The Rotterdam DK Group commissioned MARIN to perform powering, manoeuvring and seakeeping model tests for a special air lubricated Ro-Pax vessel. The DK Group required a vessel that was at least comparable to other Ro-Paxes, if not better. Better it was, Report explains.

DK Group's air lubricated Ro-Pax rigorous

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For the DK Group Netherlands B.V., MARIN performed an extensive model test program for their design of an air lubricated Ro-Pax vessel. The test results not only confirmed a significant reduction in resistance at high speeds but also showed good manoeuvrability. of a modified bow shape for better performance in waves.

The DK Group specialises in the development of air lubricated craft and one of the group's designs involves a 50 knot Ro-Pax ferry for operation in the Mediterranean and the Baltic. This craft is to be equipped with air lubrication in a single air chamber recessed in the bottom.

Air lubrication is applied to significantly reduce the calm water resistance. For the sake of a fair comparison the performance was compared with that of a conventional ship which had the same main parameters as the test ship.

Superior speed

Tests suggested that for speeds exceeding 36.5 knots, the air lubricated vessel was superior to the conventional vessel, and this improvement was significantly better with increasing speed, due to a much more favourable gradient in the curve of delivered power. Air lubrication, using a single air cavity layout, is most suited for very high-speed applications.

For a design to be successful, high transport efficiently in calm water alone is not sufficient. It must perform its task efficiently and, above all, safely in all kinds of environmental conditions. Therefore, the manoeuvring and seakeeping performance must be quantified as well.

Manoeuvring

In order to determine the performance of the design, free sailing and self-propelled tests with an active ride control system have been performed in MARIN's Seakeeping and Manoeuvring Basin. During the manoeuvring tests the emphasis was not only on the steerability, course keeping ability and manoeuvrability, but also on the roll angles.

The configuration as tested passed the pre-set manoeuvring criteria with flying colours. The manoeuvrability was even better than the manoeuvrability of similar, non lubricated Ro-Paxes. Furthermore, the measured roll angles were much lower than those of comparable vessels.

An item still to be investigated is the crabbing (sideways manoeuvring) ability: Should crabbing be performed with or without air? Without air the draught increases, so the interaction between a possible shallow harbour bottom and the vessel would be higher. With air the draught would be lower, but the side effects of the blowing air fans would have to be considered.

vessel undergoes testing but comes up trumps

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Seakeeping

Seakeeping tests were performed for bow, bow quartering, beam, stern quartering and following seas. The model was equipped with a ride control system for roll and pitch, actuating four fins. Besides measuring motions, accelerations, slamming pressures, propeller thrust and torque, the dynamics of the air volume in the air chamber and possible air suction by the propellers were monitored by means of an underwater video camera system. The tests showed that the craft was quite stable in beam and quartering wave directions.

As is not uncommon with new craft concepts, some areas which need additional attention were encountered as well such as bow slamming in head waves and propeller ventilation. Propeller ventilation occurred at all wave headings above a certain critical wave height when the air escaped from the air chamber and was sucked into the propeller disk. This resulted in large thrust and torque variations at the propellers. Clearly, a propulsion configuration capable of handling a flow with occasionally large air quantities is needed for this craft, for instance the Hydro Air Drive concept (see MARIN report 69 and 73).

Modified bow design

Bow slamming already occurred at a relatively low wave height. This was due to the combination of a low draft and flat bottom sections in the bow. MARIN designed modified deep-V bow sections that were a compromise between better seakeeping performance and an undisturbed flow in front of the air chamber.

The craft was subsequently tested in head waves in the High Speed Basin. A marked reduction in the number of occurrences of and pressures due to slamming was found. The peak values of the vertical accelerations were reduced by factor five.

Improved hull lines

The hull lines of this design were not optimised by CFD computations, whereas the conventional comparable ship implies optimised lines. The tests demonstrated that to some extent the wave pattern surrounding the ship could be optimised by utilising the interaction with waves originating in the cavity. The next generation of air lubricated vessels will be tested in the facilities of MARIN after bow shape optimisation, through CFD calculations using the RAPID code, extended such that this code now can cope with ships having an air cavity underneath.

This DK Group project shows once again that model tests, CFD computations and know-how, are an indispensable means to verify the performance of novel craft types. MARIN