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Traffic induced seismic noise recorded at vertical and horizontal arrays

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Studies reported in the literature on traffic induced seismic noise, were mostly performed by using the waveforms produced by a single vehicle recorded through horizontal arrays. Traffic flow as a seismic noise source was rarely investigated. Moreover, studies utilizing vertical or horizontal arrays are typical. However, studies combining the vertical and horizontal arrays are seldom. In the present study we present results obtained from the analysis of traffic and railway noise recorded at horizontal and vertical arrays.

Kandilli Observatory and Earthquake Research Institute of Bogazici University (KOERI) operates three seismic downhole arrays in Istanbul, one of which is 300m south of Istanbul's busiest highway. In addition to the highway, there is a subway line running parallel to the south side edge of the highway. The particular downhole array is located at Atakoy, Istanbul. The vertical array has four sensors at depths 25, 50, 70 and 140m. An earlier study made on the recordings of the downhole array have revealed that the highway – subway couple is a strong seismic source. Hence the seismic noise recordings made at the array provided a good opportunity to analyze both the near site attenuation properties and the wave propagation at the site of the array. In this study, also the space between the array and the center of the highway was instrumented to form a horizontal array. Thus in the study, seismic noise recordings were acquired using instruments deployed between the lanes of the highway so as to observe the near-field source characteristics of the excitation by cars and compare them with the far-field traces at the downhole. The observations at the downhole sensors indicate that the predominant frequency of the traffic induced seismic noise is at about 10-15 Hz while the train induced noise is at higher frequencies around 30 Hz.

Near-surface attenuation using seismic noise recordings at the engineering bedrock level exhibits high-frequency decay between 10 and 40Hz that yields a Kappa value of K=14$\pm$3ms and a quality factor Q=45$\pm$10 for the profile between the highway and the sensor. These values are attributed to near-surface attenuation properties retrieved from the down-going traffic-induced seismic waves that traverse the soil profile between the engineering bedrock and the surface. Hence, the near-site geology attenuation properties can be derived using the seismic noise data induced by a known source at a close distance recorded at engineering bedrock level.