Enhanced Comfort of Ferries driven by Voith Schneider Propeller

Dirk Jürgens, Double ended ferries, 2007-05-07, Bergen, Norway
Topics

- Technical principle of the Voith Schneider Propeller (VSP)
- Voith Roll Stabilisation (VRS)
- Slamming loads for Vessels with VSP
- Engineering for improving comfort on board
- Conclusion
Voith Schneider Propeller

1. rotor casing
2. blade
3. cinematic
4. control rod
5. servomotor
6. bevel gear
7. reduction gear
8. driving sleeve
9. propeller housing
10. thrust plate
11. roller bearing
12. gear pump
VOITH SCHNEIDER PROPELLER (VSP)
A. New Generation of VSP

Research and Development

VSP 2002 - VSP 32R6/210
VSP Type 32 R5 EC/300-2
VSP HARDANGER
VSP Type 32 R5 EC/300-2
VSP HARDANGER -blade
VSP Type 32 R5 EC/300-2
VSP HARDANGER -blade
CYCLOIDAL PROPULSOR

KINEMATICAL PRINCIPLE
LIFT FORCE DURING CYCLOIDAL PATH OF A BLADE
Cycloidal Propulsion

Modeled on Nature

Steering and propulsion combined
Control of thrust direction and magnitude
stepless
Blades not twisted, zero thrust
Slow rotating, quiet, robust
Voith Circulation Tank

19.7 m

6.2 m
Tools for VSP-Enhancement: CFD
Research and Development

CFD-Calculation results

Blade - Rotor - Channel

Thrust
Water – Hull Interaction
resistance prediction

VSP Svitzer

- Exp. SVA
- CFD Voith
- CFD w/o dyn. trim and sinkage

Resistance [N] vs Velocity [kn]

10kn 12kn 14.5kn 16kn
VSP-Propelled Vessels

VWT, DOUBLE-ENDED FERRIES, MINE HUNTERS
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Voith Roll Stabilisation (VRS)
Voith Roll Stabilisation (VRS) - Mode

Full scale Test - North Sea: Norderney
Voith Roll Stabilisation (VRS) - Mode

Full scale Test - North Sea: Norderney
Rollstabilisierungstests (VRS), Time in full scale, Hs = 0.75 m

Roll Stabilisation with VSP's

unstabilized

stabilized
Rollstabilisierungstests (VRS)
Hs = 0.75 m
Hs 0,75 m; Periode 5.0s; 135° Bowq. seas; VRS on/off

78.3 % Rollreduction
Roll tests at MARIN, $H_s = 0.75 \text{ m}$

- Significant roll angle [$^\circ$]
  - bare hull: 4.5
  - passive fins: 4.0
  - active zero speed fins: 1.5
  - VRS off: 4.0
  - VRS on: 0.5
Rollstabilisierungstests (VRS),
Time in full scale, Hs = 1.5 m

Roll Stabilisation with VSP's
unstabilized
stabilized
Roll Tests - 90 M-Yacht, SVA Potsdam

without active controller of the fins of the Voith-Schneider propellers, \( \text{rpm} = 0 \text{ min}^{-1} \)

with active controller of the fins of the Voith-Schneider propellers, \( \text{rpm} = 159 \text{ min}^{-1} \)
Roll Tests - 90 M-Yacht, SVA Potsdam

runs 0744-00 (rpm\textsubscript{M} = 318 min\textsuperscript{-1}) and 0744-01 (rpm\textsubscript{M} = 0 min\textsuperscript{-1}); $\zeta_{\text{Wasg}} = 1.0$ m; $T_{p} = 12.2$ s
Roll Tests - 90 M-Yacht, SVA Potsdam

Results of the roll tests

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<th>Datei</th>
<th>$\zeta_{siq}$</th>
<th>$T_p$</th>
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Irregular beam seas, JONSWAP-spectrum

- 89.0 % Roll reduction
- 88.9 % Roll reduction

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Steering system for the tests

- Bridge panel
- Roll Stabilization on/off
- Electronic Steering unit
  - Roll steering
  - Roll steering
- Roll sensor
- Drive pitch
- Rudder pitch
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Voith Schneider Propeller for PSV
PSV model in Vienna
PSV model in Vienna with pressure sensors
Slammingtest (H sign = 4,0m, H max = 8 m)
Location of Load Cells for Slamming Pressure Measurement
Maximum Slamming Pressure at the Load Cells

\[ p \text{ [kPa]} \]

- **VSP off**
- **VSP on**

hw = 4.0 m
\[ d = 5.2 \text{ m} \]
Number of slams > 40 kPa per 30 minute

VSP on, hw = 4,0 m, d=5,2 m

![Graph showing the number of slams > 40 kPa per 30 minute for VSP off and VSP on.](image)
110 m – Cable Layer Vessel with Voith Schneider Propeller – reduction of slamming

VSP is **not running**, the blades are partly in air

VSP is **running**, a water “cushion” is created and reduces the slamming load

Water „cushion“ created by the running VSP
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VSP Ferry at the Lake of Constance, DEF TABOR
FEM Model, DEF TABOR

1
NODAL SOLUTION
STEP=1
SUBS=8
FREQ=7.333
USUM
TOP
RSYS=0
DMX = 0.02988
SMN = 3.05E-12
SMX = 0.02988

MODALANALYSE VSF EGG (400t Zuladung)
FEM Model, DEF TABOR

1
NODAL SOLUTION
STEP=1
SUB =8
FREQ=7.333
USUM
TOP
R SYS=0
DMX = .002988
SMN = .305E-12
SMX = .002988

MODAL ANALYSE VSF EGG (400t Zuladung)
Voith Ship Simulator (Simflex)

Second bridge

DEF bridge
Voith Ship Simulator (Simflex)

VSP handle I
VSP handle II
or z-drive handle
Voith Ship Simulator (Simflex)

• Consultant for Shipowner
  – Which is the best hull from (seakeeping, manoeuvring etc)?
  – Which is the best Vessel size?
  – Which power is necessary?
  – Which steering forces are necessary?
• Development of new steering logic
  – Fuel efficiency, response time
Ship line design

VSP

Development

Experiences

Full scale test

Simulator

Model test

CFD

Voith Turbomeca
Topics

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Conclusion

- Voith Schneider Propeller (VSP) offers an unique manoeuvrability
- VSP a can effectively be used for Roll Stabilisation
- Slamming loads are reduced by an active VSP
- Voith Ship Simulator will be used to develop an fuel-efficient steering system
- Voith Ship Simulator can be used as a consultant system to find the optimum steering and manoeuvring forces
- FEM analyses are used for improving the comfort on board
VOITH

Engineered reliability.