Dynamic responses of jacket foundation offshore wind turbine considering the cyclic loading effects

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Abstract

With increasing of offshore wind turbines (OWTs) in recent years, the supporting structure are needed to suite the cases with water depth greater than 100 m. In such cases, the effects of wind, wave and current become much obvious, and jacket support structure are recommended for the OWTs. During the service period, the soil-pile interaction has a significant effect on the dynamic response of the OWT structure. Thus, this paper aims to first investigate the characteristics of soil-pile interaction under the cyclic loadings, and then study the dynamic responses of the jacket support OWTs. Based on the bounding surface elasto-plastic theory, the cyclic t-z curve is proposed, which used to simulate the load-displacement relationships along the pile shaft. Related parameters can be analyzed and calibrated based on the constant normal stiffness cyclic direct shear test of pile-soil interface. The cyclic t-z curves are programmed using the software COMSOL, and used in the FEM model for the dynamic simulation of jacket foundation OWT. Under two-way sinusoidal regular load case, the dynamic responses of jacket foundation OWT are simulated and studied. The results show that the API t-z curve will underestimate natural frequency, which leads to insecure design for jacket foundation OWTs. And the proposed cyclic t-z model can reflect natural frequency degradation under cyclic loading, which can well evaluate the dynamic response than API method.