Optimisation of Pile Installation through Scour Protection (OPIS-2.0)

Publieke samenvatting / Public summary

Aanleiding

Offshore wind turbine monopile (MP) foundations are susceptible to seabed scour, often requiring installation of scour protection systems. In the North Sea, this has traditionally involved a double-layered scour protection consisting of a filter layer of small rocks and an armour layer of larger rocks, installed using a “3-step approach.” Although this method is proven, it requires multiple installation campaigns and poses technical challenges when placing armour stones close to an installed monopile. To improve efficiency and reduce cost, logistics, and carbon footprint, the offshore wind industry is increasingly considering a “2-step approach.” In this approach, a single, thicker scour protection layer combining filter and armour functions is installed in one operation before monopile installation. While this approach offers clear advantages, experience remains limited. Several projects have reported difficulties with monopile penetration through pre-installed scour protection, influenced by rock properties and insufficient predictive capability of existing models.

Doelstelling

The proposed OPIS2.0 project builds on the HER+ funded OPIS1.0 project, completed in 2025, which demonstrated that monopiles can penetrate pre-installed scour protection layers under suitable conditions. OPIS1.0 delivered two key outcomes: a semi-empirical model to predict the self-weight penetration force based on seabed conditions, scour protection characteristics and monopile geometry,

Projectinformatie / Project information

Projectnummer / Project number
EKOOELEK26-03981798
Subsidiebedrag / Grant amount
€ 735.790,00

Algemene informatie / General information

Penvoerder / Secretariat
Stichting Deltares

Volg Topsector Energie op X / Follow Topsector Energie on X

@TSEnergie

and a Discrete Element Model (DEM) to support optimisation of scour penetration design. However, the current models lack sufficient field scale validation, may not accurately capture complex mechanisms such as layered sea beds. Asset owners emphasise the need for industry guidelines, while contractors seek validation at full scale and extension to weak and layered soils. Consequently, OPIS2.0 aims to calibrate and validate the models across a broader range of subsurface conditions at full scale to enable reliable, practical application.

Korte omschrijving

Pile penetration through a pre-installed scour protection layer is governed by many interacting variables and remains insufficiently understood, despite progress made in the OPIS1.0 project. A key knowledge gap concerns the behaviour of the scour protection under varying seabed conditions. While existing models have been validated for loose and dense sand, different responses are expected for layered soils and weak soils like mud. Another major limitation is the lack of validation at full scale, which restricts confidence in applying the current semi-empirical and numerical models in real projects. To address these gaps, three main research questions are defined. 1. How do weak and layered soil conditions influence monopile penetration behaviour through scour protection? 2. How can the existing models be validated at full scale? 3. Can an industry guideline be developed and reviewed so that model outcomes are acceptable to asset owners, contractors and other stakeholders? The study will combine scaled laboratory experiments, field data supplied by project partners, and numerical modelling.

Resultaat

The goal of OPIS2.0 will be realised by delivering the following set of results: • Output (data and report) from intermediate scaled laboratory experiments to understand the mechanisms involving differing seabed soil conditions • Field data from completed offshore foundation projects • Semi-empirical model validated for differing soil conditions at full scale, including a user interface in Python and report. •

DEM validated for differing soil conditions at full scale. Results are simulation cases as proposed by the partners, including reporting. • Industry guidelines in a report, externally reviewed

De data in deze applicatie is afkomstig van de Rijksdienst voor Ondernemend Nederland (RVO) en wordt in samenwerking met de Topsector Energie ontsloten.
Voor meer informatie over de Topsector Energie, ga naar **www.topsectorenergie.nl**.

Voor meer informatie over de TSE / Energie-Innovatie regelingen die RVO aanbiedt, ga naar **www.rvo.nl/tse**.