Dahr El Baidar slope stability - Experimental characterization and analysis

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Abstract. The slope of Dahr El Baidar, located in the Mediterranean country Lebanon, is situated in the inner part of its mountains and has been over the years a connection point linking many Lebanese and Arab regions. Due to its location and moderate altitude compared to surrounding mountains, Dahr El Baidar slope hosts an under construction road, the Pan Arab Highway, that is a vital infrastructure project designed to connect Beirut - the capital and largest city of Lebanon - to neighboring Arab countries.

After the beginning of the road execution, this slope has experienced many failures and landslides in spite of all the geotechnical investigations and studies that were performed in the project's site by esteemed geotechnical companies. These failures had caused delays at several instances in the achievement of the highway works. And yet, after many additional geotechnical investigations, this site remained a challenge for designers as well as contractors due to its intricacy and variability. This matter has induced the launch of a series of studies and researches to indentify the causes that leaded to failure and mass movements at the designated slope, among which the study described in this paper. This study was prepared after conducting geological, geotechnical and geophysical investigations and characterization of the designated site, and then using an integrated geo-assessment technique to find the main triggering factors of Dahr El Baidar slope instability. The geological study shows that the area of Dahr El Baidar slope is characterized by a significant tectonic activity due to the presence of several faults in its vicinity. Furthermore, the geological maps indicate that the site and its surrounding are composed mainly from the Cretaceous formations which are intercalations of clay, marl, sand and sandstone. Regarding the hydrogeological study, the site is situated in a zone of water infiltration mostly during the warm seasons when the snowmelt runoff from the surrounding mountains causes the water level to arise to the surface of the natural site ground. The geotechnical investigation included drilling several boreholes that were assigned to cover the entire studied area and especially in the region of the surface failure line. This investigation was followed by an interpretation of the in-situ and laboratory tests along with a quality assessment from the in-situ sampling, from which the soil profile of the studied slope was determined. The investigation pursued with three types of geophysical tests; the Multichannel Analysis of Surface Waves tests (MASW) to evaluate the ground stiffness by measuring the shear wave velocity Vs of the subsurface; the ambient noise vibration tech-

nique with the Horizontal to Vertical Spectrum Ratio HVSR method in order to estimate the fundamental site resonant frequency and the thickness of the subgrade material; and the Electrical Resistivity Tomography (ERT) to reveal the soil resistivity. The compatibility between the results of the geotechnical and geophysical investigations were then checked using well-known correlations between geotechnical and geophysical parameters, in order to select suitable soil properties to be used in the subsequent studies. After all the data acquisition, static and dynamic modeling and stability studies of the slope were performed. These studies were completed using two different softwares for a better stability analysis. The stability study results were afterward interpreted and analyzed to reach, with all of the above, a better understanding of the cause of slope failure.

As a preliminary conclusion, it is suspected that the main triggering factor of Dahr El Baidar slope instability is the presence of water affecting the mechanical properties of the soil layers existing in the site.

This work is a part of the assessment and prediction of the behavior of various critical slopes in Lebanon carried by RUMMARE, a Research Unit on Mass Movement hazard Assessment and Risk Evaluation assembling researchers from major research centers and universities in Lebanon.

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