Quantitative classification of near-fault ground motions

Jack W. Baker
Dept. of Civil & Environmental Engineering

Introduction

A quantitative method of identifying near-fault pulse-like ground-motion is described. It relies on wavelet analysis of velocity time histories, to extract and classify pulse-like features. The approach provides reproducible classifications of ground motions that will be helpful for:

- Development of ground-motion prediction models for near-fault motions.
- PSDM in the near-fault environment.
- Selection of appropriate ground motions for engineering calculations.

Wavelet decomposition

The principal translation to near-fault ground motions is to decompose the ground motion into a set of wavelets. A single “mother wavelet” is selected and used to represent the various original components. In cases where a prominent velocity pulse is present in the ground motion, its characteristic frequency is determined, using the period of the original wavelet and the period of the mother wavelet. The period of the mother wavelet is determined, using the characteristic amplitude of the pulse. The period of the original wavelet is determined, using the frequency of the pulse. The resulting classifications agree closely with subjective classifications.

Example decomposition

The figure shows the decomposition of a ground motion, along with that of a “pulse-like” event determined from a continuous wavelet transform.

Identified pulse-like ground motions

The 1980 Imperial Valley and 1994 Northridge earthquakes were identified as pulse-like motions according to the pulse classification procedure. The proposed classification procedure presents an opportunity to compare empirical observations with theoretical predictions. This work is continuing, with a focus on developing a procedure that is suitable for engineering applications.

Classifications versus source-to-site geometry

The wavelet transform has been seen to be a useful tool for characterizing velocity pulses in near-fault ground motions. The results are being utilized for research activities relating to ground motion prediction, probabilistic seismic hazard analysis, and dynamic response of structures.

Analysis software

The algorithm is currently available within the Seismic Analysis Technologies (SAT) software version of deconvolution and digital filtering techniques. It is a full-featured, online utility that can be used by all users with Internet access.

Conclusions

The wavelet transform has been seen to be a useful tool for characterizing velocity pulses in near-fault ground motions. Information regarding the existence of a pulse and its period can be determined using a quantitative and automated procedure. The resulting classifications agree closely with subjective classifications, and the identified pulse-like motions come from sites where near-fault directivity effects are expected.

The results are being utilized for research activities relating to ground motion prediction, probabilistic seismic hazard analysis, and dynamic response of structures.