

## **Finite Element Simulation of an Offshore Monopile Subjected to Cyclic Loading Using Hypoplasticity with Intergranular Strain Anisotropy (ISA) for the Soil**

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**Abstract :** Numerical simulations of offshore wind turbines (OWTs) in shallow waters demand sophisticated models considering the cyclic nature of the environmental loads. For the case of an OWT founded on sands, rapid loading may cause a reduction of the effective stress of the soil surrounding the structure. This eventually leads to its settlement, tilting, or other issues affecting its serviceability. In this work, a 3D FE model of an OWT founded on sand is constructed and analyzed. Cyclic loading with different histories is applied at certain points of the tower to simulate some environmental forces. The mechanical behavior of the soil is simulated through the recently proposed ISA-hypoplastic model for sands. The Intergranular Strain Anisotropy ISA can be interpreted as an enhancement of the intergranular strain theory, often used to extend hypoplastic formulations for the simulation of cyclic loading. In contrast to previous formulations, the proposed constitutive model introduces an elastic range for small strain amplitudes, includes the cyclic mobility effect and is able to capture the cyclic behavior of sands under a larger number of cycles. The model performance is carefully evaluated on the FE dynamic analysis of the OWT.

**Keywords :** offshore wind turbine, monopile, ISA, hypoplasticity

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