Free Vibration of Steel Pipe Piles Using the State Space Method

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Abstract

Due to their excellent vertical and horizontal bearing capacity and convenience of construction, steel pipe piles are widely used in the pile foundation engineering of sea-crossing bridges. However, during the construction of steel pipe piles, the structural vibration of the pile generated by the impact of the piling hammer causes the sound wave radiation in the surrounding seawater, which may disturb or even threaten marine fishes. As environmental protection has become a consensus in recent years, it is essential to study the propagation and suppression of pile driving noise of steel pipe piles. In this study, the steel pipe pile is idealized as a cylindrical shell and the state equation with respect to the length direction is derived by introducing the generalized internal force based on the thin shell theory. The governing equation of the steel pipe pile under different boundary conditions is then obtained for the free vibration. Finally, the vibration characteristics of steel pipe piles are analyzed in detail through numerical examples, which provides a theoretical basis for noise propagation and suppression during the construction of steel pipe piles.

Keywords: Steel pipe pile, cylindrical shell, state space method, free vibration