SITE CHARACTERIZATION OF SOME TROPICAL COLLAPSING SOILS FROM SAO PAULO STATE, BRAZIL

by
Heraldo L. Giacheti
Assistant Professor, UNESP - Bauru/SP/Brazil
Visiting Assistant Professor, UBC In-Situ Testing

ABSTRACT

The tropical region covers a large portion of the world. Deep soil layers in the region are formed by weathering of the rocks, with laterization occurring in the upper portions of the layer. Quite often the soils are unsaturated.

Tradition soil mechanics methods are generally not applicable to tropical soils because of their unique genesis and typically unsaturated condition. A good example is the inability of the Unified Classification System to differentiate between saprolitic and lateritic soils, which exhibit significantly different engineering behaviour. It is also a problem to obtain strength parameters for tropical soils because they are usually neither fully undrained or fully drained. Furthermore, the resistance of the soils is increased by suction and cementation developed during laterization process. Both factors can be lost when the soils become wet.

Two major practical geotechnical problems related to tropical soils are erosion and collapsibility. The Tropical Soil Research Group from Unesp and Unicamp, two Universities in Sao Paulo State, Brazil, has been studying collapsing soil and how it affects different types of foundations.

The research group has been carrying out laboratory tests on samples from three experimental sites in Sao Paulo State. The intent is to identify collapsing soils and assess the magnitude of collapse. Confined compression tests in a consolidometer have been used to carried out tests on undisturbed soil samples at natural water content and after flooding the sample to achieve zero suction. This procedure allows the assessment of the magnitude of collapse. Measurement and control of suction is required for better assessment and modelling of the collapsing behaviour.

The group has also been carrying out standard penetration tests (SPT), standard penetration tests with torque measurement (SPT-T), mechanical cone penetration tests (CPT), flat dilatometer tests (DMT) and cross-hole tests (CHT) to identify the soil profile and to obtain soil parameters from each layer. Plate load tests at several depths and load tests on different types of instrumented piles have been carried out with the soils in the natural water condition and after flooding to assess the collapsibility of the soil layers in situ and the behaviour of different types of foundation. Based on test results on real scale foundations and in situ testing the current approach is to develop correlations for use in foundation design.

The empirical approach used has some limitations and at the moment efforts are being made to gain a better understanding of the mechanical behaviour of tropical soils. Seismic electronic cone penetration tests (SCPT) and pressuremeter tests will be carried out on the experimental sites. Measurements of suction in the field are also required to develop a model to predict soil behaviour.

IMPROVING THE QUANTITATIVE INTERPRETATION OF RCPTU DATA

by

Chris R. Daniel,[1] Heraldo L. Giacheti,[1,2] Richard G. (Dick) Campanella[1] and John A. Howie[1]

[1]In-Situ Testing Group, Department of Civil Engineering, University of British Columbia, Vancouver, BC, Canada. http://www.civil.ubc.ca/home/in-situ
[2]Tropical Soil Research Group, UNESP, Bauru, Sao Paulo State, Brazil.

ABSTRACT

The UBC *In-Situ* Testing Group (ISTG) began performing piezocone tests with electrical resistivity measurements (RCPTU) in 1989. Resistivity modules developed at UBC and in industry have proven to be simple, useful screening tools for geo-environmental applications. They have been used to accurately locate groundwater tables and to delineate plumes of contaminated groundwater. Resistivity modules have also been moderately successful when used to estimate *in-situ* soil density.

The potential exists to characterize pore fluid resistivity beyond the screening level and to accurately measure *in-situ* porosity, degree of saturation and related soil parameters using RCPTU data. Field work performed in the past by the ISTG and other researchers has indicated that accurate, quantitative measurements are possible. A procedure using laboratory compaction equipment to relate the fluid resistivity, porosity and degree of saturation to the measured bulk resistivity, in the simple empirical framework proposed by G.E. Archie, has been developed at UBC. Whether or not the potential of the resistivity module can be practically realized depends upon the cost of the tools, the ease of testing and the accuracy of the measurements, all relative to other available tools.

The ISTG has dedicated considerable effort since the first UBC RCPTU sounding to improve the quantitative interpretation of RCPTU data. Recent work with the resistivity module at UBC has focused on improving the reliability and accuracy of measurements. To improve the calibration procedure used for the modules and to estimate the volume of soil from which in-situ bulk resistivity measurements are derived a study of the penetration depth of electric fields into surrounding strata was recently completed. Results from the study provide insight into edge effects during module calibration (typically carried out in water-filled tubs) and highlight the importance of the electrical design of modules on electric field penetration depth.

MECHANISMS AND SPATIAL VARIABILITY OF RAINFALL INFILTRATION ON THE CLAUDE WASTE ROCK PILE

by

Tracy Bellehumeur and Leslie Smith, University of British Columbia

ABSTRACT

Predictions of the generation of acidic water in waste rock piles and the time scale of metal release to the environment are related to an understanding of rainfall recharge and fluid flow within a waste rock pile. A series of infiltration experiments and visual dye tracer tests were performed on a coarse waste rock pile at Cogema Resources' Cluff Lake Mine. The purpose of this study is to provide a quantitative evaluation of spatial variability in rainfall infiltration and to identify relations between hydrologic pathways, contact areas, material properties and structural features in a waste rock pile.

Field observations on the surface of the Claude waste rock pile revealed a number of infiltration mechanisms: uniform flow into the fine matrix soils, macropore flow, rainfall ponding and overland flow to catchment drains, rapid and gravity driven flow in catchment drains. Field methods to understand the spatial distribution of rainfall infiltration were performed through a number of falling head tests in fixed ring infiltrometers. The release of a dye staining tracer in the infiltrometers and drains, followed by excavation and mapping, provided a visual record of the hydrologic pathways for rainfall infiltration.

Measurements were made of the permeability structure at the pile surface using 13 fixed ring infiltrometer experiments. The west side of the Claude waste rock pile is characterized by a coarse, 'untrafficked' surface, in which infiltration was immediate with a mean rate of 18mm/min. Recharge on the east side of the Claude rock pile is controlled by a finer compacted traffic surface and the topography of the pile surface. Intense rainstorms cause ponding and overland flow to concentrate in coarse drains at the bottom of small catchment areas, which vary in length from 5m to 35m. The rate of infiltration within the runoff area of a typical catchment. was determined to be 0.22mm/min with a standard deviation of 0.13mm/min. The recharge rate at the drain was in excess of 2.35mm/min. Less than 2% of Claude east remained in a ponded condition long after a rainfall, in which evaporation rates were similar to infiltration rates.

Following the infiltrometer experiments, the water was chased by a 20L volume of rhodamine WT visual dye tracer. Excavation in 1mm to 5mm lifts allowed for mapping of dye distribution patterns. Dye distribution was found to decrease with depth. Dye coverage decreased from 100% at the pile surface to a mean dye coverage of 18% at 3cm below the surface crust.

Two large-scale dye tracer releases of volumes 800L and 2400L were applied at the catchment drains on Claude east. A 1200L volume of dye in a 2 m x 2 m area was applied on Claude west. The mechanism for flow was a non-capillary or gravity driven flow, in which rivulet and film flow was evident in the large voids of these coarse drains. Dye tracer was observed to migrate vertically downward to an old traffic surface and spread laterally to an area of approximately 100m^2. In two of the releases, the dye tracer encountered another coarse drain through the old pavement surface. Tracer penetration depths varied from 0.5m to 4m below the surface. The low bulk density and strongly disordered waste rock pile engenders preferential flow on a scale of centimeters in the surface crust and on a scale of tens of meters between catchments.