Seismic Wave Propagation in a 6-story Building Using Seismic Interferometry of Strong Motion and Broadband Records

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Seismic waves generated by earthquakes propagate from the source in all directions throughout the Earth. At a given site on which a building is situated, incoming seismic waves, which are a convolution of the source, path, and site effects, propagate inside the building causing the structure to vibrate. The response of a building to earthquake ground motions mainly depends on the velocity of shear waves and their attenuation in the building. To investigate the response of a 6-story campus building of the University of Tokyo, we deployed ten 3-component seismometers (5 strong motion and 5 broadband sensors) for 5 months between July and November 2015. The building is 28.8 m high from the basement to the roof top, and has a rectangular shape of 85 m by 16 m, with the long side on the east-west axis. The strong motion and broadband seismometers were placed together at the basement, 2F, 3F, 5F, and roof top, and recorded continuous data with a sampling rate of 100 Hz that was shifted to 200 Hz for the last month of the experiment. We use deconvolution interferometry of ambient vibration and earthquake records to determine the properties of the waves (e.g., wave velocity, frequency content, and attenuation) propagating inside the building. We find that the frequency of the fundamental mode is around 2.7 Hz for the EW component and 3.1 Hz for the NS component, due to the rectangular shape of the building. Moreover, extracted waves propagate faster in the NS direction than in the EW direction. We also find that the deconvolved waves computed from strong motion and broadband records are similar for this building. However, broadband sensors would be more appropriate to investigate the characteristics of high-rise buildings that have long natural periods.

Keywords: Ambient seismic field, Seismic interferometry, Building response

