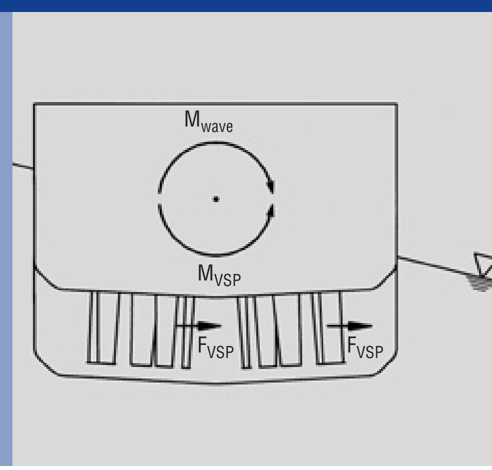
Voith Turbo

VOITH

Active Roll Damping with Voith Schneider Propulsion



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The following report describes the special features of the Voith Schneider Propeller (VSP) and Voith Cycloidal Rudder (VCR), which allow very effective roll stabilizing while the ship is stationary or under way at low and medium speed.

The technical requirement for stabilizing a ship is to suppress rolling motion – in other words to control the rotational movement about the ship's longitudinal axis, which is generated by a wave-excited moment that periodically opposes the moment on the ship that causes the rolling motion.

Generally, roll stabilization is divided into two broad areas:
1. Active operation
2. Passive operation

Active operation produces a counteracting moment by means of actively controlled machines.
A sensor detects the rolling motion and a regulator controls the counteracting moment as required.
Examples are:
- Fin stabilizers (retractable or fixed)
- Roll stabilizing tanks (active)

The advantage of these systems is their good damping property.
The disadvantages are:
- Complexity and expense
- High weight (particularly the liquid used to fill roll stabilizing tanks)
- Considerable space requirement
- High maintenance requirements
- Fin stabilizers only work at speed
- Fin stabilizers have a high resistance (even when retracted)

The passive mode of operation works on the principle of increasing the roll resistance and thus damping the rolling motion, e.g. bilge keels.
The Voith Schneider Propeller (VSP) working as ship propulsion and the Voith Cycloidal Rudder (VCR) working in active mode can generate both propulsion and steering forces. The thrust can be adjusted extremely swiftly in terms of magnitude and direction.

The very rapid thrust variation and generation of very high moments make it possible to use the VSP, as well as the VCR for efficient reduction of the ship's rolling motion. In particular when the ship is stationary or during slow motion, the roll motion can be actively reduced.

Ships Examined

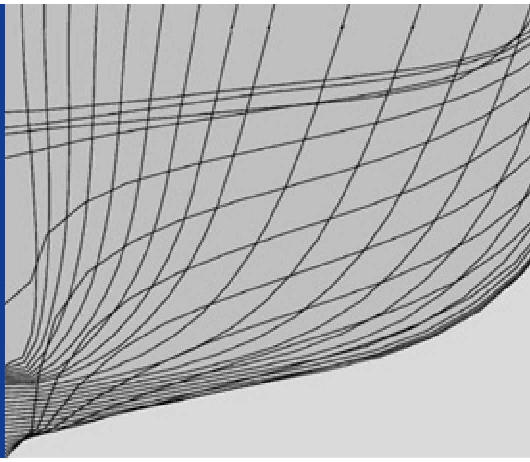


Fig. 1: Frames of the Corvette

Fig. 1a: Corvette

The research and development department of Voith Turbo Marine has examined the following ships:

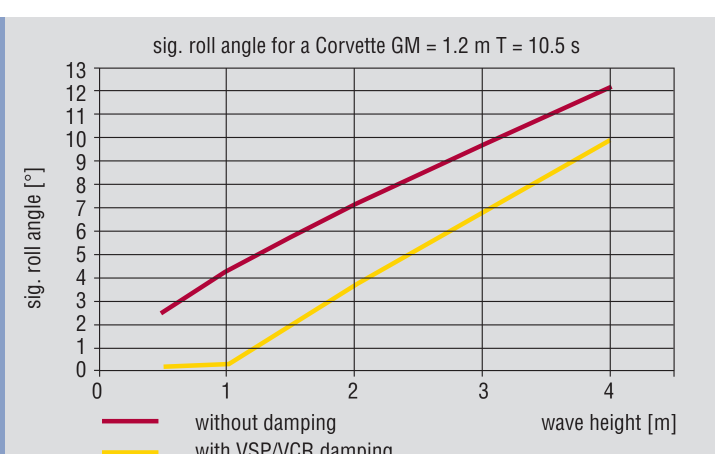
1. Corvette

All calculations are based on the ship theory and carried out by Prof. H. Soeding from the Technical University of Hamburg-Harburg. Calculations were made with the following principal dimensions for the corvette (Fig. 1a):
Loa = 84 m, Bwl = 10.8 m, D = 3.7 m,
Displacement = 1,800 m^3.
The meta-centric height GM on which the computation was based amounted to 1.2 m. Fig. 1 shows the frame used for the computation. The calculations have been carried out while the vessel was at standstill.

