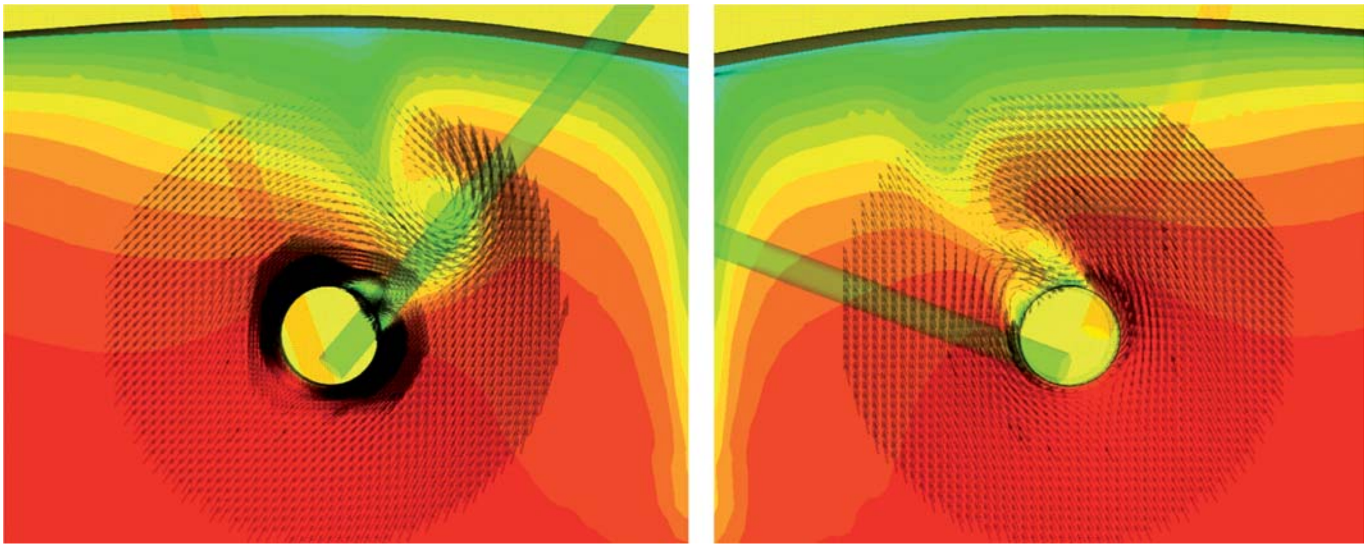


Fig. 2: Wakes in the propeller plane showing the effect of wedge shape improvement. Also shown are possible arrengements for the v-bracket arms (yet virtually inserted, not influencing the wake), whereby the solution on Stb was actually emphasized and realized.

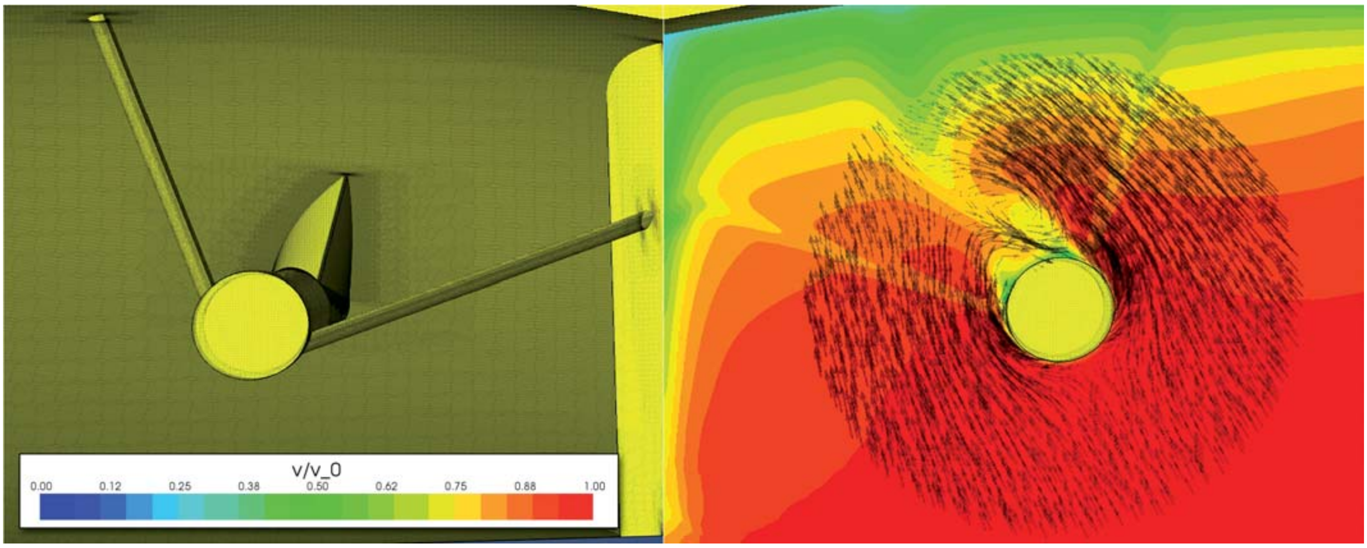


Fig. 3: Final configuration (Port) and total wake computed in the propeller plane for optimized configuration with all components integrated (Stb).

1) Don't underestimate the influence of a wedge type shaft support at the outlet, investigate alternatives. The wedge wake strongly interacts with the shafts wake. This is the first step.

2) Provide a certain flexibility for the positioning of the v-bracket arms as it is important to separate them from the wake of shaft and wedge.

3) Consider constant turning of the bracket arms around their longitudinal axis in any case to fit them into the flow, in special cases also consider additional twist.

It is believed that the minor costs invested prior to the model tests in the numerical analysis of alternatives for the shaft support clearly pay off as the quality of the wake will improve propeller operation, reducing the danger of erosion due to cavitation and the danger of vibration. It also has to be kept in mind that a high wake quality may allow for a reduction of propeller blade area and thus reduce frictional losses entering propeller efficiency.

In the above example, under the guidance of numerical results and involving our knowledge, we were able to achieve more than just a sufficient solution as was also confirmed by wake measurements and propulsion tests.

