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EXTENDED ABSTRACT

Experimental Study on Effect of Freeze and Thaw Cycles (FTC) on Creep Settlement of Silty Soil

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1. Introduction

Soil properties are affected by environmental conditions. Exposing of soil under multiple freeze thaw cycles may damage soil structure due to generated forces by water freezing and changes in mechanical and deformation features. Silty soils are highly susceptible for frost damage under the F-T cycles so, it is important to investigate their thermal and mechanical behavior. Thermal changes in susceptible soil often lead to irreversible creep deformation. The freeze and thaw cycles change soil engineering properties and mechanical behaviors by varying soil structure (Othman., 1992). A lot of research has devoted to study the effect of freeze-thaw cycles on the geotechnical properties of various soils (Wang et al., 2007). But, less laboratory works have studied the effect of freeze-thaw cycles on long term deformation and consolidation parameter of silty soil. Therefore, the aim of this paper is to determine the magnitude and rate of volume changes of soil specimen under 10 repeated cycles freeze and thaw which subjected to different vertical stresses.

2. Methodology

2.1. Experimental study

For freezing and thawing phases, specimens are placed in a refrigerator according to ASTM (D-560) test method. Deformation mechanisms are explained based on contacts of particle and relationship between coefficient of secondary compression and changes in void ratio. Also, microstructure changes of the soil samples are analyzed using scanning electron microscope (SEM).

To determine the effects of freeze and thaw cycles on the creep parameter of soil, consolidation tests are performed accordance to ASTM (D11-2435) on the samples before and after the freeze and thaw cycles. In all tests, the sample with a specified mass are poured into the confining ring. In water-saturated sample, the loadings increase from 0 to 50 kPa for a duration of 60 minutes between two consecutive loads to complete the dissipation of excess pore water pressure that was performed by Negahdar et al (2015). For freezing and thawing phases, specimens are placed in a refrigerator at −18 °C for 24 h and then at +23 °C for thawing phase for 24 h. Single stage tests at the stresses of 300, 600 and 1200 kPa are carried out on water-saturated samples.

3. Results and discussion

The relationship between coefficient of secondary compression (C_α) and stress level (σ_{creep}) of samples in single stage tests during freezing and thawing cycles are shown in Figure 1.

Test results indicate that the freeze-thaw action has significant effect on the deformation properties of soil. There is an approximately nonlinear relationship between C_α and σ_{creep}. The values of C_α in saturated samples

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increase with stress level. In saturated samples due to the higher sliding ability and lower frictional, particles slide very easily, thus more creep deformations occur in higher stress levels (Varatharajan, 2011).

The rate creep of deformations of silty samples depends on stress levels and the number of cycles of freezing and thawing. In general, the repeated cycle of freeze and thaw lead to orientation of particles and the disintegration of particles and soil structure. So that, 20 percent increase in average consolidation settlement occurs during 10 cycles of freeze and thaw. Also, the increase in stress level causes to increase in the coefficient of secondary compression during cycles of freeze and thaw.

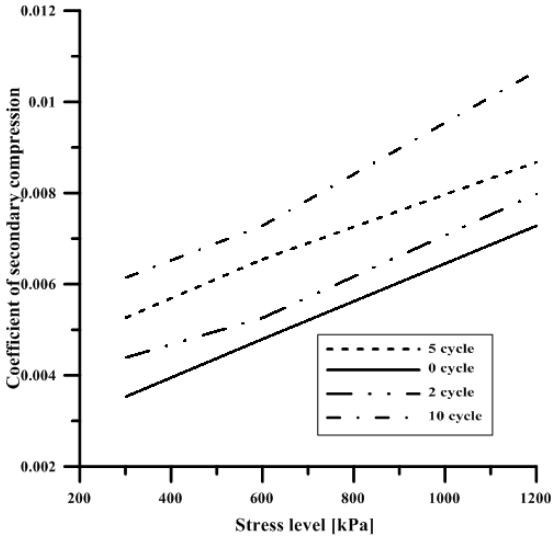

Fig. 1. Relationship between coefficient of secondary compression (C_α) and stress level (σ_{creep}) of samples in single stage tests during freezing and thawing cycles

4. Conclusions

In this study, consolidation tests are carried out on silty samples which subjected to freezing and thawing cycles. The effect of the number cycles of freezing and thawing and stress level on the consolidation and creep parameters are studied.also structure of soil using electron microscopy (SEM)are studied and the mechanism of creep by the slip, and deformation of particle is described. The results showed that:

With increasing stress level, deformation of the sample increases and after reaching to certain level of stress, increase rate of deformation decreases. However, during the cycle of freezing and thawing, by increasing the porosity samples, the value of consolidation and creep deformation increase.

The repeated cycle of freeze and thaw lead to orientation of particles and the disintegration of particles and soil structure. So that, 20 percent increase in average consolidation settlement occurs during 10 cycles of freeze and thaw. Also, the increase in stress level causes to increase in the coefficient of secondary compression during cycles of freeze and thaw.

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