Simulation of Near-Field Records using Wavelet Functions

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Received: 6 Jun 2017 Accepted: 22 April 2017

Extended Abstract

(Paper pages 707-726)

Introduction

Study on the main characteristics of strong ground motions, has relatively long history. The observations and investigations on the structural damages after strong earthquakes such as Northridge 1994 in California, Kobe 1995 in Japan, Tabas 1978 and Bam 2003 in Iran, are representatives of the destructive effects of strong near-field records. The most important specification of the near-field records which distinguish them from far-field records, is their ability to generate energized and relatively short-duration acceleration spikes as well as high amplitude and long-domain velocity pulses. Moreover, according to the lack of accurate statistical profiles as well as many deficiencies, processing the spectral existent data is not able enough to fully explain the seismic tremors. Based on the fact that the great earthquakes have long recurrence interval and also many high seismic zones of Iran do not possess strong tremors, hence generating and simulating feasible great events is required by applying closed form models and analysis of available data. In this study, in order to simulate the existent pulses in the time history of near-field records, the developed mathematical configuration is presented by analytical comprehensive attitude on the closed form model by Mavroeidis and Papageorgiou (2003).

Material and methods

Simulation of strong ground shakings, especially in areas where there is limited recorded data, plays a key role in assessing dynamic behavior of

structures. Owing to unique characteristics of strong near-field ground motions, it is not possible to determine exact effects of these strong records on structures using simplified mathematical models. It is feasible to develop more complicated models which represent much more characteristics of near-field ground motions. Mavroeidis and Papageorgiou **(**2003**)** studied the parameters affecting near-fault ground motions. Their studies resulted in introducing a mathematical model capable of interpolating velocity pulses of near-field earthquake records (MP model). This closed-form MP model interpolates long duration pulses using a set of input spectral parameters.

The pulse period, the pulse amplitude, the number and phase of half cycles are the key parameters that define the shape of velocity pulse. Thus, a four-parameter model has been developed to describe velocity pulses which contain forward directivity effects. In this research, it was observed that by using a combination of cubic and exponential terms, an enhanced model for interpolating the pulses presented in near-field earthquake records could be achieved (EMP model). Figure 1 shows the analytical interpolation of acceleration and velocity time histories using MP and EMP models.

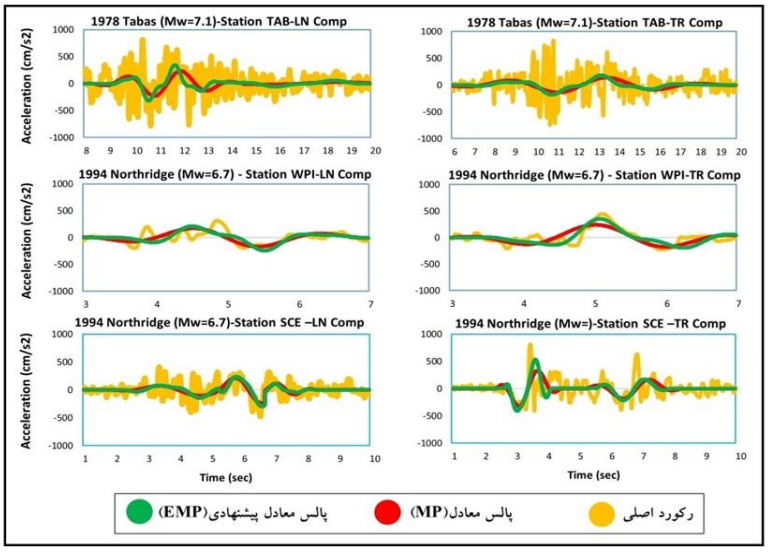

Figure 1. Fitting of acceleration time histories with MP and EMP models

Results and discussion

Based on the obtained results, it is observed that there is a striking similarity between analytical characteristics obtained by actual earthquake records and mathematical pulses. Moreover, using the enhanced closed-form model (EMP model) reduces discrepancy between the results obtained under actual and the synthetic earthquake records.

Conclusion

Findings of this research reveal that equivalent pulses could be a good representative of actual earthquake records analytically, in order to assess the seismological characteristics of these tremors. It is worth mentioning that modelization of forward directivity pulses displayed in time history of strong ground shakings, is an efficient measure in evaluating seismic response of structures. In addition, due to stochastic nature of earthquakes, computational uncertainties and descriptive limitations of analytical parameters, using closed-form models require a high level of accuracy.

Keywords: strong ground motion, energized spikes, high amplitude pulses, closed form model

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