HSVA's Ice Tank: First DP Model Tests in Ice Successfully Performed for Stena Rederi AB

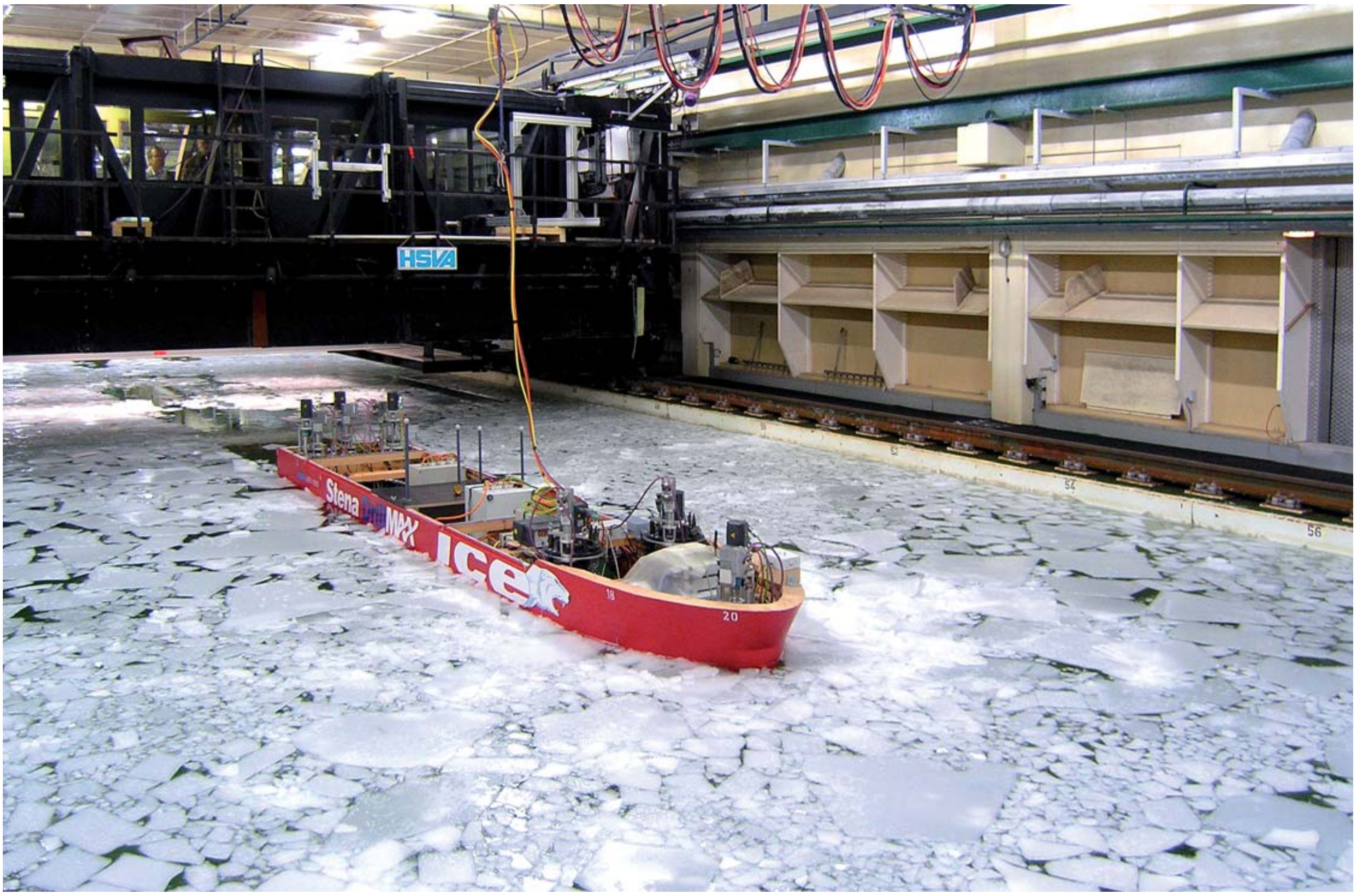


Fig. 1: Stena DrillMAX ICE under realistically modelled ice conditions (managed ice) in HSVA's ice tank

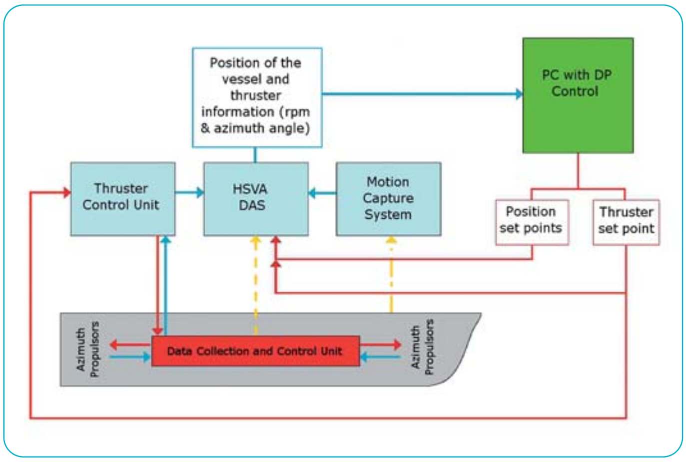


Fig. 2: Control and data acquisition set up (DAS = Data Acquisition System)

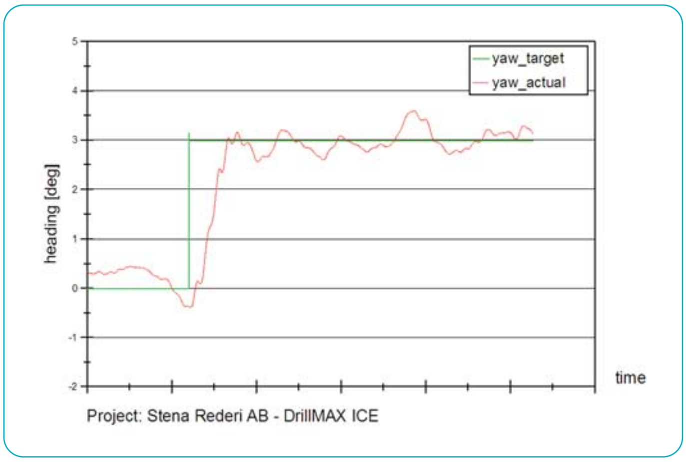


Fig. 3: Target heading and actual heading for a test in managed ice with constant ice drift

Fig. 4: HSVA model of Stena DrillMAX ICE turns DP controlled by 180° at zero ice drift speed

✎ *by Andrea Haase*

Stena Rederi AB had commissioned HSVA to perform Dynamic Positioning (DP) model tests for their drillship Stena DrillMAX ICE. It was not the first time that Stena DrillMAX ICE has been investigated in HSVA's ice tank. Tests for building up a DP system had been performed earlier. The project was carried out in close collaboration between HSVA and Stena Rederi AB, for sure one of the reasons for its success.

