Left to right: Christian, Katrin with Ole, Jan R., Peter, Ingrid, Hans-Uwe, Oliver, Hannes, Henning, Florian, Sören, Jan L.

HSVA's Resistance and Propulsion department

In 2014 and 2015 HSVA's Resistance and Propulsion department faced major changes. Some colleagues left HSVA to retire or took over new positions at HSVA or in the maritime industry. New highly motivated and experienced colleagues joined HSVA since, continuing the successful work of the department. The re-organization was finalized in May 2015 with the appointment of Dr. Florian Kluwe as the new head of department.

The resistance and propulsion department focuses on the open water performance of ships. Besides diverse model testing we offer extensive consulting and design work in close cooperation with our customers and across all hydrodynamic disciplines, supported by state-of-the art evaluation tools like CFD.

Today the following members form HSVA's Resistance and Propulsion team:

Head of Department: Dr. Florian Kluwe – Ph.D. Naval Architect – joined HSVA in 2015. After his Ph.D. Thesis in 2009, Florian worked six years at a major German shipyard, ultimately as the Head of Hydrodynamics and Software Development. Florian has a profound and interdisciplinary knowledge in hydrodynamics and ship performance and plans to focus on research and development for efficiency and safety.

Deputy Head of Department: Oliver Reinholz – Dipl.-Ing. Naval Architect – joined HSVA in 2008 with a strong background in ship design and hydrodynamics, having worked three years at a major German shipyard. Oliver is mainly responsible for our European customers and takes care of special ships and propulsion systems.

Department Secretary: Ingrid Dratwia – Technical Drafter – joined HSVA in 2005. Ingrid keeps the department running, prepares our meetings and is responsible for the video cutting and the distribution of our reports.

Project Managers

The project managers are taking care of our customers, being responsible for acquiring, organizing, performing and evaluating calm water model tests for all kinds of ships and offshore structures – always in close cooperation with the other HSVA departments:

Sören Brüns – Dipl.-Ing. Naval Architect – joined HSVA in 2014 – Sören is our point of contact for our Asian customers.

Christian Gose – B.Eng. Naval Architect – joined HSVA for the second time in 2015 (he worked in our CAD department until 2010 before he started his academic studies) – Christian has customers from all over the world.

Katrin Lassen – Dipl.-Ing. Naval Architect – joined HSVA in 2014 – Katrin manages projects for customers around the globe.

Jan Lassen – Dipl.-Ing. Naval Architect – joined HSVA in 2013 – Jan is member of the sea-keeping and manoeuvering department focusing on all topics related to manoeuvering. He supports the resistance and propulsion department temporarily.

Johannes Strobel – M.Sc. Naval Architect - joined HSVA in 2015. Hannes is mainly responsible for our Asian clients.

Hull Form Analysis, Development and Optimisation

HSVA offers hull form consulting, optimization and development for any kind of vessels and appendages.

Hans-Uwe Schnoor – Dipl.-Ing. Naval Architect – joined HSVA in 2005 with almost 30 years' experience in ship design and hydrodynamics at a leading German shipyard. His extensive knowledge led to many successful hull forms and is utilized throughout the whole HSVA.

Henning Grashorn – Dipl.-Ing. Naval Architect, Dipl.-Ing. Industrial Engineer – joined HSVA in 2002 with a two year professional background. Having done both hull form development and project management in the last years, Henning will now focus on the hull form development.

Peter Horn – Dipl.-Ing. Naval Architect – joined HSVA in 2012. Peter does all the viscous flow calculations required for hull form analysis.

Evaluation and Software

For the processing and evaluation of our test data and to keep our database and tools up to date, the department has a smart resource:

Jan Richter – Dipl.-Ing. Naval Architect – joined HSVA in 2014 with a seven year background in research and model testing. Jan does all the coding required to keep everything running and conform with the latest findings in research.

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HSVA newswave

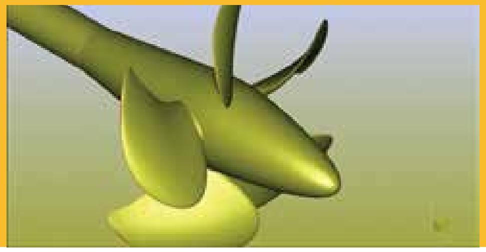
The Hamburg Ship Model Basin Newsletter

CFD-image: HSVA, Photo: Adri Schouten

CFD – How *FreSCo+* is applied to predict added resistance in waves

Success story: HSVA's long term partnership with HB Hunte Engineering

INRETRO, a European project addressing slow steaming prospects



HSVA's restored Arctic Environmental Test Basin

editorial

Dear reader,

every other year, the German National Maritime Conference takes place in one of Germany's major maritime locations. This year, October 19-20, Bremerhaven hosted the conference with more than 800 participants from the German – and international – maritime industry and politics. It became once again clear that both the national and international market are facing major challenges, related to global market processes like the low oil price, declining freight rates and the shipyard crisis in Asia. However, these challenges can be a chance as well – a chance to those who face major changes with creativity, flexibility and insight into their major strengths.

This was reflected illustratively by a panel with global maritime players discussing their view on the German maritime market. Among others the capability of the German industry to deal with complex technical systems and to provide an infrastructure for developing related new products and solutions, also based on an efficient educational system delivering skilled engineers and specialists to the industry, was underlined. The ability to identify and apply these insights was revealed as the real challenge during the discussion. In this sense, it can be inspiring and even crucial to every company in the world to mirror their real strengths – and this applies also to HSVA.

Despite the economically bumpy times, we are facing a very high level of orders – including changing demands with an increasing focus on consultation for new technical solutions. This is where we have to identify our real strength: maintaining a high quality in routine services on one hand, but also providing our high level expertise and creativity to a changing and more complex industry on the other. In this sense, I would like to thank you for your ongoing confidence and loyalty – and your trust in our capability to develop further in new directions.

Some of our recent exciting projects are described in this Newswave issue. I hope you will enjoy reading it, together with our brand new layout!

Janou Hennig

Dr. Janou Hennig

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Accurate CFD prediction of added resistance in waves

The accurate prediction of the added resistance in waves is a topic of high interest in the ship design process. With the introduction of the EEDI (Energy Efficiency Design Index) and the consequential search for energy efficiency increasing measures the question of the minimum power requirement for the safe operation of the ship even in heavy seaways receives special attention.

