Evaluation of unsaturated soil behavior based on consolidated-drained and constant water content tests results

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Abstract

The surficial soils in the majority of Iran"s region are in unsaturated state, having negative pore-water pressure, which contribute to their strength. The main aim of this study is to investigate the effect of matric suction, net confining pressure and drained condition on the shear strength and volume change characteristics of silty sand. The shear strength and volume change behavior of soil, were studied in this work using triaxial compression tests including; consolidated-drained (CD) and constant water content (CW). The test results indicate that the matric suction has an important role in the mechanical behavior of soil. Also the shear strength of the compacted specimens obtained from the CW tests are completely different from the shear strength obtained from the CD tests for same initial matric suctions and confining pressures.
Keywords: Unsaturated soil, Silty sand, Shear resistance, Matric suction, Volume change

1. INTRODUCTION

Civil engineers build on or in the earth's surface. Most of the earth's land surface comprises notoriously hazardous geomaterials called "unsaturated soils". These soils are a hazard to earth structures and earth-supported structures because on wetting, by rain or other means, they can expand or collapse with serious consequences for cost and safety. Unsaturated soils, which are the majority of surface or near-surface soils on the earth's land surface, are introduced together with their characteristic of partial saturation giving rise to pore air as well as pore water and hence an air–water interface forming a contractile skin. The importance of stress state variables in defining the engineering behaviour of strength, deformability and transient flow is discussed and the selection of the two independent stress state variables (net normal stress and matric suction) is explained. The associated physics of surface tension and cavitation (and how to avoid it) are described. The case is made that saturated soil is a simplified special case of unsaturated soil and so there are fundamental differences between the two in terms of classification and analysis methods. This important distinction has major implications for practicing civil engineers. Also geotechnical engineers have been increasingly challenged by problematic soils around the word. Some soils which have been identified as problematic are expansive soils, collapsible soils and residual soils. These soils are generally unsaturated with three phase materials, containing soil particles, water and air that pore-water pressures of these soils are negative relative to atmospheric conditions. In unsaturated soils the negative pore-water pressure contributes to the shear strength of the soils, as the surface tension or soil suction pulls the soil particles together. During rainfall, rainwater that infiltrates into the soil causes reduction in suction, which in turn reduces the shear strength of the soil and eventually leads to slope failures.

It is incumbent upon the geotechnical engineer to know and understand the loading conditions for which the stability analysis is being performed to evaluate. All of these loading conditions apply to both natural and man-made fill and cut slopes, but each condition does not have to be analyzed in every case. In the other word, each of these loading conditions requires the selection of the appropriate soil strength parameters. Once the rate of loading (i.e. loading condition) is determined, the soil response should be determined (i.e. drained or undrained). The drained response of soil is determined by loading the soil slowly enough to allow for the dissipation of pore pressures. Conversely, the undrained response of a soil is determined by loading the soil faster than the pore pressures can dissipate.