The tests were split up into a one week pre-test phase (in air and in open water) and into a two week ice testing phase. All tests in ice were performed in managed ice. The ice drift was simulated by moving the vessel through the ice. In order to achieve most realistic ice conditions different specific ice floe distributions had been determined from full scale observations. Those were then transferred into HSVA's ice tank. Regarding the model ice the speciality was that the ice consisted of both, floes of different size and of brash ice. The percentage each size held was varied during the different days. Figure 1 shows an example of one of the tested ice conditions.

The model was equipped with six azimuth thrusters all controlled by the DP system. A sketch of the systematic control and data acquisition set up is given in Figure 2. Data of both types – target values from the DP system and actual values from the measurement equipment were logged together in one system. For post processing this allows a good judgement on how well the model followed the target position given by the DP computer. An example of such a comparison is shown in Figure 3.

Different types of tests were performed during which the ice drift velocity and ice drift direction towards the model were changed. The model also had to change heading while being exposed to ice with different drift velocities. In one typical test the model had to turn 180° at zero ice drift speed. Such a test is shown in the snap shots given in Figure 4.

After finishing the test series, it was concluded that the model followed the DP target values for position and heading very well.

HSVA's New Side Wave Generator: Demonstrator now Operating

Fig. 1: Building extension ready for the installation of the Side Wave Generator

Fig. 2: During installation

by Katja Jacobsen

Due to new standards and requirements on safety as well as economic aspects of ships in seaways it is essential for modern model basins to be prepared for changing requirements. With the new Side Wave Generator HSVA increases its seakeeping test facilities dramatically for meeting these requirements. With the aim to acquire new markets and thus new orders HSVA extends as first model basin worldwide its Towing Tank with a new computer controlled Side Wave Generator in order to investigate seagoing ships in realistic sea scenarios.

In January 2008, HSVA started the project ViTa II for the generation of beam and oblique waves in its Large Towing Tank. The project is partially funded by the Free and Hanseatic City of Hamburg. After two years of intensive planning, designing, engineering and manufacturing the New Side Wave Generator (SWG) is now installed and ready for operation. It is mounted on the long side of the tank wall in the centre of the large Towing Tank of HSVA. During downtime, the wave generator is stowed outside of the tank in the walkway with a dedicated stowing system. This was a requirement to the SWG in order to avoid imposing any spatial limitations to other tests such as propulsion or manoeuvring tests.

The new Side Wave Generator (SWG) is a snake wave generator consisting of 80 flaps each having the width of 0.5m. The 80 flaps are arranged on five single sections. Each flap is controlled individually, therefore arbitrary waves and sea states can be generated, like:

- Regular waves
- Multichromatic waves (limited number of frequencies)
- Irregular long-crested sea states (PM, JONSWAP, TMA spectra, but also user-defined spectra)
- Selected subseries of irregular sea states satisfying given parameters (e.g. steepness)
- Irregular short-crested sea states
- User-defined wave trains
- All of the above described waves and seaways can be generated within an angle from 20° to 160°, i.e. enabling investigations in beam and in oblique sea states.
- Together with the existing wave generator (long-crested waves in longitudinal tank direction) the combination of wind seas and swell can be simulated.

Integrating the Side Wave Generator on the long side of the existing Large Towing Tank puts the acceleration and deceleration phases of the ship model outside of the actual measuring region. Thus, the length of the side wave generator can entirely be exploited for the measurements.

On the other side of the towing tank, facing the Side Wave Generator, a wave absorber consisting of vertically positioned perforated steel plates is installed. The purpose of the wave absorber is to damp away the incoming waves and thus to minimise wave reflections from the tank wall in the measuring area disturbing the generated original wave spectrum. The absorbers remain permanently in the tank, they can, however, be folded to the wall outside the operating times in order to keep HSVA's large towing tank width.

Fig. 3: The first waves

The total length of the demonstrator of the new SWG is 40m – as a first step in the process of improving HSVA's seakeeping testing techniques. It will be tested intensively during the next months. One main target is its integration in a computer controlled testing procedure, which includes model, towing tank and existing wave generator. With the demonstrator of the SWG tests with smaller models or/and slower speeds will be possible because of the short measuring time. However for tests with models at zero speed, e.g. offshore structures, the Side Wave Generator can already now be exploited within its full capacity. After the successful demonstration of the technique and its applications, it is planned to extend the Side Wave Generator to a total length of 140m. After completion it will then be possible to carry out seakeeping tests in beam and in oblique waves with the large models HSVA use during all tests.

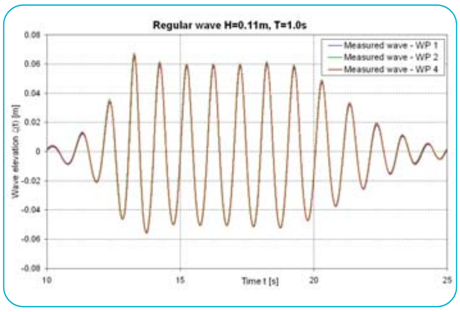


Fig.4: Regular wave measured with 3 wave gauges aligned in the mid of towing tank

