ESTIMATING MAXIMUM POUNDING FORCE BETWEEN TWO ADJACENT STRUCTURES

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ABSTRACT

Seismic pounding between adjacent buildings with inadequate separation and different dynamic characteristics can cause severe damage to the colliding buildings. Therefore, the earthquake resistant design of structures due to pounding needs the knowledge of maximum pounding force. Efficient estimation of the maximum pounding force is required to control the extent of damage in adjacent structures. In this paper, an analytical approach on the basis of statistical relations is presented for the approximate computation of maximum pounding force between two adjacent single-degree-of-freedom (SDOF) systems subjected to stationary and non-stationary excitations. The pounding effect has been simulated by applying the nonlinear viscoelastic model. The proposed approach can significantly save computational costs by obviating the need for performing dynamic analysis and accurately estimating the maximum of pounding force. Accuracy of the proposed approach in comparison with the exact method is investigated using nonlinear dynamic analysis.

INTRODUCTION

Among different cases of structural damage, seismic pounding of the buildings with inadequate separation distance has been identified as the cause of severe damage in past earthquakes. Such poundings can be expected in major cities which have valuable under-construction lands and contain many buildings with small distances in between. Pounding between adjacent structures can produce large acceleration demands on the floors which are directly involved in collisions (Cole et al., 2010). So, efficient estimation of the maximum pounding force would help engineers in the seismic evaluation processes of closely-spaced structures to control the extent of damage.

Researchers have proposed numerous pounding models in order to model the poundings between buildings, such as linear elastic (Maison and Kasai, 1992), linear viscoelastic (Anagnostopoulos, 1992), nonlinear elastic (Chau and Wei, 2001) and nonlinear viscoelastic model (Jankowski, 2006). The linear elastic model consists of a linear spring that does not take the energy loss during contact. The linear viscoelastic model is a more precise model than the linear elastic model and considers the energy loss during collisions. Anagnostopoulos, (1992) used this model for simulating the pounding between adjacent SDOF systems in series. Maison and Kasai, (1992) simulated pounding between a light high-rise building and a massive low structure. In that study, a single linear spring was placed at the roof level of the lower structure for pounding force modeling procedure. The linear elastic model was also used by Anagnostopoulos and Spiliopoulos, (1992) on adjacent lumped mass models of 5 and 10-storey buildings with bilinear force deformation characteristics. For modeling of the pounding force more realistically, a nonlinear elastic model was employed by a number of researchers. Davis, (1992) used this model to simulate pounding of SDOF