

Research on foundations of offshore wind turbines

Introduction

The expansion of wind energy to offshore locations is a logical development. The characteristics of sea winds versus mainland winds are more optimal for energy generation. Moreover, the best onshore locations for wind energy parks are already occupied in the densely populated Europe. Even though the possibilities at sea are considerable, there are some additional technical challenges involved. The disruption of the current caused by the presence of the pile induces local scour at the foundation's base. This phenomenon seriously affects the stability and dynamical behavior of the foundation. The most economically viable solution is to place a scour protection around the wind turbines' foundation. The goal of the scour protection is not to avoid scour completely yet to shun scour from within a certain perimeter around the foundation.

A second important aspect for the design of offshore wind turbines is the wave run-up on the pile.

Wave run-up on pile of wind turbines

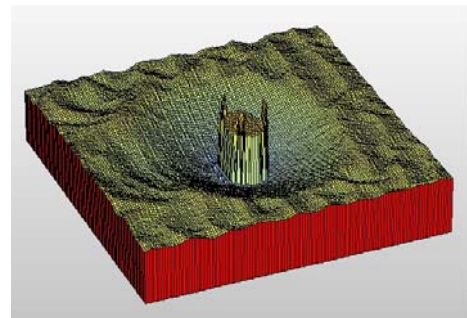


Due to the disruption of the waves by the pile, waves tend to run up highly onto the pile. High run-up was the cause of unexpected damage of the entrance platforms of the Horns Rev wind turbines (Denmark). Experimental research was performed at Aalborg University (AAU), Denmark to estimate the magnitude of wave run-up under different wave conditions. The picture on the left shows the experimental test set-up at AAU to measure wave run-up on a conic gravity-based foundation (cone-shaped, to provide the necessary stability for the wind turbine). Wave run-up is determined visually (color bars) and with wave gauges. A formula for the wave run-up

was derived from the experiments.

Erosion

The figure on the right shows a experimentally measured scour profile around a monopile foundation of a wind turbine. The scour depth depends on the wave and current conditions, but can amount to two times the pile diameter. The diameter of the scour "hole" is usually between five to eight times the pile diameter.



Erosion protection

The scour protection should guarantee the foundation's stability. Such scour protections usually consist of rip-rap material placed around the wind turbine's foundation. While designing and constructing the scour protections of existing wind farms, physical model tests were always performed in order to assess the often overly conservative design, in which no movement of the protection stones was allowed. The Department of Civil Engineering at Ghent University developed a less conservative design method to obtain a stable scour protection for combined wave and current loading.

Contact:

dr. ir. Leen De Vos (Leen.Devos@mow.vlaanderen.be)