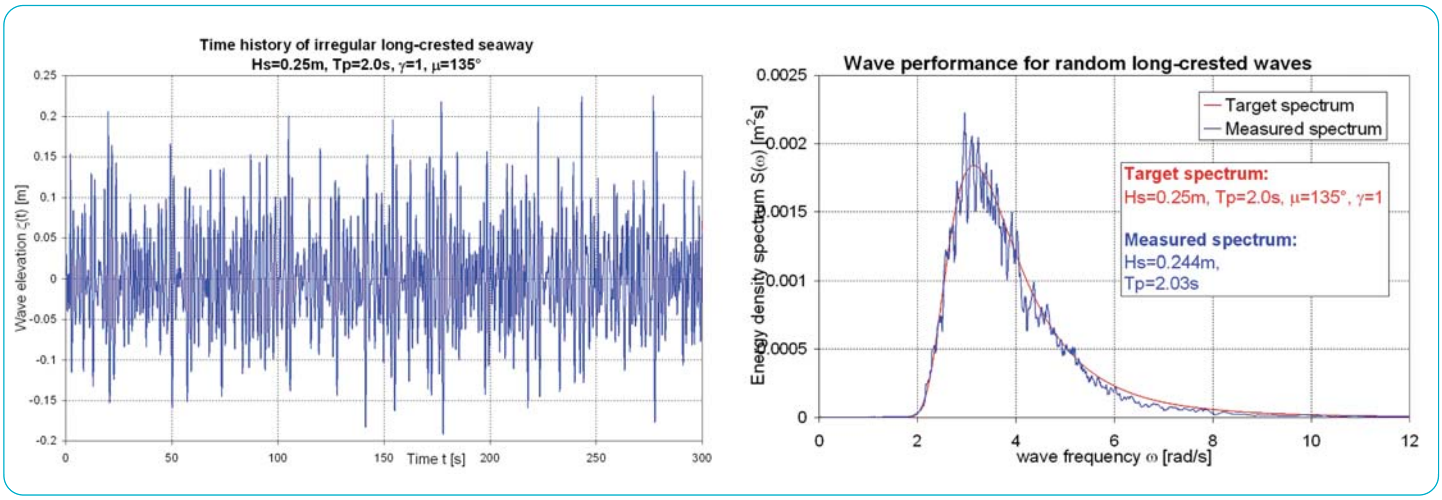


Fig.5: Time history and spectrum of an irregular sea state with Hs=0.25m, Tp=2.0s, g=1 at an angle of 135°

Successful Development and Validation of the Becker Mewis Duct®

by Hilmar Klug

Almost three years ago, in summer 2008, HSVA was contracted by the Hamburg based company Becker Marine Systems in order to provide support in the development of a novel energy saving device named Becker Mewis Duct®.

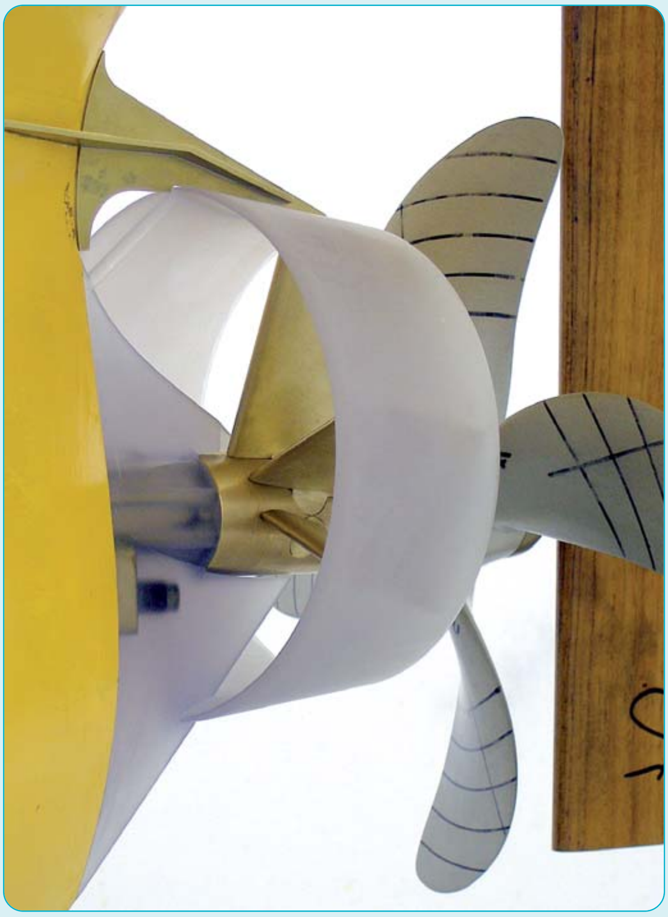
The Becker Mewis Duct® is the patented combination of a pre-swirl stator with a wake equalizing duct. The device is named after its inventor Mr. Friedrich Mewis, a former head of the resistance and propulsion department of HSVA.

Following the first very successful tests late in summer 2008 the Becker Mewis Duct® was introduced to the market on the SMM 2008 exhibition.

One year later the model tests for the first actual installation of the Becker Mewis Duct® were performed and promised a reduction of the power consumption by about 6%.

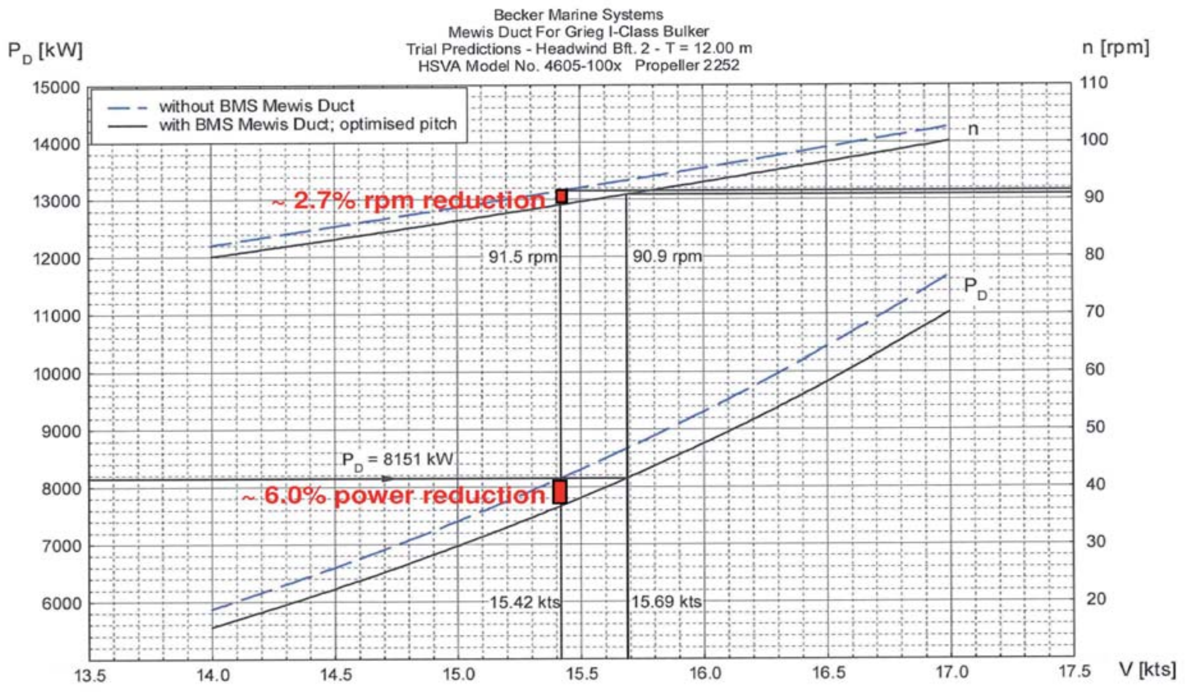
Again one year later the first full scale vessels have been fitted with this new energy saving device. Sea trials, performed with and without Becker Mewis Duct®, which together confirm the energy saving effect predicted on the basis of the model tests carried out.

