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Investigating the Effect of the Shapes of In-filled Concrete Trenches on the Railway Induced Vibrations

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Abstract

Development of rail transportation with rely on increasing speed and axle load in recent years, has been encountered with significant progresses. If the induced noise and vibration due to rail way system wasn't controlled, it would effect significantly on the residential areas and other sensitive places. Although in the technical literature the inserting the in-filled concrete trenches on both sides of the rail lines has introduced as one of the strategies to reduce ground born vibrations, but the avalibale studies shows that the effect of trench shape on the vibration reduction hasn't been investigated. So in the present study, three types of rectangular shape, v-shape and step-shape in-filled concrete trenches have been compared in terms of efficiency with equal areas. For this purpose, a series two-dimensional dynamic analysis were perfomed to model the bahavior of ballasted railway under harmonic load with ABAQUS as finite element based computer code. The numerical results of the investigated analyses indicate that the step shaped trenches have the highest performance for reduction of train-induced vibrations.

Keywords: vibrations reduction, in-filled concrete trenches, harmonic load, finite element method, amplitude reduction ratio.

1. INTRODUCTION

Trains have a major role in the public transportation more than half a century. The various types of railway trains including freight and passenger trains for high-speed railway lines and heavy haul tracks have been manufactured. Most of large cities have been encountered with adjacency of railway lines to the some sensitive residential areas such as laboratories, hospitals, research centers or buildings with high accuracy facilities because of popularity in the high-speed railways in the world. Today, the vibrations due to trains have been more considered by engineers, researchers and urban transportation planners.

Four main steps exist for transferring vibrations due to trains to infrastructures and adjacent structures which include: (A) The vibration of track system(generation) [Zakeri, 2009][27] (B) Transmission of vibrations due to trains on the rails in the surrounding environment, (C) Effect of vibrations on the adjacent buildings(reception). Strategies of reduction of train induced vibration include reduction of vibrations in the ground, sources and reception [Esmaeili, 2008][28]. One of the most effective strategies to reduction of train induced vibrations is making barriers (trenches). Other methods to reduction of train induced vibrations include flat wheels, grinding rails, elastic foundation, rail pads, sleeper pads, ballast mats and etc. [Wilson et al 1983][22]. Trenches including open and in-filled concrete trenches have been used for reduction of vibration due to machines for years. Researchers who investigate in this field follow Segol et al (1978)[19] used finite element along with a special energy absorber for the effect of open and in-filled (betonies – slurry) trenches in the layered soil. In another study, experimental study for the effectiveness of open trenches in the reduction of vibrations has been investigated by woods (1968)[23]. Also, Thau and Pao (1966)[21] used analytical methods for studying the fractured waves around obstacles in the spherical and parabolic forms. Yang and Hung (2008) [25,26] and Hung et al (2004)[10] have used two dimensional finite/infinite and semi three dimensional elements for analysis of the open trenches, in-filled trenches and elastic foundation parametrically. Other studies in this field have been done by Emad and Manolis (1985)[6], Beskos et al (1990)[5], Ahmad and AL-Hussaini (1996)[1,3], Ahmad et al(1996)[1], Ni et al(1994)[17,18], AL-Hussaini and Ahmad (1996)[1,3], Yeh et al(1997)[24], Ni and Hung (1998)[18], Andersen and Nielsen (2005)[2],