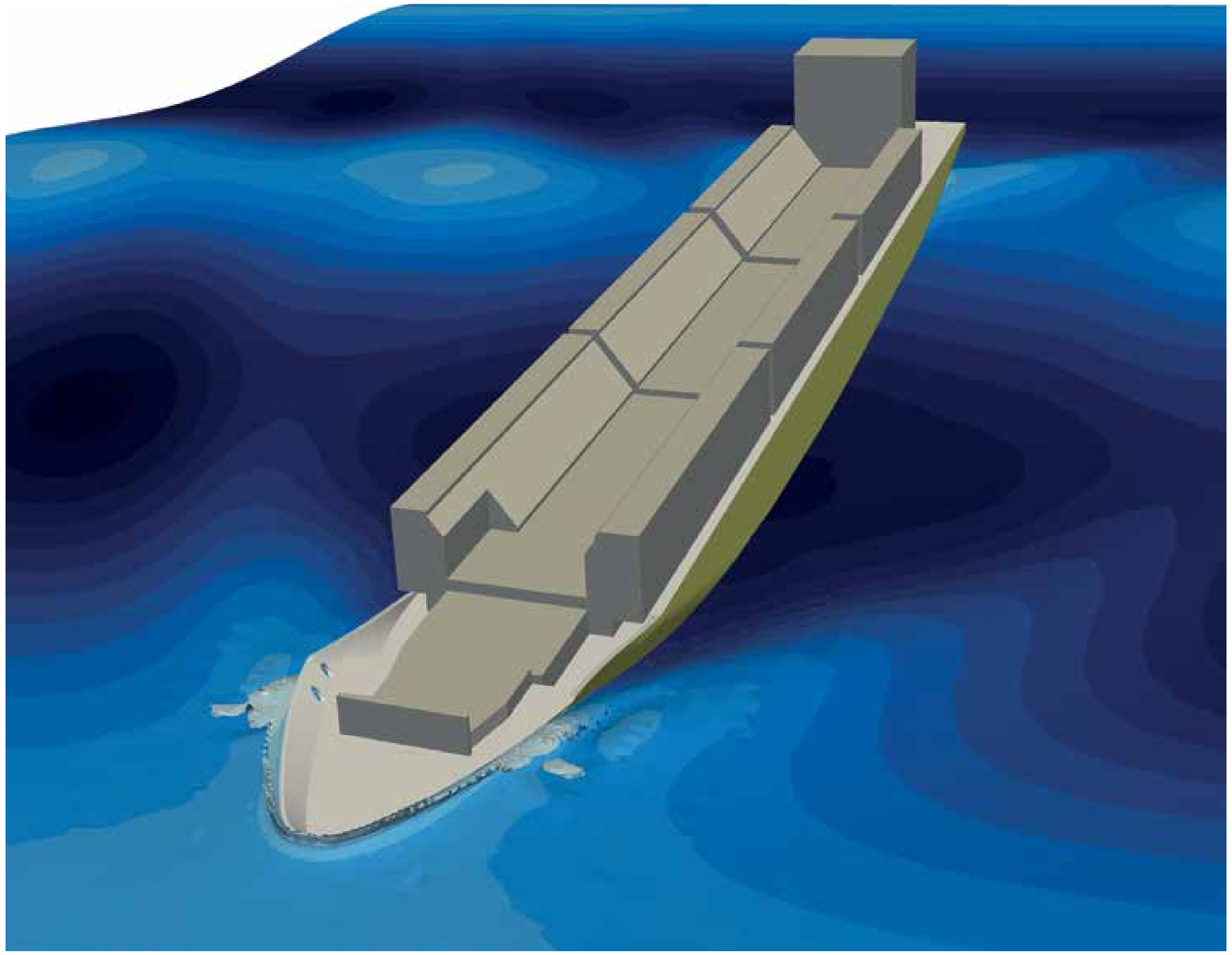
by Jan-Patrick Voß

The decisive factor for the power requirement in operation is the wave induced added ship resistance, which is traditionally considered in the power estimation by a general margin. This Sea-Margin is typically specified by 10-20% of the calm water power requirement, regardless of the ship size. While the wave added resistance in realistic seaways can be very small compared to the calm water resistance for large ships, it can be in the same order as the calm water resistance for small ships on the contrary.

Hence a general power margin can lead to an overestimation of the power requirement for large ships and an underestimation for small ships, respectively.

For a "demand-oriented" power estimation numerical calculations or model tests can be performed in order to determine the wave induced added resistance. These predictions are typically based on regular waves, whereby the head waves are traditionally believed to lead to highest wave resistance. In the scope of numerical methods both non-viscous, potential theory based methods in combination with analytical formulations for the wave resistance according to [1], [2] or [3] and viscous, RANS-equation based methods are applied. With respect to the computional effort potential theory based methods are prefered over RANS-codes. However, these methods can deliver inaccurate results, especially for full hull forms and waves shorter than the ship length, for which the added resistance is increasingly affected by viscous effects. Thus, the application of RANS-codes is particularly recommended for larger ships, considering typical wave lengths in realistic seaways.

For the prediction of the wave added resistance in the scope of both research and commercial projects HSVA develops in cooperation with the TUHH the viscous RANS-code ***FreSCo+***, which incorporates a two-phase VoF-model for free surface capturing and a flow-field coupled Eulerian motion-solver. ***FreSCo+*** has been being successfully applied to the prediction of wave added resistance in the context of the BMWi funded project HyMOTT, which deals with the numerical prediction of the seakeeping and manoeuvring performance of offshore supply vessels under realistic operational conditions. For the validation of ***FreSCo+*** the wave added resistances for three types of vessels were predicted and the results compared with model test data.



Bulk Carrier

In 2009 model tests were conducted by HSVA for a panmax bulk-carrier with 217m length for a range of Froude numbers and head waves with two different wave lengths. Both wave lengths tested were significantly shorter than the ship length. Thus, it could be expected that the ship motions are small and, from that, most of the added wave resistance is caused by wave reflections (diffraction) from the ship's bow. Simulations were performed for both calm water and head waves for two Froude numbers.

The computed results (Fig. 2) show a good agreement with the measurements for both simulated Froude numbers in both calm water and in waves. The maximum deviation from the measurement appears for the calm water condition at the lowest Froude number and is less than 5%.

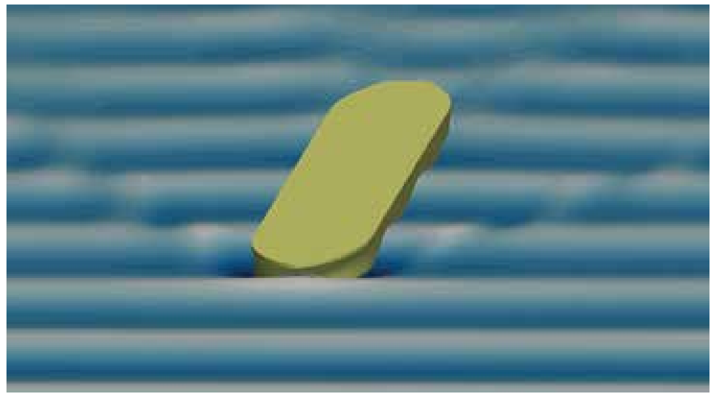


Figure 1: Snapshot of the simulation for the bulk carrier at Froude number 0.134 and head waves with 30% of ship length

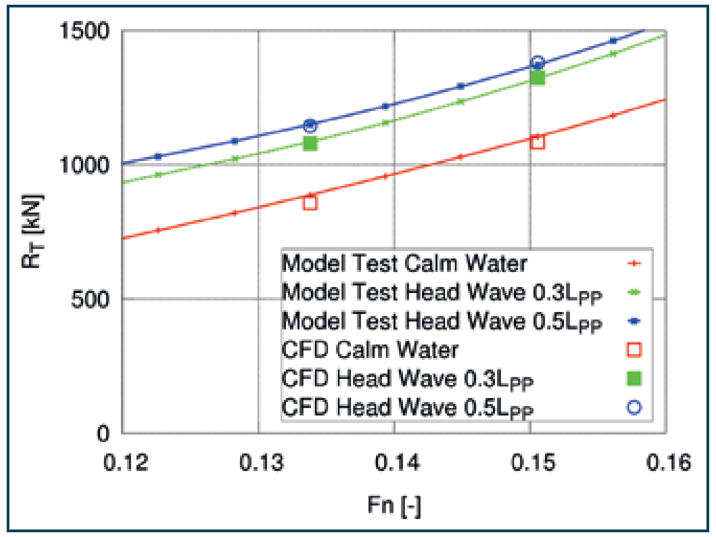


Figure 2: Total resistance in full scale for calm water and head waves for the bulk carrier at various Froude numbers

Container Vessel

In the course of the Tokyo CFD-Workshop 2015 model test results for the KCS (Kriso Container Ship) were provided. The KCS is a panmax container vessel of 230m length, which is well documented and used for the validation of numerical methods in research. HSVA will participate in the workshop submitting the ***FreSCo+***results for comparison with model tests carried out by NMRI (National Maritime Research Institute, Japan) at a Froude number of 0.26 and head waves of various wave lengths.

As for the bulk-carrier the computed results match the measurements for both calm water and head waves very well. The maximum deviation from the model test is 4.7% and can be observed for the wave length of 1.37L_{PP} Further, it can be seen that, for the waves shorter than

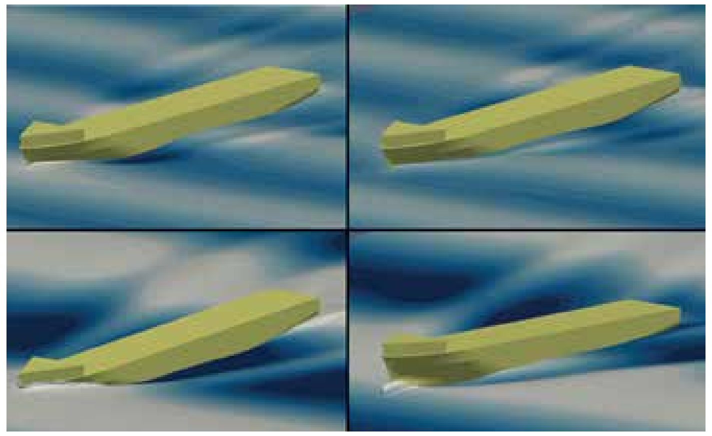


Figure 3: Snapshots of the simulations for the KCS in head waves with wave height of 2.35m and wave length of 149.6m (top left/right) and wave height of 5.65m and wave length of 315.3m (bottom left/right)

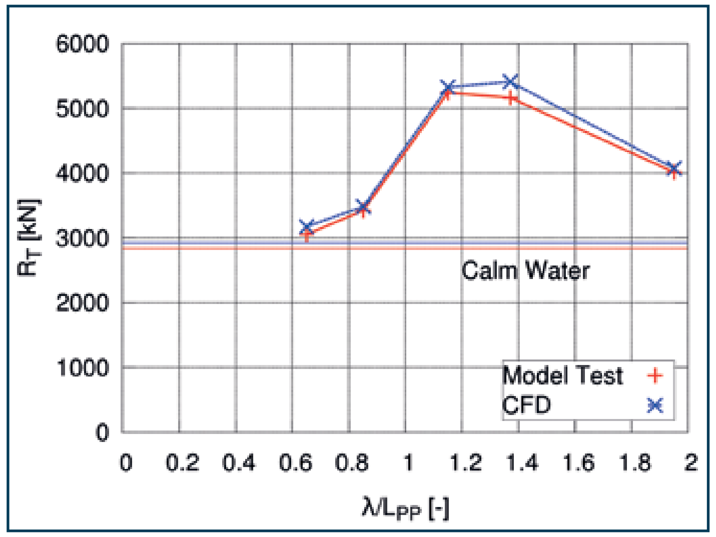


Figure 4: Total resistance in full scale for calm water (solid lines) and head waves (lines with points) for the KCS

ship length, the added resistance is very small. This can be explained by the small ship motions and little wave radiation in combination with little wave defraction due to the slender bow. However, for wave lengths in the range of 1.2 to 1.4L_{PP} the added resistance reaches its peak due to heavy ship motions and wave radiation caused by exciting the ship in its natural pitch frequency.

