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Analysis of the Taipei basin response for earthquakes of various depths and locations based on empirical data and numerical modeling

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The city of Taipei is located on a sedimentary basin in northern Taiwan. Maximum thickness of the sediments in the triangle shaped basin is about 1000 meters in the western part of the basin. The Taipei area was affected by several destructive earthquakes in the past. Recent analysis of observed data revealed significant difference between deep and shallow events. We studied the frequency-dependent site response (spectral amplification SA) of the Taipei basin on earthquake excitation using records of recent earthquakes. We utilize strong-motion records obtained at 32 stations of the Taipei TSMIP (Taiwan Strong Instrumentation Program) network during 83 deep and 142 shallow earthquakes (M > 4.0) between 1992-2004. From analysis of the characteristics of empirical spectral amplification and comparison with a simple 1D model of the soil column and 3D FD modeling we found:

(1) Good agreement of the characteristics of site response across the basin, which were estimated using records of deep earthquakes (depth > 35 km), with the theoretical spectral ratios calculated using the 1D-models of soil column.

(2) In addition to amplification caused by layered deposits, the data for shallow earthquakes show also influence of (a) surface waves generated by distant earthquakes and (b) low-frequency (< 1.0 – 2.0 Hz) waves generated within the basin.

(3) Extremely high amplification for some shallow earthquakes at frequencies 0.3 Hz – 1.0 Hz within the basin that may be dangerous for high-rise buildings and highway bridges.

(4) Earthquake azimuth dependence of parameters of site amplification for particular areas inside the basin for shallow earthquakes.

The obtained results may be used in probabilistic seismic microzonation of the basin when considering many possible earthquakes located at various distances. 2D and 3D numerical modeling of wave propagation may be applied to simulate the seismic influence from large scenario earthquakes. Furthermore, numerical modeling of wave propagation can be used to extend the observed data base for areas where the station network is not dense enough.