ESC2016-180, 2016
35th General Assembly of the European Seismological Commission

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4–10 September 2016 Trieste

Landslide characterization using ambient seismic noise techniques at Dunaszekcső, Hungary

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Loess high banks along the right side of the Danube in Hungary are potential subjects to landslides. In order to study one of the most active high bluffs small scale ambient seismic noise measurements have been carried out at Dunaszekcső. The study area lies at the top of the Castle Hill of Dunaszekcső, where major landslides occur every 10 to 20 years. The bluff consists of Pleistocene sediments, the thickness of the youngest loess series on top is 40 m on average and it is prone to collapse. The present head scarp is at the eastern part of the study area. The hill's highest point is approximately 60 m above the mean water level of the Danube. Castellum Lugio, a fortress of Roman origin once stood at the top of the hill. The eastern part of the fortress's remnants has been already destroyed by previous landslides. The stones of the castle were reused at local constructions, currently no remains of walls can be seen on the surface.

The aim of our research was to map near surface velocity anomalies in order to detect tension cracks, which are assumed to precede landslides. Seismic interferometry and microseismic sounding method was applied to study the area.

Phase cross-correlation and phase weighted stacking were used to calculate cross-correlation functions of ambient noise recordings. Dispersion curves were determined using the multiple filter technique and group velocity tomography was carried out at 0.1 s period. Rayleigh waves at this period sample the uppermost 4 m. The determined average group velocity was 171 ms-1.

Using the microseismic sounding method it is possible to map velocity variations as higher spectral amplitudes represent an inclusion with lower velocity than in the hosting medium and vice versa. Spatial amplitude distribution was determined at several frequencies, then frequency values were converted to depths using the velocity obtained from seismic interferometry.

Based on the ambient noise measurements we have identified a low-velocity region, which represents a highly creviced area, where tension cracks are visible at the surface and slope failure takes place. Another low velocity region was found at the northwestern part of the study area, which might indicate a previously unknown, loosened domain. The highest velocities were observed at the supposed remnants of the historical fort, which might be caused by the buried remnants of the fort's walls or rock debris.