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Assessment of the Effect of Content Frequency of Ground Motions on Input Energy

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Abstract

Input Energy that produced by ground motions in structures, is an important factor in structural analysis. In this study, wavelet transform is used as one of the useful tools in engineering for evaluating input energy and its effect on structure. Ground motion with specified frequency content are decomposed into different signals with the help of wavelet transform that each new signal covers specified frequency content of the main signal. As a result of this transform, input energy as one of the most important factors that effects on structural damage is studying using different signals with different frequency bandwidth. Input energy of 5-story structure under different near to far distance ground motions are studied using this procedure. The results illustrated the relationship of input energy and frequency content of earthquakes.

Keywords: frequency content, input energy, wavelet transform, damage, ground motion.

1. INTRODUCTION

The idea of using energetic concepts in structural design to resist earthquake has been discussed early in the development of earthquake engineering. Hudson and Housner, at the end of the 1950s, demonstrated that structures failed when the energy demand imposed by an earthquake exceeded the energy supply, determined by structural properties [1, 2]. Most energy design methods are based on the premise that the energy demand can be predicted, therefore, suitable member size can be provided to dissipate the input energy within an acceptable limit state. The input energy to a structure during an earthquake is an important measure of both the ground motion characteristics and structural properties. Therefore, in developing an energy-based design approach and assessing the damage potential of ground motions, one must know the earthquake input energy.

Earthquake input energy has usually been computed in the time-domain. The time-domain approach has several advantages, e.g. the availability for non-linear structures, the description of the time-history response of input energy and the possibility of expressing the input energy rate. But, the time-domain approach is not necessarily appropriate for probabilistic analysis. For that purpose, the frequency-domain approach is suitable because it uses the Fourier Amplitude Spectrum (FAS) of input ground accelerations and the time invariant transfer functions of the structure. Prior research demonstrates that the input energy spectrum could be exactly made with the FAS and without information of phases [3, 4].

Wavelet transform is used as one of the new and useful tools in engineering for studying the frequency content of earthquakes. This transform can consider time dimension and cover irregular signals with sudden transformations well with changeable window and different wavelet functions. One of the most interesting properties of wavelet transform is that the signal can be decomposed into different signals that each new signal covers specified frequency content of the main signal. In this way, it is more precisely to study frequency content of earthquake. Iyama and Kuwamura, analyzed earthquake signal using wavelet transform and develop it from input energy point of view that resulting in relationship between wavelet coefficients and input energy [5]. Zhou and Adeli, offered the wavelet energy spectrum for evaluating time-frequency properties of earthquake energy [6]. They illustrated that suggested wavelet energy spectrum can use for evaluating frequency content of earthquake energy. Yazdani and Takada, presented a procedure based on Discrete Wavelet Transform (DWT) for the purpose of modifying the real earthquake ground motion to have the same spectra and the same total input energy [7]. It is shown that several earthquake ground motions having the same response spectra may have different energies and damage potential. Yazdani, studied the effect of ground motion variables on the stochastic input energy of the different frames modeled [8]. The relative contributions of these sources of variability to the overall variability in input