Cruise Vessel

In the scope of the BMWi funded project PerSee HSVA carried out model tests for a cruise vessel of 220m length for a wide range of encounter angles and wave lengths. The results were presented in Newswave 2014/1 and are published within the proceedings of the ISOPE conference 2015 [4]. For the validation of ***FreSCo+*** HSVA started with the computation of the head wave cases. Computations for oblique, beam and following waves are planned. Figure 5 shows the computed results for a Froude number of 0.232 for calm water and head waves of three wave lengths. The maximum deviation from the model test is 3.9% and can be obeserved for the shortest wave length.

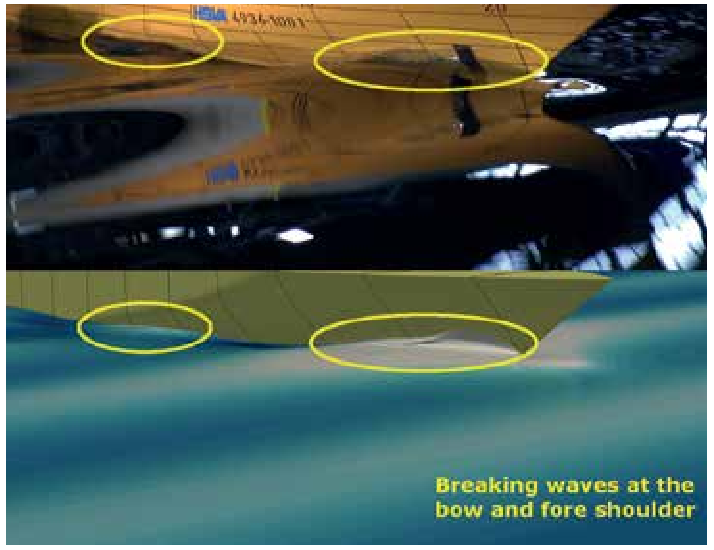


Figure 5: Snapshots of the model test (top) and simulation (bottom) for head waves with wave length of 18% L_{PP}. Breaking waves can be observed at the bow and fore shoulder in both the model test and the simulation

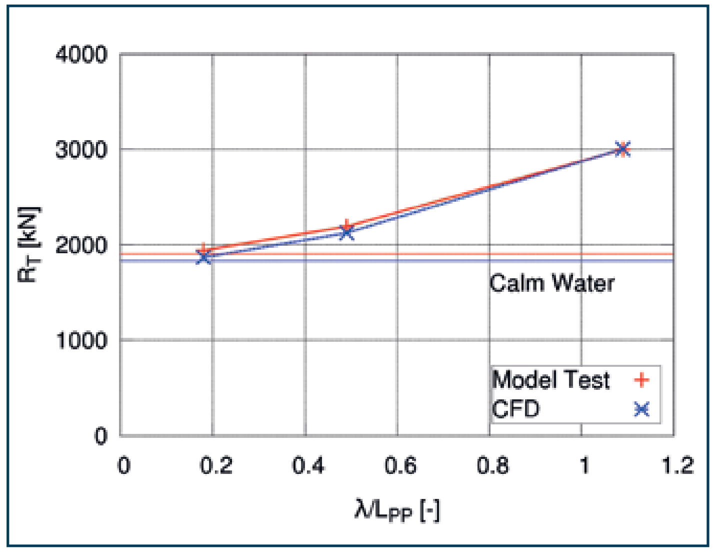


Figure 6: Total resistance in fullscale for calm water (solid lines) and head waves (lines with points) for the cruise vessel.

Summary

The computed results for the three vessels lead to the conclusion, that ***FreSCo+*** can be applied to the prediction of the added resistance for various types of vessels. Furthermore, the results indicate that the prediction is very accurate for both short and long waves compared to the ship length. From this, it can concluded that the two dominating parts of the wave resistance – diffraction and radiation – are correctly determined by the present method. ■

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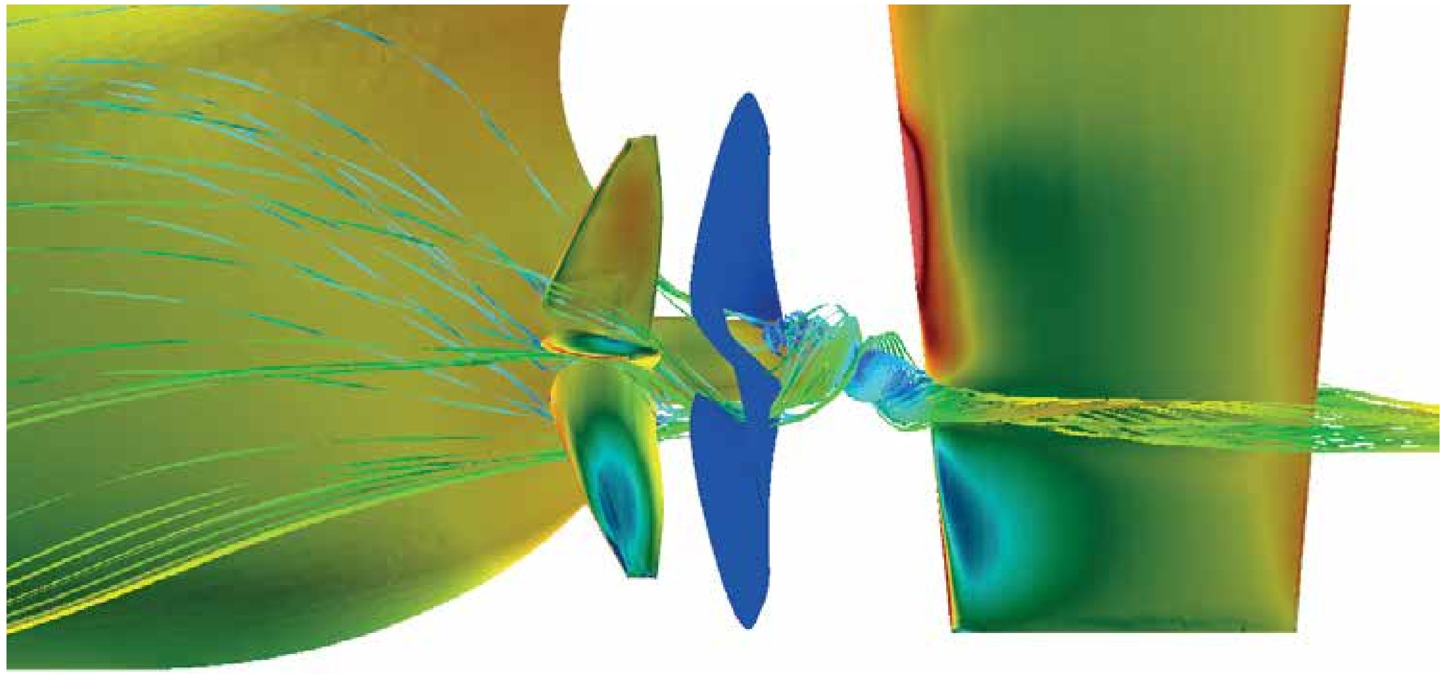
[2] Faltinsen, O. M, Minsaas, K. J., Liapis, N., and Skordal, Prediction of Resistance and Propulsion of a Ship in Seaway, Proceedings of the 13th Symp. on Naval Hydrodynamics pp. 503–550, Tokyo, Japan, 1980.

[3] Gerritsma, Beukelman, Analysis of the resistance increase in waves of a fast cargo ship, International Shipbuilding Progress, Vol. 19, No. 217, pp. 285–292, 1972.

[4] Valanto, P., Hong, Y., Experimental Investigation on Ship Wave Added Resistance in Regular Head, Oblique, Beam and Following Waves, Procs. Twenty-fifth Int. Ocean and Polar Eng. Conf., Hawaii, USA, June 21–26, 2015.



