Dynamic Analysis of Offshore Monopile with Heat Exchanger System for Energy Storage

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Abstract

This paper proposes a novel concept of extracting geothermal power from the oceanic crust, using an offshore wind turbine structure, combined with an active heat exchanger system comprising of fluid pipes. The offshore monopile system uses a thermoelectric generator with the working principle of Seebeck effect that converts the temperature difference between the fluids in the inlet-outlet pipe to produce electricity. Thermal analysis of steel monopile with fluid-carrying-pipes has been carried out using finite element method through a heat flow analysis, taking into account the complex heat transfer process of convection through fluid pipes and conduction between the pipe-soil-monopile system. The effect of offshore loading is taken into account using random wind and wave loading simulated using the Kaimal and the Pierson Moskowitz spectra, respectively. The combined effect of thermal as well as offshore loading on the monopile, resultant pore pressure development in soil due to the loads, the axial and radial stresses and strains in the structure and the shear stresses in soil were studied in detail. The strains and displacement of the structure are checked against the serviceability limits for the offshore wind turbine structure and it has been observed that the combination of offshore as well as thermal load on the monopile foundation along with the duration of the load, affects the stresses and strains in the structure significantly.