Estimation of Amplification Characteristics in the Damaged Areas of the 2023 Kahramanmaraş Earthquake Using Strong-Motion Records

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Abstract

On February 6, 2023, a Mw 7.8 earthquake occurred on the East Anatolian Fault Zone, followed by a Mw 7.5 earthquake. The heavy damage was widely experienced in the ten provinces in the southeastern Turkey. Understanding the relationship between ground motion and building damage is important for improving future earthquake resilience in the areas. This study focuses on spectral analyzing strong-motion records from AFAD and temporary observations conducted between March 2023 and January 2024.

The strong-motion records of the main shock from AFAD revealed significant differences across various regions, indicating varying site effects. In Antalya, which suffered the heaviest building damage, the waveforms of the main shock were similar, but differences in the PGA and response spectrum highlighted the influence of site amplification.

We conducted temporary strong-motion observations at 22 sites in five affected areas with reference stations installed in surrounding hills or mountainous areas. Site amplifications were evaluated from spectral ratios of ground motion records observed at the temporary and existing stations to those of the reference stations. In Antakya, the site effects are significantly large at frequencies less than 2 Hz.

We also estimated the response spectrum of the main shock using the spectral ratios from aftershock records. It was observed that the amplitudes of the estimated spectra in Antakya was equivalent to the amplitudes of the Japanese design spectra. The station farthest from the plain's center recorded the smallest amplitude, while the stations closer to the city center showed large responses, likely due to differences in soil conditions. Additionally, a highly positive correlation was found between the building damage and the average velocity responses in a period range from 0.7 to 1.5 seconds.

We concluded that the amplification characteristics using strong-motion records from the 2023 southeastern Turkey earthquake contains large effects on the building damage.