Large-scale 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. (2008, 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. However, due to the rather small scale (1:50) of the model, the viscous scale effects in the porous protection layer cannot be fully investigated. Another issue is the design of the filter layer when considering the bed sand particles flushing effects. Schendel et al. (2015) suggested the use of a wide-graded single armour layer instead of using a double layer (composed of filter + armour layers), but the stabilising process remains unclear. Consequently, there is a need for large-scale tests to investigate these physical processes in detail. Therefore, within an upcoming European Hydralab+ research project, large-scale physical modelling of monopile foundations will be carried out in the Fast Flow Facility (FFF) infrastructure of HR Wallingford which is able to support tests scale of 1:8.33. 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

The main objective of this research is to establish a basic benchmark dataset on the stability of scour protection around monopile foundations which will serve as a basis for future wave flume model tests, for numerical validation purposes and for future foundation design. In the following, the research methodology is presented. Firstly, the scale effects of intermediate scale and large scale experiments will be quantified by means of pore pressure measurements and filter velocity. Secondly, the performance of narrow-graded two layer and wide-graded single layer scour protection will be tested and compared to guide the future foundation design. Thirdly, extreme wave and current conditions shall be studied to evaluate the risk of foundation failure. These large scale tests will be conducted in May and June of 2018.

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