HSVA PSS design proves 6-7% power gain in dedicated sea trials

The GRIP (Green Retrofitting through Improved Propulsion) project - an EU project with 11 partners – has just ended very successfully in March this year. Some of the results coming from the GRIP project have been reported already in Newswaves 2012-01 and 2013-02. In this article, we would like to present the most important and successful results we achieved in GRIP project.

Figure 1: A photograph of the bulk carrier VALOVINE built by Uljanik shipyard

by Yan Xing-Kaeding, Scott Gatchell & Heinrich Streckwall

Within GRIP, HSVA participated in a competition: to design an Energy Saving Device (ESD) for a newly built handymax bulk carrier VALOVINE (see photo in Fig. 1) by project partner ULJ (ULJANIK BRODOGRADILISTE DD). The HSVA-PSS design was selected by the GRIP Consortium to be tested on the GRIP validation bulk carrier.

The complete design, optimization and evaluation procedure have been conducted in full scale. The in-house RANS code ***FreSCo+*** was coupled with the in-house propeller code QCM (Quasi-Continuous Method) to investigate the complex interaction of hull-ESD-propeller. The resulting HSVA-PSS design is shown in Fig. 3 together with the pressure distribution on the hull, rudder, and PSS under self-propulsion condition. As can be seen, the final PSS has three stator fins on the port side of the ship only. Besides working successfully with pre-swirl against

Figure 2: Photo taken in the dry dock just after the installation of PSS

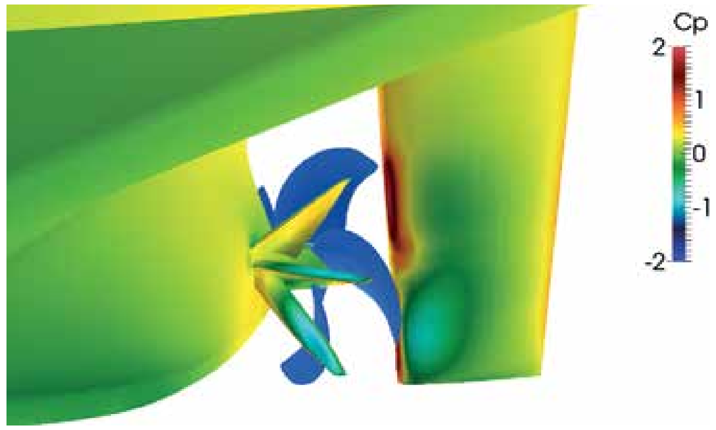


Figure 3: The bulk carrier with the PSS; pressure distribution on the surfaces of hull, rudder, and PSS

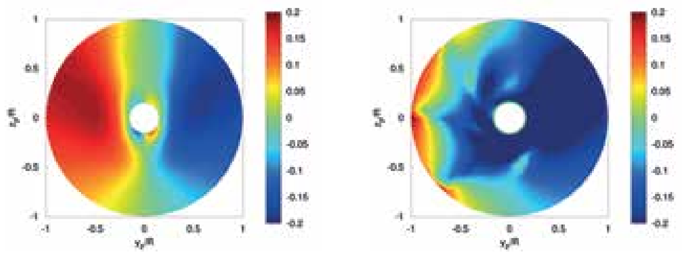


Figure 4: Tangential nominal wake: without PSS (left) and with PSS (right)

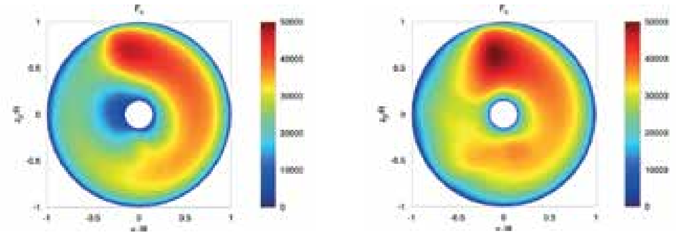


Figure 5: Propeller thrust distribution: without PSS (left) and with PSS (right)

rotational losses at the propeller it is also found that the modification of the tangential inflow to the propeller makes the propeller loading more homogeneous (see Figs. 4 and 5). As expected, the predicted propeller rpm reduction is about 5% in this case. The influence on the axial wake is not significant, as can be observed in Fig. 6.

Once the hydrodynamic design is ready, the manufacturing of the PSS started in the Uljanik yard. Afterwards, a dedicated dry dock was arranged for the PSS installation. Figure 2 shows a photo taken just after the PSS installation.

Two sea trials took place at Adriatic Sea in the spring of 2014 with one week in between and were conducted by the same trails team (by project partner MARIN) and measuring equipment on board. Both trials were performed in good weather condition. The results of a reduction of nearly 7% on power at equal speed (16kn) or an increase of 0.3 kn on speed at equal propulsion power confirmed the effectiveness of the PSS, shown in Fig. 7. The installed PSS geometry has been measured via 3D laser scan technique and CFD predictions based on the measured geometry are compared to the sea trial results with good agreement, see Fig. 8.

Another effect observed from the PSS is the hub vortex reduction. Figure 9 shows the streamlines passing through the propeller hub region indicating a weaker hub vortex due to PSS. This has been confirmed during the cavitation observation in the sea trials. Figure 10 (left) shows the propeller during 100% MCR sailing in a straight course in heavy ballast conditions prior to the installation of the ESD. The propeller showed suction side sheet cavitation and a clear cavitating hub vortex. Figure 10 (right) shows the same condition but with the stator fins installed (a section of the fin is shown in the right bottom). For the whole speed range during trial with the ESD installed there was no cavitating hub vortex visible in the slipstream of the propeller.

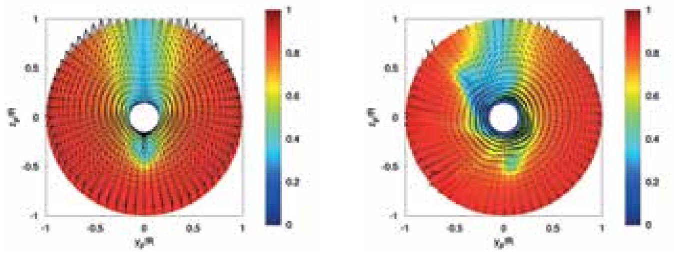


Figure 6: Axial nominal wake and tangential velocity vectors: without PSS (left) and with PSS (right)

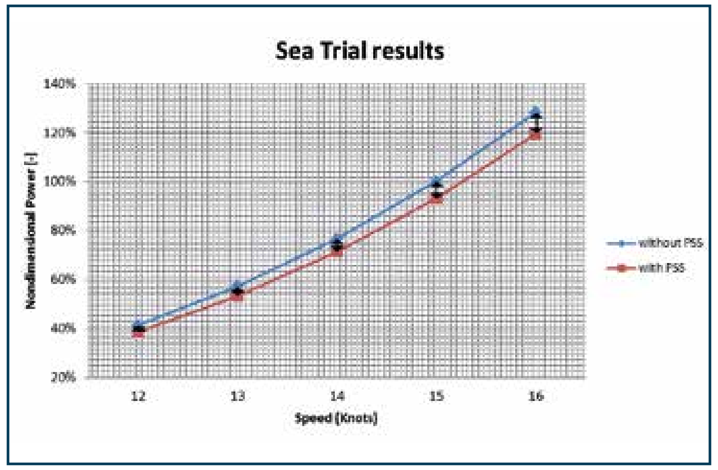


Figure 7: Speed trials results without and with PSS

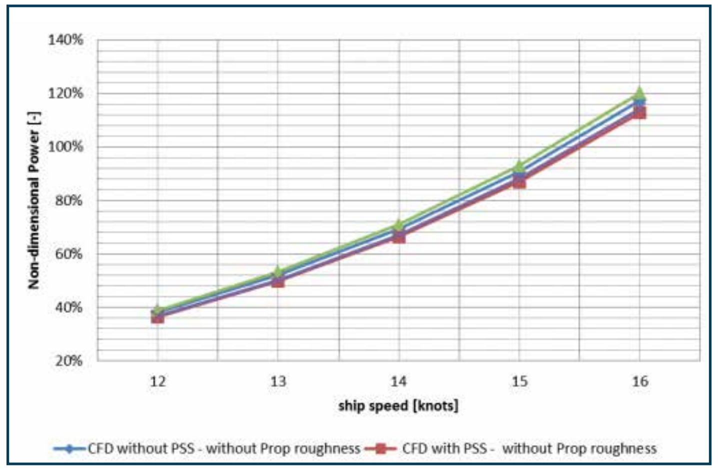


Figure 8: Comparison of predicted power-speed relation without and with considering the propeller blade roughness

Since the PSS has been designed for a single design condition, a further step has been taken to examine it against off-design conditions to assess the life cycle performance of such a device. Different operational conditions have been investigated to evaluate the PSS performance, and it turned out that the PSS gives positive net gains for all loading conditions, though the highest gain is seen at design condition as expected. In general, the PSS seems to be not very sensitive to the operational conditions of the vessel and, therefore, can be considered as a life cycle adapted design. ■

