Geophysical Research Abstracts
Vol. 12, EGU2010-11024, 2010
EGU General Assembly 2010

Evolution and Reduction of Scour around Offshore Wind Turbines

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In response to growing socio-economic and environmental demands, electricity generation through offshore wind turbine farms is a fast growing sector of the renewable energy market. Considerable numbers of offshore wind farms exist in the shallow continental shelf seas of the North-West Europe, with many more in the planning stages. Wind energy is harnessed by large rotating blades that drive an electricity generating turbine placed on top of a long cylindrical monopile that are driven into the sea-bed, well into the bed rock below the sediment. Offshore wind turbines are popular due to consistently higher wind speeds and lower visual impact than their onshore counter parts, but their construction and maintenance is not without its difficulties. The alteration of flow by the presence of the wind turbine monopile results in changes in sedimentary processes and morphology at its base. The increase in flow velocity and turbulence causes an amplification of bed shear stress and this can result in the creation of a large scour hole at the monopile base. Such a scour hole can adversely affect the structural integrity and hence longevity of the monopile. Changes to the sea bed caused by this may also locally affect the benthic habitat.

We conducted an extensive series of rigid and mobile bed experiments to examine the process of scour under tidal currents. We also test the effectiveness of a flow-altering collared monopile in reducing scour. Firstly, we used Particle Image Velocimetry (PIV) and Acoustic Doppler Velocimetry (ADV) to visualise and analyse the flow and turbulence properties in the local flow around the monopile and collared monopile over a smooth rigid bed under tidal flow. The measured flow, turbulence and shear stress properties are related to mobile bed tests where a Seatek 5 MHz Ultrasonic Ranging system is used to identify the evolution of scour under reversing tidal currents. The tidal evolution of the scour hole around the monopile is compared with that under unidirectional currents and that around the collared monopile. Results show that the evolution of scour under tidal currents is quite different than that of a unidirectional current and that the scour hole shape is also more symmetrical than the scour hole under a unidirectional current, which is quite asymmetrical. Results also indicate that the collared monopile design is effective in reducing the depth of scour that occurs at its base. This data will also be used for a validation of the numerical model of scour processes around the pile.

Key words: Monopile, Scour, Tidal Flow, Scour Reduction