Parametric Hull Form Optimization for a Wind Farm Installation Vessel

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WHO IS DEKC

HISTORY
WHAT IS DEKC
MARITIME DESIGN & ENGINEERING COMPANY

EMPLOYEES
- Structural Designers
- Mechanical Engineers
- Naval Architects
- Stability Experts
- FEM Experts
- CFD Experts
- Project Managers
- Detail Structures and Outfitting Engineers

MARKET EXPERIENCE
- Yachts
- Offshore
- Architecture
- Dredging
- Wind
- Construction
- Shipping
- Fishing
- Passenger Transport
WHY DEKC
COMPLETE RANGE OF MARINE ENGINEERING

DESIGN

DETAIL ENGINEERING

OPERATIONAL SUPPORT

DESIGN ENGINEERING KNOWLEDGE CENTER
Van Oord’s AEOLUS

- L = 140 m
- B = 38 m
- T = 6.0 m
- Speed = 12 kn
Upgrade?

- Deeper max draft
- Sponsors along side
- Larger main crane
- Enlarged spudcans

DESIGN ENGINEERING KNOWLEDGE CENTER
AEOLUS 2.0

- \( L = 140 \text{ m} \)
- \( B = 44 \text{ m} \)
- \( T = 6.6 + 2.0 \text{ m} \)

- No changes to propulsion or powerplant

- Speed = ??? kn
Topics for today

• Project outline
• Geometry modeling
• Optimization
• Results
Project Outline
Goals
Goals

• Increase spudcan size
  • Current construction not to be changed
  • Spudcans protrude below hull
Goals

- Increase spudcan size
  - Current construction not to be changed
  - Spudcans protrude below hull

- Increase vessel transport capacity
  - Increase design draft
  - Add sponsons
Goals

• Increase spudcan size
  • Current construction not to be changed
  • Spudcans protrude below hull

• Increase vessel transport capacity
  • Increase design draft
  • Add sponsons

• Minimize speed loss (no extra power)
  • Flow bodies designed around spudcans
  • Sponson and flow body optimization
Additional Requirements

• Good buildability
  • Consider building section dimensions
  • Minimum intersection angles

• Easy integration on existing vessel
  • Align with existing construction
  • Maintain tank boundaries
  • Keep to flat intersection surfaces as much as possible
Geometry Modeling
Sponson Geometry

Intersection curves

Flat-of-side curves

F-spline curves

Meta-surfaces
Flow Body Geometry

- F-spline curves
- Intersection curve
- Along flat-of-bottom
Production of Sponsons and Flow Bodies

• CAESES geometry imported directly into Cadmatic Hull
• No production fairing necessary (good quality shape!)
Optimization
Global Strategy

• Objectives
  • Minimize resistance
  • Minimize velocity gradients in propeller plane
  • Maximize hull efficiency

• Two optimization steps
  • Minimizing wave resistance
  • Minimizing viscous resistance and propulsive losses
Minimizing Wave Resistance (1)

• Sponson interacts with fwd shoulder wave
  • Generate favorable interference
  • Smooth fwd shoulder

• Focus on sponson geometry
  • Minimize entry angle at waterline
  • Maximize smoothness at waterline
  • Constructional constraints respected
Minimizing Wave Resistance (2)

Current

Upgraded

Wave Elevation

DESIGN ENGINEERING KNOWLEDGE CENTER
Minimizing Viscous Losses (1)

• Parametrized sponson and flow body models

• Two-stage multi-objective optimization
  • Global optimization using Sobol
  • Local optimization using Tsearch

• Software connection from CAESES to Numeca FINE/Marine

Resistance, Wake

STL domain, Optimization routine
Minimizing Viscous Losses (2)
Results (1)

• Simulations performed with appendages and actuator disks
  • Effective power determined directly
  • Hull efficiency calculated

• Delivered power prediction based on:
  • Determined hull efficiency
  • Towing tank tests
  • Sea trial data
# Results (2)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Draft</td>
<td>+10.0 %</td>
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<tr>
<td>Beam</td>
<td>+15.8 %</td>
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<tr>
<td>Calm-Water Resistance (without optimization)</td>
<td>+257.0 %</td>
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<tr>
<td>Calm-Water Resistance (after optimization)</td>
<td>+28.6 %</td>
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<tr>
<td>Propulsive Efficiency</td>
<td>-6.9 %</td>
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<tr>
<td>Design Speed</td>
<td>-8.3 %</td>
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</tbody>
</table>
AEOLUS 2.0

- L = 140 m
- B = 44 m
- T = 6.6 + 2.0 m
- Speed = 11 kn