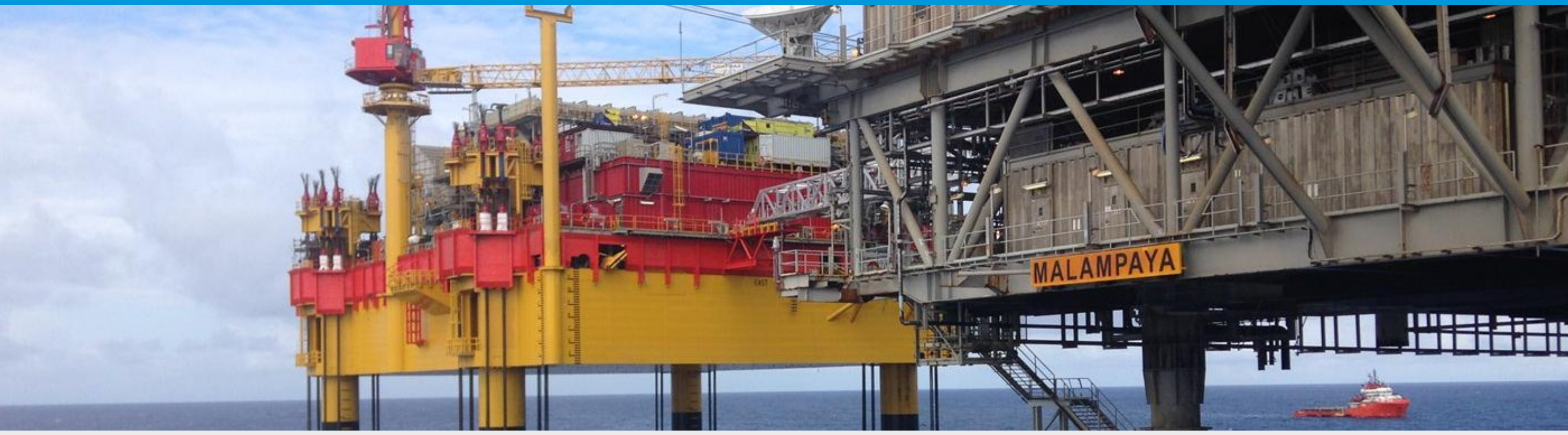


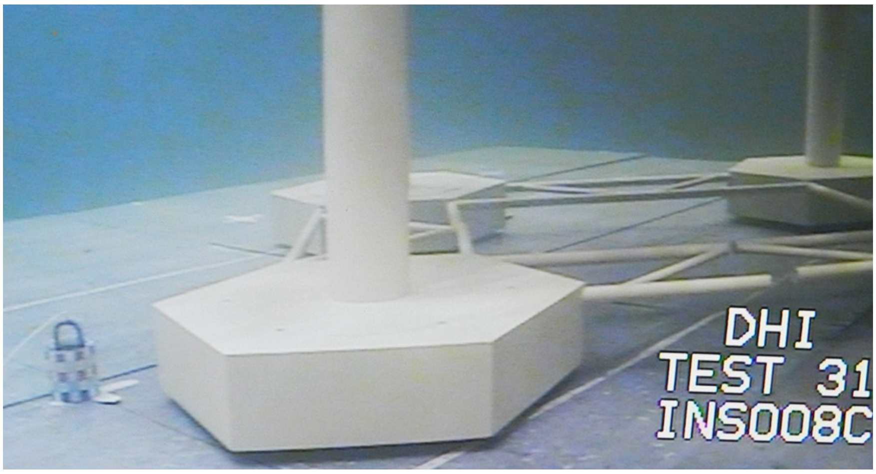
TOWING AND INSTALLING OF AN OFFSHORE PLATFORM

Testing the marine operations for Malampaya Phase 3 self-installing platform

Shell Philippines Exploration B.V. wanted to extend the life of their Malampaya offshore gas field by installing a second platform. Before doing this however, they needed to test the towing, lowering and touchdown process for the platform. Shell and Arup, the substructure designer, also wanted to ensure the platform deck was elevated enough to avoid direct slamming pressures from extreme wave crests after installation as well as to determine current- and wave-induced velocities around the platform. We helped them do this by conducting several tests in our ocean and shallow water basins, complemented with CFD modelling.

EXTENDING THE LIFE OF AN OFFSHORE GAS FIELD

Malampaya is the largest offshore gas field in the Philippines. The first undertaking of its kind in the Philippines, Malampaya employs state-of-the-art deepwater technology to draw natural gas from far beneath the country's waters. This gas fuels three natural gas-fired power stations with a total generating capacity of 2,700 megawatts – providing 40-45% of the power generation requirements of Luzon, the largest and most populous island in the Philippines. Since 2001, the Philippines has been importing less fuel for power generation, resulting in foreign-exchange savings and energy security.



DCP's footings hovering above the seabed before touchdown. ©Shell

CLIENT

Shell Philippines Exploration B.V.

