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DYNAMIC RESPONSE OF LAYERED SATURATED SOIL SUBJECT TO SUBWAY TRAIN LOADS

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ABSTRACT

Environmental vibration induced by subway trains has accepted common concern, more importance is attached to dynamic response of such system. In China, areas nearby Shanghai, such as Hangzhou, are widely covered with soft soil. This work is mainly due to the vibration in such area generated by the new construction subway trains. The model for layered saturated soil subject to subway train loads is presented. Hereby dynamic responses are performed with the transmission and reflection matrices method. The corresponding solutions of displacements and stresses in time domain are derived by performing inverse Fourier transformation. In terms of the solutions, numerical results are accordingly illustrated with compared to those in existing literatures. The solution herein can be a theoretical basis for dynamic response analysis of soil structure interaction due to urban subways.

Keywords: dynamic response, subway train loads, layered saturated soil.

INTRODUCTION

High-speed transportation has reached a fast development stage, due to rapid increase in high-speed railways, urban subways, expressways, and airfields. It is estimated that by 2020, China will build 20,000 kilometers of high-speed rail network, and train speed will reach 500km/h. Vibrations induced by the passage of underground trains are a major environmental concern in urban areas. These vibrations propagate through the tunnel and surrounding soil into nearby buildings causing annoyance to inhabitants and malfunctioning to sensitive equipment. Vibrations may also interfere with sensitive equipment, as used in scientific research laboratories and hightech industries. Therefore, more importance is attached to dynamic response of vibration induced by subway trains.

Researches on vibration from underground railways have received a special interest in the last few decades. Different methods such as analytical, semi-analytical or numerical methods for the analysis of underground train-induced vibrations have been developed in recent years (Gupta, 2010; Kuo, 2011; Forrest, 2006). The general trend towards lighter constructions with longer spans along with the introduction of new underground railway lines in urban areas, have led to more vibration in buildings. This in turn has led to more complaints from occupants of buildings. Modelling of vibration from underground railways has recently gained more importance on account of the need to evaluate accurately the performance of vibration countermeasures before these are implemented.

As is widely known that in the east part area of China, for instance, fields in Shanghai and Hangzhou area are mainly consisted of soft soil. A layered saturated soil model is an

important model in seismology, earthquake engineering and civil engineering. In order to study the dynamic response due to rapid increased urban subways. The paper presents two objects. First, a model for layered saturated soil resting on top of a rigid bedrock subject to underground moving loads which is from subway trains. Moreover, dynamic responses are performed with the transmission and reflection matrices (TRM) method. The corresponding solutions of displacements and stresses in time domain are derived by performing inverse Fourier transformation. The force solution for a single metro wheel in a layered saturated soil can be used to integrate that corresponding to whole moving uniform loads by the subway train.

RESULTS AND CONCLUSIONS

The TRM method is used to solve the problem of vibration generated by underground moving train loads in soft soil areas. Displacements and stresses in time domain are derived subsequently. Numerical results are accordingly illustrated with compared to those in existing literatures. It is proved that the dynamic response of layered saturated soil subject to subway train loads satisfy the expected results. The solution herein can be a theoretical basis for dynamic response analysis of soil structure interaction due to urban subways.

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