Offshore & Dredging Engineering

Technische Universiteit Delft

Combined earthquake & wave action on offshore wind turbine monopile foundation

The offshore wind industry has been extended over the last years in areas of active seismicity, such as East Asia, where the design of offshore wind turbines becomes significantly challenging, because not only the aerodynamic and hydrodynamic loads act on the offshore structures, but also earthquake is a big threat.

The present master thesis deals with the dynamic analysis of the response of an offshore wind turbine monopile due to the application of hydrodynamic and earthquake loads. The interest is focused on the understanding of the dynamic properties contributing to the dissipation of energy experienced by the structure. More specifically, the sources of damping are investigated, emphasizing on the hydrodynamic and the soil damping. A numerical approach for the estimation of the hydrodynamic viscous damping is presented based on the calculation of the drag coefficient C_D and its dependency on the Reynolds number, the Keulegan-Carpenter number and the surface roughness.
Furthermore, the soil radiation damping is studied by including the interaction of the soil with the structure. The supporting soil is modelled around the monopile with frequency-dependent springs and dampers. The estimation of the soil coefficients is accomplished by integrating in the model of the structure, an advanced soil model developed by Dr. J. De Oliveira Barbosa.

The analysis of the response of the structure is executed by examining three load cases for the hydro-dynamic and earthquake loads. The overall outcome reveals that a noticeable amount of energy is dissipated because of the presence of the soil radiation damping, coming also to the conclusion that the soil-structure interaction should be considered as frequency-dependent during earthquake. Despite the fact that the approach for the estimation of the hydrodynamic viscous damping constitutes a more precise method, its participation for the specific tested cases is limited to the total amount of damping.

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