ABSTRACT

The Physical, Chemical and Mechanical Properties of Trinidadian Soils Related to Mass-Movement

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In Trinidad and Tobago, information on soil index properties have been centred mainly on agricultural data, with physical and engineering parameters restricted to textural distribution. Land use changes, extensive building construction and urbanization has highlighted the need for extensive soil data applicable to soil strength properties.

This study investigated the relationships between soil agricultural properties and soil engineering properties towards increasing the applicability of existing soil information as it pertains to soil strength and stability. The relationship between external factors such as climate and vegetation to soil strength parameters were also investigated at laboratory and field scale, the later using a case study approach.

Thirty soils were selected covering all taxonomical classes within Trinidad. Soil strength parameters (shear strength and friction angle), and soil index properties (particle size distribution, pH, ECEC, capillary and non-capillary void space, Atterberg limits and bulk density) were measured for all soils. Regression analysis produced significant regression equations for peak and residual friction angle based on % sand and % clay, with R^2 adjusted values of 0.821 and 0.701, respectively.

Predictive equations were used to generate friction angles (peak and residual) for all local soils utilizing the existing data on particle size distribution. The resultant data was introduced as an instability factor in landslide susceptibility modelling in the form of PFAS (Peak Friction angle minus slope) and RFAS (Residual Friction angle minus slope). These parameters proved to increase the predictive capability of the landslide susceptibility model when compared to conventional instability factors alone.

Further analysis was conducted to determine the influence of soil moisture content on soil suction and their relationship to strength according to the Mohr-Coulomb failure criterion. Twenty six soils were selected covering a range of

textural classes. Soil suction was measured for all soils for a range of moisture contents (0-100%). Adsorption curves were developed for groups of soils based on clay content. Results indicated that R^2 values increased with clay content. Interpolated suction values were used to calculate the minimum strength of chosen soil series by combining with the friction angle data derived previously.

Moisture content variability associated with, vegetation, soil depth (0.05m, 1m and 1-2m) and climatic parameters (rainfall quantity, evapotranspiration and temperature) was then explored as a proxy to understanding variations in soil strength in the field. Aforementioned parameters were measured for a period of seven months at a field site in Southeastern Trinidad (10.2667°N, 61.3833°W). Results indicated soil moisture was significantly affected by both depth and vegetation when considered at a daily, weekly and monthly time period. At D3 (1-2m, depth at which FA and Suction was measured) however variability was much less pronounced with the grass plot having lower moisture content for the duration of the study. Mean strength ranged from a low of 3.42kPa in the no-grass plot to a high of 3.86kPa in the grass plot.

Climatic parameter showed non-significant correlations and non-distinct trends with soil moisture content indicating the need for an amplified monitoring period, as wells as consideration of additional parameters, which would have eliminated the anomaly of the atypical dry season encountered and improve characterization of the water balance relationship. Lengthened monitoring periods may allow for average moisture regimes to be established facilitating the estimation of soil suction/cohesion and consequently soil strength /stability.

Integration of the information gathered can significantly enhance civil and geotechnical engineering testing regimes, policy development and land resource management, reducing cost and increasing efficiency and applicability.

Keywords: Trinidad and Tobago; Soils, Friction Angle; Soil Suction; Soil Water Characteristic Curves; Slope Stability; Shear Strength; Soil Water; Climatic Models.