Since the very beginning about ten model test campaigns have been performed with Becker Mewis Duct® for high block ships such as bulk carriers and tankers. The tests results together with those of the viscous flow computations performed in the design phase are providing a deeper knowledge about the Becker Mewis Duct® system and support the further optimisation of it.

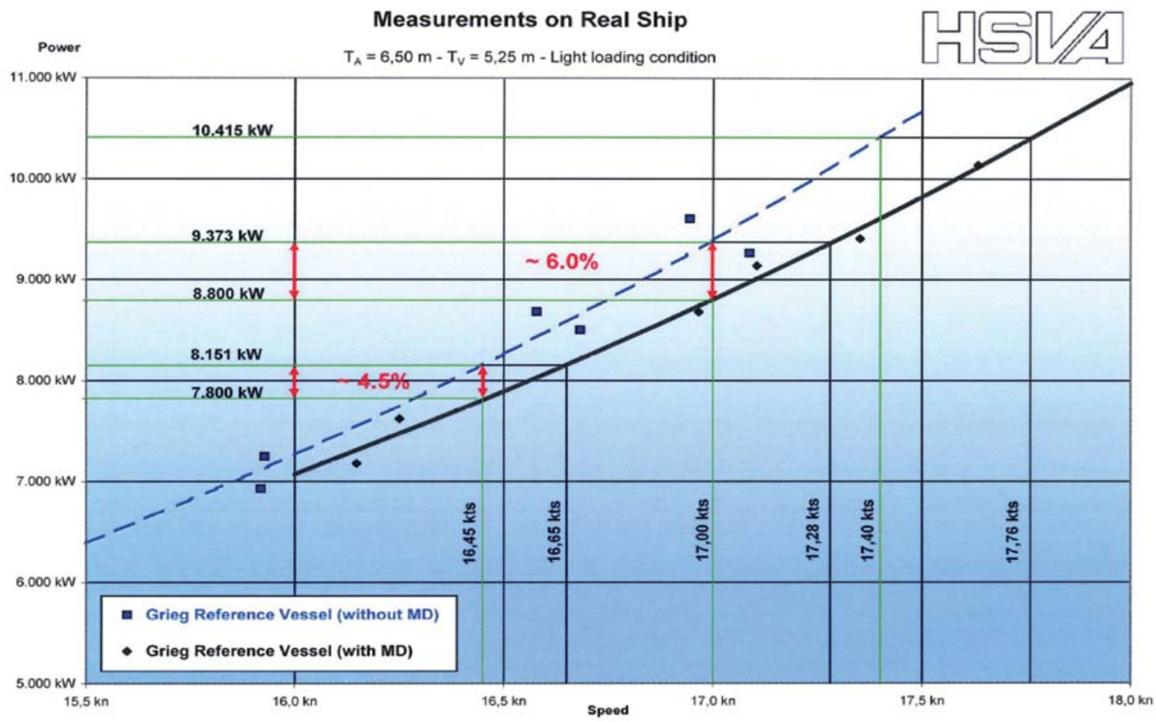


Becker Mewis Duct® in model scale

Becker Mewis Duct® in full scale



Model Test Results with and without Becker Mewis Duct®



Sea Trial Results with and without Becker Mewis Duct®

Advanced Slamming Measurements with new Panels

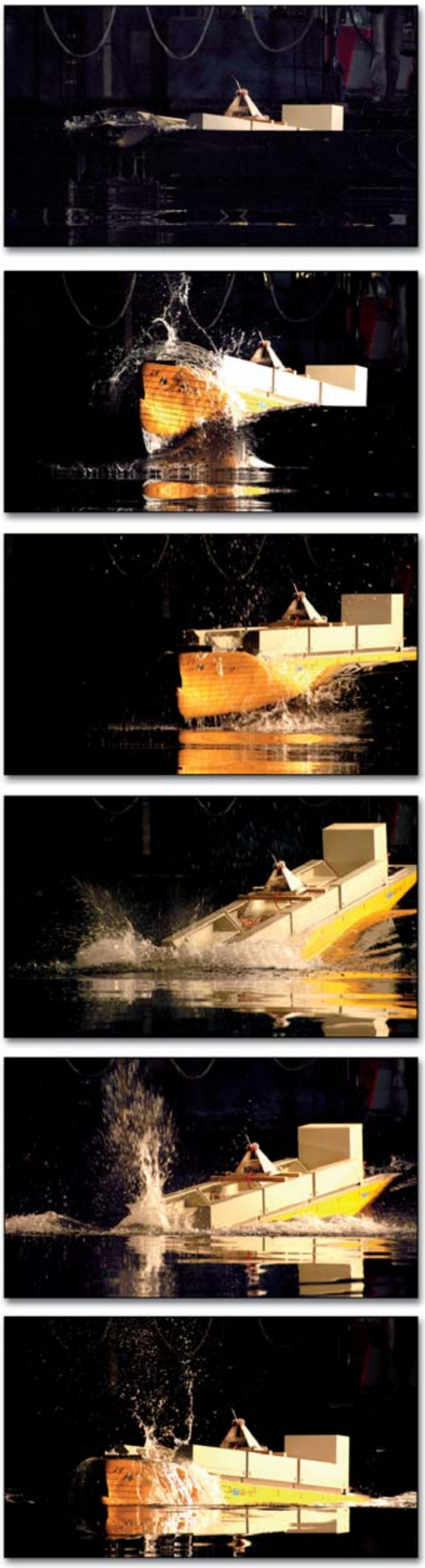


Fig. 1: Container Ship going through a wave packet

✐ *by Peter Soukup*

The phenomenon of slamming is well known. Large heave and pitch motions in heavy seas can cause the ship hull surface to impact with the water surface with a sufficiently high relative velocity to result in very high local pressures. The resulting forces acting on the structure can cause vibrations and even damage. Therefore it is important to investigate and quantify these forces acting on the ship, which can in a reliable manner be done with measurements in model tests.