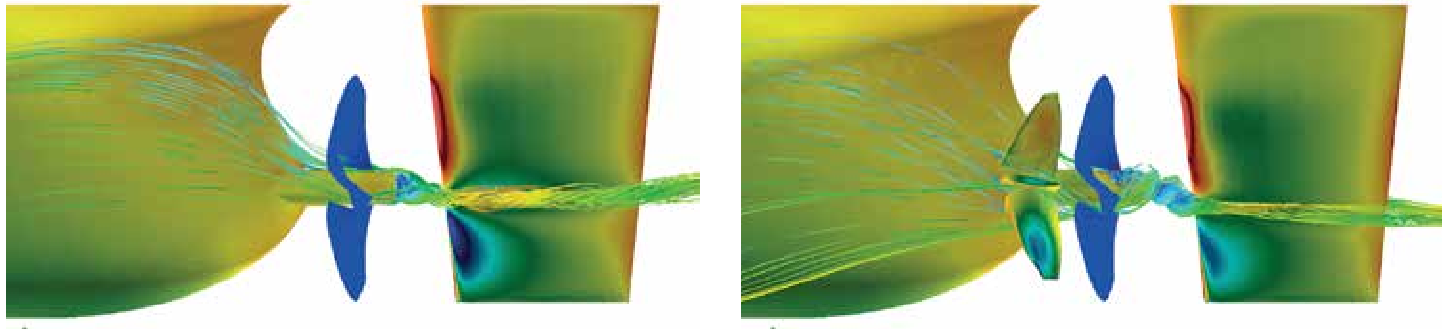


Figure 9: Streamline passing behind the propeller hub together: without ESD (left) and with PSS (right)

Figure 10: Propeller cavitation and cavitating hub vortex for ship without PSS (left) and propeller cavitation for ship with PSS (right)

INRETRO, a European project addressing slow steaming prospects

In the European Project MARTEC HSVA as model basin and Mecklenburger Metallguss GmbH (MMG) as the German propeller manufacturer are participants of the Consortium, further consisting of the Polish Model Basin CTO, the Polish industrial partner BOTA and the Turkish industrial partner MILPER. Generally the MARTEC funding structure supports research, which follows and adjusts to actual trends in ship building. "INRETRO" clearly addresses the "slow steaming" trend and started in July 2015.

by Heinrich Streckwall

MMG's and HSVA's motivations to enter "INRETRO" differ: MMG wants to enhance retrofit measures and replace existing propellers by alternatives with higher efficiency. HSVA as a model basin wants to combine results from numerical propeller simulations and measurements from the towing tank to enhance the quality of full-scale power predictions. Different intentions must not necessarily mean that the work done in the "INRETRO" project remains distinct and unconnected. It is a characteristic of "INRETRO" that numerical test cases are calculated in parallel by all partners using different RANS solvers.

Enhancing the reliability of full-scale speed/power-curves originating from model tests require to study scale effects and/or reduce the scaling range, here expressed as a Reynolds number, i.e. speed × length-interval. Using the in-house RANS code ***FreSCo+***, HSVA aims at studying the propeller/hull interaction process and especially supporting artificial propeller tests showing the benefit of a reduced scaling range from model to full scale.

An "artificial" propeller test setup realized anyhow for every model propeller is the Open Water Test. Here the propeller is exposed to homogeneous axial inflow, which includes a reversion of the shaft direction, pointing downstream now. Traditionally the Resistance Test and the propeller Open Water Test are the sources of parameters expressing the propeller/hull interaction in model scale. One of these parameters, the "Relative Rotative Efficiency" states the increase of performance for a hull-adapted propeller design when it is taken from Open Water conditions to work behind the hull (such a performance growth reads typically 2%). It is the task of the propeller designer to fully access these benefits in the actual non-uniform flow environment and it is the task of the model basin to extract this specific quality from test results.

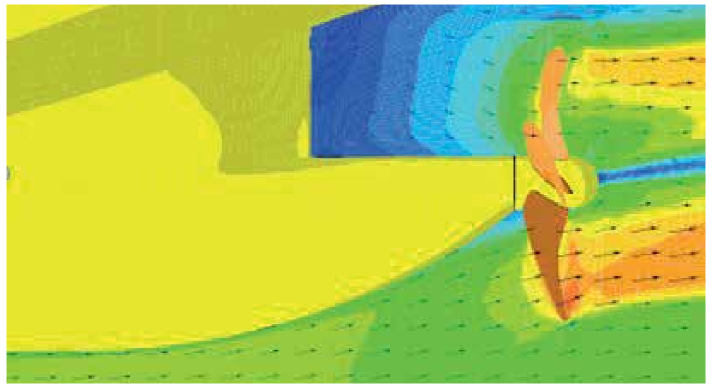


Figure 1: Inhomogeneous velocity profiles behind the hull according to a RANS simulation which includes the rotating propeller

If a proven quantity is provided for the "Relative Rotative Efficiency" it implies that power results from the propeller Open Water Tests can serve for full-scale power prediction. As there are no constraints for the propeller shaft frequency in Open Water Tests this helps to reduce the scaling range. "INRETRO" suggests to extract the 'Relative Rotative Efficiency' from RANS simulations. One may review the equivalent experimental approach to justify such numerical efforts.

The direct experimental process leading to the "Relative Rotative Efficiency" would demand for using Open Water shaft frequencies that are as low as in the Propulsion Mode. In such case the comparison of efficiencies could suffer from sensitivity to the incoming turbulence, which would range on a high level in Propulsion Mode and on a low level for Open Water. In addition, for practical reasons, the experimental "hardware" and – as already mentioned – the shaft orientation differs from Propulsion to Open Water.

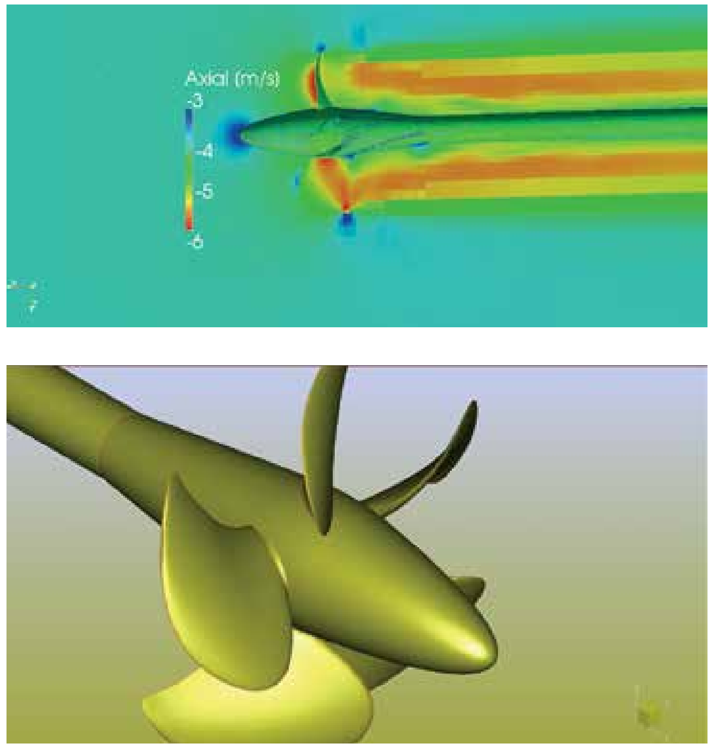
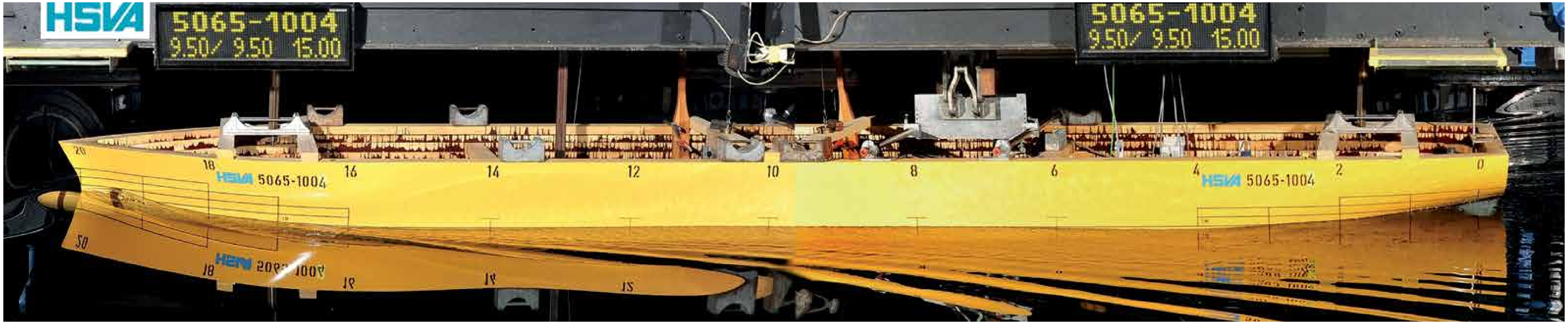


Figure 2: Rotational symmetric velocity profile in Open Water setup (top) and shaft arrangement complying with Open Water Test setup (lower)

In the numerical approach leading to the "Relative Rotative Efficiency" it is supposed to use the same grid structure to cover the propeller blades and the surrounding that either includes the hull and the boss cap (Propulsion, see Figure 1) or just the hub details and the elongated shaft (Open Water, see Figure 2). The involved Reynolds numbers are shifted artificially to a high level as the "Relative Rotative Efficiency" is considered weakly or even not at all Reynolds number dependent. In this scenario Open Water Tests performed at high Reynolds numbers represent the experimental basis for the full-scale power prediction. This combined approach appears especially helpful for projects that comply with the "Slow Steaming" trend.

