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An approach for generating spectrum and energy-compatible synthetic accelerograms

Jiawei Chen
jchen848-c@my.cityu.edu.hk
City University of Hong Kong
Hong Kong, China

ABSTRACT

For the purpose of seismic performance verification of bridges in the process of seismic design, it is desirable to use spectrum-compatible accelerograms. However, it is well known that the correct evaluation of seismic response of structures depends on the well-suited seismic inputs. The appropriate seismic assessment of structures under earthquake loading is affected by the characteristics of accelerograms. For example, Aria Intensity, that is effective in presenting the damage potential of accelerograms. It is found that the Arias Intensity is capable of predicting the likelihood of damage of structures with short period (e.g., short-span bridges. Thus, in addition to being spectrum-compatible, there is a need to correct Arias Intensity of synthetic accelerograms to be energy-compatible in the time domain. Therefore, a simplified method that can generate synthetic accelerograms that are both spectrum-compatible and energy-compatible is necessary. This study proposed a method that can modify Arias Intensity when generating spectrum-compatible synthetic accelerograms for given seismic records. This method introduces an energy-compatible algorithm to the spectrum-compatible model, which makes the generated synthetic accelerograms match with the target response spectrum in the frequency domain and Arias Intensity in the time domain. The proposed method has been validated using various seismic records, its performance is satisfactory and its application is straightforward and quite useful in any seismic design of building new bridges or retrofitting old bridges.

Keywords: Arias Intensity; synthetic accelerograms; spectrum-compatible; energy-compatible; seismic design

1 INTRODUCTION

Earthquake may cause great damage to bridge structures, and a proper seismic load input of bridges has always been an important research direction in the field of earthquake engineering. Design response spectra are typically used in modern bridge codes or specifications to characterize the seismic load. For this reason, it is frequently important that the spectra of the input accelerograms are comparable to or envelope the specified target design spectra when nonlinear time history dynamic analysis are required. Spectrum-compatible accelerograms are the name given to this class of seismic inputs. For seismic design, spectrum-compatible accelerograms have become quite popular, and several spectrum-compatible models have been presented (e.g., Gasparini and Vanmarcke 1976; Zentner and Poirion 2012.

However, it cannot guarantee an accurate seismic evaluation when the accelerograms are only spectrum-compatible. Recently, the accurately reproduction of the natural characteristics (e.g., Peak Ground Acceleration (PGA, Cumulative Absolute Velocity (CAV, and Arias Intensity (AIof

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