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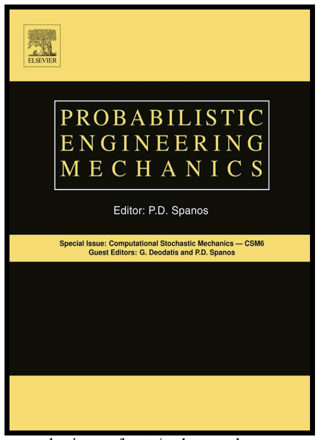

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Random dynamic analysis of a train-bridge coupled system involving random system parameters based on probability density evolution method

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ABSTRACT

The development of high-speed railway has made it important to clarify the influence of random system parameters (i.e. vehicle load, elastic modulus, damping ratio, and mass density of bridge) on train-bridge dynamic interactions. The probability density evolution method (PDEM), a newly developed theory which is applicable to train-bridge systems, can capture instantaneous probability density functions of dynamic responses. In this study, PDEM is employed to implement random dynamic analysis of a 3D train-bridge system subjected to random system parameters. The number theory method (NTM) is employed to choose the representative point sets of random parameters, whose initial probability distribution is divided by *Voronoi cells*. , MATLAB® software is prepared for calculation, the *Newmark-β* integration method and the bilateral difference method of TVD (total variation diminishing) are adopted for solution. A case study is presented in which the train travels on a three-span simply supported high-speed railway bridge. The calculation accuracy and computational efficiency of the PDEM has been verified and some conclusions are provided. Furthermore, the influence of train speed under various combinations of random parameters is beyond discuss.

KEYWORDS: Probability density evolution method; Train-bridge coupled system; Number theory method; Random system parameters

1 Introduction

As bridges occupy a considerable part of the length of the high-speed railway in China, the dynamic problems of train-bridge coupled system have received increasing attention. Generally, track irregularities are considered as main incentive for train-bridge coupled system, they are frequently adopted as excitations in the random dynamic analysis of train-bridge systems. Besides track irregularities, the stochastic dynamic responses of train-bridge systems caused by random system parameters also cannot be ignored, due to the long stretches of simply supported concrete bridge beams which are produced wihin various manufacturing condition. It is worth clarifying the random dynamic characteristic behavior of train-bridge coupled vibration caused by random system parameters. Linear and nonlinear analysis, taking the randomness of system parmameters into account , have been investigated in depth for decades [1-4]. Nevertheless, these theories have not captured engineering applications well. Moreover, no random vibration theory for train-bridge coupled systems has been systematically built [5].

Random dynamic analysis of coupled train-bridge systems has long been studied. In 1976, Fryba first investigated the bridge random vibration caused by moving loads [6]. Then, several scholars worked in this field

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