A Spatial Correlation Model of Peak Ground Acceleration and Response Spectra Based on Data of the Istanbul Earthquake Rapid Response and Early Warning System

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Ground motion intensity measures such as the peak ground acceleration (PGA) and the pseudo spectral acceleration (PSA) at two sites due to the same seismic event are correlated. The spatial correlation needs to be considered when modelling ground-motion fields for seismic loss assessments, since it can have a significant influence on the statistical moments and probability distribution of aggregated seismic loss of a building portfolio.

Empirical models of spatial correlation of ground motion intensity measures exist only for a few seismic regions in the world such as Japan, Taiwan and California, since for this purpose a dense observation network of earthquake ground motion is required. The Istanbul Earthquake Rapid Response and Early Warning System (IERREWS) provides one such dense array with station spacing of typically 2 km in the urban area of Istanbul. Based on the records of eight small to moderate (Mw3.5 – Mw5.1) events, which occurred since 2003 in the Marmara region, we establish a model of intra-event spatial correlation for PGA and PSA up to the natural period of 1.0 s.

The results indicate that the correlation coefficients of PGA and short-period PSA decay rapidly with increasing interstation distance, resulting in correlation lengths of approximately 2-3 km, while correlation lengths at longer natural periods (above 0.5 s) exceed 5 km. Finally, we implement the correlation model in a Monte Carlo simulation to evaluate economic loss in Istanbul's district Zeytinburnu due to an Mw7.2 scenario earthquake.