Urban Maglev Transportation System and Its Dynamic Coupling Behaviours

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Summary

The purpose of present study is to develop a framework for dynamic interaction analysis of actively controlled maglev vehicle and flexible guideway structure, and to investigate the effect of vehicle and guideway characteristics on dynamic responses of low and medium speed maglev system. Dynamic governing equations are derived by combining the five degree of freedom maglev vehicle model, the modal properties of a guideway structures and LQG controller for electromagnetic suspension. And then the effect of vehicle models, vehicle speed, irregularity, guideway deflection ratio, span length, span continuity and damping ratio on dynamic responses of the relatively low speed maglev vehicle and guideway structures are investigated. From the numerical simulation, it is found that the air gap of the vehicle is strongly affected by vehicle speed, tract roughness and guideway deflection ratio. Especially the guideway deflection ratio is the most influential parameter which governs the air gap. Continuous span girders are found to be effective to reduce the air gap because of its smooth curvature and small deflection slope near the support. However the span length and damping ratio of guideway structure do not affect to the air gap. Overall dynamic magnification factor of guideway girder are not severe compared with traditional wheel type vehicle.

Keywords: maglev vehicle; guideway; dynamic interaction; active control; roughness; urban transit maglev

1. Introduction

The advantages of the maglev system compared with the conventional wheel-rail system are known to be its reduced risk of derailment, increased riding comfort, reduced noise, reduced need for maintenance of the guideway, and energy saving [1].

Many researchers have been studied the dynamic interaction between the traditional train and flexible bridges. However, although the maglev is regarded as a future transportation system, very limited research has been performed in the field of the maglev vehicle-guideway structure interaction problem. Hedrick et al. [2] carried out a numerical simulation for a simple maglev vehicle running on a two-span continuous guideway bridge in order to investigate vehicle riding quality. Cai et al. [3] performed a parametric study on short span bridges crossed by a two degrees-of-freedom maglev vehicle with passive spring and dashpot suspension. Recently, Kwon et al. [4] performed a numerical simulation for an eleven-dof maglev vehicle with equivalent passive suspension running on a suspension bridge under gusty winds in order to test the applicability of such a flexible bridge for the guideway structure. In this paper, a theoretical model for active controlled maglev vehicles and guideway structures is presented to investigate the dynamic behaviors of the maglev-guideway coupling system.

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