For this purpose small pressure sensors are usually distributed over the locations of interest, like the stern section, the bottom near the bow and especially the parts with high bow flare. Due to the small size of these sensors also local effects and high pressure peaks can be measured, which can be of interest for special cases. In general averaged loads acting on the hull plates are needed. These are computed by integrating the local pressures over the surface including all local effects, which might distort the result. In some cases it is better to measure an integral value, which is the total force acting on a predefined surface. Therefore HSVA developed a test scheme within the research project MoDeSh to determine slamming loads by force measurement panels. One panel consists of a force transducer and a plate, which is in-plane with the hull surface. Figure 2 shows three of these panels: One to measure bottom slamming at frame 16.5 and two for bow flare slamming at frames 18.5 and 19.5. One further panel was mounted on the stern section. With this technique it is possible to determine the slamming loads, which are relevant for the structural design of the vessel.

The new panels were used in model tests of a panamax container ship in regular and irregular waves and in the concentration point of transient wave packets. Latter makes it possible to quantify the loads in a precisely defined extreme condition as illustrated in the series of pictures in Figure 1, where the ship goes through a 30m high wave.

Fig. 2: Slamming Panels in the bow section

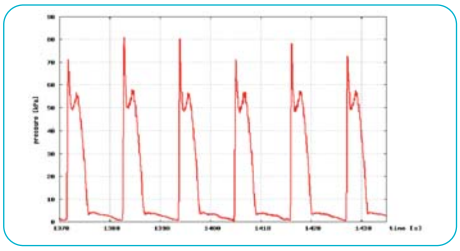


Fig. 3: Time history of the slamming pressure in regular waves

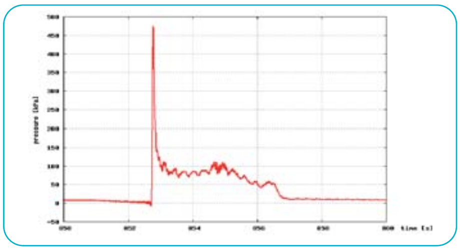


Fig. 4: Time history of the slamming pressure in a transient wave packet

Figures 3 and 4 show the time histories correlated to in full scale of the pressure measured with the slamming panel at frame 19.5. While the pressure loads in a very high regular wave were still moderate up to 80 kPa, a six times higher peak value of 475 kPa was found in an extreme wave generated with a transient wave packet.

With HSVA's techniques in wave generation and slamming measurement, it is possible to determine slamming loads in regular waves as well as to obtain the slamming probability in irregular waves. Moreover it is also possible to measure the peak loads in one single wave.

These model tests additionally served to get a variety of validation data for RANSE simulations and to improve HSVA's experience in slamming analysis. Thus, HSVA is well prepared for slamming load investigations for customers who need detailed information on forces for the determination of design loads.

Full Scale Cavitation Observations – Various Options for Any Purpose

by Christian Johannsen

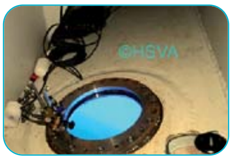
Cavitation observation on the propeller or rudder of a real ship is one of the very challenging tasks within the field of onboard measurements. Different options for recording and lighting technique as well as for the kind of hull openings are available and result in a large variety of possible combinations with specific **pros** and **cons**. This must be confusing to those in charge of choosing the best option for their particular case, having a specific motivation for the observation with individual circumstances and restrictions involved.

To structure the variety of hardware options, the table given below might be helpful. It shows four columns with different recording and lighting techniques in combination with the hull openings required for that. The rows of the table display the pros and cons of the different options to ease a proper selection.

But hardware is only one side of the medal. Much more important is a reasonable planning of the trip. Where to go to encounter clear water? How to bring the equipment onboard with minimal risk, travelling and transportation cost? These things simply require a strong partner on your side, having experience with different harbours or other possible disembarking locations as well as with water qualities in various sea areas in all seasons.

Even more important is what comes afterwards. It is quite easy to buy professional video equipment and to place it in front of a window in the shell. But how to judge the result? This is not a matter of playing with video enhancing software tools resulting in smooth cross-fades and lovely background music. It is a matter of turning videos into meaningful answers to your questions and of recommending realistic remedies for the hydrodynamic problems obtained. This, however, requires experience from your partner, which has been gathered over years by model testing, full scale investigations and CFD application.

HSVA's Boroskop Looking Through a Tiny Hole in the Shell



HSVA's Class Approved Observation Window in the Shell

HSVA can offer both, specialised and class approved hardware as well as experience in all aspects mentioned above. HSVA will be happy to tailor your full scale cavitation observation campaign to your needs. HSVA is your strong partner for onboard cavitation observation.

	Photographs / videos at daylight using a Boroskope	Photographs / videos at daylight using observation windows	High speed videos at daylight using observation windows	Photographs / videos at strobe light using observation windows
Hull injuries	some M20 bores	some windows Ø 300 mm	some windows Ø 300 mm	some windows Ø 300 mm
Dry docking required for preparation	no[1]	yes	yes	yes
Dependence on sunshine	strong	weak	strong	no
Picture quality	low	reasonable	reasonable	very good
Capturing cavitation dynamics	no	no	yes	no
Capturing cavity details	no	no	no	yes
Cable connection required from engine room to observation place	no	no	no	yes
Simultaneous pressure pulse measurement possible	yes	additional M20 bores needed	additional M20 bores needed	additional M20 bores needed
Complete equipment available from HSVA	yes	yes	yes	yes
Typical purpose	trouble shooting	type approval	type approval	research

[1] *In most cases holes can be drilled from inside by temporary trimming the vessel to the bow*

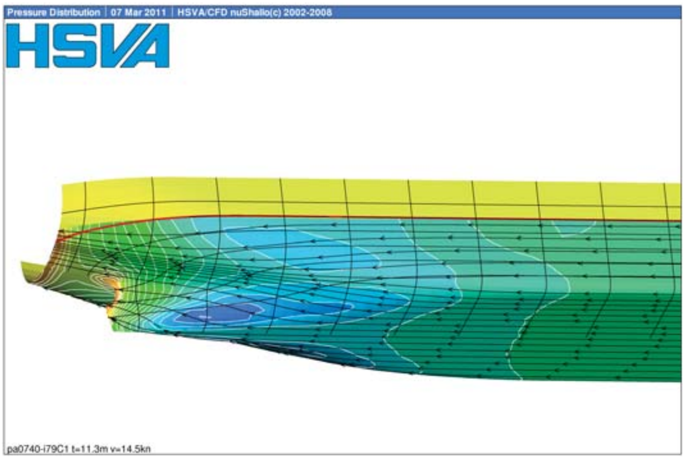
Optimisation of the 63500 DWT Bulk Carrier CROWN 63

