Abstract

The three parameters that characterize an earthquake ground motion are amplitude, frequency content and duration. Most of the Ground motion models (GMMs) available in the literature are for amplitude and frequency content parameters such as response spectral amplitudes and Fourier spectrum. There are limited GMMs for the duration of ground motion though duration along with amplitude can be a very helpful metric for seismic hazard analysis.

Focus of this dissertation is to characterize the significant duration of ground motion records and to study their scaling with common seismological parameters such as earthquake magnitude and source-to-site distance. Significant duration of an earthquake is described as the time needed to acquire 5 to 75 percent ($D_{5\text{-}75}$), 5 to 95 percent ($D_{5\text{-}95}$) and 20 to 80 percent ($D_{20\text{-}80}$) of normalized arias intensity. The arias intensity is calculated as the sum of the square of the acceleration time history record which is essentially the energy content of the record. Correlation of the geometric means of the horizontal and vertical components of the significant durations ($D_{5\text{-}75}$, $D_{5\text{-}95}$ and $D_{20\text{-}80}$) with source, path and site parameters has been studied for the shallow crustal earthquakes. The magnitude of the earthquakes investigated were in the range of 3.5 to 7, source-to-site distance ranges from 30 to 300 kms and the time averaged shear wave velocity in the upper 30 m of the soil column beneath the station (V_{S30}) varied from 250 to 2100 m/s.

Artificial neural network (ANN) model is developed for significant duration ($D_{5\text{-}75}$, $D_{5\text{-}95}$ and $D_{20\text{-}80}$) and the standard deviation of the model which is decomposed into between-event components and within-event components was determined using mixed effects regression. A feed forward ANN is used with 2 neurons in the input layer, 5 neurons in the hidden layer and 1 neuron in the output layer. The total standard deviation (σ) varied between 0.44-0.56, with within-event variations in the range 0.4-0.52 and between-event variations in the range 0.20- 0.23. Though the model did not assume any prior empirical function, it was able to produce results which are comparable to traditional parametric empirical models for duration. The model was able to produce features that aligned with various seismological parameters such as magnitude scaling and distance scaling. Scaling of ground motion duration from the present study was found comparable with the other regional and global duration models. The between station residuals showed significant trend with V_{S30} and the Z1 parameter (depth to the horizon where V_S is 1km/s). Thus, this study clearly showed that the duration at softer and deeper sediments is longer in comparison to the average modelled duration.