A new analytical-numerical continuous wave-based approach for analyzing dynamic behavior of single and group piles

Abstract:

Foundations are one of the significant elements of structures as they convey the superstructure load to the ground. Deep foundations or piles are specific type of foundations that are commonly used, especially when the loads need to be transferred to the stiffer soil layers. In many situations, piles are subjected to dynamic loads such as earthquake, wind, sea waves, and industrial vibrations, and hence studying their dynamic behavior is of great importance. Therefore, this thesis intends to propose a new wave-based approach for studying the dynamic behavior of single and group piles. In this method, Timoshenko beam theory is used for wave propagation analysis within different elements of a structure and piles. Thereafter, a new assembly technic is utilized to consider the whole structure as a system in which the waves propagate continuously. All of the governing wave propagation equations for the piles and structural elements are solved analytically, and after assembling these equations, the whole system of equations is solved numerically. The soil around the piles are modeled using discrete springs and dampers. After developing the wave-based approach and verifying its performance, it is coupled to genetic algorithm (GA) for finding the optimal geometrical parameters of a structure subjected to a loading with a specific frequency. The objective function of the GA is minimizing the displacement in a specific location and the geometric parameters include length, diameter, angle, and spacing of the piles in addition to the pile cap dimensions. It should be noted that the proposed wave-based approach has very good precision and low computational cost, and it can be effectively coupled with optimization algorithms.