Edge scour at scour protections around piles in the marine environment - Laboratory and field investigation

When building offshore wind turbines with monopile foundations, scour protection typically is placed to avoid scouring of the soil close to the monopile. An important aspect is that the scour protection itself causes erosion, inflicted by the local increase in current and/or wave velocities and in turn increased bed shear stresses. Scour of the edge material alongside the scour protection may cause deformations and failure of the scour protection of offshore wind turbine foundations. This can reduce the stability of the stone layer and cause exposure of cables running between the monopiles where they go from buried to the transition piece on the foundation. Although much information is available on the design of scour protection systems around monopiles, little is known on the mechanisms causing edge scour and the equilibrium stages of the edge scour process in steady current, waves and combined waves and current. This paper presents an extensive experimental campaign to explain the edge scour process in current and combined irregular waves and current, as well as tidal current. The three-dimensional flow field around the pile and scour protection is resolved by particle image velocimetry and bed shear stress measurements, showing a local increase in the flow velocities and bed shear stresses leading to increased sediment transport and scour. The governing process in steady current is a pair of symmetrical counter-rotating vortices emerging in the near bed region in the wake of the pile and scour protection, causing a significant downstream scour hole. It is found that the equilibrium scour hole depth and length scales with the pile diameter and the ratio between the thickness- and the width of the scour protection. In the second part of the present paper, the results from the experimental campaign are compared with the edge scour experienced in practice, outlined by a survey program of the offshore wind park Egmond Aan Zee and a published field investigation of Scroby Sands OWF by Whitehouse et al. (2011).

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