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Observed Site Effects during the 1999 Chi-Chi Earthquake and Its Aftershocks

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The 1999 (Mw 7.6) Chi-Chi, Taiwan earthquake provided the most well recorded strong-motion data set to date and represents a unique opportunity to evaluate site effects during a large earthquake. Additionally, several moderate aftershocks were well recorded and allow for a comparison between the site effects experienced during the mainshock and aftershocks. This paper presents a study of the ground motions from the 1999 (Mw 7.6) Chi-Chi, Taiwan earthquake and its aftershocks considering the effect of soil conditions on ground shaking. Peak ground acceleration and acceleration response spectra were studied for the mainshock and six aftershocks. The aftershocks range from Mw 5.3 to 6.3. Event-specific attenuation relationships for peak ground acceleration and spectral acceleration at various periods and different site conditions were developed for the Chi-Chi mainshock and the six aftershocks. Site amplification factors (S_a , SOIL/ S_a , ROCK) were derived from the regression results. These amplification factors were compared with those from current building codes. Results indicate that the observed amplification at stiffer sites (site classes C and D) during the mainshock was similar to the values used in the International Building Code (IBC 2003). The amplification observed during the aftershocks generally was within +/- 20% of the amplification observed during the mainshock. For softer sites (Site Class E), however, the amplification observed during the mainshock was smaller than currently incorporated in IBC (2003) and the amplification varied significantly among the aftershocks. Additionally, long-period amplification was significant at site class E sites and was potentially caused by surface waves experienced at these soft sites.

[\[Back\]](#)

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