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Shallow geophysical investigation for mapping an active landslide: A case study from NW Turkey

Yunus Levent Ekinci, Alper Demirci, and Tolga Bekler
Çanakkale Onsekiz Mart University, Department of Geophysical Engineering, Çanakkale, Turkey (ylekinci@comu.edu.tr)

Landslides, which develop as downward or lateral relocation of every kind of natural or backfill material by any triggering factor, occur where landslide-prone conditions exist. The occurrence of many landslides was commonly associated with clay-rich and structurally complex areas where precipitation amounts are sufficient for the emergence of slope failures. The Biga Peninsula located in northwestern part of Turkey is an area where landslides are quite common. In the peninsula, slope instabilities are mostly associated with the presence of Early Miocene aged deeply weathered volcanic terrains composed of andesite, tuff and agglomerate and, in particular, marine deposits (Çanakkale Formation) with clay intercalations of Middle-Upper Miocene age. The studied landslide is located in about 13 km east of the Lapseki district of Çanakkale city. The surveyed area lies between the latitudes 40°23´51´´-40°23´54´´ and longitudes 26°48´16´´-26°48´19´´. This study is an example of landslides that threaten highways and presents an assessment of high resolution electrical resistivity tomography (ERT) and seismic refraction tomography (SRT) investigations.

ERT survey was carried out by using Wenner-Schlumberger electrode configuration along a profile of 102 m long. Electrode spacings were set to be 3 m for 32 measuring stations along the survey line. A total of 252 apparent resistivity data were acquired for 12 data levels. Apparent resistivity data acquisition was performed by using the Iris-Syscal R1 Plus resistivity meter. We performed the seismic refraction survey along a 120 meters profile. Recordings were gathered at the same locations as the ERT survey. SRT data (P-wave arrivals) were acquired by the 12-channel seismic recorder Geometrics ES-3000. The sampling interval and record length were selected as 0.125 msec and 256 msec, respectively. The location of each source point occupied to geophone location as keeping running profile to the end of the profile. The profile was shifted as six geophone locations after the source to achieve adequate ray coverage.

Resistivity values are in the range of 2 and 10 ohm.m in the model resistivity section and show the perturbation of clay, silt and sand layers at vertical section of the sequence, which is in good agreement with field outcrops of the Güzelyalı member. Water saturated landslide material composed of silty clay-rich unit marked by low resistivity zone (2-4 ohm.m) are located between the horizontal distances of $\sim$60-80 m and this zone is defined by the velocities in the range of $\sim$1250-1550 m/s in SRT image. The ERT image shows the increasing thickness of this clay-rich bed in depth, which is controlled by the upward protruded sand-rich unit with relatively high resistivity values (>6 ohm.m). This protrusion is likely associated with the existence of the toe of a buried landslide body under the accumulation zone of the recent slide. The slide occurred as a shallow reactivation on the upper part of an old landslide body, which could be a continuation of slide-prone lithology of the old landslide area in the east. Thus, a significant risk may arise for the very active Çanakkale-Bursa highway in case of future failures.

Keywords: Landslide, clay, electrical resistivity, seismic refraction, Çanakkale-Turkey