Automated identification of velocity pulses in near-fault ground motions

by Jack W. Baker

An automated method is described for identifying ground motions containing strong velocity pulses, such as those caused by near fault directivity. The approach uses wavelet analysis to extract the largest velocity pulse from a given ground motion. The size of the extracted pulse relative to the original ground motion is used to develop a quantitative criterion for classifying a ground motion as “pulse-like.” To identify the subset of these pulses potentially caused by directivity effects, two additional criteria are applied: the pulse arrives early in the ground motion and the absolute amplitude of the velocity pulse is large. The period of the velocity pulse, a quantity of interest to earthquake engineers, is easily determined as part of the procedure. Validations of these automated classifications relative to manual classifications are performed, showing the two approaches produce similar results.

This classification approach is useful for a variety of seismology and engineering topics where pulse-like ground motions are of interest, such as probabilistic seismic hazard analysis, ground motion prediction (“attenuation”) models, and nonlinear dynamic analysis of structures. The procedure can be used as a stand-alone classification criterion, or can be used as a filter to identify ground motions with potential directivity effects deserving more careful study. Several new results are shown using this processing procedure, such as the distribution of pulse orientations relative to fault strike, and the probability of observing a pulse as a function of earthquake magnitude and source-to-site geometry.