CHALLENGE

Need to test (under strict time limits) a number of critical aspects of Shell's self-installing Depletion Compression Platform (DCP) project, including:

- verifying the exposure of the platform while towing it from the yard to the installation site during high seas to enable the client to define weather windows for installation and touchdown of the footings on the seabed
- determining the elevation of the platform deck above sea level to avoid critical loading from wave crests reaching it
- verifying design flow velocities for the rock preparation pads and scour protection before and after platform installation

SOLUTION

- Using two of our physical model test facilities to comply with test specifications:
  - an ocean basin to conduct tow and installation/touchdown tests at the largest possible scale
  - a shallow water basin to conduct in-place condition tests of both extreme wave conditions as well as a combination of waves and current at reasonable model scale
- Using Computational Fluid Dynamics (CFD) modelling to determine current- and wave-induced velocities around the platform

VALUE

Solidified the confidence of the project owner and designer in the selected design and installation procedure

LOCATION / COUNTRY

South China Sea off the coast of the Philippines

In order to maintain production from and extend the life of Malampaya, Shell Philippines Exploration B.V. decided to install a second platform – Depletion Compression Platform (DCP) – to facilitate compression into the gas field. They selected a self-installing platform, which was designed by Arup and built at Keppel Shipyard in Subic Bay.

After construction, the platform was towed to the site and installed – first, by lowering the four legs to the seabed and then subsequently jacking the deck structure up to the necessary elevation above the water's surface. Finally, the DCP will be connected to the existing platform with a bridge.

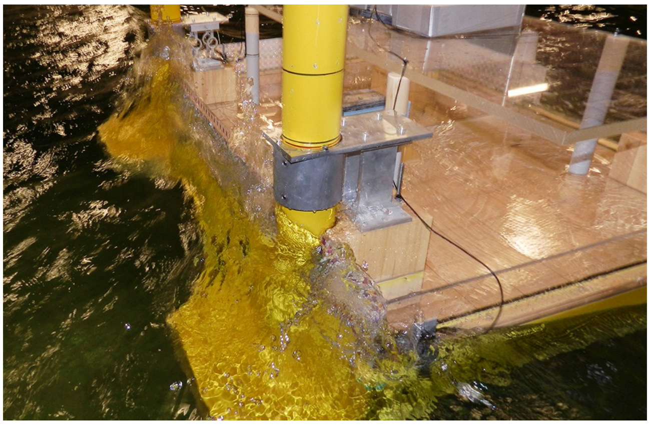
TOW AND INSTALLATION TESTS

Large volumes of water entering the platform must be avoided during the wet tow operation from the construction yard to the field site. As such, the platform needed sufficient freeboard (the distance from the waterline to the upper deck level) to minimise green water on deck.

Our wet tow test verified the elevation of the outer wall on the platform and determined if the design needed to be modified. Carried out in our ocean basin (model scale 1:40), the model was kept in position with soft mooring lines while exposed to multi-directional waves from three different directions. We measured:

- platform motions using the Qualisys tracking system
- impact forces on one of the four legs

We tested the stability of the platform in intermediate stages of lowering the platform legs at different wave directions. The final touchdown was simulated by lowering the water level in the basin until the platform was completely resting on its legs.



Platform tow test – wave overtopping. ©Shell

TESTS OF DCP IN-PLACE CONDITIONS

With the aim of documenting the necessary elevation of the platform deck to avoid loading from extreme wave crests reaching the deck, simultaneously tests were carried out on a model of the installed platform.

We tested the design requirement in our shallow water wave basin (scale 1:70) using multi-directional waves up to and above the design wave conditions to determine the minimum air gap between the wave crests and the platform deck. In order to ascertain whether the presence of both platforms might enhance the crest elevations, the setup included the DCP and the neighbouring existing platform.

MODELLING FLOW VELOCITIES AROUND THE PLATFORM LEGS

Our shallow water facility provides through-flow current generation as well as simultaneous generation of uni-directional waves. By testing in the shallow water basin, we were able to determine flow velocities generated by a combination of waves and ambient currents, which could be used as a basis for the design of:

- the seabed rock preparation pads (which support the footings of the platform legs)
- permanent scour protection around the platform footings

We recorded the flow velocities using ultra-sonic flow equipment close to the structure and the seabed in tests that represented different wave directions and current exposure. We further analysed flow velocities at the seabed and the effect of irregular waves on the near-bed flow field around the platform legs using CFD modelling with OpenFOAM®.

The assessment of the potential impact of flow amplification due to the presence of the existing platform's subsea tank was of particular importance. To assess this, we developed a tailored three-dimensional (3D) numerical solver in which waves and current were implicitly represented through a time-varying body-force approach.

Our analysis of the flow field yielded a mapping of local zones that are sensitive to scour development. Coupled with the local velocity amplification, this formed the basis for scour risk assessment, allowing for countermeasures to be taken for relevant parts of the platform footings.

Seabed preparation by Boskalis vessel Ndeavor. ©Boskalis

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