by Hilmar Klug

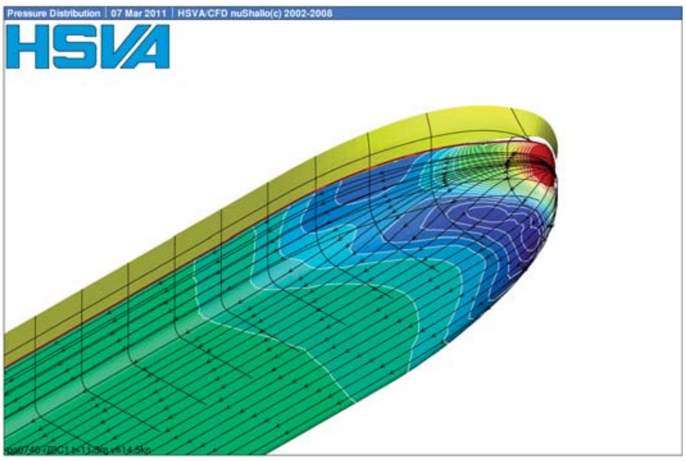
Almost two years ago the Shanghai based design office GreenSeas Marine Technology (GSMT), the French shipping company Setaf Saget and HSVA joined forces for the development of hydrodynamic design for the new 63500 DWT Bulk Carrier CROWN 63, which is now under construction at the Chinese shipyard Sinopacific.

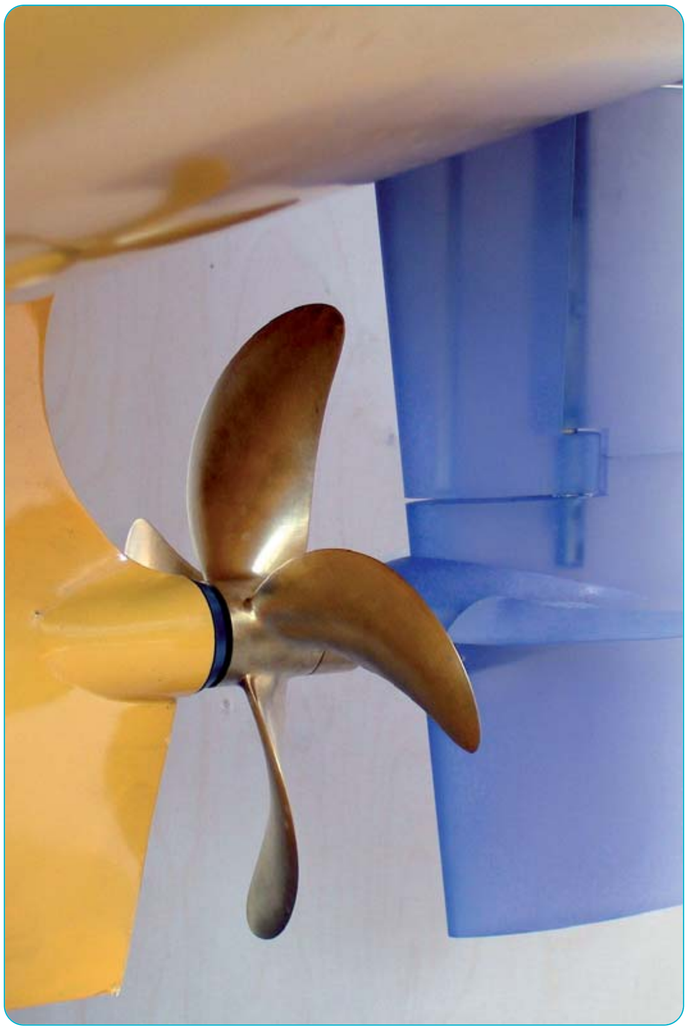
The development started with the initial hull lines of GSMT. In a first step potential flow calculations as well as viscous flow calculation have been performed in order to support the design optimisation. The first calm water tests showed that there was some room for improving the performance since the project was to herald significant fuel saving. Consequently the hull lines were further optimised by HSVA's specialists. Changes in the general arrangement allowed for larger modifications of the hull lines and the next test series confirmed the significant reduction of the power consumption and increase of the achievable speed. After a further refinement of the hull lines the next step was the optimisation of the rudder/propeller arrangement. An actual design propeller (developed by Nakashima) was manufactured and combined with a conventional semi-balanced rudder designed by HSVA. The new rudder reduced the power consumption by 2.7% and was fitted with a rudder-bulb and rudder-fins in the next steps. Both energy saving devices, rudder-bulb and rudder-fins, have been designed by HSVA and reduce the power consumption in total by 3%.

Finally the present vessel is the benchmark vessel for this ship type and size in HSVA's database, with a speed of 14.52 knots on design draft with 10% sea margin and a delivered power of 6,640 kW.

