Field characterization and numerical modeling of an unstable soil.

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Modern infrastructure has to be developed under complex geological conditions such that the stability of the foundations should be safe to the environment and the population. One of these complex sites has been identified in the Trans-Mexican Volcanic Belt. The geological materials are made up of tuffs and volcano-sedimentary deposits where a subway tunnel has been built. Water supply for the town comes from a deep regional aquifer; however, a local shallow aquifer was detected during the construction of the tunnel. Few years after the operation of the subway, some infiltration of water and fine sediments were detected inside the construction.

In this paper, we present a methodology to characterize the subsurface to prevent possible liquefactions events that endanger the safe operation of the subway and buildings. Geophysical electrical tomography was carried out along parallel lines of the tunnel to identify the possible variation of layers lithology, mainly the presence of clay that could be washed out of the soils. Fifteen shallow piezometers (20 m deep) were drilled in the area to determine the groundwater flow and the geological column. In addition, 5 geotechnical holes were developed to determine the soil stability in the tunnel and surroundings. Soil samples were analyzed in the lab for determination of geotechnical properties. A groundwater flow model was developed to simulate the fluxes and pressure around the tunnel at present and for possible remediation scenarios.

The groundwater gradient of 0.025, an average hydraulic conductivity of 0.00014 m/sec and a total flux of 217 liters/sec were determined. A critical phreatic level of 3.5 m was established to maintain the stability of the tunnel. Some very unstable zones were detected at shallow levels (mixture of sand and water). Remedial actions include the application of a technique that increases the density of the subsurface, groundwater flow and sediment control.