The right side of Figure 2 is in addition disclosing the first common numerical test case treated within "INRETRO". Due to the already available numerical results from various other sources it deemed reasonable to start with Open Water calculations on the so called "Potsdam Propeller Test Case" (PPTC). The PPTC already served as basis for two numerical workshops (linked to SMP11 and SMP15). After agreeing on geometrical details the numerical calculations have been started, and works are ongoing. ■



Success story: HSVA's long term partnership with HB Hunte Engineering – Optimized hull-forms for state-of-the-art vessels

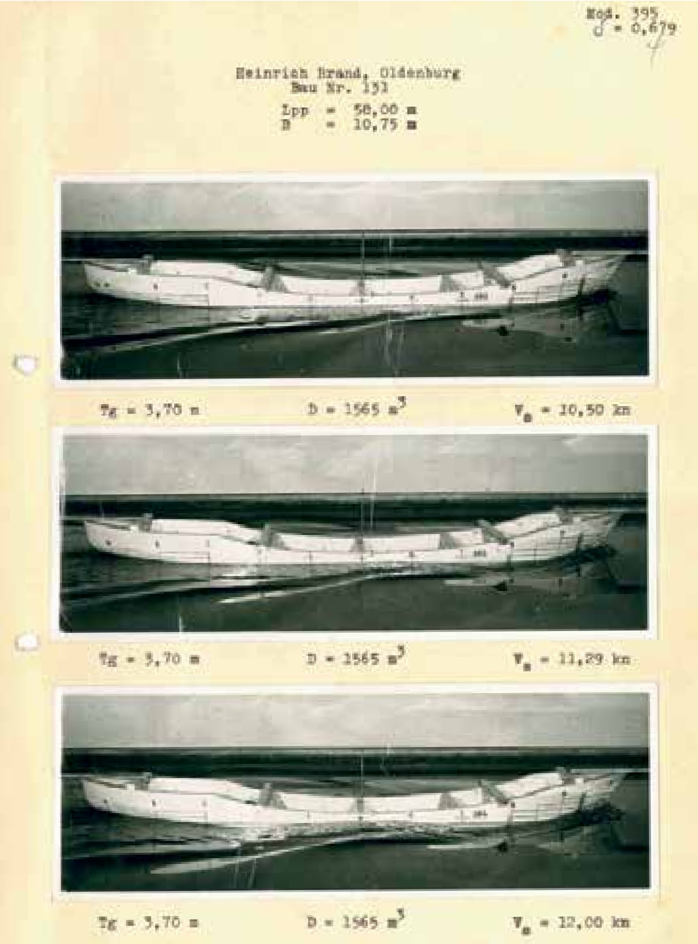
One of HSVA'S standing clients is the German family owned company HB Hunte Engineering formerly Heinrich Brand Shipyard. The company has a long tradition in ship design and building and is nowadays a full service provider in the maritime industry.

by Henning Grashorn

The successful cooperation between the Brand Family and HSVA started more than sixty years ago in early 1954 with model tests for a coastal cargo vessel – HSVA's model No.: 395! – later built as "Kurt Bastian".

A large variety of vessels has been tested at HSVA - from ice-breaking cargo vessels and paper carriers to multi-purpose container vessels and gas tankers. Always focusing on optimum hydrodynamics, many advanced features were investigated through the years – like the asymmetric stern, implemented on several Brand ships in the 1980s.

After the transition from shipyard to an engineering company, HSVA became the supplier of hull form design for HB Hunte in addition to the established cooperation in model testing and hydrodynamic consulting. Since then HSVA has on request of HB Hunte developed and optimized hull forms for dock ships, cable layers, life stock carriers and container vessels.



Mod. 395
δ = 0,679

Heinrich Brand, Oldenburg
Bau Nr. 131

Lpp = 58,00 m
B = 10,75 m

T_g = 3,70 m D = 1565 m^3 V_s = 10,50 kn

T_g = 3,70 m D = 1565 m^3 V_s = 11,29 kn

T_g = 3,70 m D = 1565 m^3 V_s = 12,00 kn

One ship type stands out in the cooperation. HB Hunte Engineering has a long history in the design and engineering of gas tankers, including sophisticated gas plants – with the first of such vessels built in 1961 at the Heinrich Brand Shipyard – and tested at HSVA. HSVA as well has a long reference list of hull forms developed, optimized and tested for ships of this type for various customers.

This was the basis for a series of lines developments for gas tankers through successive projects. The series started more than ten years ago and contains a whole family of designs ranging from 5000 m^3 to 85000 m^3 loading capacity.

It began in 2004 with the development of a 6,500 m^3 Ethylene Carrier. This design already concentrated on a specific operating profile at a time when hull form optimization was still focusing on the singular design draught at design speed. This often resulted in prominent bulbous bows which began to show their deficiencies when operators started to implement slow steaming after 2009 – a problem that was avoided with the "multi-purpose bulbs" defined by HSVA.

Since then six different gas carriers designs were made and realized by HB Hunte Engineering with the hull form developed and tested at HSVA. In total 16 gas carriers have been built and 9 vessels will be delivered within the next years.

HSVA Model No.	Capacity
MO4306	6500 m^3
MO4681	5000 m^3
MO5030	5000 m^3
MO5065	36000 m^3
MO5099	85000 m^3
MO5164	18000 m^3

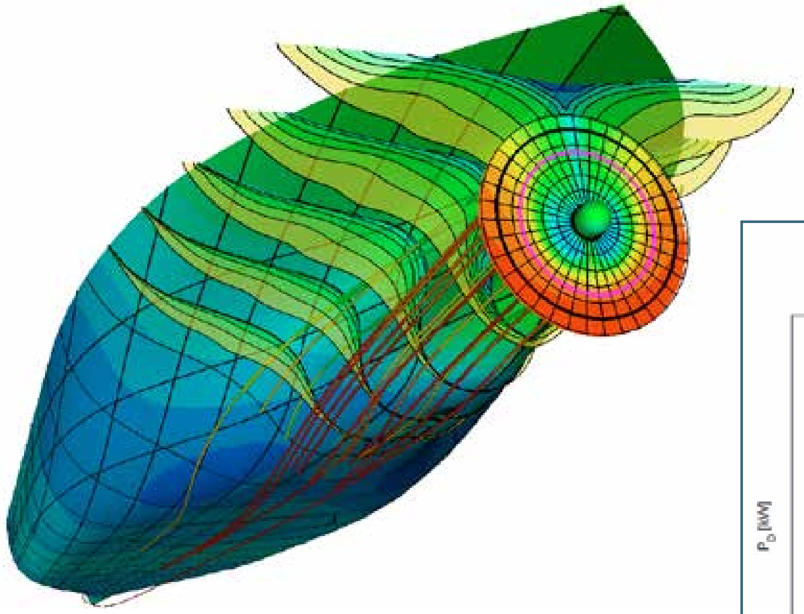
The notable advantage of this design series is that for each vessel the results of the preceding design could be used as a starting point for the new hull form, while applying the same basic design philosophy to all vessels. This strategy allowed to utilize all pre-existing experience and to lead an evolutionary improvement process allowing to quickly find an effective hull form and to concentrate on optimizing design details.

As for all HSVA hull form designs some general principles were applied:

- **Strong orientation at the practical ship operation. With HB Hunte Engineering mostly working for the ship owner side, all designs were focused on the overall performance.**
- **Getting the bare hull to its optimum, thorough review of flow around the hull and toward the propeller. Emphasis on a good wake field.**
- **Sound arrangement of appendages.**

During the design processes HSVA also benefits strongly from its extensive CFD validations – especially in this case where both model test results and CFD results are available for almost the complete series. A result of this is the possibility to skip the stock propeller tests and use directly a propeller that was designed with a calculated wake field.

