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Soil-pile-structure-wave interaction simulation of standalone wind turbine

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ABSTRACT

A comprehensive study is performed on the soil-pile-structure-wave interaction of standalone wind turbine supported on monopile foundation. The system is modelled by a superstructure on a finite element (FE) model of pile-soil system, where the Mohr-Coulomb plasticity model and the surface-to-surface contact algorithm are used to characterize the soil behavior and the soil-pile interaction, respectively. Dynamic analysis of the offshore wind turbine under combined wave and wind loadings is carried out in time domain and frequency domain using finite element method by software ABAQUS. Three real-world offshore wind turbines are selected from the literature with detailed structural and soil data to verify the accuracy and credibility of the FE model. A parametric study is conducted for the modern NREL 5MW wind turbine with focus on the wave loading, in terms of the influence of the wave theory, wave spectrum and wave-structure interaction. The results show that wave theory and wave-structure interaction bring about minor difference in displacement and internal force response, where the former is mainly caused by the second-order component in the nonlinear wave theory, and the latter concentrates on the component around the natural frequency. Compared to the wave theory and wave-structure interaction, the influence of the wave spectrum on the displacement and internal force response is distinct, especially with respect to the component around the peak frequency.

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