Large-scale experimental modelling of scour protection around wind turbine monopile foundations

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Introduction

Offshore wind farms contribute significantly to contemporary renewable energy production. To ensure the safety of the wind turbine structure and reduce the installation cost, the design of the foundation is crucial. When exposed to waves and currents, the wind turbine foundation faces the risks of scouring, therefore, an armour layer protection is usually applied to prevent the scouring hole around the monopile foundation. Experiments with scale models of monopiles in physical wave flumes are proved to be a powerful way to estimate the performance of the scour protection layer. Previous research by De Vos et al. (2012) has resulted in the proposal of scour protection design formulae for both static and dynamic stability, while the extended work of Loosveldt and Vannieuwenhuyse (2012) analysed the feasibility of the design method using a wider range of environmental conditions. As scale effects exist in small scale model test and may lead to an over conservative design, the large scale modelling is necessary to investigate the relationship between the ocean conditions and corresponding armor layer damage. Therefore, within a European Hydralab+ research project, large-scale physical modelling of monopile foundation with scales of 1:8.33 and 1:16.66 has been carried out in the Fast Flow Facility (FFF) infrastructure of HR Wallingford. The Coastal Engineering Research Group of Ghent University is coordinating this project, with partners from the University of Porto, the Ludwig-Franzius-Institute for Hydraulic, Estuarine and Coastal Engineering, IMDC NV and HR Wallingford.

Objectives

These large scale tests have been conducted during May and July in 2018. The main objective of this research is to establish a benchmark dataset on the stability of scour protection around monopile foundations which will serve as a valuable reference for future wave flume model tests, for numerical validation purposes and for future foundation design. The hydrodynamic data is recorded by various high resolution instruments and the scour protection profiles are measured by underwater laser scanner. Based on the data processing, several researches are being carried out after the experiments. Firstly, different damage evaluation methodologies proposed by participating partners will be compared and analyzed, this helps to establish a proper economic concept for scour protection design. Secondly, the scale effects between previous small tests and current large scale tests are to be analyzed and quantified which would reveal the fundamental mechanism of the physical process. Thirdly, the performance of narrow-graded and wide-graded single layer protection will be tested and compared. Moreover, as combined wave and current conditions are applied, the research will investigate the hydrodynamic interactions between waves and currents based on laboratory data as well as the impact on scour protection stability.

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