Fortunately HB Hunte is a client not only with the aim for the optimum as usual, but also with the scientific curiosity (and funding) to investigate also the details. This led to



a series of joint investigations beyond the usual testing program, for example an extensive model test series was performed addressing a systematic assessment of the rudder-propeller arrangement. The vessel was tested with:

- **stock propeller and symmetrical rudder without bulb**
- **design propeller and symmetrical rudder without bulb**
- **design propeller and twisted rudder without bulb**
- **design propeller and symmetrical rudder with bulb**
- **design propeller and twisted rudder with bulb.**

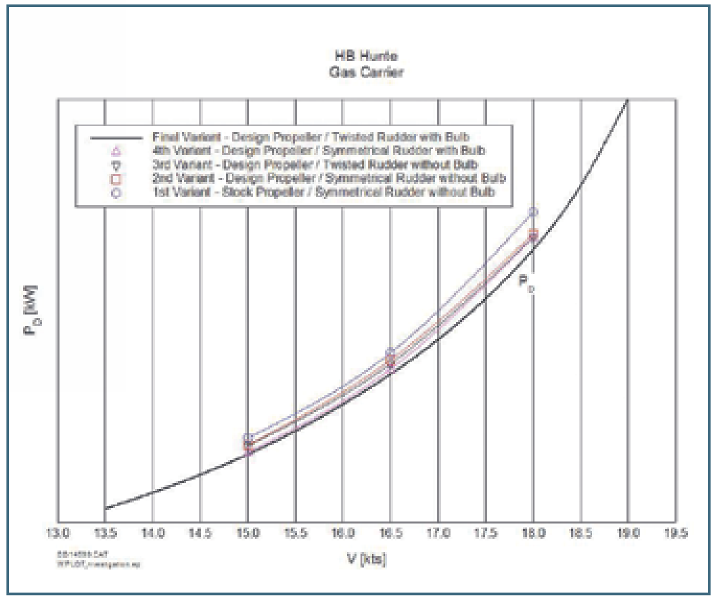
For such investigations HSVA utilizes its knowledge in rudder design and makes a review of the engine concept and corresponding adapted propeller layout.

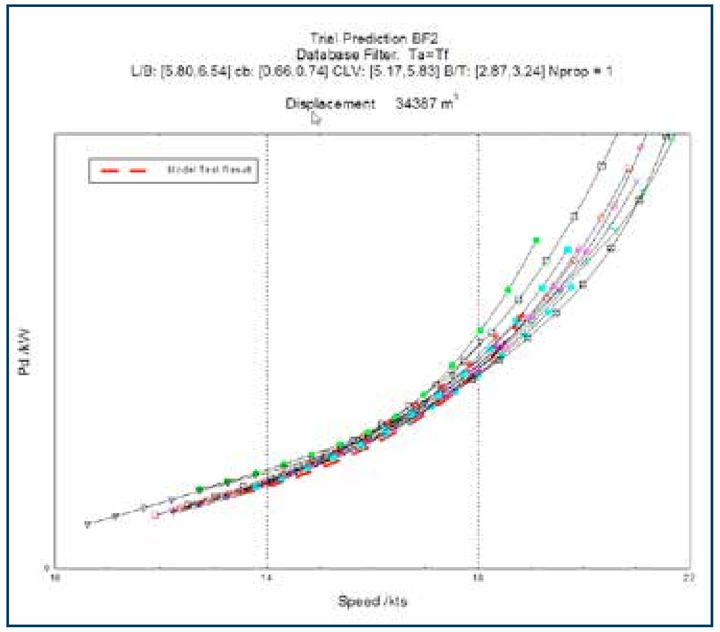
Consequently hull forms were developed with a strong focus on optimization for practical operation. Database comparisons with similar vessels show the superior performance over the entire operating speed range for the family of designs jointly developed.

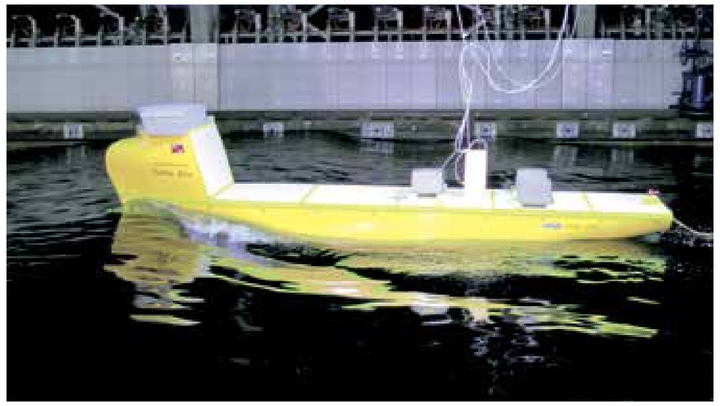
HSVA is looking forward to continuing the successful and trustful cooperation with HB Hunte Engineering – transferring the joint knowledge and experience also to other sophisticated and complex types of ships. ■

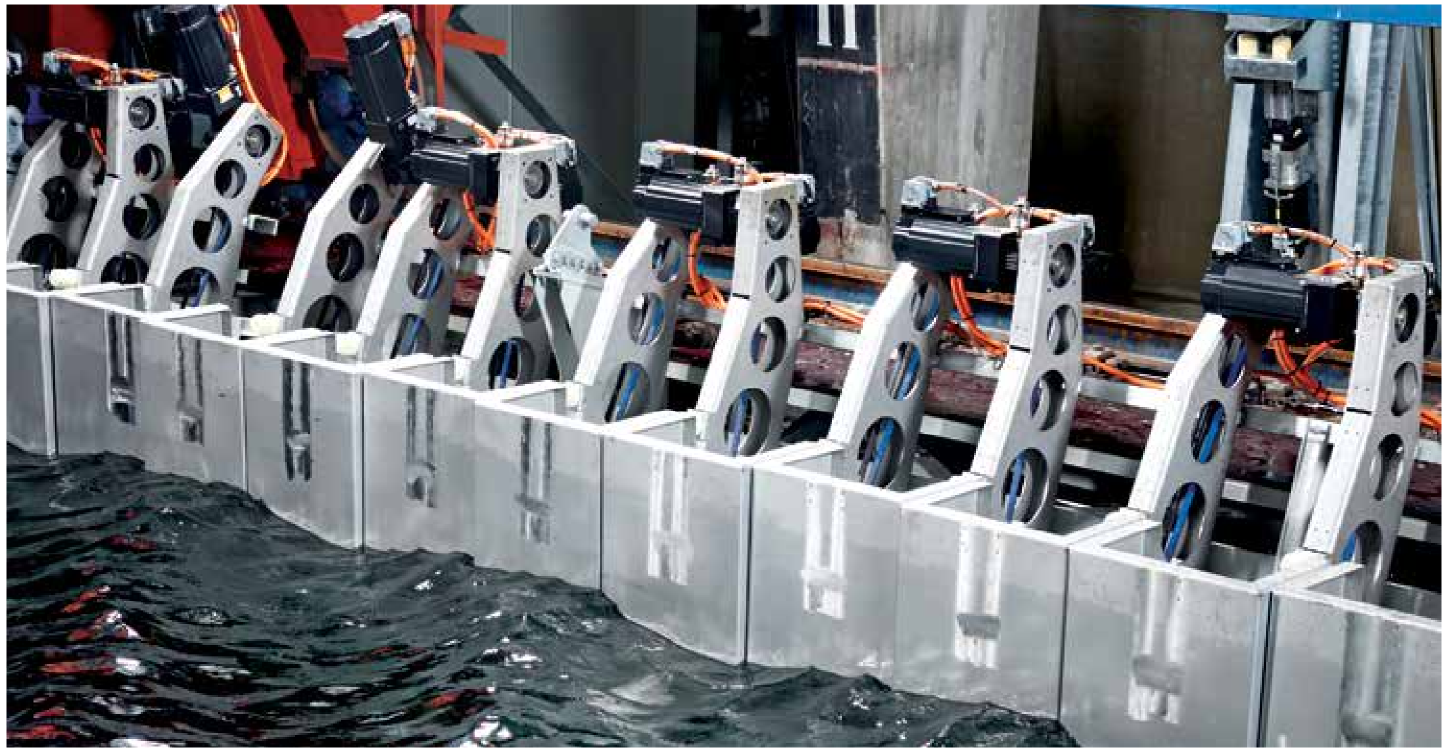
Heinrich Brand Shipyard / HB Hunte Engineering GmbH

The Heinrich Brand shipyard was founded in 1850 and was operational till mid of the 1990s. During that time all kinds of vessels were built up to a deadweight of 10,000 tons. In 1997 came the transition to HB Hunte Engineering GmbH.