2 VCRs with a total static thrust of 117 kN were used as a basis for the computation of the active roll damping. This value corresponds to 85 % of the max. attainable transverse force, which was reduced in order to make allowances for the interaction of the two VCRs and between the hull and VCRs.

The results (Fig. 1b) for the Corvette with a wave length of 174 m over a period of 10.5 seconds, as found in many natural swells, were:
The roll effect could be suppressed almost completely for a significant wave height of H 1/3 > 1 m. The roll amplitude could be reduced by half in the case of a significant wave height of H 1/3 = 2 m. The roll reduction is smaller for higher waves.

Fig. 1b: Roll angle with and without active roll damping for a Corvette



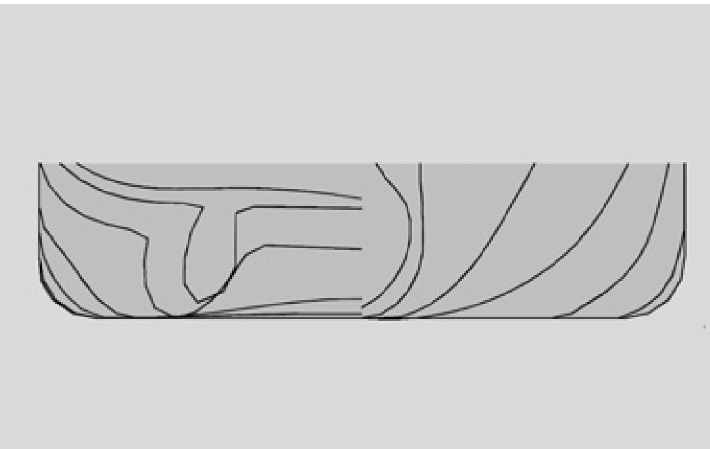


Fig. 2: Frames of the Crane Ship

Fig. 2a: Crane Ships

2. Crane Ship

Calculations were made with the following dimensions for the crane ship:
Lpp = 133.8 m, Bwl = 26.5 m,
D = 6.5 m, displacement =
15,820 m. The meta-centric height on which the computation was based amounted to GM = 1.3 m. Fig. 2 shows the frames used for the computation.

2 VCRs with a static thrust of 417 kN were subjected to roll damping. The reduction of the static thrust to 85 % of the max. thrust takes into account the interaction of the two VCRs and between the hull and VCRs.

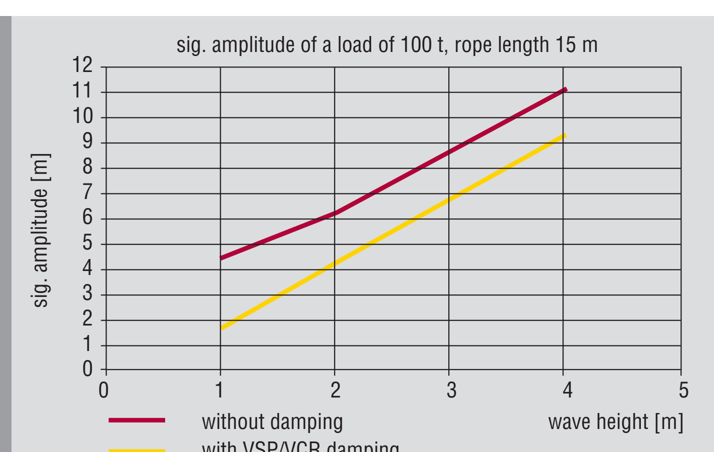
The result for the crane ship with suspended load is: due to the large natural period of the crane vessel, there is almost no excitation by the sea.

However, with crane ships (Fig. 2a), even small roll moments can produce large roll excursions as a result of the load hanging on the hook.

For the most unfavorable significant wave period in a natural swell with 1.5 m of wave height, it was calculated that the load oscillation amplitudes can be reduced by approx. 50 % with the VCR actively damping the roll oscillation (Fig. 2b).

It was also calculated that a larger reduction in the oscillation amplitude is possible for smaller significant wave increases.

Fig. 2b: Roll angle with and without active roll damping for a Crane Ship



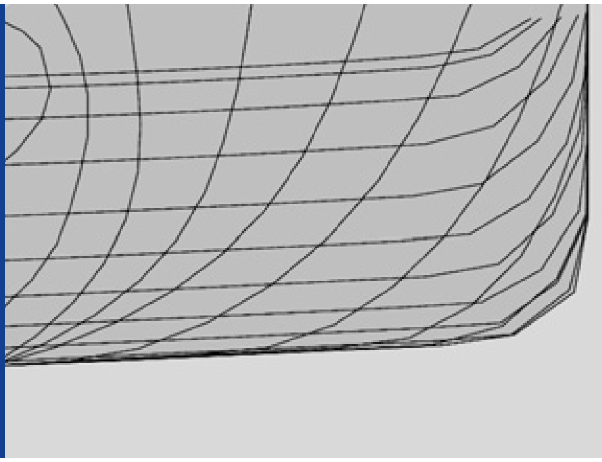


Fig. 3: Frames of the PSV

Fig. 3a: Platform Supply Vessel with Voith Schneider Propellers

3. PSV (Platform Supply Vessel)

Calculations were made on the on the basis of the following dimensions for the PSV:
Lpp = 77.4 m, Bwl = 19.2 m,
D = 6.05 m, trim = 0.6 m.
The meta-centric height on which the computation was based amounted to GM = 1.3 m.

