SCOUR PROTECTION HANDBOOK

Winnowing for two rock gradings and monitoring by stereo photography

When an offshore wind turbine is installed, the disturbed flow around the foundation causes enhanced sediment transport at the base of the foundation, resulting in the development of scour holes. Scour can undermine shallow foundations or change the natural frequency of monopile foundations, resulting in shorter lifetimes due to fatigue. The most common way to mitigate this risk involves the installation of scour protection.

Although over 4,000 offshore turbines are now connected to the grid, there were no guidelines until recently on how to design scour protection safely and cost-effectively. A wide range of designs have therefore been installed, even in neighbouring wind farms. The result is either an increase in maintenance costs and a risk of cable damage, or over-conservative, over-expensive designs. The Handbook Scour Protection methods (HaSPro) Joint Industry Project was established to solve these issues by systematically testing a wide range of scour protection methods under all governing hydrodynamic conditions. In addition to several designs consisting of loose rock, more innovative solutions based on artificial vegetation, ballast-filled mattresses, gabions, block mattresses and even self-installable mattresses were also put to the test.

In the HasPro project, model tests were performed at three different model scales: in the Scheldt Flume (small scale), the Atlantic Basin (intermediate scale) and the Delta Flume, which is the world's largest wave flume. The most innovative concepts were first investigated at the smallest scale. This scale is suitable for fast cycle times and quick modifications of the test setup. In the next step, it was possible to include the full offshore hydrodynamics with a mobile sediment bed at the intermediate scale. Edge scour, falling apron effects and winnowing (the removal of sediment by suction) were also studied at this scale. Finally, selected concepts were validated at the largest scale in the Delta Flume. A monopile weighing 4,000 kg and equipped with observation windows and a high-tech camera system was mounted in the flume and installed in a sediment bed. Two months of testing resulted in an abundance of data that are being converted into new design formulae.

A trend in the future, now that the Levelised Cost of Energy for offshore wind energy has been dropping significantly, will be to improve ecological values in the wind farms. Scour protection systems are already known for their biodiversity. In HaSPro, we are taking this one step further: we aim to adapt scour-protection designs in order to attract two umbrella species: the European flat oyster and the Atlantic cod.

The test results are available in a large database that can be accessed using a dedicated 3D viewer. They show the relevant deformation patterns for all tested methods under various design conditions. The new design formulae are incorporated in the Scour Protection Design Tool. Augmented Reality and Virtual Reality techniques were used for the visual interpretation of the results.

This project is supported by twenty industrial partners, the Dutch Top Consortia for Knowledge and Innovation (TKI) "Offshore Wind" and TKI "Delta Technology".

Contact
Tim Raaijmakers, tim.raaijmakers@deltares.nl, t +31 (0)6 4691 1177
Greta van Velzen, greta.vanvelzen@deltares.nl, t +31 (0)88 335 8054

Further reading
https://topsectorenergie.nl/tki-wind-op-zee/rd-projecten/haspro-jip-handbook-scour-protection-methods