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FRIENDSHIP-Framework Case Study: Optimization of a Mega-Boxer

DSME's 14,000 TEU Container Vessel MSC Danit

With a capacity of 14,000 TEUs, an overall length of 365.5 meters and a deadweight of 165,517 metric tons, the MSC Danit was the world's largest container vessel. When finished in 2009 by Korean shipyard Daewoo Shipbuilding & Marine Engineering (DSME). Despite its record size, the most stunning is its performance. DSME used the FRIENDSHIP-Framework for the variation and optimization of proven parent ships in order to arrive at maximum performance and efficiency. The final hull displayed less than 50 percent in wave resistance in comparison to the baseline! In addition, the optimization within the FRIENDSHIP-Framework had a favorable effect on the propulsion performance.

How was the optimization undertaken?

The design conditions for the carrier were:

- LOA of almost 380 m
- LPP around 360 m
- Breadth just below 52 m
- Design draught of 14 m
- Guaranteed speed of 24 knots
- Fn approx. 0.207
- 90% MCR with 15% sea margin at a scantling draught of 15.5 m

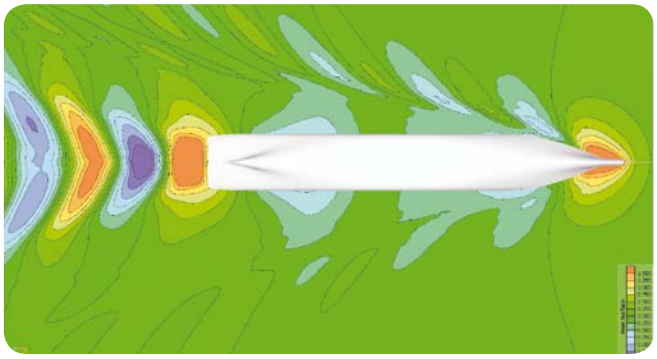
DSME approached design and optimization of the carrier in two phases:

Phase 1 comprised:

1. Selection of two proven parent ships with high nose type bulbs as starting point
2. Scaling to principal dimensions
3. CFD simulations for re-combinations of various fore- and aftbodies
4. Identification of most promising candidate as baseline for parameter study

After selection of the candidate for further study, phase 2 combined:

1. Investigation of a series of variants through parametric modeling and CFD
2. Identification of the influence of individual form parameters
3. Selection of the best hull form
4. Model testing at HSVA (Hamburg ship model basin)



[Fig. 1] Optimization: baseline (upper half) vs. optimized hull (lower half) at design speed

Systematic investigation and variation

In a systematic parameter study, the parent ships were varied by swinging the baseline's sections using the Generalized Lackenby approach of the FRIENDSHIP-Framework. With the Generalized Lackenby approach, the region of influence on the hull shape can be selected flexibly. In addition the slopes of the shift functions can be defined freely at either ends. Through this, variations may start well forward of the bossing and may end just aft of the forward perpendicular. With zero slopes at the beginning and at the end transitions become very smooth. A series of variants was produced and numerically simulated for wave resistance. Here, SHIPFLOW, the advanced CFD code of FRIENDSHIP SYSTEMS' cooperation partner FLOWTECH, was applied.

Variants indicated a beneficial modification of the parallel length of the mid-body from 5 percent to 15 percent LPP. Change to the scope of the sectional areas curve (SAC) as available with the Generalized Lackenby was applied in steps of 5° from minus 25° to 25°. Through the increase of the parallel mid-body the wave resistance coefficient could be further reduced by up to 8 percent. Additional improvement was achieved through adjusted volume distribution at the forward perpendicular.

The hull form finally chosen for model testing featured a straight type and rather steep SAC with pronounced slope at entrance and run and a comparatively long parallel mid-body. The design waterline displayed a small entrance angle and a relatively strong shoulder between stations 12 and 16.

Outstanding results in model testing

Based on the results of the optimization within the FRIENDSHIP-Framework, a model of the optimized ship was tested in the towing tank at HSVA in Hamburg, Germany (see Fig. 2).

[Fig. 2] Model test for new hull form (photo courtesy of HSVA)

In relation to the baseline the final hull displayed a wave resistance minimized by more than 50 percent (see Fig. 1) and, additionally, a positive effect on the propulsion performance. The wave patterns seen in both the numerical simulations and the model tests were found favorable and stable. Reduced wave resistance and high robustness of the vessel guarantee maximum efficiency and durability.

In brief, the optimization within the FRIENDSHIP-Framework achieved:

- Reduction in wave resistance by more than 50 percent
- Modification of the mid-body
- Adjusted volume distribution at forward perpendicular
- Better propulsion
- Generation of stable wave patterns
- Higher robustness of the vessel
- Optimal trim

Benefits seen by customer DSME

"For DSME's design process we see three major advantages in applying the FRIENDSHIP-Framework" explains Choi Young Bok from DSME's Hydrodynamic R & D team:

1. Increased speed performance
2. Increased automation
3. Speed up in optimization

The optimization of the ship hull has a lasting and very positive effect on the fuel consumption. With an optimized hull – and powered by its 72,240 kW engine – it makes the most of every ton of fuel.

With its final properties as displayed below, the 14,000 TEU vessel has set standards for speed and shape in its class of megaboxers. The position of the superstructures in the midship, the engine room located in the aft and the funnel position are very innovative and, all technical and building properties put aside, the MSC Danit is a real beauty.

Further information is provided in the paper "DSME sharpens edge for 14,000 TEU carrier" published by The Naval Architect in the 2008 edition on "Design and Construction of Containerships".

[Fig. 3] MSC Danit frontal (courtesy of DSME)

If you wish to get more details or to get in touch with DSME's Hydrodynamic R & D team, please contact Mr. Stefan Harries.

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