Numerical Study on Influence of Input Wave's Frequency on Dynamic Pre-Hole Isolation Pile-Soil Interaction in IABs

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Abstract

The expansion joints and bearings can be eliminated in integral abutment bridges (IABs) to fundamentally resolve their durability problems. The pile beneath the abutment is considered as the most vulnerable component of IABs under earthquake. The seismic response of the pile in IABs could be reduced by using the pile with pre-hole filled by damping material (called pre-hole isolation pile). In this paper, a finite element model of shaking table tests on the pre-hole isolation pile-soil system under sine wave load was established by using ABAQUS/Explicit. The influence of the input wave's frequency and the dimension of pre-hole on the dynamic pre-hole isolation pile-soil interaction was analyzed. It can be concluded that with an increase in the dimension of pre-hole, the fundamental frequency of pile-soil system decreased. When the input wave's frequency is less than 8 Hz, the pre-hole isolation pile is more flexible than the normal pile. When the input wave's frequency is 4 Hz, the pre-hole isolation pile with larger pre-hole diameter or depth shows the best seismic performance. However, when the input wave's frequency is 8 Hz, the best seismic performance of pre-hole isolation pile with smaller pre-hole diameter or depth is obtained.

Keywords: integral abutment bridge; pre-hole isolation pile; dynamic soil-pile interaction; finite element model; input wave's frequency; dimension of pre-hole; fundamental frequency of the pile-soil system.

1 Introduction

In order to resolve the durability problems of expansion joints and bearings, improve the driving comfort and reduce the maintenance cost, the concept of integral abutment bridges (IABs) can be adopted. The seismic performance of IABs could be excellent because of high redundancy and integrity [1-2]. The bending moment of the superstructure in IABs can be transferred to the substructure because the superstructure is rigidly connected to

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