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Numerical Study on Influence of Mass on Dynamic Performance of Piles with Pre-hole Seismic Isolation System in IABs

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ABSTRACT

Integral abutment bridges (IABs) could fundamentally resolve the durability problems of expansion joints. The concrete piles beneath the abutments are the most vulnerable components in IABs. To improve the seismic performance of IABs, the pile with pre-hole filled by damping materials (called pre-hole seismic isolation system) has been proposed. In this paper, the shaking table test of the pre-hole seismic isolation system under sine wave load is simulated by using the finite element software ABAQUS/Explicit. The influence of the mass on the pile top and the pre-hole dimension on the dynamic performance of the pre-hole seismic isolation system was analysed. It can be concluded that with an increase in the mass or pre-hole dimension, the fundamental frequency of the pile-soil system decreased. With an increase in the input wave's frequency, the pile with a pre-hole seismic isolation system could have a better seismic performance by reducing the mass or pre-hole dimension.

Keywords: integral abutment bridge; pile with pre-hole seismic isolation system; dynamic soil-pile interaction; finite element model; mass on pile top; pre-hole dimension; fundamental frequency.

1 INTRODUCTION

Integral abutment bridges (IABs) can resolve durability problems, improve driving comfortability, and reduce maintenance costs by eliminating expansion joints, deck joints, and bearings. Furthermore, compared with bridges with expansion joints, IABs have higher redundancy and better seismic performance (Briseghella and Zordan 2015; Erhan and Dicleli 2015; Huang et al. 2015; Kozak et al. 2018). However, due to the rigid connections between the superstructure and substructure in IABs, the piles are influenced by the combination of the bending moment, axial force and shear force transferred from the superstructure caused by the thermal variation and seismic action (Huang

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