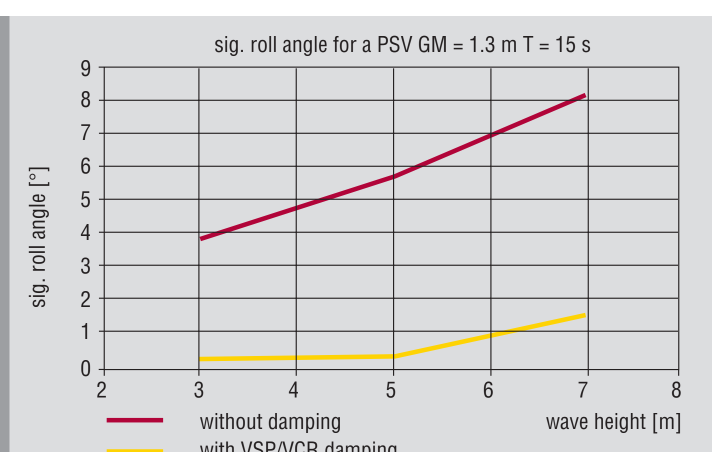
Resistance and propulsion test reports for this ship are available from Marintek under report number 601956.00.01 (February 2002). Fig. 3 shows the frames used for the computation.

The ship (Fig. 3a) is calculated with 2 VSPs, producing a transverse thrust of total 467 kN, including the factor 0.85 as stated above, caused by the mutual influence of the VSPs and hull.

Results (Fig. 3b): The roll motions of the PSV could be almost completely suppressed up to a significant wave height of 6 m (Fig. 4) and a long crest periodic swell with a period of T = 15 seconds.

The same damping characteristics were computed up to a wave height of 3 m over a wave period of T = 10 seconds.

Fig. 3b: Roll angle with and without active roll damping for a PSV



Technical Assumptions

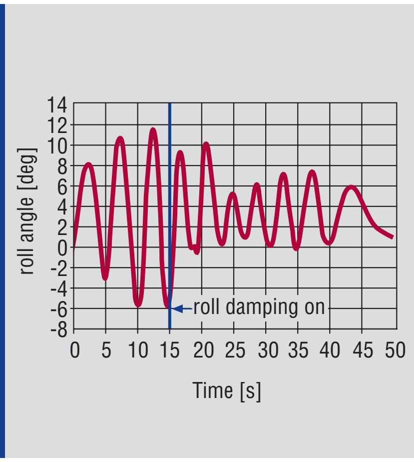


Fig. 4: Measured roll angle in full-scale test

The technical requirements, such as suppressing the rolling motion, as well as the rotational movement at very low and zero speed, are to be met.

Assumptions are:

- High accuracy in terms of steering (reacting) times to meet the time criteria, governed by the roll period of the ship
- Thrust (force) deviation in magnitude and direction, according to the ship's movement, without undesirable directions

Model Testing

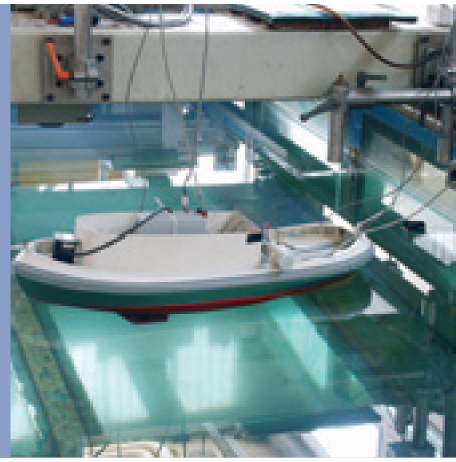


Fig. 5: Voith Roll Stabilizing investigations

An investigation (Fig. 5) was conducted to prove, whether the Voith Roll Stabilization (VRS) system can fulfill the requirements:

- Damping of the rolling motion of a ship without forward motion
- Damping the oscillation of a suspended load in case of a floating crane

The damping produced by the Voith Schneider Propeller (VSP) or Voith Cycloidal Rudder (Fig. 6) is referred to as active damping.

Full-Scale Trials

Fig. 6: Voith Cycloidal Rudder

The research project "Roll Damping with Voith Schneider Technology" examined how strongly the rolling motion of ships that are stationary or moving slowly through water can be reduced by the use of Voith Cycloidal Rudders (Fig. 6) or Voith Schneider Propellers.

The first calculations funded by the research and development department of Voith Turbo Marine and the computations by Professor H. Soeding showed that the technical requirements are already fulfilled by the cycloidal drive.

In order to verify the theoretical computations concerning the applicability of Voith Roll Stabilizing (VRS) to roll damping, full-scale trials were carried out in the North Sea. Fig. 4 shows the results of the measured roll angle.

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