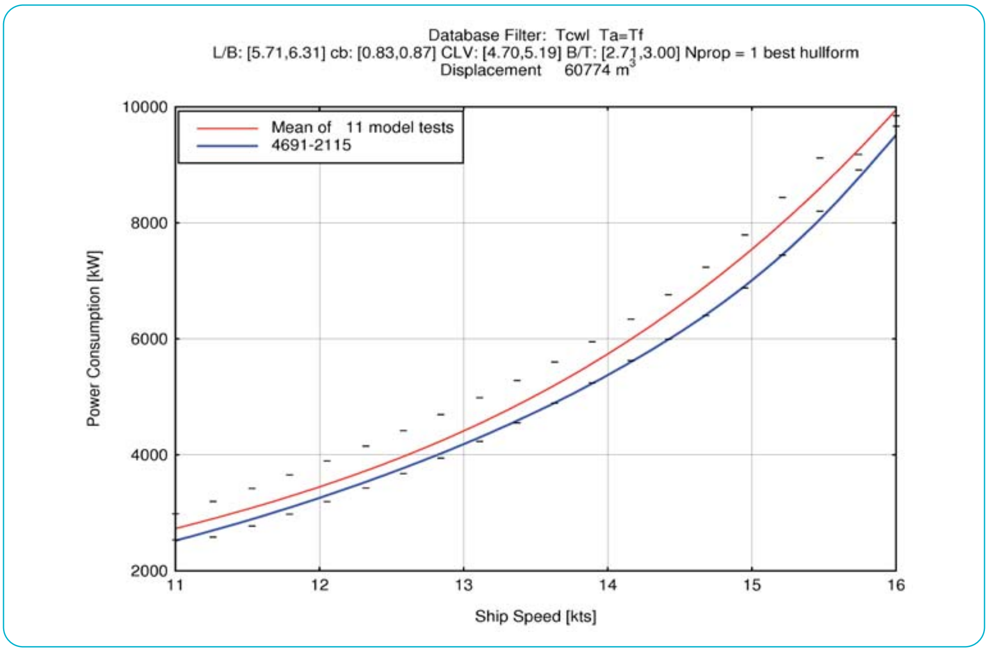


Computed pressure distribution and flow lines

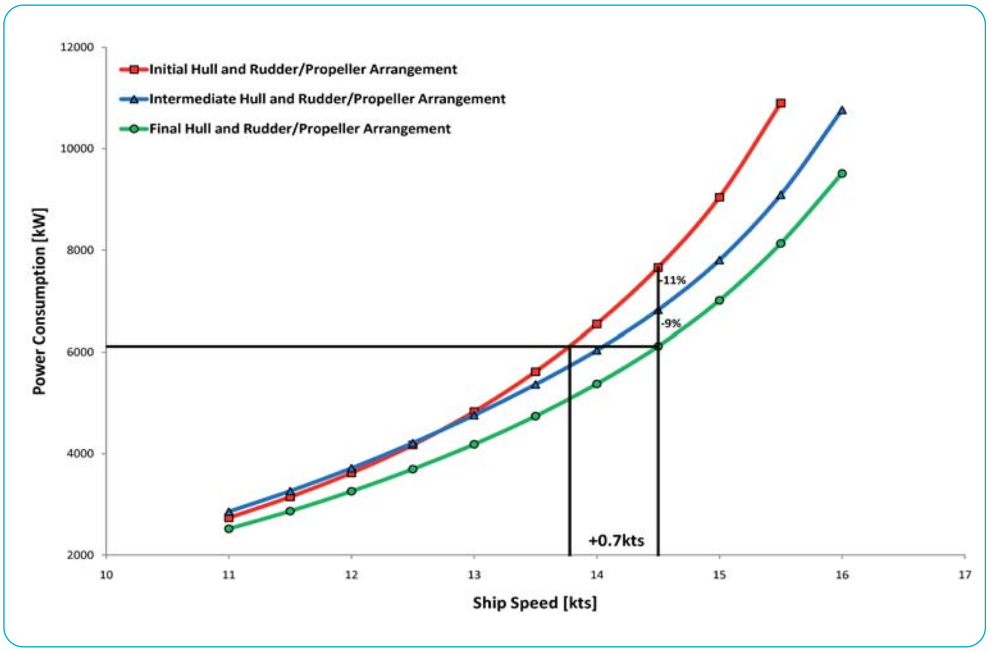




Semi-balanced rudder with energy saving devices



Comparison with similar vessels in HSVA's database



Improvement in power consumption

Ship model during the calm water tests

Member of staff

Martin Gutsch joined HSVA in November 2008 as a project manager in the Propellers and Cavitation Department. In close cooperation with our customers he is mainly responsible for the performance of cavitation tests carried out in HYKAT. Additionally, he manages the use of special measuring equipment for research projects in the conventional tunnels or wherever needed.

Martin Gutsch studied Naval Architecture at the University of Duisburg-Essen, Germany. His master's thesis focussed on scale effects involved in model propeller performance, acquainting him with HSVA when conducting model tests for that.

In his free time Martin enjoys Italian culture, inviting friends to Mediterranean cuisine.

HSVA is an active partner in the FP6 Hydro-Testing Alliance (HTA) Network of Excellence (NoE) which organizes the 2nd International Conference on

Advanced Model Measurement Technology for the EU Maritime Industry (AMT'11)

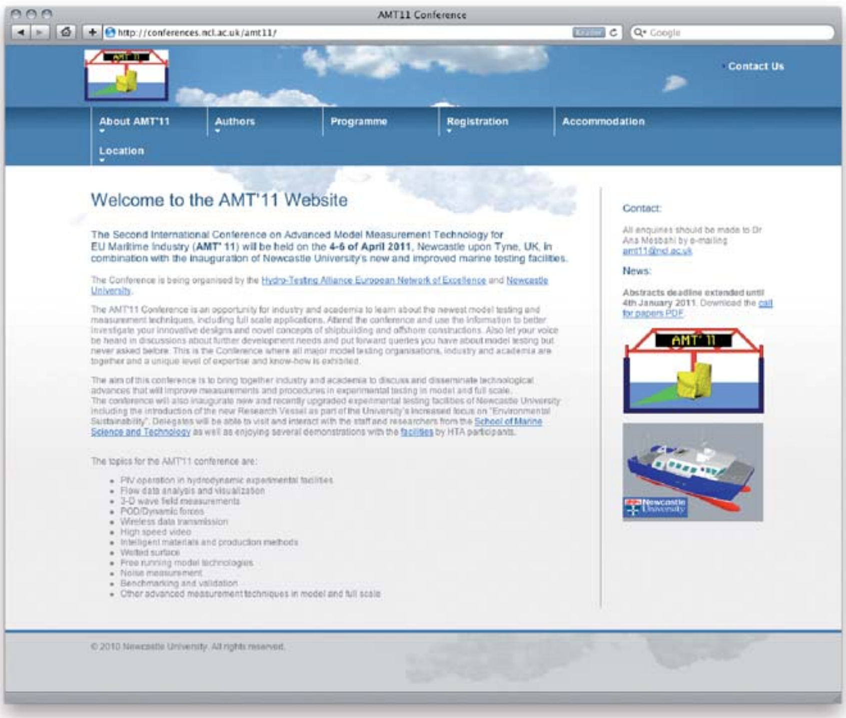
4-6 April 2011, Newcastle upon Tyne, UK

The conference topics include:

- PIV operation in hydrodynamic experimental facilities;
- Flow data analysis and visualization;
- 3-D wave field measurements;
- Podded/Dynamic forces;
- Wireless data transmission;
- High speed video;
- Intelligent materials and production methods;
- Wetted surface;
- Free running model technologies;
- Noise measurements;
- Other advanced measurement techniques and benchmarking and validation.

Among others, HSVA's experts are there to discuss these interesting topics with you.

For more information please see at:
http://conferences.ncl.ac.uk/amt11/



Hamburg Ship Model Basin • Bramfelder Straße 164 • D-22305 Hamburg
Phone: +49 - 40 - 69 203 0 • Fax: +49 - 40 - 69 203 345 • Email: info@hsva.de • Web: www.hsva.de