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Freezing-Thawing Effects on the Physico-mechanical Properties of Ankara Grey Clay

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Abstract

The amount of snow that falls all through winter months and the number of days per annum with freezing temperatures, below zero in the eastern provinces of Turkey have increased in recent years. The Capital city of Ankara settled on a sequence of lacustrine sediments. The name of a part of sediments is Ankara Clay. Soil samples 1, 3, 7, 14 and 21 days were subjected to freeze-thaw cycles (FT). After tests, changes in the properties of the samples were examined. The liquid limit values of 14 FT cycles decrease about 31% and after that increase about 9%. A decrease about 12% for first seven cycles and continue increase about 11% in plastic index values were determined. The cohesion and internal friction angle increase about 37% and 10.5% in value after FT tests.

Keywords: Frozen Soil, Freezing and Thawing Test, Atterberg Limits, Shear Strength, Ankara Clay.

1. INTRODUCTION

The design and construction of earth structures influenced seasonally by subzero temperatures requires the determination of mechanical properties of the construction materials under appropriate thermal conditions. Water saturated materials exhibit a zone of partially frozen soil at the frozen-unfrozen soil interface. To define the critical failure surface and governing shear strength in this zone, the effects of partial freezing on the mechanical behavior as a freezing front advances, must be well understood (Hohmann and Czurda, 1997). The researches which were conducted in the countries with cold climate have indicated that the increase in the number of freezing and thawing cycles weakens soil strength while creating high porosity in the soil (Huang, 1983; Chen, et al., 1994; Thevanayagam et al. 2002; Coop, 1991; Allman and Atkinson, 1992; Georgiannou et al., 1990; Jafari and Shafiee, 2004). Temperature is an important factor influencing the value of strength of frozen soils (Wu and Ma, 1993, Wang et al., 2006). This is because the unfrozen water content of frozen soil became smaller and smaller with the freezing temperature descending gradually and the simultaneous increase of close-contact ice, intensified ice cemented cohesion and strengthening of the ice itself. Wang, et al., 2007 in their work on Qinghai-Tibet clays exposed samples to a maximum of 21 closed-system freezing-thawing in the temperature range of -7 ^{0}C to +14 ^{0}C. After 7 cycles of freeze-thawing, increase of volume, decreases of water content and cohesion and don't change of angle of internal friction were determined. In the other way by increasing of the cycle's number of stress-strain curve, units are deformed from hardening-strain to softening-strain. In parallel with the weakening of soil strength, some problems are faced in shallow foundations such as distortions and holes occurred in road structures.

The aim of this work was to determine the effects of freezing and thawing (FT) on Atterberg limits and shear strength of Ankara Clay as a function of FT cycles.

2. MATERIAL

Ankara Clay consists of a sequence of lacustrine sediments that comprises the surface of the Ankara Valley and extends in places down to 100 m. These expansive soils are found in central, western, and southern parts of Ankara, the capital of Turkey. During the past decades, rapid expansion of the city and its population because of internal migration from different regions of Turkey have led to intensive construction of various kinds of structures, especially low-cost and one-story buildings in suburbs, and have resulted in expanded networks of streets and buried utilities. Because of the expansive nature of this clay, damage to the roads and low-rise buildings caused by differential volume change of the clay occurs, particularly in the southern part of city. This