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Geophysical investigations to characterize slope stability at planned viaduct site in Constantine, Algeria.

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A new viaduct is planned across the Rhummel valley in Constantine, Algeria. The site has a complex geological setting with local occurrences of seismic activity and slope instability. There is evidence of slope instability on the hillslope at an older existing bridge located nearby the planned viaduct. A main cause of slope instabilities in Constantine are a result of urbanisation, where the surface conditions are significantly altered, without appropriate reinforcement measures applied. This work presents results from geoelectrical and seismic refractions surveys carried out along the planned bridge alignment carried out, in part, to determine if unstable slopes are present in areas where viaduct pylons and abutments are planned.

The site geology is characterised by Mio-Pliocene Conglomerates-Sands-Red Clays on the southern section and Tellian Marls-Marlstones in the valley centre and Tellian Marls overlying limestone in the northern section. On the northern slope lithological logs indicate localised zones of weathered marl. This geological setting combined with the steep slopes (more than 25%) found in the site has increased the risk for landslides in this area.

The aim of the surveys was to map the strata and localize the faulting systems and their extension along the planned bridge alignment as well as evaluate the landslide hazard through a geophysical and geological interpretation. Three seismic surveys and ten geoelectrical surveys were located at the planned viaduct site. A reference line survey for comparison was carried out along a nearby hillslope where slope instability is known to occur.

Electrical resistivity tomography surveys were carried out using a multi-electrode system with a minimum electrode separation of 5 m covering profiles that were between 350 and 400 m long. The data was interpreted using a Laterally Constained Inversion where the resistivity data is stacked as a succession of soundings constrained according to expected geological conditions.

Seismic surveys comprised of three parallel lines along the viaduct (each 700 m long) and one along the hillslope with known slope instability (350 m long). The seismic data was acquired using a 8 Kg hammer and at locations separated 15 m and combined with a heavy weight drops spaced at 50 m. The latter source included both inline and offset shots. The interpretation of the seismic traveltime data was performed using a wavepath Eikonal traveltime inversion.

The results from the hillslope with known instabilities indicate coincident occurrence of localised low velocities (750 m/s) and very low resistivities (< 5 Ohm-m) in the unstable zone. Along the viaduct an area on the northern slope shows the same characteristics in several seismic and resistivity profiles. The very low resistivity zone is localised to maximum 3-5 m depth which correlates with movement noted inclinometer readings.

The slope instability affecting the site was determined to be surficial (3-5 m depth) and possibly attributed to disruption of natural water drainage by urbanisation, thereby resulting in increasing water saturation of marls that form the foundation of the east section of the planned viaduct. An area affecting two planned pylons was identified for increased risk for surficial slope instability.