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Measurement and Reproductive Analysis of Vibration Characteristics of Structures Using Running Train

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Abstract

Using excited vibrations by running trains, the measurements of characteristics of RC rigid-frame structures with spread foundation were carried out. In this measurement, the damping ratios varied from 2.66% to 6.50%, although the measured structure was same. Although the previous studies indicated the interrelation between the height and the frequency of structures, and the interrelation between damping ratio and frequency of structures, these interrelations were not disclosed in this measurement. Moreover, train running FEM analyses with whole model with appropriate constitutive laws were carried out to reproduce the measured vibrations. The parametrical study of structure's damping ratio, whole model's frequency, damping ratio and vibration wave shape were almost same as the measured ones. As a result, by applying proper constitutive law and damping ratio of the structure, vibration characteristics and vibration behaviour of structure could be evaluated.

Keywords: vibration characteristics; damping ratio; frequency; analysis; FEM

1 Introduction

For bridges as rigid-frame structures and girder-pier structures, the vibration characteristics, for example frequency and damping ratio, are dominant parameter to evaluate the behaviour of the structures and derailment of the train during earthquake.

According to the design code for track structures in Japan [1], a risk of derailment is evaluated by a spectrum which uses intensity of relative velocity response spectrum and equivalent peculiar period. We proposed spectrum which evaluates risk of derailment using the above spectrum, seismic acceleration and structural vibration characteristics. At these evaluations, application of appropriate vibration characteristics are important.

Vibrations are generated by some methods such as microtremor, impact of large plumb-bob and shaking machines [2][3]. Then, the Fourier spectrum of the vibration is analysed to estimate the vibration characteristics. However, some methods take cost and date. Some methods need space and time for measurement. Some methods' energy to generate vibration is small to evaluate damping ratio. The value of 5% for damping ratio is usually applied for reaction spectrum for seismic design [4]. However, the damping ratio is different form 5% because of the material nonlinearity. The nonlinearity causes that, the larger the external force of the vibration generating method is, the bigger the damping ratio is. Therefore, it is necessary to evaluate vibration characteristics with large vibration generating energy with small restriction.

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