MoVeR – Development of a modular method for the investigation of the seakeeping behaviour of ships in arbitrary natural sea states – with wave packets

The present demonstrator version of the Side Wave Generator enables the HSVA to investigate ships at forward speeds also in beam and oblique seas. Despite of the relatively short length (40 m) of the SWG it is possible to predict ship motion behaviour in arbitrary realistic natural sea states at arbitrary wave headings, also in stern quartering seas, by using a new testing method based on wave packet techniques developed within the research project MoVeR.

by Petri Valanto & Katja Jacobsen

Depending on the size and speed of the ship model especially in stern quartering seas it is not always easy to obtain a sufficient number of wave encounters with the model during the measurement to enable a very reliable ship motion prediction. This shortcoming has to a large extent been removed with the new testing method. Thus the scope of seakeeping tests at HSVA has been significantly extended to determine the seakeeping behaviour of vessels with forward speed in arbitrary sea states over the full range of wave encounter angles with only a few test runs. Of course the basic limitations of linear RAO techniques apply also in this case, for example in prediction of nonlinear ship roll motions.

Within the research project MoVeR, sponsored by the German Ministry for Economic Affairs and Energy (BMWi), this new modular experimental method was developed for the prediction of the seakeeping behaviour of ships in arbitrary seaways. The method is based on the transient wave packet technique, which allows the very fast and accurate determination of the linear Response Amplitude Operators (RAO). As in irregular sea states also the wave packets contain energy over a wide frequency range. The phase relation in a wave packet, however, is not randomly distributed like in a typical seaway, but such that all generated wave components meet at the same time at the same position, that is at the concentration point. For this, the wave maker first generates the short waves, which are followed by waves of continuously increasing length. Since the propagation velocity of waves increases with their length, the longer waves catch up the shorter ones.

Thus the transient wave packet technique allows the very efficient and accurate determination of the response amplitude operators saving lot of testing time, and yielding ideally the whole RAO within one test run. In head, head-quartering, and beam seas the determination of RAO's for ships at forward speed is straightforward by dividing the measured Fourier response spectrum by the Fourier spectrum of the wave packet. However, for stern quartering and following sea conditions the applicability of the wave packet technique is not as straightforward as it is in head seas: The model motions are recorded at the encounter frequencies ω_e, but the RAO needs to be expressed as function of the wave frequency ω_0. But in the case of following waves the resulting wave encounter frequency ω_e, being a function of the squared wave frequency ω_0, the ship speed V_s, and the wave heading μ,

$$\omega_e = \omega_0 - \omega_0^2 \cdot {}^{V_s}/_{g} \cdot \cos\mu \qquad (1)$$

is not unique, while it can be caused by different wave frequencies.

In real life in shorter waves the ship can be faster than the waves, in the longer waves the ship can be slower, but the encounter frequency in the analysis can be the same. To overcome this problem, the simple solution is to perform two test runs in different wave packets containing the two frequency ranges. The final response amplitude operator is then composed by the two response amplitude operators over the two different frequency ranges. Even with two runs this wave packet method is much more efficient than tests in regular waves, which may require more than ten test runs to resolve the RAO accurately enough.

Using the determined RAO's the statistical responses of the ship, like the root mean square values (RMS), or probabilities of exceedance, can be determined for an arbitrary sea state by stochastic analysis. These values can of course be obtained with standard seakeeping tests in irregular sea states, though one test run is required for one test condition in one single sea state.

What the new method can provide is a much more efficient technique for predicting ship responses especially in stern quartering seas, where obtaining a sufficient number of wave encounters with the model during the measurement is particularly important for reliable results. The new method is applicable to many linear processes related to seakeeping and it saves time and money. And finally, the HSVA model testing is not only tradition; it is also developing better techniques. We are well on the way. ■

HSVA
The Hamburg Ship Model Basin
Setting the Standard in Ship Optimisation
www.hsva.de

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stand no. **N2F21-04**.

HSVA's small ice tank was built in 1971. The basin is 30 m long and 6 m wide. It was HSVA's second ice model test basin (the first one had been built in 1958 and does not exist anymore) and primarily served to host all kinds of model tests also those with ship models.

HSVA's restored Arctic Environmental Test Basin

by Andrea Haase

As the demand for ice model tests was increasing HSVA built its third ice tank in 1984 – the large ice tank – being 78 m long and 10 m wide. From then on, most model tests that involved ship models were performed in the larger ice tank while environmental tests – such for marine biologists but also such with oil spill experiments (carried out in several EU-Hydralab projects) – were performed in the then called "Arctic Environmental Test Basin" (AETB).

After 44 years of service – that left its mark on the facility - it was decided to give the test facility a second life. Broad renovations were scheduled including all sectors of the tank. The first step – performed in the beginning of 2015 – was the maintenance and repair of the fabric of the building that is the concrete structure. Further steps that include the cooling system and more important the main carriage are scheduled for 2016 and 2017.

Within the first step of the renovations the old main carriage was completely destructed and also the old rails were demounted. Only the rail bearings were kept and repaired where needed. Figure 1 shows a photograph of the old carriage and rails.

In the next step, the tank observation windows were demounted and the gaps closed with concrete. The window frames had rusted and water had leaked through. Also one window had been destroyed completely by accident during model tests. As in modern model test practice the underwater observations are made by video cameras rather than watching the tests from below water surface, and as the windows were the weak point of the basin it was decided to resign them completely. Figure 2 shows a picture of the construction side, when the windows were closed.

The concrete itself had been coated in the past. However, the coating had been damaged over the years; partially the damage was quiet severe. In consequence the coating of the entire basin and surrounding floors (except in the trim basin) was milled and renewed. This process is shown in Figure 3.

The specialty about the new coating is that it is a one piece layer of synthetic material covering the entire facility – only excluding outer walls and ceiling. The used material is a polyurea and was applied in a single working step to ensure the tightness of the coating. Snapshots taken about every one and a half hour show the progress of the coating application and are presented in Figure 4.

Figure 5 shows the basin before renovations had started and after completion of the coating.

Next to the main works of the renovations several smaller things have been changed. For example the old guard rails have been demounted and replaced by gratings covering the stair heads. As the observation tunnel is not needed anymore, it was decided to let go of the guard rails along the stair heads and replace them by an even surface to step on. Furthermore rubber mats have been outlaid on the entire floor surface (as shown in Figure 6) to ensure slip resistance even when water is spilled and freezes on the floors. An impression of the final stage of the first phase of renovations is given in Figure 7.

Even if further steps of the renovations are still to come, the basin is ready for use. Tests with oil and ice and marine biological tests can already be performed now. Also research and development projects are already scheduled in the tank calendar. IVOS – "Ice Induced Vibrations of Structures" – is one of them, where next to other tests full scale ice interacting with structures will be tested. Another one is ProEis – "Einfluss der Formgebung von Schiffen auf die Propulsionseffizienz und die Propeller-Eis Belastung" – where investigations regarding propeller ice interactions will be made. In the AETB it is possible to simulate rotational currents and if needed also a wave maker is available. ■

Figure 1: AETB's old main carriage

Figure 2: Observation windows are closed

Figure 3: Old concrete coating is removed

Figure 4: New polyurea coating is applied

Figure 5: AETB in winter 2014/15 before renovations started and after completion of coating

Figure 6: Stair heads covered with gratings and rubber mats surrounding the basin

Figure 7: HSVA's AETB at its final stage after completion of the structural work in 2015

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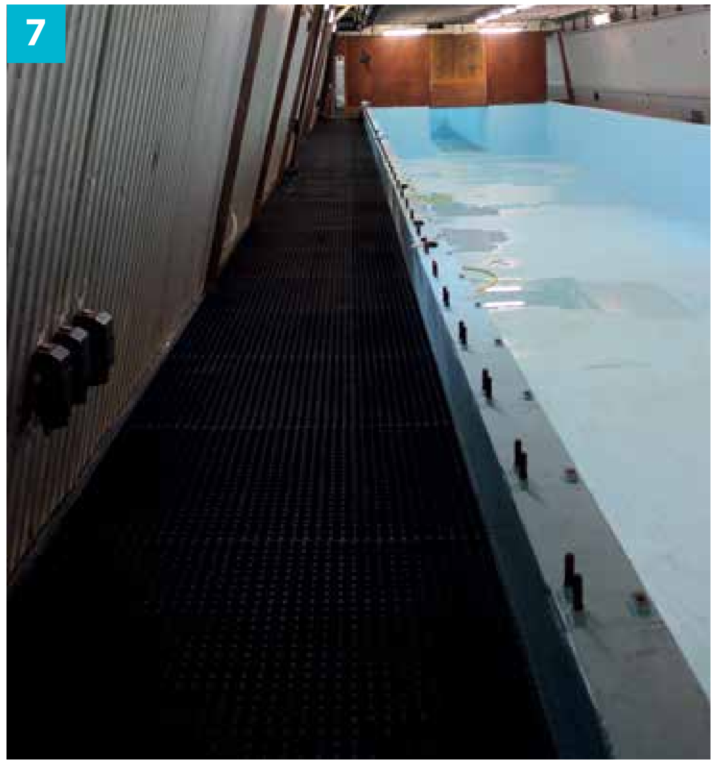

1

2

3

5a

5b

6