MARIN set to open its new Depressurised Wave Basin marking a world first

In a few weeks time MARIN will inaugurate its new and unique Depressurised Wave Basin (DWB). MARIN has combined a depressurised towing tank with a wave maker – creating a world first. Report interviews the project leaders about the challenges of this unique project.

The new research facility will officially be opened on March 19 next year by the Dutch Minister of Economic Affairs, Agriculture and Innovation Maxime Verhagen. The DWB – dubbed "the Cathedral" at MARIN - will facilitate the testing of ships and offshore structures in the most realistic operational conditions possible in the world today.
MARIN was keen to differentiate this pioneering facility from others in the world, so it took the bold decision to add wave makers and entirely refurbish the 40-year-old Depressurised Towing Tank in Ede and turn it into the new facility. "The wave basin was mainly used for cavitation research in calm water but we wanted to broaden its application so we decided to add the wave maker. We can now both make waves and reduce the ambient pressure, which gives us unique new possibilities," says Jan de Boer, MARIN Department Manager, Maintenance, Development & Support.

Air pressure in the entire basin can be decreased to as low as 2.5% of the atmospheric pressure. Now that a wave generator is added, cavitation and ventilation of propellers in operational conditions with waves can be investigated, a capability that is not present anywhere else in the world.

"As well as cavitation and ventilation itself, the new facility has a strong focus on underwater noise. With a special 'silent carriage' it will be possible to measure the noise generated by the propulsor very precisely."

The reduced pressure also means that many important aspects can be studied using an accurately scaled condition for both water and air such as the correct scaling of the stiffness of air cavities e.g. air chambers and air cushions, which would be too stiff in normal testing conditions. This facilitates the simulation of the correct motion behaviour of ships, offshore structures and wave energy converters. The flooding process of damaged ships can also be simulated accurately.

Jan de Boer (left) and Hans Mulder: " The DWB project is truly pioneering, literally something that has never been built before"

The final focus of the research in the DWB relates to wave impact loading on ships and offshore structures. "During wave impact, sometimes air is entrapped and also that becomes too stiff when it is compressed. The reduced pressure will give much better insight into the actual pressures on the hull of the ship," explains De Boer.

When both wave generators work together they can produce waves from any direction, not merely head waves. "This represents the most realistic conditions at sea and is far different from the somewhat artificial head waves," he says.

Two weeks to fill giant basin This huge project (representing an investment of E17m) started in February 2010 when Hans Mulder, a Senior Project Manager at consulting and engineering firm Royal Haskoning, started working on the design specifications, contracting and detailed design. By April 1, 2011, work started on emptying and cleaning the tank and the site preparation.

There were many considerations and challenges the project team had to overcome. A 120 m wave generator had to be installed along the long side of the basin, together with a 160 m beach along the opposite side. A 14 m wave generator was installed along the short side of the basin, together with a beach spanning the full width at the other end.

In addition, a silent towing carriage was installed. The background noise of the silent towing carriage allows radiated noise measurements of ship propellers that need to comply with the ICES CR209 standard. By using two hydrophones, it is possible to measure flow noise, the noise of breaking bow waves, or from the propeller, both in the near and far field. The existing towing carriage was also fitted with a new sub-carriage that facilitates free running sea keeping tests.

0.75 m waves The long side wave generator is able to generate short and long crested waves with a maximum wave height Hs=0.4 m and Tp=3 s and the short side wave generator can produce short and long crested waves but with an increased height of up to Hs = 0.75 m and Tp = 4 s. This is the highest wave generator capacity at MARIN.

Just the sheer scale is astounding. The DWB contains 35 million litres of water and took an extraordinary two weeks to fill! Mulder comments that the DWB project is truly pioneering - literally something that has never been built before. "Nobody has ever thought about these issues and we had to solve them. There is a lot of experience of operating a vacuum facility but not with a wave maker in it!"

Given the unique nature of the project, not many companies were able to realise such a challenge. MARIN chose Edinburgh Design Ltd for the wave-making equipment. This












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Mulder: "No one has ever built anything like this, there are no specialists"

company was largely chosen because the wave generators are equipped with Automatic Reflection Compensation (ARC). This feature was very important in a relatively narrow wave basin, De Boer stresses.

Since little experience exists in the industry, except perhaps for the aerospace and aircraft industry, most adaptations had to be made by MARIN itself, in close cooperation with several contractors. The behaviour of material under vacuum conditions is sometimes different than under ambient conditions. In addition, the way systems work under these conditions is not commonly known. To determine the design loads on the beaches no method or design code was available so MARIN naturally, turned to model testing and decided to build a 1:10 scale model to determine the loads.
There were many other challenges to be addressed. Because of the vacuum, everything is operated by remote control so obviously equipment has to be totally reliable, stresses Mulder. "We had to encapsulate all of the engines and the cabling needs lots of additional protection and insulation."

Some of the major challenges were the short build time, the complexity of the controls and the safety aspects. "We spent a lot of time and energy getting the safety measures right," he says. For instance, an extensive risk analysis was carried out examining the safety aspects involved when both carriages were driving at the same time. Safety during construction was also important especially given the challenge of such a restricted site.

Superb cooperation One very important reason for the success of the project was cooperation between all of the various contractors and this was Mulder's responsibility. "No one has ever built anything like this, there are no specialists. To avoid any delays we asked the contractors to think about their work process resources carefully."

He adds: "Cooperation between contractors was very good, everyone was very flexible and willing to help. This is a big compliment to all the contractors."

The DWB will carry out its first tests on a wave energy converting device which has been initiated from a Joint Industry Project involving Dutch shipyard group Damen, Vuyk Engineering Rotterdam (a member of the IHC group), technical solutions provider Imtech, Meteoconsult, TU Delft and MARIN. "This is a perfect example of industry working together and transforming research and knowledge into concrete products," emphasises De Boer.

They are both certain that the new research facility will make an important contribution to improving safety and the efficiency of propulsion and in reducing resistance, consequently improving energy efficiency and helping to reduce emissions.