SIMULATION OF NEAR FAULT GROUND MOTIONS USING NEURO-FUZZY NETWORKS AND WAVELET ANALYSIS

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ABSTRACT

The existence of recorded accelerograms to perform dynamic inelastic time history analysis is of the utmost importance especially in near-fault regions where directivity pulses, known as the most important characteristics of these ground motions, impose extreme demands on structures and cause widespread damages. But due to the lack of recorded acceleration time histories, it is common to generate proper artificial ground motions. In this study, in order to generate near-fault pulse-like ground motions, first, it is proposed to extract velocity pulses from an ensemble of near-fault pulse-like ground motions and then simulate nonpulse-type ground motion using Adaptive Neuro-Fuzzy Inference Systems (ANFIS) and wavelet packet transform (WPT). In the next step, the pulse-like ground motion is produced by superimposing directivity pulse on the previously generated nonpulse-type motion in a way that it is compatible with an specified near-field spectrum. Particle swarm optimization (PSO) is employed to optimize both the parameters of pulse model and cluster radius in subtractive clustering and principle component analysis (PCA) is used to reduce the dimension of ANFIS input vectors. Finally, a number of interpretive examples are presented to show how the proposed method works.

INTRODUCTION

Near-fault ground motions have different characteristics from those of far-fault ground motions. Forward-directivity pulse and permanent displacement so-called "fling step", are the most important ones which should be considered during designing and analyzing the response of structures located near the source. The high-amplitude, long-period velocity pulses are produced by the forward-directivity effects resulting from the pattern of fault dislocation. when fault rapture propagates toward the site with a velocity that is almost equal to shear wave velocity and the direction of fault slip is aligned with the site, this shows itself in the form of velocity pulse in the velocity time history (Somerville et al., 1997). Forward-directivity pulses and fling steps occur in fault normal and fault parallel directions, respectively. The forward-directivity pulses are just considered here for the aims of this study. Imposing extreme demands (such as higher base shears, inter-story drifts and roof displacements) on structures by pulse-like ground motions on the one hand and the lack of recorded near-source acceleration time histories plus the importance of existence of such records in order to perform dynamic inelastic time history analysis on the other, provide researchers with an extra incentive to investigate and present methods in order to generate proper near-fault pulse-like ground motions.